INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN
MTC FORT PICKETT, BLACKSTONE, VA
2022-2026

ARMY NATIONAL GUARD - MANEUVER TRAINING CENTER FORT PICKETT
INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN
FY 2022-2026

I agree with and support the implementation of this Integrated Natural Resource Management Plan. This plan meets the requirements of the Sikes Act and its implementation will support both conservation of natural resources and military training at Army National Guard - Maneuver Training Center Fort Pickett.

Date: 29 JUN 22

Timothy P. Williams; The Adjutant General of Virginia, NGVA-ZA

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ARMY NATIONAL GUARD - MANEUVER TRAINING CENTER FORT PICKETT
INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN and
ENVIRONMENTAL ASSESSMENT

FY 2022-2026

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_______________________________________ Date: 3/30/21

Ryan Brown, Executive Director, Virginia Department of Wildlife Resources

INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN
MTC FORT PICKETT, BLACKSTONE, VA
2022-2026

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Cynthia A Schulz Date: 2022.04.01 07:27:17 -04'00' Date: 4/1/2022

Cindy Schulz; Field Supervisor, Virginia Ecological Services,
U.S. Fish and Wildlife Service

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Executive Summary

The Army National Guard - Maneuver Training Center Fort Pickett (Fort Pickett) Integrated Natural Resources Management Plan (INRMP) covers fiscal years 2022 through 2026. Various federal laws, Department of Defense (DoD) directives, and Army regulations require the preparation of an INRMP for Fort Pickett. The Code of Federal Regulations (CFR) Chapter 9 and the Sikes Act Implementation Act (SAIA) (16 United States Code [U.S.C.] 670 *et seq.*) require the preparation of an INRMP for all military installations with significant natural resources. Section 101(b)(2) of the SAIA [16 U.S.C. 670a(b)(2)] states that each INRMP "must be reviewed as to operation and effect by the parties thereto on a regular basis, but not less often than every 5 years." The National Environmental Policy Act (NEPA) of 1969 dictates that planners of public actions using federal monies, such as those on military installations, shall consider the environmental impacts and effects of "major federal actions." Section 1508.18 in the Council for Environmental Quality (CEQ) regulations lists the adoption of a formal INRMP as a major federal action. The INRMP is to be prepared in cooperation with the U.S. Fish and Wildlife Service (USFWS) and the Virginia Department of Wildlife Resources (DWR).

The mission of Fort Pickett is to provide a Maneuver Training Center capable of handling up to brigade size elements for live-fire and maneuver training for Army Reserve Components, Active Components of all services and other DoD-affiliated groups. The primary uses of Fort Pickett by the Reserve Components is live-fire and maneuver training of combat, combat support and combat service support units. Most units combine live-fire exercises with maneuver training.

INRMPs are planning documents that allow DoD installations to implement integrated landscape management of their natural resources, while coordinating with various stakeholders. They help ensure military operations and natural resources conservation are integrated and consistent with stewardship and legal requirements. The objective of the INRMP is the planned, deliberate management of natural resources to support the installation and operational mission objectives in order to meet Army stewardship objectives and enhance the quality of life for DoD personnel. The Fort Pickett INRMP will serve as the principal management plan governing all natural resource activities on the installation and is based upon ecosystem management principles. In accordance with Army policy, the Fort Pickett INRMP will ensure that no net loss in the capability of the installation lands to support the military mission of will occur as a result of natural resource management practices.

In addition, the Fort Pickett INRMP describes how the ecosystem will be managed to enhance military training and preserve ecosystem function and integrity. Implementation of this INRMP is the responsibility of three main organizations including: Virginia Army National Guard-Facilities Management Office-Environmental (NGVA-FMO-ENV); Division of Plans, Operations, Training, and Security (NGVA-MTC-OP); and Department of Public Works (NGVA-MTC-PW). Communication and cooperation amongst these organizations provides the framework for integrating natural resource management actions and the installation's military mission. For successful integration and implementation, the effectiveness of the INRMP management actions must be assessed.

The potential environmental impacts of proposed management actions were examined prior to their inclusion within the Fort Pickett INRMP. Thus, all management actions were designed to not only mitigate potential negative environmental effects, but in fact improve the overall Fort Pickett environment.

The purpose of the proposed action is to ensure that all natural resources activities are integrated to prevent redundancy of effort and manage Fort Pickett on an ecosystem basis. In addition, natural resource activities will be integrated with military training requirements. The integration of natural resources and training requirements will allow the Virginia Army National Guard (VAARNG) and Fort Pickett to fulfill the military mission while conserving and protecting valuable natural resources.

Implementation of the Fort Pickett INRMP will successfully meet ecosystem management objectives. The rejection of the current INRMP would necessitate a costly re-assessment of current goals and objectives of natural resource management. Because the current INRMP meets the criteria and goals set forth in Army regulations and memoranda and sets the criteria for environmental and safety best management practices, implementing the Fort Pickett INRMP will help the installation commander to manage natural resources more effectively. This will ensure that installation lands remain available and in good condition to support the installation military mission. Implementation of this INRMP is subject to availability of funds. Projects necessary to support mission sustainability and ensure compliance with applicable laws and regulations are given highest priority.

Acronyms

ALU	Aquatic Life Use
ARNG	Army National Guard
ATTACC	Army Training and Testing Area Carrying Capacity
BMP	Best Management Practices
BRAC	Base Realignment and Closure
CAA	Controlled Access Area
CDS	Container Delivery System
CEMML	Center for Environmental Management of Military Lands
CFR	Code of Federal Regulations
CMI	Conservation Management Institute
CRM	Cultural Resource Manager
CWA	Clean Water Act
DCR	Virginia Department of Conservation and Recreation
DEQ	Virginia Department of Environmental Quality
DGIF	Virginia Department of Game and Inland Fisheries (now DWR)
DHHIA	Dedicated High-Hazard Impact Area
DoD	Department of Defense
DoDI	Department of Defense Instructions
DoDM	Department of Defense Manual
DOF	Virginia Department of Forestry
DWR	Virginia Department of Wildlife Resources (formerly DGIF)
ESA	Endangered Species Act
ESMP	Endangered Species Management Plan
FASTC	Foreign Affairs Security Training Center
FOB	Forward Operating Base
GIS	Geographic Information System
GPS	Global Positioning System
ICRMP	Integrated Cultural Resources Management Plan
INRMP	Integrated Natural Resource Management Plan
IPBC	Infantry Platoon Battle Course
ITAM	Integrated Training Area Management
LCTA	Land Condition Trend Analysis
LRAM	Land Rehabilitation and Maintenance
MACOM	Major Army Commands
MPRC	Multi-Purpose Range Complex
MTC	Maneuver Training Center
NGVA-FMO-ENV	Virginia Army National Guard-Facilities Management Office-Environmental
NGVA-MTC-OP	Departments of Training and Security
NGVA-MTC-PW	Department of Public Works

NEPA	National Environmental Policy Act (1969)
NHPA	National Historic Preservation Act (1966)
NLEB	Northern long-eared bat
NRHP	National Register of Historic Places
NRPZ	Nottoway River Protection Zone
OIC	Officer in Charge
PM	Project Manager
POC	Point of Contact
POL	Petroleum Open Learning
RBP	Rapid Bioassessment Protocol
RFMSS	Range Facility Management Support System
RTLA	Range and Training Land Assessment
SAIA	Sikes Act Implementation Act
SHPO	State Historic Preservation Office
SGCN	Species of Greatest Conservation Need
SMZ	Streamside Management Zone
SOP	Standard Operating Procedures
SRA	Sustainable Range Awareness
SRP	Sustainable Range Program
WAP	State Wildlife Action Plan
WPZ	Watershed Protection Zone
TMDL	Total Maximum Daily Load
TRI	Training Requirements Integration
USFWS	United States Fish and Wildlife Service
USACE	U.S. Army Corps of Engineers
U.S.C.	U.S. Code
VAARNG	Virginia Army National Guard
VSCI	Virginia Stream Condition Index
WAM	Workplan Analysis Module

1.0 FORT PICKETT INRMP VISION AND GOALS

The Army National Guard-Maneuver Training Center Fort Pickett (Fort Pickett) Integrated Natural Resources Management Plan (INRMP) covers management actions from FY 2022 through FY 2026. The Sikes Act Improvement Act of 1997 (SAIA) requires INRMPs for all Department of Defense (DoD) lands and waters that have suitable habitat to support natural ecosystems. The INRMP is designed to organize and consolidate data and technical information required to manage natural resources into a single document and serve as the basis for ecosystem management at Fort Pickett in support of the training mission (Department of Defense Manual [DoDM] 4715.03, November 25, 2013). DoDM 4715.03 states that each INRMP shall:

1. Ensure no net loss to the training and testing capability and capacity of the installation and range and enhance those capabilities to the maximum extent practicable.
2. Contain information needed to make appropriate decisions about natural resources management.
3. Maintain a relevant and updated baseline list of flora and fauna located at each installation for all pertinent taxonomic and regionally important groups.
4. Ensure that biologically or geographically significant or sensitive natural resources, such as ecosystems or species, are monitored and managed for their protection and long-term sustainability. Incorporate the principles of ecosystem-based management.

1.1 PURPOSE AND NEED

The Fort Pickett INRMP will serve as the principal management plan governing all activities on the installation with impacts to natural resources. The Fort Pickett INRMP will ensure that no net loss in the capability of military installation lands to support the military mission of Fort Pickett will occur because of natural resources management practices. In addition, the INRMP describes how the Fort Pickett ecosystem will be managed to enhance military training and preserve ecosystem function and integrity.

Fort Pickett is federally owned land managed by the Virginia Army National Guard, a federally funded agency, and therefore is subject to all federal laws and regulations. The National Environmental Policy Act (NEPA) requires that prior to any major action occurring on Fort Pickett, the installation must:

1. Consider the potential environmental effects of the action,
2. Determine whether these effects adversely impact the environment, and
3. Examine alternatives to the proposed action.

Military training activities and natural resource management activities in support of military training are considered major federal actions subject to NEPA. A NEPA analysis must completely disclose any potential environmental effects and fully demonstrate that the proponent has examined the environmental consequences of the proposed action in detail.

NEPA dictates that planners of public actions using federal monies, such as those on military installations, shall consider the environmental impacts and effects on the natural system (air, water, soil, flora, and fauna) and human health. Section 1508.18 in the Council for Environmental Quality (CEQ) Regulations lists the adoption of a formal INRMP as a major federal action.

The environmental impacts of potential management actions have been assessed prior to the implementation of the Fort Pickett INRMP. Thus, all management actions were designed not only to mitigate potential negative environmental effects, but to improve the Fort Pickett environment.

The SAIA recognizes the importance and value of military lands to natural resources. It seeks to ensure that these ecosystems are protected and enhanced while allowing the military lands to continue to meet the needs of military operations. Accordingly, the SAIA requires the DoD to develop and implement INRMPs for military installations with significant natural resources across the United States. INRMPs are prepared in cooperation with the U.S. Fish and Wildlife Service (USFWS) and state fish and wildlife agencies to ensure proper consideration of fish, wildlife, and habitat needs.

These plans are reviewed every year by military installations and reviewed for operation and effect at least every five years, with major revisions as required.

In general, natural resource constraints to land use at Fort Pickett are related to activities regulated by federal and state agencies pursuant to environmental legislation. As such, compliance with these mandates is an important part of the natural resources planning process for Fort Pickett. Furthermore, a thorough understanding of environmental regulations and how they are implemented is necessary to ensure that mission land use requirements are met on a sustainable basis. Both federal and state laws and regulations require the assessment of potential environmental impacts associated with implementing major programs or activities at Fort Pickett. On the federal level these include:

- Executive Order 11988
- Executive Order 11990
- Endangered Species Act (16 U.S.C. 15542, 1982-1987)
- Clean Water Act (33 U.S.C. 1251 *et. seq.*; Section 404)
- Clean Air Act (40 CFR part 50)
- Army Regulation 200-1 (27 August 2008)
- Army Regulation 350-19 (August 2005)
- Environmental Analysis of Army Actions (32 CFR 651; Army Regulation 200-2)
- SAIA (16 U.S.C. §670a-670o, 1960 & 1989), as amended
- National Environmental Policy Act (NEPA Pub. L. 91-190, 42 U.S.C. 4321-4347)
- Migratory Bird Treaty Act (16 U.S.C. 703-712, 1918-1998)
- Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d)

- Aquatic Nuisance Prevention and Control Act of 1990

Fort Pickett aims to sustain training lands' natural resource base in quantity, quality, and configuration to meet current and future requirements following Fort Pickett's 2004 Master Plan and the Army's Sustainability Drivers & Regulations:

- Executive Order 13693
- Army Regulation 200-1
- Army Sustainability Campaign Plan (ASCP) (2010)
- ARNG Sustainability Policy (2014)
- Energy Policy Act of 2005
- Energy Independence & Security Act of 2007
- DoD Strategic Sustainability Performance Plan
- Army Strategy for the Environment
- DoDM 4715.03 (November 2013)
- Department of Defense Instructions (DoDI) 4715.03 (March 2011)

Fort Pickett's primary goal is to support the training of active, reserve, and National Guard combat, combat support and combat services support units in successful techniques of organization, deployment, and combat operations under as wide a variety of conditions as possible. In order to further this mission, the training areas must have a wide range of terrain features in order to more fully duplicate possible combat and support environments. These requirements make the proactive management of natural resources necessary in order to fulfill the military mission of Fort Pickett.

In addition to the DoD and Department of the Army objectives, the Virginia Facilities Management-Environmental (NGVA-FMO-ENV) staff, in concert with the Division of Plans Training and Security (NGVA-MTC-OP), and the Department of Public Works (NGVA-MTC-PW) have developed specific goals and objectives for natural resources management at Fort Pickett. These objectives aim to improve coordination among departments at Fort Pickett while maintaining and enhancing military training lands.

1.2 MILITARY MISSION

GOAL: Provide quality natural resources necessary in order to fulfill the military mission of Fort Pickett.

1.3 OBJECTIVES

1. Assure there is no net loss of training land due to environmental and/or natural resources management issues, unmanaged impacts of military training, and forest succession.
2. Maintain the open areas suitable for tracked and wheeled maneuvers in a cost effective and environmentally sensitive manner.

3. Maintain Forward Operating Base (FOB) training sites.
4. Establish a comprehensive, environmentally sound program for supporting an increase in combat support and combat service support training.

1.4 NATURAL RESOURCE OVERALL GOALS AND OBJECTIVES

The overall goal of the INRMP is to ensure sound environmental stewardship of the public lands managed at Fort Pickett. Table 1 includes the goals and objectives for each management program along with the corresponding INRMP section which describes the programs. The specific projects proposed for the implementation of the listed objectives are included in Appendix A: Natural Resources Tasks.

Table 1. Overall Goals and Objectives

	GOALS	OBJECTIVES	
1.	**FOREST MANAGEMENT**		**Section 5.1**
	Support and enhance the military training mission and meet military natural resource stewardship requirements.	Practice responsible timber harvesting that integrates and supports training land while maintaining a healthy and natural forest ecosystem.	
		Develop, maintain, and utilize current forest inventory data to effectively manage the forest.	
		Incorporate mission-critical issues with forest management.	
1.A	**PRESCRIBED FIRE MANAGEMENT**		**Appendices L & M**
	Maintain and improve training suitability and sustainability.	Implement prescribed fire on a minimum of 2,000 acres/year.	
	Increase and improve rare and endangered species habitat.	Ensure that all Michaux's sumac colonies are subjected to fire (prescribed or training caused) at least once every three years.	
	Increase overall installation biodiversity.	Ensure that all open grasslands and shrublands are subjected to fire (prescribed or training caused) at least once every three years.	
	Reduction in natural fuel accumulation.	Use existing vegetation/land-use maps to develop a Geographic Information System (GIS) map of wildland fire-carrying fuel types for Fort Pickett for use in standard fire spread geospatial models.	
	Improve productivity of forests.	Identify and map critical areas of Fort Pickett where fuel reduction burns are required to maintain safe training conditions and ensure training caused wildfires do not jump to adjacent private property.	

	GOALS	OBJECTIVES	
		Revise, update, and identify manageable burn units in a geodatabase. Each burn unit will have at least one long- term goal identified.	
		Identify Fort Pickett prescribed fire working group.	
2.	**NONGAME SPECIES MANAGEMENT**		**Section 5.2**
	To comply with federal environmental law and Army regulations	Incorporate recommendations of the Virginia Wildlife Action Plan into natural resources management on the installation.	
	To identify trends and biologically significant changes in species diversity and abundance.	Perform monitoring on a regular basis to create a baseline and detect negative trends in a timely manner.	
		Focus on endangered species and indicator species.	
3.	**RARE, THREATENED AND ENDANGERED SPECIES HABITAT MANAGEMENT**		**Section 5.3**
3.A	**Michaux's Sumac (*Rhus michauxii*) Management**		**Section 5.3.1**
	Proactively preserve and enhance the Fort Pickett Michaux's sumac population.	Implement active habitat management and utilize applied research.	
	Develop management guidelines that are compatible with both mission critical military training and habitat management practices for Michaux's sumac.	Quantitatively and qualitatively monitor the Michaux's sumac population at Fort Pickett on a yearly basis.	
	Cooperate with state and federal conservation agencies to enhance and establish viable populations outside Fort Pickett to further the recovery efforts for Michaux's sumac.	Appropriately Identify and sign Michaux's sumac colonies.	
	Maintain and conserve suitable habitat for Michaux's sumac via military training weapons fire and prescribed burning.	Delineate and map Michaux's sumac colonies.	
		Transplant Michaux's sumac colonies.	
		Off-site colony protection.	
3.B	**Roanoke Logperch (*Percina rex*) Management**		**Section 5.3.2**
		Prevention of degradation of Roanoke logperch habitat.	

	GOALS	OBJECTIVES	
	Proactively preserve the Roanoke Logperch population through active habitat management and applied research.	Quantitatively and qualitatively monitor the Roanoke logperch population. Abundance, distribution, and habitat condition should be monitored at least every three to five years.	
3.C	**Bald Eagle (*Haliaeetus leucocephalus*) Management**		**Section 5.3.3**
	To maintain current habitat for bald eagles, including nest and perch trees.	Yearly monitoring.	
		Ensure that the USFWS *National Bald Eagle Management Guidelines* are followed.	
3.D	**Bat Management**		**Section 5.3.4**
	To maintain habitat for bats, specifically for the Federally listed northern long-eared bat (*Myotis septentrionalis*) and Indiana bat (*Myotis sodalis*) as well as the State listed tri-colored bat (*Perimyotis subflavus*) and Little Brown Bat (*Myotis lucifugus*).	Conduct surveys to monitor the populations of bat species.	
		Maintain compliance with Section 7 of the Endangered Species Act for federally listed bat species.	
		Ensure that all requirements in the *Programmatic Biological Opinion on Final 4(d) Rule for the Northern Long-eared Bat and Activities Excepted from Take Prohibitions* are met.	
3.E	**Mussel Management**		**Section 5.3.5**
	To maintain and improve existing habitat and preserve and enhance existing populations.	Monitor the populations of mussels within the Nottoway River.	
		Improve water quality.	
4.	**FISH AND GAME MANAGEMENT**		**Section 5.4**
	To provide a framework for professional fish and game management which does not interfere with the Fort Pickett military mission.	Provide support for the military mission through adherence to the ecosystem management concepts upon which the Fort Pickett INRMP is based.	
	To integrate management with other natural and environmental resources.	Provide practical applications of scientific and technical principles to the management of fish and game populations and habitats to maintain such populations for recreational, ecological, and/or scientific purposes.	
		Conduct analysis and provide reports/findings of fish and game populations and harvests in order to develop regulations that are consistent with population goals necessary for quality hunting and fishing experiences for Fort Pickett personnel and the general public.	

	GOALS	OBJECTIVES	
		Develop a fish and game management program, which will result in good public relations with the community.	
		Cooperate with state and federal natural resources agencies to maintain legal compliance with environmental and natural resources laws.	
		Develop yearly written fish and game management goals based upon the concepts within the INRMP and findings from fish and game management personnel, specifically analysis and reports on game populations and harvest.	
5.	**WATER QUALITY MANAGEMENT AND WETLAND CONSERVATION**		**Section 5.5**
	Protection of surface waters, wetlands, and floodplains from sediment.	Minimize the impact of land uses on soil erosion and sedimentation.	
	Meet all Federal and State permitting requirements for any impacts.	Keep soil sediment, as a pollutant, in wetlands and waterways within compliance limits.	
	Maintain information on the locations of all surface waters, wetlands, and floodplains on Fort Pickett.	Identification and rehabilitation land disturbed by operations and real property management activities.	
	Ensure that the water quality in surface waters is maintained.	Streams and wetlands protection zones will be enforced to reduce impacts from military land use and improve water quality.	
		Perform benthic macroinvertebrate surveys to assess water quality.	
6.	**INTEGRATED PEST MANAGEMENT**		**Section 5.6**
	Reduction of pest populations through use of integrated combination of techniques.	Identify, prioritize, monitor, and control invasive and noxious species and feral animals on its installations whenever feasible.	
7.	**SUSTAINABLE RANGE PROGRAM**		**Section 5.7**
	To improve the way the Army designs, manages and uses ranges to ensure that current and future doctrinal requirements are met.	The integration of facilities management, environmental management, munitions management, and safety management to efficiently manage and maximize the capability, availability, and accessibility of ranges and training land to support doctrinal requirements, mobilization, and deployments under normal and surge conditions.	

	GOALS	OBJECTIVES	
7.A	**Range and Training Lands Program (RTLP)**		**Section 5.7.3**
	Provide centralized management and prioritization for planning, programming, design and construction activities for live-fire training ranges and maneuver training lands.	Identify the needs for range projects and training land requirements for live-fire ranges and maneuver areas.	
	To assist the installation in the integration of mission support and environmental stewardship.	Establish how Fort Pickett's ranges are managed and maintained to support the mission requirements of installation.	
7.B	**Integrated Training Area Management (ITAM)**		**Section 5.7.4**
	Integrate environmental planning procedures into all operations.	The goals of the ITAM program are met through the four different components included below that make up a management and decision-making process that integrates Army training and other mission requirements for land use with sound natural resources management practices.	
	Protect natural and cultural resources.		
	Ensure that operations comply with environmental standards. Receive no notices of violations or fines for non-compliance.		
	Prevent future pollution and reduce hazardous waste and toxic releases.		
7.B1	*Range and Training Land Assessment (RTLA; formerly LCTA)*		*Section 5.7.4.3*
	Provide centralized management and prioritization for planning, programming, design, and construction activities for live-fire training ranges and maneuver training lands.	Identify LRAM projects.	
		Ensure that biological considerations are part of the LRAM project prioritization process.	
		Determine the effectiveness of LRAM projects.	
		Calculate the land condition curves that support the Army Training and Testing Area Carrying Capacity (ATTACC) methodology.	
		Create maps that depict the availability, suitability, accessibility, and capacity of training lands.	

	GOALS	OBJECTIVES	
		Recommend boundaries and training load distribution for newly acquired and existing training land, so that the capacity of the training land can best support a new or changing training mission and a new intensity load.	
		Conduct internal encroachment assessments by routinely reviewing plans, such as the INRMP, Integrated Cultural Resources Management Plan (ICRMP), agricultural leases, annual burn plan, and timber harvest plan.	
7.B2	*Training Requirements Integration (TRI)*		*Section 5.7.4.4*
	Ensure accessibility to adequate training lands under natural conditions.	Provide a decision support procedure that integrates training requirements with land management, training management, natural and cultural resources management and data derived from RTLA and Army Conservation Program components.	
		Provide military trainers and land managers with the necessary information they need to integrate training with land constraints and carrying capacity.	
7.B3	*Land Rehabilitation and Maintenance (LRAM)*		*Section 5.7.4.5*
	Provide quality lands for military training, while reducing long-term, negative impacts on the environment using best land management practices.	Identify land maintenance requirements.	
		Identify project sites that require restoration, rehabilitation, or reconfiguration to improve access to training areas and increase duration of use.	
		Develop a scope of work for the projects that includes a site description, design, resources required, and expected outcome.	
		Develop project prioritization lists based on RTLA data, GIS data, input from TRI and other available information.	
		Execute projects as resources are made available.	
		Evaluate the effectiveness of the completed projects.	
		Ensure that completed projects receive adequate preventative maintenance.	
		Coordinate long-term land maintenance plans with other real property management programs on an installation.	

	GOALS	OBJECTIVES	
7.B4	*Sustainable Range Awareness (SRA)*		*Section 5.7.4.6*
	Provide a means to prevent damage to natural and cultural resources through educating military land users.	Minimize resources damage by educating land users of how their activities impact the environment.	
		Instill a sense of pride and stewardship responsibility in land users.	
8.	**RECREATION MANAGEMENT**		**Section 5.8**
	Provide natural recreational opportunities for military members and other federal and civilian staff.	Ensure that all natural recreational areas are managed with a focus on sustainability of the resources.	
9.	**PUBLIC OUTREACH**		**Section 5.9**
	Increase the public's awareness of environmental programs on Fort Pickett.	Education of the public through informational publications, presentations and encouraging public participation in special events.	
10.	**CANTONMENT AREA MANAGEMENT**		**Section 5.10**
	Control and treat stormwater to reduce the pollutants discharged into aquatic systems.	Improve water quality in aquatic ecosystems and wetlands.	
11.	**CLIMATE CHANGE**		**Section 5.11**
	Maintain Fort Pickett's ability to sustain the training of soldiers.	Identify and implement sound natural resources strategies that provide benefits to the ecosystem.	

1.5 RESPONSIBILITIES

Fort Pickett will strengthen and build community partnerships to achieve sustained and sound environmental stewardship and a ready military force through communication, coordination, consultation, and collaboration. The installation will foster open relationships to increase understanding by all. Fort Pickett will communicate the readiness requirements and environmental initiatives, while at the same time, listening to its neighbors' needs and concerns to build win-win situations together.

<u>Responsible and Interested Parties</u>

Full implementation of this INRMP requires collaboration and coordination with many internal and external parties. The list of stakeholders is below.

Internal Stakeholders

- Commander, Fort Pickett
- Army National Guard (ARNG) Installations and Environment Directorate (ARNG I&E), VA
- Department of Military Affairs - Maneuver Training Center (MTC) Fort Pickett
- Natural Resources Program Manager, VA Department of Military Affairs - MTC Fort Pickett
- Cultural Resources Program Manager, VA Department of Military Affairs - VA Army National Guard
- NGVA-MTC-PW, VA Department of Military Affairs - MTC Fort Pickett
- ITAM, VA Department of Military Affairs - MTC Fort Pickett
- Range Operations, VA Department of Military Affairs - MTC Fort Pickett

Cooperative Stakeholders

- U.S. Fish and Wildlife Service
- Virginia Department of Wildlife Resources

External Stakeholders

- U.S. Department of State
- Virginia Department of Environmental Quality
- Virginia Department of Conservation and Recreation
- Virginia Department of Forestry
- Virginia Marine Resources Commission

Federally Recognized Tribes in Virginia

- Pamunkey Indian Tribe
- Chickahominy Tribe – Eastern Division
- Monacan Indian Nation
- Upper Mattaponi Indian Tribe
- Chickahominy Indian Tribe
- Nansemond Indian Tribe
- Rappahannock Tribe

Federally Recognized Tribes Outside of Virginia

- Catawba Indian Nation
- Cherokee Nation of Oklahoma

- Cayuga Nation of Indians
- Eastern Band of Cherokee Indians
- United Keetoowah Band of Cherokee Indians
- Tuscarora Nation of New York

2.0 INSTALLATION OVERVIEW

2.1 LOCATION

Fort Pickett is located in the Piedmont physiographic province of southeastern Virginia, approximately 100 kilometers (kilometers) southwest of Richmond and 5 kilometers east of the town of Blackstone (Figure 1). Virginia is divided into five major physiographic provinces. From west to east, these are the Cumberland Plateau; the Valley Ridge; the Blue Ridge; the Piedmont; and the Coastal Plain. Fort Pickett is approximately 25 kilometers west of the fall line demarcating the Coastal Plain and encompasses approximately 41,000 acres of land in three counties: Nottoway, Brunswick, and Dinwiddie. There is approximately 24,996 acres of training land available for combat, combat support, and combat service support (CSS) training. In addition, a 10,499-acre Controlled Access Area (CAA) serves as a buffer zone for the Dedicated High Hazard Impact Area (DHHIA) and various live-fire exercises.

Access to Fort Pickett is gained through several highways; Route 460 on the northern border; State Road 40, which runs through the upper portion of the installation; and Route 46, along the western border of the installation. Fort Pickett is located approximately 24 kilometers from Interstate 85 and 56.5 km from Interstate 95. Three entrances, all within 6.5 kilometers of U.S. Route 460, allow access to the cantonment area, while Route 40 provides access to the airport.

An extension of the Norfolk Southern Railroad provides service to Fort Pickett and runs along the northern boundary of the base. The rail line is used to transport heavy tactical equipment (e.g., Abrams M1A1 main battle tanks, Bradley Fighting Vehicles, STRYKERs, mobile artillery, etc.) to and from Fort Pickett. The Blackstone Army Airfield is a joint use facility used by both the Town of Blackstone and Fort Pickett. The airfield is open year-round and is regularly used for military aircraft transport training (e.g., C-17, C-130 etc.), military airborne operations, and by civilian aircraft.

2.2 FORT PICKETT HISTORY

The U.S. Government purchased land totaling approximately 46,018 acre of Southside Virginia land in 1941 from nearly 500 private landowners, corporations, and churches to create what was then known as Camp Pickett (Installation Design Guide 1992). Unfortunately, it was necessary to condemn the land of 26 families to clear land for Camp Pickett. These families were paid between $10 and $12 per acre for their land (Coleburn 1998). A majority of the structures associated with these farmsteads were demolished. However, a few structures do remain such as the Wells house. At the time of the initial acquisition of lands, the area was composed of farms with small fields scattered in a matrix of mixed pine and hardwood forests.

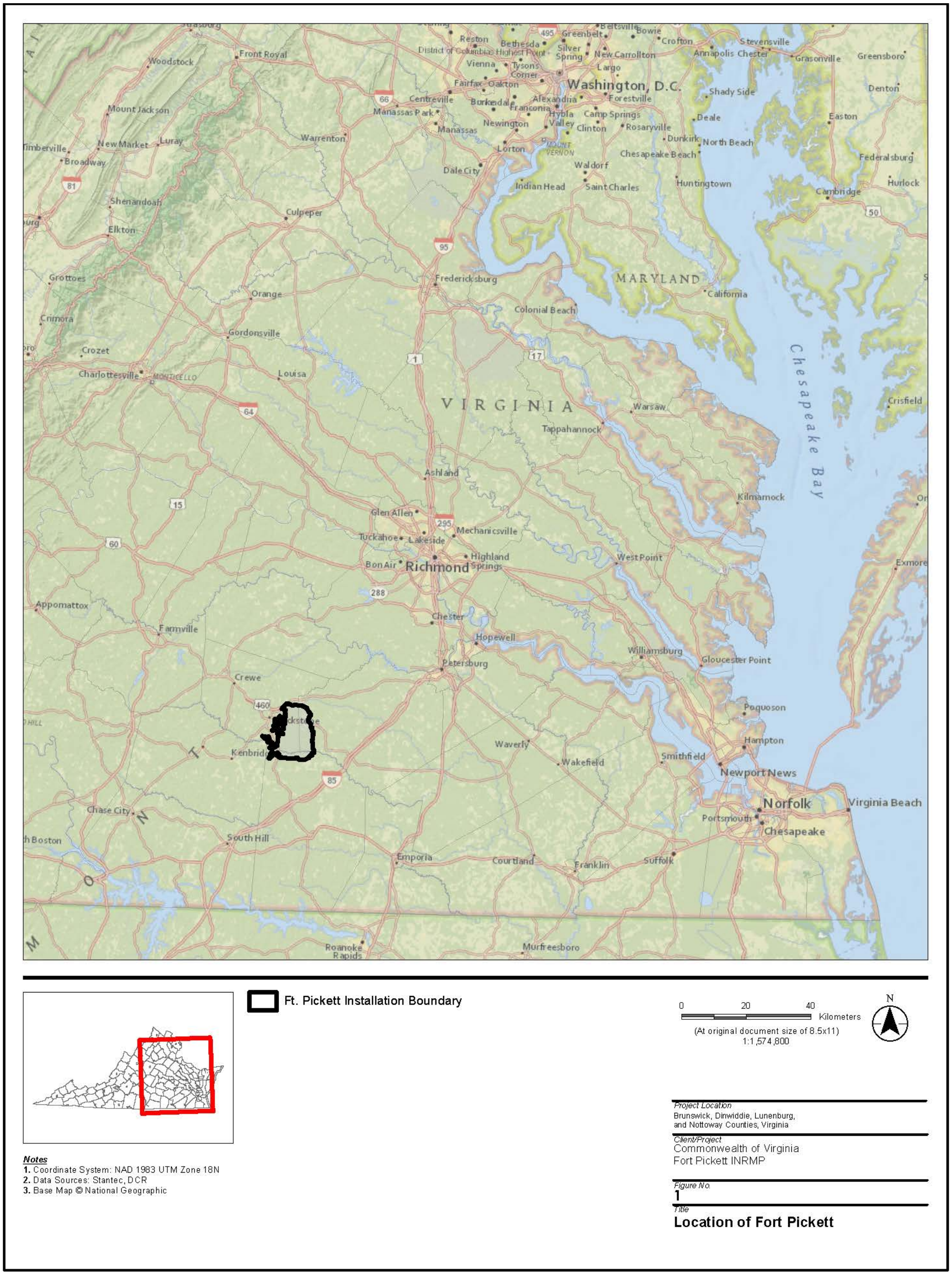

Figure 1. Location of Fort Pickett

Camp Pickett was named in honor of Confederate States of America Major General George Edward Pickett and was formally dedicated on 3 July 1942. Initial construction on the Camp began in 1942 and ended with the completion of 1,600 buildings, 60 kilometers of surfaced roads, 202 kilometers of secondary roads, four 1,524 meters long runways and 18 kilometers of railroad (constructed to meet the main line of the Norfolk and Western Railroad). A bakery, several churches, seven motion picture theaters, a large field house and a stadium with a seating capacity of 20,000 were also constructed during this time (Installation Design Guide 1992).

Camp Pickett's peak activity occurred during World War II (WWII), when seven combat divisions, (six infantry divisions and one armored division) were stationed at various times for the final phases of advanced training before shipping to overseas theaters. In 1943, 85,000 troops were trained and stationed at Camp Pickett. A 2,112-bed hospital that included 89 buildings and 26 warehouses was completed in 1943 and used to treat injured soldiers from WW II and the Korean War. Camp Pickett also served as a WW II German prisoner of war camp. Camp Pickett was deactivated twice between 1946 and 1949. In 1950, Camp Pickett was reactivated to train troops needed to fight in the Korean War but was closed again in January of 1954 following the war. In the 1950s the National Guard established a training center at Camp Pickett. In July 1973 Camp Pickett's status was changed to semi-active and in 1974 Camp Pickett was redesignated as Fort Pickett (McMaster and Hendry 1982).

In 1995, the Base Realignment and Closure Commission (BRAC) recommended the closure of Fort Pickett. Through the BRAC process, 2,792 acres were identified as surplus to the DoD needs. These acres included an agricultural research station leased by Virginia Polytechnic Institute and State University and portions of the cantonment area. Fort Pickett's status changed again in 1997 as a result of BRAC. On 1 October 1997, the operation of Fort Pickett was ceded to the Virginia Army National Guard (VAARNG) and the installation was renamed the Army National Guard Maneuver Training Center- Fort Pickett. All excess areas identified in the BRAC process were formally transferred in April 2000.

2.3 CLIMATE

The climate of the lower piedmont is characterized as humid sub-tropical, with hot, humid summers and mild winters. Information collected from 1972-2016 by the Western Regional Climate Center (WRCC) in what they still referred to as "Camp Pickett" was used to report average climate data (WRCC 2017). The annual mean temperature is 13.7°C (56.6°F), with a mean maximum temperature of 20.5°C (68.9°F) and a mean minimum temperature of 6.9°C (44.4°F). Frequent short cold spells occur in winter, with temperatures in the low teens. Extreme temperatures of -24.4°C (-12°F) and 39.4°C (103°F) have been recorded. Mean annual precipitation is 118.1 centimeters (cm) (46.5 inches [in]), with an average low of 7.5 cm (2.95 in) in February and an average high of 11.9 cm (4.7 in) in July. Precipitation is fairly well distributed throughout the year and is generally sufficient for good crop production. However, short dry periods occur most years and several severe droughts have been experienced. Prevailing winds are out of the southwest, except when frontal systems pass through.

The growing season averages 191 days, with the last spring frost usually occurring in mid-April and the first fall frost usually taking place in late October. The Fort Pickett region occasionally receives heavy precipitation and high winds from tropical storms generated over the Atlantic Ocean. Hurricanes from the Atlantic Ocean usually dissipate before reaching the area, with the greatest damage caused by heavy rainfall and winds that can reach 80.5 kilometers per hour. Tornadoes occur occasionally in the spring and late fall.

2.4 TOPOGRAPHY

Topography at Fort Pickett is characterized by low, gently rolling terrain with generally level uplands dissected by stream drainages. The total relief within the installation is 76 meters, ranging from 61 meters above sea level along the Nottoway River to approximately 137 meters above sea level north of the Blackstone Army Airfield (Installation Design Guide 1992). Approximately 90% of Fort Pickett is in the Nottoway River drainage basin, which consists of six small tributaries that flow into the Nottoway River (US Army Hygiene Report 1991). The northern training area of the installation is considered a level upland, with a dendritic drainage pattern. The southern training area shows more relief, with deeply dissected topography and steeper slopes and ravines (William and Mary 1995).

2.5 GEOLOGY

The bedrock geology of Fort Pickett, composed of a variety of igneous and metamorphic rock, is typical of the southeastern piedmont. Most of the rock formations underlying the piedmont were formed during the late Paleozoic (250 million years ago) period (William and Mary 1995). The Paleozoic was a period of tectonic movement and mountain building where sedimentary rocks metamorphosed into slates, gneisses, and schists. During this period, magma also welled to the surface and formed resistant granite. The Mesozoic period (248-65 million years ago) witnessed the formation of the Atlantic Ocean, which drastically changed drainage patterns in the piedmont. East flowing streams flowed with greater rapidity toward the newly forming Atlantic Ocean, thus eroding the mountains formed during the Paleozoic. Today most of the overburden has eroded away, except for pockets of highly resistant granite, leaving soft "rotted" rock called saprolite. Saprolite usually occurs as deep red clays (Terwillger 1991).

There are two exceptional geologic features that affect the biota of Fort Pickett: a sill of basic rock along Shacks Hole Road and granite flatrocks occurring along a tributary of Birchin Creek (Fleming and Van Alstine 1994). There are no economically significant petroleum resources located within the boundaries of Fort Pickett; however, there is an active rock quarry that is used for military training and provides a reliable source of gravel for road maintenance and other activities.

A reconnaissance map of the bedrock geology of Fort Pickett was produced by the Virginia Department of Mines, Minerals, and Energy (DMME - Division of Mineral Resources) in 1999 (Figure 2) (Terwilliger 1999).

The following is a description of the geology units in Figure 2:

> **Biotite gneiss**: Light gray, medium-to fine-grained, strongly foliated; consists of interlayed quartzo-feldspathic and biotite-rich lenses; composed of biotite, plagioclase, quartz, microcline, epidote and sometimes hornblende; forms loose loamy soils; depths to bedrock vary from meters.

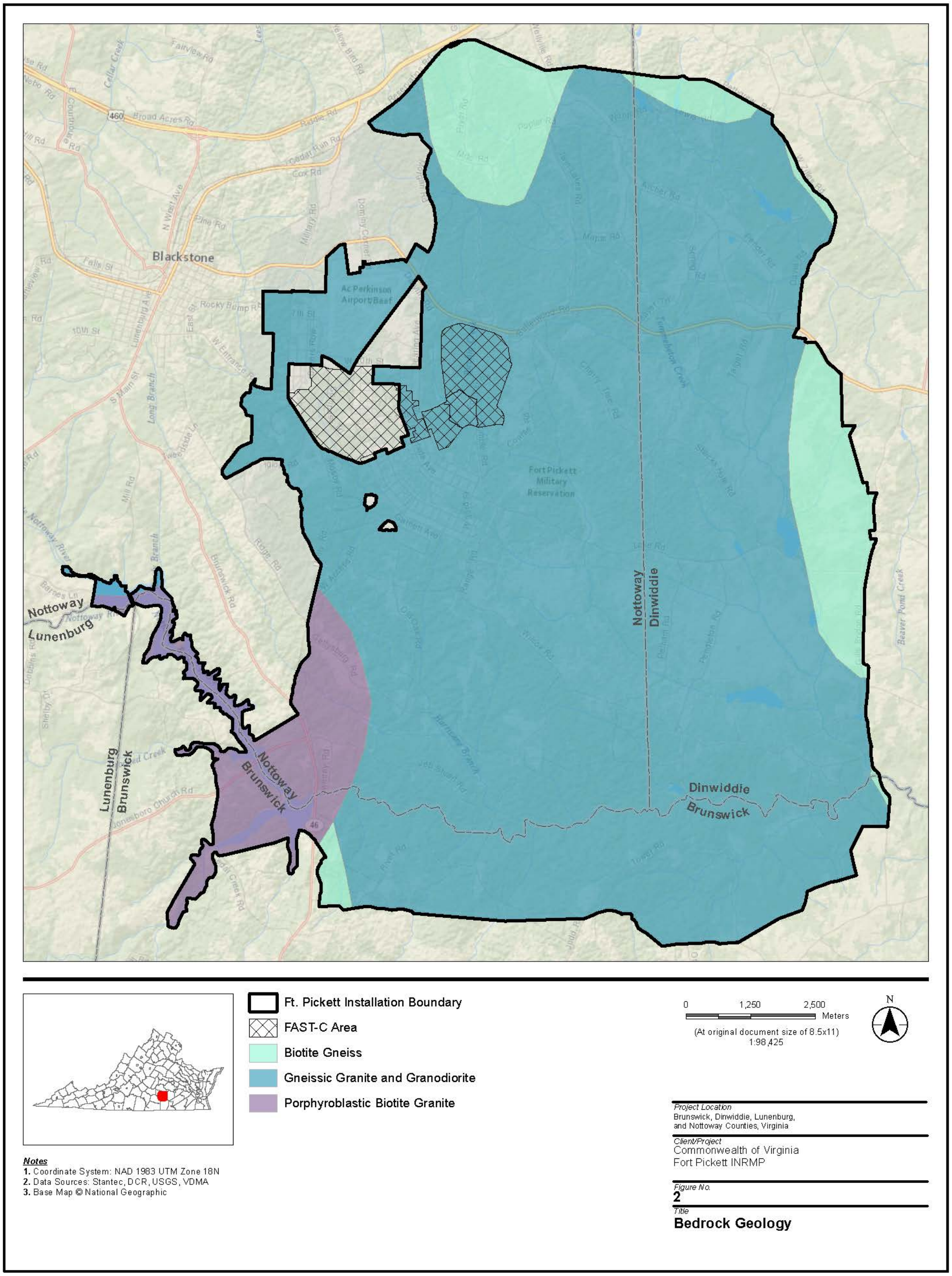

Figure 2. Bedrock Geology

Gneissic granite and Granodiorite: Light-gray to white, fine- to medium-grained, massive to foliated, muscovite-biotite gneissic granite to granodiorite containing minor garnet, and xenoliths of biotite gneiss and amphibolite. Several different intrusive phases are present.

Porphyroblastic biotite granite: Light gray, medium-to coarse-grained, well foliated, commonly lineated granite gneiss; characterized by potassium feldspar megacryst; forms light-colored sandy soils; depth to bedrock varies widely over short distances and ranges from 1-10 meters in thickness.

2.6 SOILS

The soil types occurring on Fort Pickett have been mapped by the U.S. Department of Agriculture's Natural Resource Conservation Service (NRCS). The soils types were simplified to produce Figure 3. More detailed mapping with a brief description of each mapped type of soil can be found in Appendix B.

Fort Pickett is located on the boundary between the Piedmont and the Coastal Plain soil divisions. Typically, Coastal Plain soils are sandy, while Piedmont soils are generally clayey (Godfrey 1980). Soils at Fort Pickett generally consist of a quartz sandy loam surface layer ranging in depth from 15-46 cm over a micaceous clay loam, with a frost depth of 61 cm.

Soil suitability for construction in undeveloped areas is considered fair (*Installation Design Guide* 1992). Areas of soil aridity in the Piedmont are not due to a lack of precipitation, but rather the inability of the soil to hold water. Erosion and low soil fertility have long been a problem in the Piedmont due to the small amount of level land in this area and to poor farming practices (Fenneman 1938).

The majority of the upland soils found on Fort Pickett are not frequently flooded, have a slow to moderate infiltration rate, and are non-hydric. Loams and sandy loams are the most common soil types on Fort Pickett. Light-colored silt and clay loams contain approximately 2% organic matter, compared to dark colored soils that contain 4-10% organic matter. The amount of organic matter in a soil reduces soil erodibility, increases water holding capacity and increases the nutrient supply (Winegardner 1995).

There are four wetland soils found on Fort Pickett: Chewacla, Wehadkee, Worsham, and Chastain (Gravatt *et al.* 1999). These wetland soils share many of the same characteristics: they are thermic, have slow infiltration rates and are found on low slopes ranging from 0-2%. Wehadkee is the most common wetland soil found on Fort Pickett, covering 2,689 acres. Worsham Sandy Loam occurs on approximately 124 acres but is an ecologically important wetland soil of depressional areas (Fleming 1994). It is the only wetland soil type that is not frequently or occasionally flooded. All of the wetland soils listed are hydric soils, with the exception of the Chewacla component of the Chewacla-Wehadkee complex (Nicholson 1998). Hydric soils are defined as soils that are "wet long enough to periodically produce anaerobic conditions thereby influencing the growth of plants" (Winegardner 1995). The majority of these soils support woody vegetation under natural conditions (Nicholson 1998). The large number of wetlands occurring throughout Fort Pickett significantly improves water quality by filtering groundwater and surface run-off.

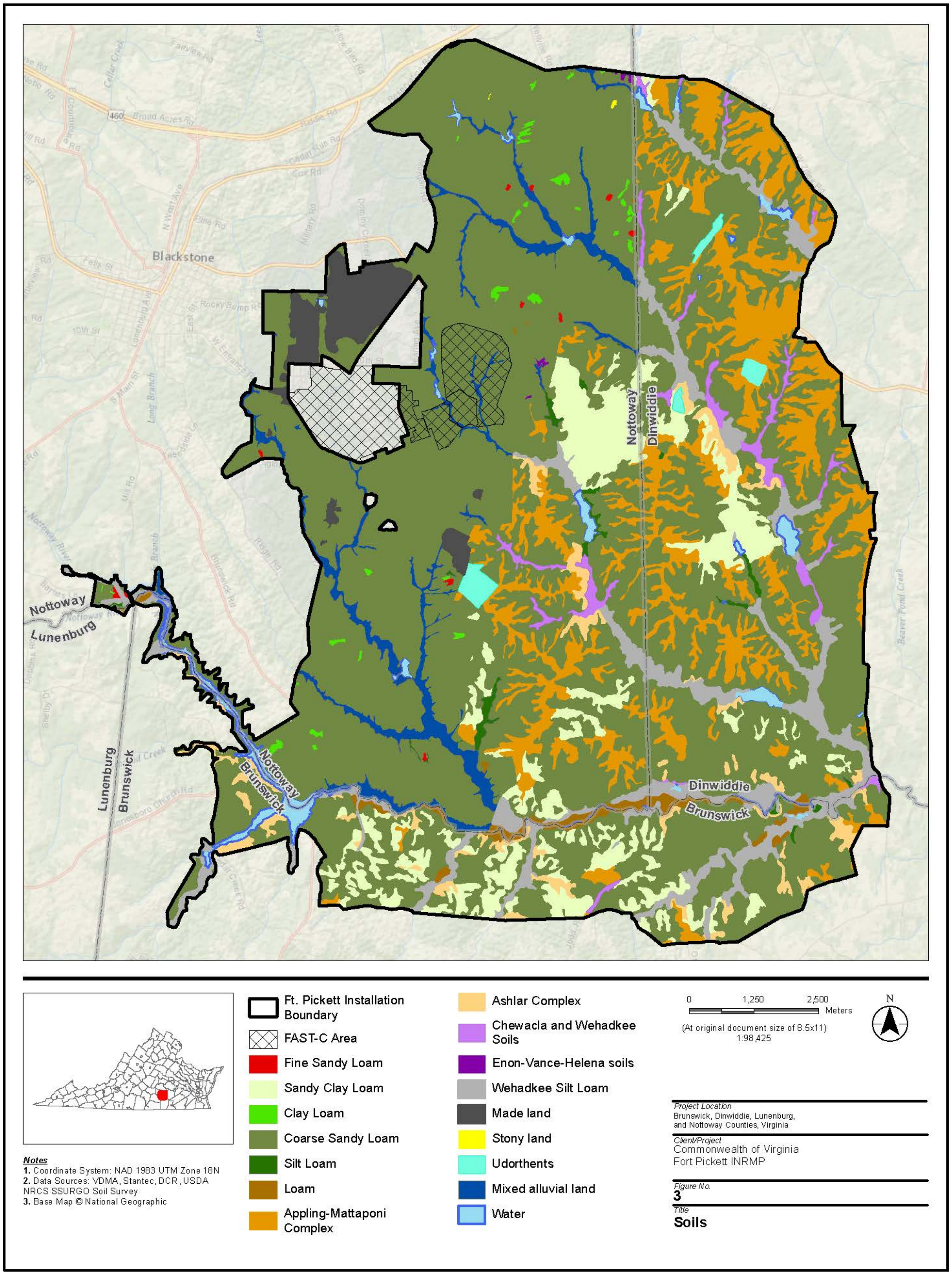

Figure 3. Soils

2.7 HYDROLOGY

The hydrology of Fort Pickett is typical of the lower Piedmont region of the southeastern United States. The Nottoway River is the primary surface water drainage system located on Fort Pickett and is responsible for a large area of Southside Virginia. The Nottoway flows east, toward the coast, until reaching Sussex County where it turns southward. At the Virginia-North Carolina border, the Nottoway joins with the Blackwater River to form the Chowan River, which eventually empties into the Albemarle Sound in North Carolina (Terwilliger 1991). The Nottoway dissects the southern portion of the base and serves as the boundary between Nottoway and Brunswick Counties. The Nottoway is used as a drinking water source, for irrigation, for fish propagation and for recreation, all of which are typical of many streams in the southern Piedmont.

2.7.1 Fort Pickett Reservoir

The main water source for the installation and the Town of Blackstone is the Fort Pickett Reservoir, a 385-acre reservoir located on the Nottoway River with an average capacity of 29,222,516 liters (L) per day. Fort Pickett initially owned the water source, but as of September 1997, ownership of the filtration plant, pumping station and storage tanks was transferred to the Town of Blackstone. The water treatment plant has a capacity of 18,926,500 L per day, with a 3,785,300-L ground storage reservoir. Treated water is stored in three elevated water storage tanks located in the northwest and southwest cantonment areas. Two of the tanks can hold 1,514,120 L and the other tank holds 946,325 L.

The reservoir has two main branches that join west of State Route 46 to form the main body of the reservoir. The confluence of the Nottoway, Little Nottoway, and Reedy Creek form the northwest branch. The southwest branch arises from the confluence of South Branch, Cedar Creek, and several small unnamed drainages. The outflow of the reservoir is the Nottoway River proper, which flows through the entire southern portion of the installation. Throughout its course, it adds three of the four other major drainages (which either arise in or flow through the installation's boundaries) to its waters. The reservoir is used by military personnel and civilians for fishing and boating. There are three boat landings located at the reservoir but no other facilities. Much of the shoreline is heavily vegetated with stands of pine and hardwood trees that serve as an important scenic resource as well as protective cover for the reservoir watershed.

2.7.2 Nottoway River

The Nottoway River (Figure 4) is the primary surface water drainage system for Fort Pickett, dissecting the southern portion of the facility, and is responsible for draining 3,680 square kilometers of Southside Virginia, making the waterway an important part of the cultural and ecological resources of the region.

Figure 4. The Nottoway River on Fort Pickett

2.7.3 Waters Originating Within Fort Pickett Boundaries

There are two major drainages that largely originate within the boundaries of Fort Pickett and flow into the Nottoway. Tommeheton and Birchin Creeks arise in the northwestern portion of the installation and flow in a southeasterly direction, draining much of the Installation (Figure 5). The two creeks meet in the extreme southeastern portion of the base and enter the Nottoway at the installation boundary near Gills Bridge. Two large man-made impoundments occur within the CAA on both Tommeheton and Birchin Creeks. Many portions of their drainages have a low relief and are slow moving and marshy, forming extensive wetlands.

2.7.4 Waters Originating Outside Fort Pickett Boundaries

There are two drainages that arise outside the installation and flow through portions of the installation. The extreme northeast portion of Fort Pickett, east of Archer Road, is drained by Butterwood Creek. Butterwood Creek enters the installation in the northwest portion of Training Area 14 and flows southeasterly, exiting the installation east of Pender Road. Long Branch flows into the southwestern portion of the installation, crossing the boundary north of Route 46. Long Branch joins with an unnamed drainage southeast of the junction of Old Oak Road and Gettysburg Road to form a wide marshy drainage called Hurricane Branch. Hurricane Branch flows southeasterly, emptying into the Nottoway east of Range Road.

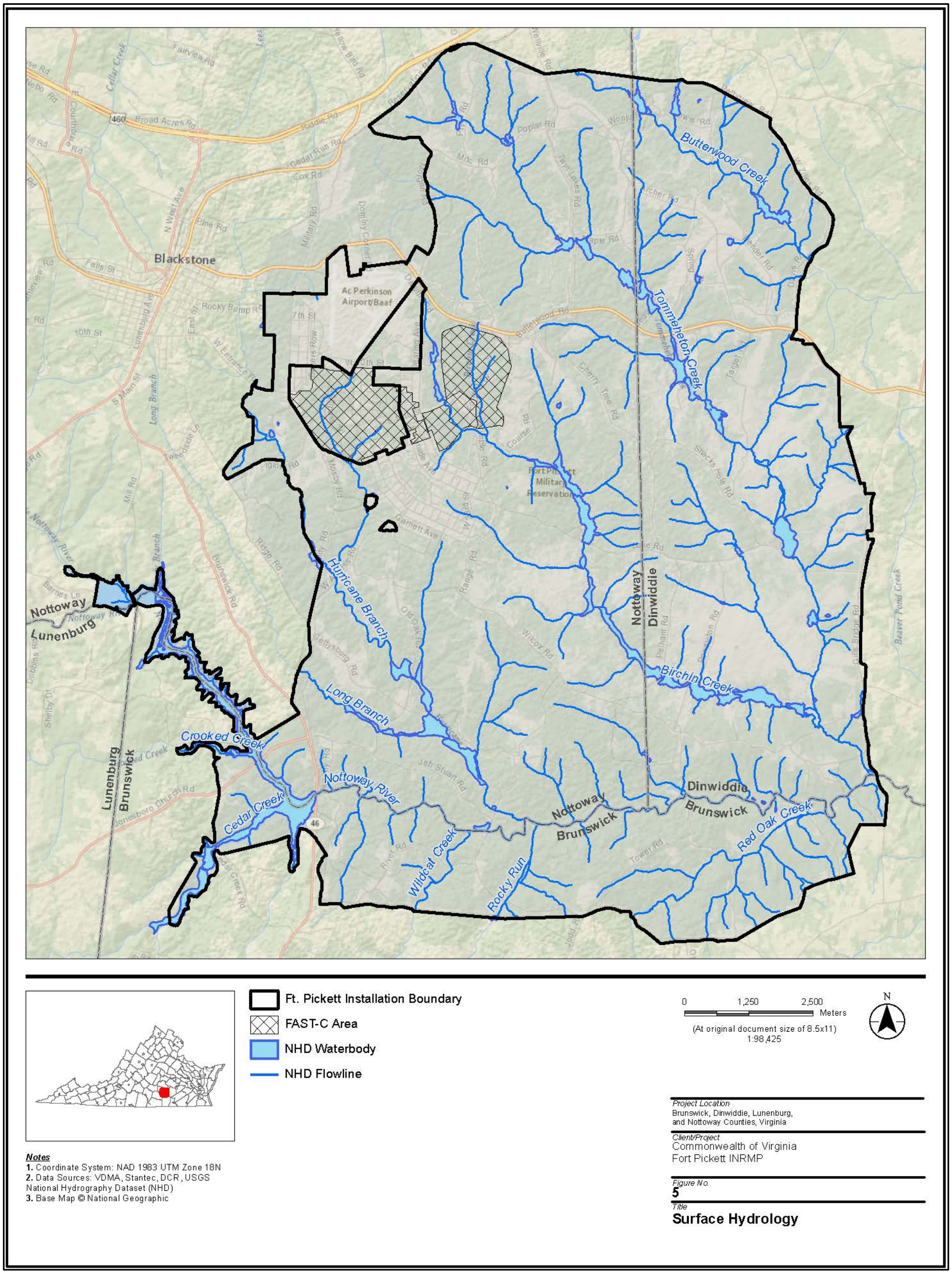

Figure 5. Surface Hydrology

2.7.5 Impoundments

There are fourteen ponds and lakes located on Fort Pickett (Table 2, Figure 6). The largest of these is the Fort Pickett Reservoir, which serves as the water supply for both Fort Pickett and the Town of Blackstone.

Table 2. Impoundments and acreages

Impoundment	Acreage
Fort Pickett Reservoir	384
Tommeheton Lake	51
Floyd Pond	45
Birchin Lake	45
Twin Lakes	20
Lewis Pond	13.2
Pryor Road Reservoir	13
Engineer Bridge Site	12.8
Butterwood Pond	8
Dearing Pond	7.2
Wonju Pond	3
Winterling Pond	3
Reservation Pond	2.5
Beaver Trail Pond	2.4

2.7.6 Groundwater

A study conducted in 1989 showed depth to groundwater ranges from 2.0 to 10.0 meters. The water table begins to fall in April and is replenished in the winter months. Most groundwater is found at less than 45.5 meters of depth, with the majority found in the upper 9.0 meters (Installation Design Guide 1992). Most natural springs on Fort Pickett occurs at the head of major drainages and is associated with seepage wetlands. Shallow groundwater occurs in a multi-aquifer system, with the aquifers being localized lenses in the saprolite and bedrock fractures. A study of an area northeast of the now closed Trimble Road landfill conducted in 1989 and 1991 supported the generalization that shallow depths to groundwater are between 3.5 and 7.0 meters. Groundwater systems within the Piedmont province include a combination of saprolite and fractured bedrock occurrences.

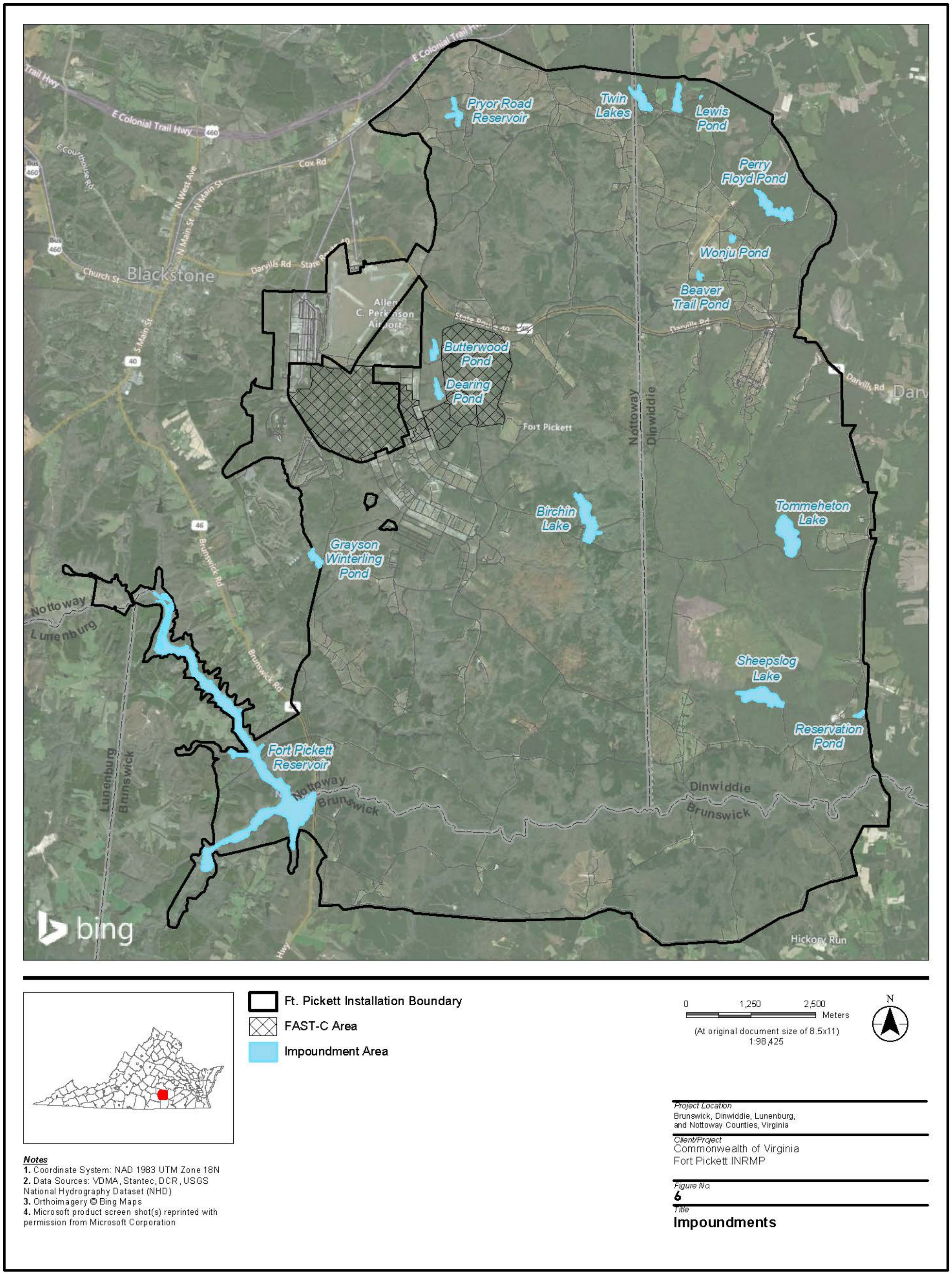

Figure 6. Impoundments

2.8 FLOODPLAINS

Executive Order 11988 (3 CFR 1977 (1977)) applies to floodplain management and requires that federal agencies take action to minimize occupancy and modification of the floodplain. Specifically, Executive Order 11988 prohibits federal agencies from funding construction in the 100-year floodplain unless there are no practicable alternatives. In 2015, Executive Order 13690 (80 FR 6425 2015) amended Executive Order 11988 and added updates and new concepts. The most important changes include the requirement that in the development of possible alternatives for all actions to which Executive Order 11988 applies federal agencies shall use natural systems, ecosystem processes, and nature-based approaches where possible. Floodplain management was also expanded to include a higher flood elevation than the base flood elevation for federally funded projects. The Federal Emergency Management Agency (FEMA) is responsible for creating and maintaining flood insurance rate maps (FIRM). Fort Pickett is located within eight different FIRM panels. All the floodplains are designated as Flood Zone A, which are areas where no base flood elevation has been determined. As such, the locations shown on the FIRM panels are general locations and any proposed impacts to these areas would require flood studies to be completed to determine the limits of the floodway and zone AE, areas where the base flood elevation has been determined, prior to any fill being placed.

The majority of Fort Pickett is located outside the 100-year floodplain. There is an expansive floodplain area along the banks of the Fort Pickett Reservoir, along the Nottaway River and extending up Hurricane Branch for approximately 1.5 miles. Another area of floodplain runs seven miles up the Tommeheton Creek, including Tommeheton Lake and almost two miles up Birchin Creek including Sheeplog Pond. All the floodplain areas appear to be well vegetated and undisturbed by fill. Most of the floodplain areas fall within areas already protected from development. The intermittent and perennial streams, as well as the wetlands on the base, are protected by a 25-foot vegetated buffer on either side. The Nottoway River Corridor and Macrobasin Protection Zone covers 4,000 acres of wildlife habitat adjacent to the Nottoway River. Copies of the eight FIRM panels that cover Fort Pickett are included in Appendix C.

3.0 BIOTIC OVERVIEW

The purpose of this chapter is to provide detailed information on the biotic (flora and fauna) components of the ecosystem. To fully understand and apply ecosystem management at Fort Pickett, it is necessary to have a detailed grasp of the biotic components of the ecosystem. The information presented in this chapter is gleaned from various agency reports, professional literature, field data, planning level surveys (i.e. vegetation mapping, faunal survey, and forest inventory) and the Range and Training Land Assessment (RTLA) program. Though this chapter provides detailed information, it is not all-inclusive; the reader is encouraged to consult detailed species information in Chapter 6 and literature cited throughout this chapter for full reports.

The flora and fauna present on Fort Pickett are the result of the interactions between the abiotic (Chapter 2) and biotic constituents of the ecosystem and the impacts of pre-historic and historic occupation by humans. Anthropogenic impacts such as farming, forestry, and intentionally set fire have shaped the regional biota over the last 10,000 years. The direct and indirect effects of military training, and the impacts it has on the flora and fauna at Fort Pickett, are discussed in detail in Chapter 5.

3.1 HABITAT TYPES

Regionally, the vegetation of the Fort Pickett area is part of the oak-hickory-pine region described by Braun (1950). Many of the plant species (Appendix D) are typical of the southeastern Piedmont, with some distinct Coastal Plain influences (Fleming and Van Alstine 1994).

This section will provide a broad overview of vegetative conditions at Fort Pickett, based on scales much larger than those described in Dorr et al. (2007). For the purposes of this report the vegetated areas of Fort Pickett can be characterized into four different habitat types: forests and woodlands, shrublands, grasslands, and wetlands. These four major habitat types provide refuge for a wide range of wildlife occurring at Fort Pickett. The disturbances associated with military training, particularly fire, create a mosaic of different habitat types ranging in age which is favorable from a wildlife management perspective. All remaining areas have been combined into the "other" category, including areas such as open water and mowed ranges.

Plant ecologists have developed vegetation classification systems for the purpose of organizing and communicating information about plant communities. Conceptually, it is useful to consider vegetation communities as a function of the interactions of climate, soil, topography, elevation, and other organisms (including humans). In other words, the vegetation communities we observe today arise from a combination of environmental conditions and historical land use.

The vegetation patterns observed at Fort Pickett have been greatly influenced by past and present human activity, particularly military training. Military training is often associated with deleterious effects on vegetation communities and degradation of natural landscapes. However, the disturbances associated with military training in some cases mimic natural disturbances (e.g., fire) and can be beneficial to ecosystem processes, while providing valuable wildlife habitat. Monitoring how current vegetation conditions affect military training (and vice versa) is important to maintaining the military mission by providing ample opportunities and environments for training activities.

There are many types of plant community classification systems, which range from local to worldwide applicability. The vegetative communities at Fort Pickett, for example, have been described both by Fleming and Van Alstine (1994), Dorr et al. (2007) and the Center for Environmental Management of Military Lands (CEMML; 2012). Fleming and Van Alstine (1994) described specific and fairly small-scale plant communities based on plant assemblages and soil characteristics. This survey was important in understanding the diversity of vegetation communities occurring within Fort Pickett, but the small scale is not ideal for planning purposes. Alternatively, Dorr et al. (2007) mapped plant communities throughout the installation and produced a community classification system using a broader approach to capture larger community types based predominantly on overstory tree species composition, or broad-scale vegetation characteristics (i.e. herbaceous/grassland communities). CEMML (2012) produced a vegetation classification based on the National Vegetation Classification System (Table 3). Stantec used aerials flown in 2017 in combination with an automated process known as Object-Based Image Analysis (OBIA) to update the land cover classification (Figure 7; Stantec 2019).

Table 3. National Vegetation Classification System (NVCS) subclass level vegetation communities at Fort Pickett (CEMML 2012).

NVCS Subclass Level	Acres	% of Total
Deciduous Forest (Closed Tree Canopy)	17,750	41.9
Evergreen Forest (Closed Tree Canopy)	8,288	19.6
Perennial Graminoid Vegetation	7,709	18.2
Mixed Evergreen/Deciduous Forest (Closed Tree Canopy)	6,256	14.8
Deciduous Woodland (Open Tree Canopy)	678	1.6
Non-Vegetated	620	1.5
Evergreen Woodland (Open Tree Canopy)	321	0.8
Mixed Evergreen/Deciduous Woodland (Open Tree Canopy)	289	0.7
Shrubland	121	0.3
Hydromorphic-rooted Vegetation	117	0.3
Perennial Forb Vegetation	82	0.2
Annual Graminoids or Forb Vegetation	67	0.2
Unconsolidated Material Sparse Vegetation	17	0.04
TOTAL	**42,315**	**100**

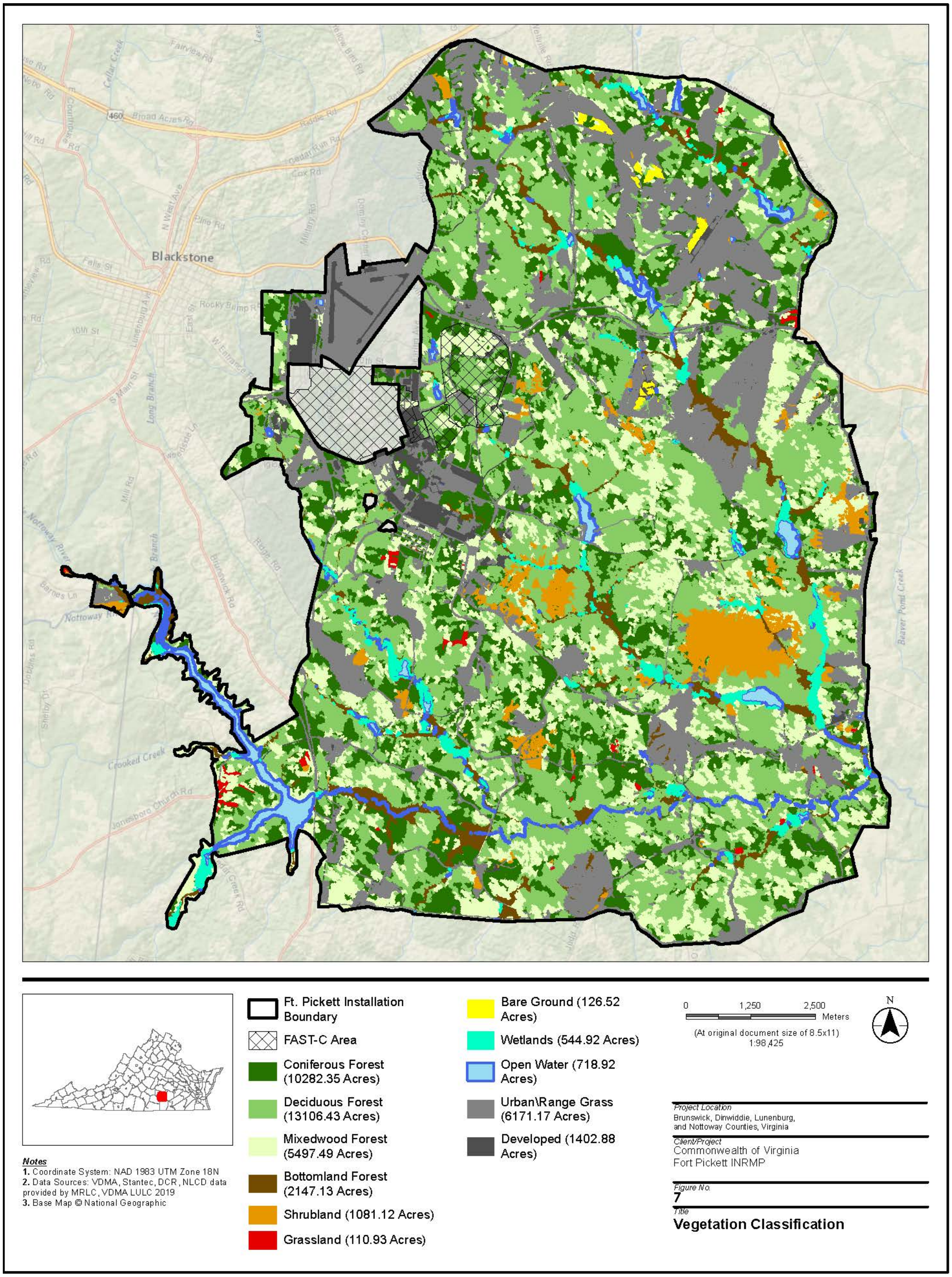

Figure 7. Vegetation Classification (Stantec 2019)

3.1.1 Forests and Woodlands

Fort Pickett has diverse forest cover comprised of over 50 tree species, occurring in a variety of combinations and cover types across the landscape (Williams 2000). A list of the vascular flora occurring at Fort Pickett can be found in Appendix D. Forests and woodlands at Fort Pickett encompass more land than all other habitat types combined, covering roughly 75% of the installation (Stantec 2019). The soils mostly support forest cover under natural conditions, but disturbance associated with military training has altered some forests and woodlands to provide more suitable training opportunities.

Forests at Fort Pickett are closed canopy with a cover of greater than 60% and greater than 6 m in height. Woodlands have lower vegetative cover (25-60%) above 6 m and have areas of understory often dominated by herbaceous and graminoid species.

The majority of the hard mast producing stands, pine and pine-oak stands are located on well-drained sites varying in location from coves to ridge tops. The mixed hardwoods generally occupy slightly more mesic sites. On well-drained sites, previous management of the site is the primary factor that determines current species composition, with pine and pine-oak mixes most common on abandoned agricultural fields. Hardwoods generally occur in areas that have not been managed for agricultural purposes for over 100 years.

3.1.2 Shrublands

There are approximately 1,081 acres of shrubland habitat on Fort Pickett (Stantec 2019). Shrublands are successional vegetative communities maintained by physical disturbance from military training and fire (prescribed or accidental). Nevertheless, these communities are in 'dynamic equilibrium' with the military disturbance regimen and occur in a definable pattern across the landscape. Boundaries between these community types are not distinct and these communities are distributed along a disturbance gradient.

Shrublands represent a very small percentage of the total land area at Fort Pickett (2.6%). These are defined as having less than 15% cover above six meters and woody vegetation below six meters comprising more than 25% of the vegetative cover. Although representing a small area on Fort Pickett, these areas are particularly attractive to game birds and other wildlife.

The dominant woody species in these communities are loblolly pine (*Pinus taeda)*, sweetgum, and various oak species. Along with the abundant tree saplings, the understory is mostly composed of broomsedge (*Andropogon virginicus*), little bluestem (*Schizachyrium scoparuim*) and types of panicum (*Dicanthelium spp.* and *Panicum spp.*) dominate the grass component of the herbaceous strata. Various goldenrods (*Solidago spp.*) and Asters (*Aster spp.*) dominate the forb component of the herbaceous strata.

3.1.3 Grasslands/Herbaceous

There are approximately 7,685 acres of grasslands on Fort Pickett consisting of developed, grassland/herbaceous, and urban/range grass cover types (Stantec 2019). The open areas at Fort Pickett exist because of the training requirements of the military and are maintained in an early successional status by military training activities, prescribed fire, and mowing. Many of these plant communities are uncommon or absent altogether in the surrounding Piedmont and several are considered state and/or globally rare (Fleming and Patterson 2012). The boundaries between community types in this system are even less distinct than in the forested community types because of the unique and heterogeneous disturbance regime. The intensity, frequency, and type of disturbances are the single most important factor in determining the composition of open area communities at Fort Pickett. At high levels of physical disturbance, invasive forbs and grasses dominate the communities. At other locations, frequent low-intensity fires led to the development of rare eastern prairies dominated by native grass species.

The grasslands and herbaceous habitat types at Fort Pickett have been characterized based on their low density of woody species and high cover (greater than 60% of herbaceous and graminoid species). There are two perennial grassland alliances mapped on Fort Pickett. The '*Andropogon virginicus* Herbaceous Alliance' is scattered throughout Fort Pickett, and is generally associated with small arms ranges, airfields, and the Impact Area. The '*Typha* (*angustifolia, latifolia*) – (*Schoenoplectus* spp.) Semi-permanently Flooded Herbaceous Alliance' is associated with pond and lake margins and areas along streams where water impoundments create standing water. There are two perennial forb alliances mapped on Fort Pickett. The '*Polygonum* spp. (section Persicaria) Seasonally Flooded Herbaceous Alliance' is found around pond margins along streams. The '*Nymphaea odorata – Nuphar* spp. Permanently Flooded Temperate Herbaceous Alliance' consists of floating vegetation and is found in and around ponds where water levels are generally between one half to two meters (CEMML 2012). There are three additional herbaceous types mapped on Fort Pickett that are associated with planted agricultural fields, highly disturbed non-agriculture sparsely vegetated areas, and urban areas (CEMML 2012).

3.1.4 Wetlands

Based upon preliminary assessments, there may be between 2,500 and 2,800 acres of wetlands (Table 4). Wetlands are regulated by the U.S. Army Corps of Engineers (USACE) under Section 404 of the Clean Water Act of 1972 (33 U.S.C. 1251 *et. seq*.). Wetlands are defined as those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include areas such as swamps, marshes, bogs, and fens. This definition emphasizes hydrology, vegetation, and saturated soils.

Table 4. Approximate Wetland Acreages

Wetland Classification	Acres
Palustrine Emergent Wetlands	200 - 300
Palustrine Scrub Shrub Wetlands	700 - 800
Palustrine Forested Wetlands	1,600 - 1,700
Totals	**2,500 – 2,800**

Wetlands possess three essential characteristics: (1) hydrophytic vegetation, (2) hydric soils, and (3) wetland hydrology, which is the driving force creating all wetlands. The three technical criteria specified are mandatory and must all be met for an area to be identified as a wetland.

Wetland classification is similar to characterizing forest types in that there are varying levels of classification systems, some more specific than others. The most accepted wetland classification system is the Cowardin classification system, which recognizes five major types of wetlands: marine, estuarine, palustrine, riverine, and lacustrine (Cowardin 1979). All the wetlands at Fort Pickett are either palustrine, riverine, or lacustrine. A detailed wetland delineation using the Cowardin classification system has not been performed for the entire base, however delineations exist for a few smaller project areas.

Dorr et al. (2007) identified two types of wetland habitats at Fort Pickett: wetland shrubland, and wetland herbaceous. Wetland shrublands are largely composed of alder (*Alnus* spp.) or buttonbush (*Cephalanthus* spp.) and may include sparse tree cover above 6 meters. The wetland herbaceous species are typically from the genera *Juncus*, *Scirpus,* and *Carex*. In areas of standing water, cattails (*Typhus*) will become the dominant herbaceous vegetation.

Wetlands provide valuable ecosystem services by improving water quality, retaining nutrients, trapping sediment, providing flood protection, and habitat for wildlife. Common tree species associated with the wetland forests of Fort Pickett are red maple (*Acer rubrum*), willow oak (*Quercus phellos*), American hornbeam (*Carpinus carolinianus*), American elm (*Ulmus americana*) and sweetgum (*Liquidambar styraciflua*). Tag alder (*Alnus serrulata*), buttonbush (*Cephalanthus occidentalis*) and swamp rose (*Rosa palustris*) are common in the shrub layer (Gravat et al. 1999).

3.1.5 Rare, Threatened and Endangered Flora

The vegetation at Fort Pickett is a diverse and interesting representation of flora of the Virginia Piedmont with several southern and coastal plain influences. Van Alstine et al. (1996) conducted a floristic inventory of Fort Pickett and identified 821 taxa in 395 genera, within 111 families. This survey recorded over 100 county records when conducted in 1994 (Van Alstine et al. 1996). On a separate vascular plant inventory, the Williamsburg Environmental Group (WEG), now Stantec, identified wetland species occurring at Fort Pickett from 2005-2007, 49 of which were previously identified in county records.

The flora of Fort Pickett contains many species that are widely distributed throughout the eastern deciduous forest biome; however, many of the dominant species (loblolly pine, sweetgum, southern red oak (*Quercus falcata*)) are decidedly southern in their distribution (Fleming and Van Alstine 1994). The Fort Pickett flora is fairly typical of the southeastern Piedmont; however, there are many Coastal Plain species that reach their westernmost extent at Fort Pickett. The groundwater seepage wetlands harbor many of these species. Furthermore, the Nottoway River corridor and macrobasin provides an excellent migration route for species more common in the Coastal Plain and mountains. Currently there is only one federally protected plant species, Michaux's sumac (*Rhus michauxii*) within the boundaries of Fort Pickett. Along with this federally protected species, several species identified at Fort Pickett are currently ranked state rare (Table 5).

Table 5. Global and state rare plant species identified at Fort Pickett (Townsend 2009; DCR 2017).

Common Name	Scientific Name	Federal Status	State Status	Global/ State Rank
Michaux's sumac	*Rhus michauxii*	Endangered	Threatened	G2G3/S1
Velvety sedge	*Carex vestita*	n/a	n/a	G5/S2
Plukenet's flatsedge	*Cyperus plukenetii*	n/a	n/a	G5/S2
Viviparous spikerush	*Eleocharis vivipara*	n/a	n/a	G5/S1
Short-leaved beardgrass	*Gymnopogon brevifolius*	n/a	n/a	G5
Lesser marsh St. John's wort	*Hypericum tubulosum*	n/a	n/a	G4/S2
Rafinesque's seedbox	*Ludwigia hirtella*	n/a	n/a	G5/S2
Old field milkvine	*Matelea decipiens*	n/a	n/a	G5/ S1
Bush's muhly	*Muhlenbergia bushii*	n/a	n/a	G5/S1
Downy phlox	*Phlox pilosa*	n/a	n/a	G5/S1
Torrey's mountain mint	*Pycnanthemum torreyi*	SOC	n/a	G2/S2

Global and State Ranks: G/S1 - Critically imperiled in the state because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state. Typically, 5 or fewer populations or occurrences; or very few remaining individuals (<1000). **G/S2** - Imperiled in the state because of rarity or because of some factor(s) making it very vulnerable to extirpation from the state. Typically, 6 to 20 populations or occurrences or few remaining individuals (1,000 to 0). **G/S3**-Vulnerable in the state either because rare and uncommon, or found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation. Typically, 21 to 100 populations or occurrences (1,000 to 0). **G/S4** - Apparently secure; Uncommon but not rare, and usually widespread in the state. Possible cause of long-term concern. Usually>100 populations or occurrences and more than 10,000 individuals. **G/S5** - Secure; Common, widespread and abundant in the state. Essentially ineradicable under present conditions. Typically, with considerably more than 100 populations or occurrences and more than 10,000 individuals. **G/S#?** - Inexact or uncertain numeric rank. **SH** - Possibly extirpated (Historical). Historically known from the state, but not verified for an extended period, usually > 15 years; this rank is used primarily when inventory has been attempted recently. **G/S#G/S#**- Range rank; A numeric range rank, (e.g. S2Ss used to indicate the range of uncertainty about the exact status of the element. Ranges cannot skip more than one rank. **SU** - Unrankable; Currently unrankable due to lack of information or due to substantially conflicting information about status or trends. **SNR**- Unranked; state rank not yet assessed. **G/SX** - Presumed extirpated from throughout its range or state. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered. **SNA**- A conservation status rank is not applicable because the element is not a suitable target for conservation activities.

3.1.6 Rare Plant Communities

Rare and unique plant communities are primarily maintained using prescribed fire and wildfires caused by training maneuvers. A majority of the training-caused wildfires occur within the Controlled Access Area (CAA). The CAA serves as a buffer zone for the existing live-fire range complex that supports various small arms, tank, and artillery training. Throughout Fort Pickett's history, tactical arms training has resulted in wildfires that burn the CAA annually or bi-annually. These fires are usually moderately intense ground fires that are allowed to burn unhindered within the CAA, only rarely resulting in intense crown fires. As a result, a unique mosaic of pyric disclimax plant communities, such as loblolly pine savannas, oak- hickory woodlands and little bluestem grasslands, has developed within the CAA (Fleming and Van Alstine 1994; Dorr et al. 2007).

The effects of fire and its use as a natural resource management tool are discussed in-depth in Chapter 7. Communities were initially characterized by Fleming and Van Alstine (1994), and further characterized by Dorr et al. (2007). The following fire-maintained communities have been recognized as potentially rare in the state of Virginia. They are named based upon the dominant species, in terms of vegetative cover, in each stratum of the community.

Oak-Hickory Woodlands and Savannas

Many areas of the CAA have plant communities dominated by hickories and oaks. Examples of this community type can be found north of Wilcox Road and east of the junction between Shacks Hole and Cherry Tree Roads (Figure 8). This community is a type of the Oak–Hickory Woodlands and Savannas classification described by Fleming et al. (2012). The state conservation status for this community has been assigned as Critically Imperiled (Fleming et al. 2012), as it is only found on Fort Pickett and the U.S. Marine Corps Base at Quantico. The oak-hickory community located north of Shacks Hole Road is underlain by a sill of basic rock, which results in a slightly more basic soil. Fleming and Van Alstine (1994) attribute the increased herbaceous diversity found at this site to the basic soils.

Figure 8. An example of fire-maintained oak-hickory woodland at Fort Pickett.

A post Oak-Black Oak-White Oak/Little Bluestem Woodland community occurs with some frequency in the CAA. Occurrences of this community type have been noted north of Wilcox Road and both east and west of Shacks Hole Road. This community is a type of the Oak–Hickory Woodlands and Savannas classification described by Fleming et al. (2012). The State conservation status for this community has been assigned as Critically Imperiled (Fleming et al. 2012). The threats to the continuation of this community come mainly from the reduction or elimination of the fire regime caused by military training that has led to its formation. The exact location of each occurrence may shift over time; however, its continuation appears to be secure. The locations of current occurrences should be noted, for they may be of interest as possible habitat for rare or endangered species.

Loblolly Pine/Little Bluestem Savanna

There are numerous occurrences of this community element within the CAA (Figure 9). The best examples occur on the south side of Lake Road and north of Wilcox Road. This community is similar to the Loblolly Pine Savannas classification by Fleming et al. (2012). The State conservation status for this community has been assigned as unrankable by the state of Virginia due to a lack of information (Fleming et al. 2012). The loblolly pine / little bluestem savanna community type harbors the state threatened Bachman's Sparrow and is considered a high priority for conservation.

Figure 9. An example of a Loblolly Pine/Little Bluestem Savanna at Fort Pickett

Indian Grass/Little Bluestem Grassland

A natural occurrence of this community type encompassing approximately 99 acres is located northwest and east of the intersection of Pine and Gettysburg roads, occurring on either side of Pine Road as it runs north toward Wilcox Road. The composition of this community is similar in many respects to the central tall grass prairie. This community is similar to the Piedmont Prairies classification presented by Fleming et al. (2012). The state conservation status for this community has been assigned as “unrankable” by the state of Virginia due to a lack of information (Fleming et al. 2012). The community is dominated by Indian grass (*Sorghastrum nutans*) and little bluestem (*Schizachyrium scoparium*), both of which are native warm season grasses. In order to maintain the viability of these warm season grass communities, fire must be used to control woody encroachment.

The occurrences located on M.R.T.C. Road (Training Area 11) and the site southeast of Observation Point 4 (Training Area 33) have been planted by natural resource personnel. The occurrence southeast of OP4 is the most vigorous and is quite well established.

Groundwater Seepage Wetlands

Also referred to as seepage swamps or bogs, groundwater seepage wetlands are unique wetland habitats that harbor rare and interesting plant life. These wetlands are considered a type of "isolated wetland" influenced by tides, rivers, or lakes. Isolated wetlands get their hydrologic inputs from precipitation and groundwater seeps. Some salamander species and other amphibians have evolved to reproduce in these small and sometimes seasonal pools, which in turn provide food for other wildlife. Tree species found in these types of wetlands include red maple, loblolly pine, sweetgum, and water tupelo.

There are at least two ground water seepage wetlands at Fort Pickett, both of which are maintained by fire. These types of wetlands are more common in the Coastal Plain, which makes the Fort Pickett occurrences unique. These seepage wetlands support several rare native plants such as velvet sedge (*Carex vestita*), a state imperiled species.

Nottoway Macrobasin

The Nottoway River corridor and macrobasin is one of the least impacted and most important natural areas on Fort Pickett. It possesses many diverse aquatic and terrestrial habitats which support an assortment of plant communities and their associate flora and fauna. The Nottoway riparian corridor and macrobasin encompasses 4,739 acres in the southern portion of Fort Pickett (Figure 21, Page 5.80). The Virginia Natural Heritage Program considers the Nottoway basin macrobasin one of the most important natural areas on Fort Pickett (Fleming and Van Alstine 1994; Van Alstine et al. 1996) and gives the Nottoway macrobasin a biodiversity rank of B3, indicating that it has a high level of biological and ecological significance. Furthermore, areas that have a B3 ranking possess "excellent examples of rare community types and have a good occurrence of a rare species" (Fleming and Van Alstine 1994). More information about the Nottoway River Protection Zone can be found in Section 5.5.5.

3.1.7 Non-Native and Invasive Plant Species

Fort Pickett will follow the most recent copy of the *Integrated Pest Management Plan* (IPMP) for the Virginia Army National Guard. This plan outlines methods of controlling pests (disease vectors, nuisance organisms, and unwanted vegetation).

The vast majority of the invasive pests present on Fort Pickett are plants. These undesirable plants include tree of heaven (*Ailanthus altissima*), poison ivy (*Toxicodendron radicans*), kudzu (*Pueraria montana*), among others. Information on the management of these species can be found in Chapter 5.

3.2 FAUNA

The unique land use and variety of habitat types at Fort Pickett provide valuable habitat for a broad range of fauna. The following section provides a detailed synopsis of the types of animals found within the installation, with an emphasis on rare/threatened species.

A comprehensive faunal survey was conducted during 1999-2000 by the Virginia Natural Heritage Program (Chazal and Derge 2001). The survey identified 25 fish species, 18 amphibians, 16 reptiles, 92 birds, 10 mammals, and numerous invertebrate species. However, several other specialized surveys have been completed to achieve a better understanding of the animals present on Fort Pickett (Table 6).

Table 6. Faunal surveys conducted at Fort Pickett

Year	Title
	Birds
1995	Birds of Nottoway, Dinwiddie & Lunenburg Counties of the Piedmont surrounding Fort Pickett, Virginia.
2000	Avian communities at Fort Pickett, Virginia.
2007	Avian atlas of Fort Pickett, Virginia.
2007	Birds of Fort Pickett, Virginia.
2010	Surveys of nesting Bald Eagle and Great Blue Herons on Fort Pickett 2008- 2010.
2012	Grassland bird density and diversity on Fort Pickett.
2012-2013	Surveys of nesting Bald Eagles at Fort Pickett.
2014	Migratory bird survey in forested habitats.
2019	2019 Bald Eagle Nest Survey on MTC Fort Pickett
	Fish
2000	A survey of the fish fauna at three sites on Nottoway River in Fort Pickett, Virginia.
2002	Survey for Roanoke Logperch, *Percina rex*, from the Nottoway River system, Chowan drainage, Virginia.
2005	Endangered species management plan for the Roanoke Logperch (*Percina rex*) at Fort Pickett, Virginia.
2005	Rapid bioassessment of the Nottoway River on Fort Pickett.
2006	Fish survey of the Nottoway River for Fort Pickett Maneuver Training Center.
2007	Fish health survey and biological assessment of the Nottoway River for Fort Pickett.
2013	Roanoke logperch surveys.
	Herpetofauna
2003	Records of amphibians and reptiles from Fort Pickett.
2005	Assessing the species richness of amphibians at Fort Pickett.
2007	Species richness of amphibians at Fort Pickett.
2007	Determining the occurrence and relative abundance of reptile species occurring in different habitat types at Fort Pickett.

Year	Title
Mammals	
2006	Bat species assemblage at Fort Pickett.
2006	Small mammal survey for Fort Pickett.
2008	Meso-mammal survey.
2015	Meso-mammal survey.
2017	Bat Survey of the Training Areas and Direct Fire Ranges.
2019	Bat Survey Report.
2020	Mist Netting, Radio Telemetry, and Emergence Surveys.
Aquatic Species	
2006	Benthic macroinvertebrate sampling in support of Land Condition Trend Analysis on Fort
2006	Freshwater mussel surveys of the Nottoway River at Fort Pickett.
2013	Macroinvertebrates.
2014	Distribution and abundance of freshwater mussels on Fort Pickett.
2020	Assessing Freshwater Mussel Assemblages and Evaluating Instream Habitat on MTC-Fort Pickett.

3.2.1 Mammals

Since the 2001 all fauna survey conducted by Chazal and Derge, individual mammal surveys have been conducted by the Conservation Management Institute at Virginia Tech (CMI)(Wolf 2006b; St. Germain 2006; St. Germain *et al.* 2008). Surveys were conducted based on size and morphology of animals, so for the purposes of this report mammal assemblages will be described based on three categories: small mammals, meso-mammals, large mammals and bats. Appendix E provides a complete list of the mammalian species believed to be present on Fort Pickett.

Mammalian species found on Fort Pickett are typical of the southern Piedmont region. Small mammals are classified as mammals that weigh less than 300g. In the 2006 small mammal report, a series of Sherman-traps and pitfall traps were used to sample small mammals in both the northern and southern training areas (Wolf 2006b). The 2006 common species trapped were the hispid cotton rat (*Sigmodon hispidus*), white-footed mouse (*Peromyscus leucopus*), and least shrew (*Cryptotis parva*). None of the species documented are listed as rare or endangered according to the Virginia Department of Conservation and Recreation (DCR).

Large and meso-mammals were documented at Fort Pickett using camera traps, predominantly in the southern training area (St. Germain *et al.* 2008). The most common large and meso-mammalian species identified were white-tailed deer (*Odocoileus virginianus*), eastern gray squirrel (*Sciurus carolinensis*), raccoon (*Procyon lotor*), opossum (*Didelphis marsupialis*), and bobcat (*Lynx rufus*) (St. Germain *et al.* 2008). Other interesting species documented include black bear (*Ursus americana*), coyote (*Canis latrans*), beaver (*Castor canadensis*), river otter (*Lutra canadensis*), and striped skunk (*Mephitis mephitis*) (St. Germain *et al.* 2008). The northern long-eared bat (NLEB, *Myotis septentrionalis*), an endangered species, has been captured during surveys in 2007 (St. Germain 2008) and 2014. The Indiana bat (*Myotis sodalis*), an endangered species, has been acoustically identified on the base (Duffey et al. 2020).

A bat survey using acoustic detectors (Anabat™) and net trapping techniques was conducted in June and July 2005 (St. Germain 2006) and 2007 (St. Germain 2008). The surveys documented the presence of eight bat species: little brown bat (*Myotis lucifugus*), NLEB, tri-colored bat (formerly eastern pipistrelle) (*Perimyotis subflavus*), big brown bat (*Eptesicus fuscus*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), evening bat (*Nycticeius humeralis*), and silver-haired bat (*Lasionycteris noctivagans*). This survey was conducted prior to white-nose syndrome affected southern Virginia and could be valuable in determining the impact it had on bat populations in the southern Piedmont.

A bat survey focusing on the training areas and direct fire ranges was conducted in 2016 (St. Germain 2017). The survey used acoustic detectors and live-capture techniques. The presence of 11 bat species were detected and all eight of the previously documented bat species were detected as well as three new species: Southeastern myotis (*Myotis austroriparius*) and the Mexican free-tailed bat (*Tadarida brasiliensis*). The number of bat calls overall had declined since the 2007 study. One state endangered species, the little brown bat, was captured and no federally endangered bats were captured.

A Phase III mist net survey was completed by Normandeau Associates, Inc. in 2019 specifically for the NLEB and Indiana bat (*Myotis sodalis*). During the survey, big brown bats (*Eptesicus fuscus*), evening bats (*Nycticeius humeralis*), and eastern red bats (*Lasiurus borealis*) were caught in the nets. No NLEB or Indiana bats were caught during the survey.

An acoustic survey of the base was conducted by GAI Consultants for EEE Consulting, Inc. in June and July of 2020. The survey prioritized identifying any NLEB and Indiana bats that might be present. The survey identified the presence of 11 species of bat including the Indiana bat at one location and multiple bat calls for the NLEB, tri-colored bats and little brown bats.

On 2 April 2015, the USFWS listed the NLEB as threatened throughout its range under the Endangered Species Act (ESA). The final 4(d) rule (81 Federal Register 1900-1922), was issued on 14 January 2016 and became effective 16 February 2016. A complete discussion of the restrictions can be found in Section 5.3.4.6, NLEB, within the chapter on Rare, Threatened and Endangered Species Habitat Management.

The NLEB was quite common and acoustically detected frequently during the 2007 planning level survey on Fort Pickett (St. Germain 2008, 2012). Six individuals were captured during this trapping survey (St. Germain 2008). Detailed analysis showed that the NLEB utilized numerous habitats across the installation (Figure 10). While they live and occur in forested environments, the majority of acoustic activity occurred over open water where they actively forage, often gleaning insects from the surface of the water or off nearby vegetation. During the 2016 survey (St. Germain 2017) the NLEB was detected more sporadically and no individuals were captured during the trapping portion of the survey.

The NLEB is irregularly distributed within its range (Schwartz and Schwartz 1981). In the east, it is found in the Florida panhandle, Alabama, Georgia, Arkansas, Kentucky, Tennessee, and northeastern Mississippi. In the north, it ranges across southern Canada and the northern United States east of the Rockies (Choate et al. 1994). This species is primarily a cave dweller, but females seem to prefer trees or barns. They hibernate from October to March and tend to return to the same caves each year. Individuals roost in deep crevices, either alone or with one or two others

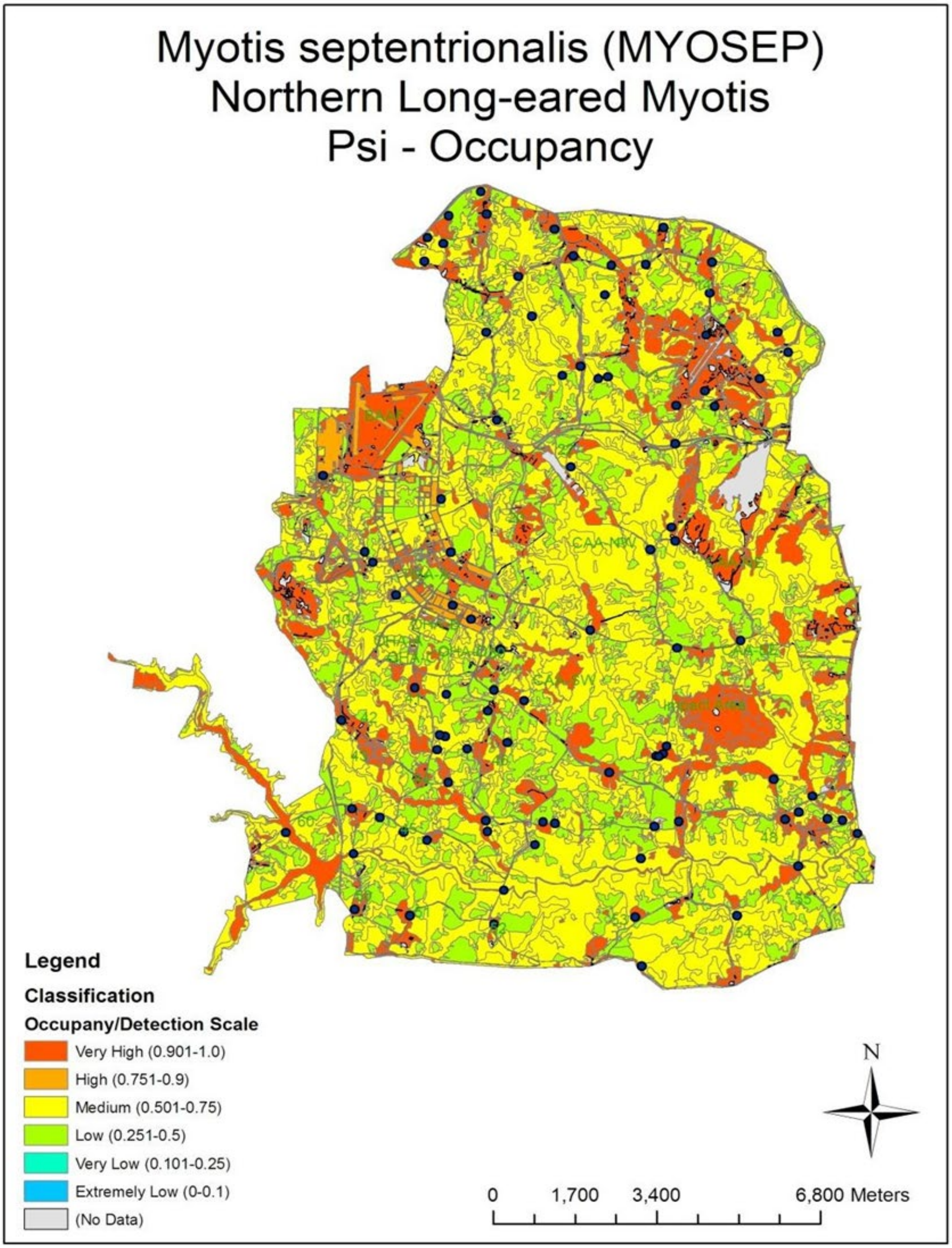

Figure 10. Species distribution map for northern long-eared bat on Fort Pickett in 2007 (St. Germain 2012) ***Dots represent sampling locations**

(Schwartz and Schwartz 1981). Northern long-eared bats may disperse 160 kilometers (100 miles) from hibernacula (Choate et al. 1994). Foraging begins just after dark and continues until just before dawn, with a bimodal peak at 1-2 hours and 7-8 hours after sunset (Sealander and Heidt 1990, Choate et al.1994). Bats forage among trees on hillsides and ridges, feeding primarily below the crowns of trees (Schwartz and Schwartz 1981). They have an estimated life span of 14 years (VAFWIS 2005).

3.2.2 Herpetofauna

The many wetlands and water bodies occurring throughout Fort Pickett provide excellent habitat for many species of amphibians and reptiles. Four surveys have been conducted on Fort Pickett for herpetofauna (Roble *et al.* 2003; Germain 2005b; St. Germain *et al*. 2007, and Wender 2016). Roble *et al*. 2003 sampled all amphibians and reptiles, documenting 23 and 30 respectively. Of the species identified, the Northern cricket frog (*Acris crepitans*), Northern spring peeper (*Pseudacris crucifer*), and pickerel frog (*Lithobates palustris*) were the most common and widespread amphibians. Interestingly, many old ditches, tank traps and foxholes that have filled with water have become excellent upland reproductive habitat for spotted salamanders (*Ambystoma maculatum*). Common reptilian fauna includes the black rat snake (*Elaphe obsoleta*), Eastern gartersnake (*Thamnophis sirtalis*), broadhead skink (*Plestiodon laticeps*), and eastern box turtle (*Terrapene carolina*). The spotted turtle (*Clemmys guttata*) was identified also identified. The copperhead (*Agkistrodon contortrix mokasen*) is the only venomous snake at Fort Pickett.

The two surveys conducted by the Conservation Management Institute (CMI) in 2005 and 2007 were intended to conduct a complete species inventory to determine the species richness of amphibians at Fort Pickett. Eighteen species were documented in 2005 and 19 species in 2007. No federally listed threatened or endangered species were encountered.

An updated survey of reptiles and amphibians was completed by Stantec (Wender 2016). A portion of the survey locations were duplicated from those conducted in previous amphibian surveys conducted by St. Germain *et al*. (2007) and St. Germain (2005). Additional locations were selected to cover all accessible areas within the base that contained potential areas of suitable habitat for amphibians and reptiles. During the survey effort, a total of 43 species of amphibians and reptiles were observed, including seven salamanders (Order Caudata), 13 frogs/toads (Order Anura), 11 snakes (Order Squamata, Suborder Serpentes), five lizards (Order Squamata, Suborder Sauria), and seven turtles (Order Testudines). Species were documented and mapped within all surveyed habitat areas. A large number of species detected during previous surveys were confirmed during the 2016 survey: amphibians, 21 out of 23 species; reptiles, 23 out of 33 species. In addition, a total of four species not previously recorded at Fort Pickett were observed: two-toed amphiuma (*Amphiuma means*), green treefrog (*Hyla cineria*), broad-headed skink (*Plestiodon laticeps*), and rough earthsnake (*Haldia striatula*). Several species that were confirmed during the 2016 survey are identified by the Virginia Department of Wildlife Resources (DWR) in Virginia's 2015 Wildlife Action Plan (WAP) list as species of greatest conservation need (SGCN): spotted turtle (Tier IIIa), woodland box turtle (*Terrapene carolina carolina*, Tier IIIa), common ribbonsnake (*Thamnophis sauritus sauritus*, Tier IVa), and snapping turtle (*Chelydra serpentina*, Tier IVb). No federally or state threatened or endangered species were encountered; however, the spotted turtle was encountered in 2003 and is currently under review by the USFWS for listing. A complete list of the herpetofauna found at Fort Pickett is in Appendix F.

3.2.3 Birds

The abundant native grasslands and shrublands occurring throughout Fort Pickett provide habitat for many species of birds throughout the year. Common grassland birds at Fort Pickett are the grasshopper sparrow (*Ammodramus savannarum*), eastern meadowlark (*Sturnella magna*), and Savannah sparrow (*Passerculus sandwichensis*). Indigo bunting (*Passerina cyanea*) and field sparrow (*Spizella pusilla*) are common shrubland constituents (Murray *et al*. 2000). The Nottoway River floodplain forests support a wide variety of warblers and neotropical migratory songbirds such as the American redstart (*Setophaga ruticilla*) and prothonotary warbler (*Protonotaria citrea*).

Although the cerulean warbler (*Setophaga cerulea*) and Bachman's sparrow (*Peucaea aestivalis*) have been documented on Fort Pickett, biologists conducted surveys for cerulean warblers and Bachman's sparrows (CMI 2011) and did not detect either species. There have been confirmed nesting bald eagles (*Haliaeetus leucocephalus*) on Fort Pickett since 1999. Currently, there may be four active bald eagles' nests on the installation.

A grassland bird survey was conducted in 2010-2011 and nine avian SGCN associated with grassland habitats on the installation were detected. These species include the brown thrasher (*Toxostoma rufum*), eastern kingbird (*Tyrannus tyrannus*), eastern meadowlark, eastern towhee (*Pipilo erythrophthalmus*), field sparrow, grasshopper sparrow (*Ammodramus savannarum*), northern bobwhite quail (*Colinus virginianus*), and yellow-breasted chat (*Icteria virens*) (St. Germain and Schneider 2012). A survey for migratory birds utilizing forested habitats was completed in 2015.

Appendix G provides tables of migratory birds that may occur at Fort Pickett and all the bird species documented during the grassland study. A copy of the memorandum of understanding (MOU) between the DoD and the USFWS to promote the conservation of migratory birds and the "Technical Recommendations for Military Lands" (Bart *et al*. 2012) is also included. These agreements discuss the protection and management of migratory birds on DoD installations.

3.2.4 Aquatic Vertebrate Fauna

The Nottoway River and Butterwood Creek from the Twin Lakes downstream have been designated as Threatened and Endangered Species Waters due to the presence of the federal and state endangered Roanoke logperch. A fish survey of the Nottoway River was performed in 2005-2006 by CMI (Wolf, 2006). Surveys were conducted on two sections of the Nottoway River. Sampling occurred along 500-foot-long stretches at the Range Road site (Reach A) and the Tower Road site (Reach B). A total of 26 species of fish were collected. The dominant species in both reaches was the bull chub (*Nocomis reneyi)* with the satinfin shiner (*Cyprinella analostana*) and swallowtail shiner (*Notropis procne*) being the next most abundant species. There were four species of darter collected at each site with the glassy darter (*Etheostoma vitreum*) being the most abundant. Two Roanoke logperch were also counted during subsequent targeted inventory surveys using shocking. More information on the types of fish located in the Nottoway River can found in Appendix H.

3.2.5 Aquatic Invertebrate Fauna

The varied terrestrial and aquatic habitats at Fort Pickett have led to a diverse array of invertebrate fauna. Of particular interest are freshwater mussels, located in the Nottoway River and in other water bodies throughout Fort Pickett (Table 7). The Atlantic pigtoe mussel (*Fusconia masoni*), dwarf wedgemussel (*Alasmidonta heterodon*), yellow lance mussel (*Elliptio lanceolata*) and green floater (*Lasmigona subviridis*) are species of note found in the Nottoway River and its tributaries. Appendix I provides a list of invertebrate fauna found within the boundaries of Fort Pickett.

Table 7. Freshwater mussels documented in the Nottoway River on Fort Pickett

Common name	Scientific name	Federal Status	State Status
Dwarf wedge mussel *	*Alasmidonta heterodon*	Endangered	Endangered; Ia
Triangle floater	*Alasmidonta undulata*	n/a	IVa
Eastern elliptio complex	*Elliptio complanata/congerea*	n/a	n/a
Carolina slabshell	*Elliptio congarea*	n/a	n/a
Yellow lance *	*Elliptio lanceolata*	Threatened	IIa
Atlantic pigtoe	*Fusconia masoni*	Threatened	Threatened; Ia
Eastern lampmussel	*Lampsilis radiata*	n/a	IVa
Eastern floater	*Pyganodon cataracta*	n/a	n/a
Giant floater	*Pyganodon grandis*	n/a	n/a
Creeper	*Strophitis undulatas*	n/a	IVa
Paper pondshell	*Utterbackis imbecillis*	n/a	n/a
Notched rainbow	*Villosa imbecillis*	n/a	III a

* Species not encountered during CMI surveys on Fort Pickett.

WAP Tiers: Tier I- Critical conservation need; **Tier II**- Very high conservation need; **Tier III**- High Conservation Need; **Tier IV**- Moderate Conservation Need; Conservation Opportunity Ranking (a, b, or c): **a** -Managers have identified "on the ground" species or habitat management strategies expected to benefit the species; at least some of which can be implemented with existing resources and are expected to have a reasonable chance of improving the species' conservation status; **b** - Managers have only identified research needs for the species or managers have only identified "on the ground" conservation actions that cannot be implemented due to lack of personnel, funding, or other circumstance; **c** - Managers have failed to identify "on the ground" actions or research needs that could benefit this species or its habitat or all identified conservation opportunities for a species have been exhausted.

The greatest diversity of freshwater mussels in the world is found in North America with nearly 300 species. Freshwater mussels are filter-feeding bivalves that live relatively sedentary lives, with many species known to have life spans exceeding 25 years. They have a unique life history that requires the larval stage (i.e., glochidia) to parasitize a host fish to complete its life cycle and distribute throughout river systems. Considered freshwater ecosystem engineers, mussels play key ecological roles with their ability to filter large portions of the water column through their gills and modify habitat. They provide physical habitat and serve as food sources to other animals, supply nutrients to the water column through nutrient cycling, remove silt and pollutants from the water column, and stabilize substrates. Because of their sensitivity to environmental change, they are considered useful indicators of water quality and aquatic ecosystem health (Vaughn *et al*. 2008). Unfortunately, mussel populations have declined significantly in the last 50 to 100 years due to habitat loss and degradation, with over 70% of the species found in North America listed as endangered, threatened, of special concern, or extinct - making them the most imperiled taxa in the United States (Williams *et al.* 1993).

Mussels that occur in streams that flow into the Atlantic - from the James River basin in Virginia south to the Satilla River basin in Georgia - belong to the Southern Atlantic province of the Atlantic Slope biogeographical faunal region. This province contains 46 species of freshwater mussels, 27 of which are known to occur (or have historically occurred) in the Chowan River basin (Bogan 2002; Alderman 2005; Alderman and Alderman 2009; Haag 2012). The upper Nottoway River is located within the Chowan River Basin and stretches across the southern end of Fort Pickett. Surveys conducted by the CMI in 2006, 2007, and 2014 have identified 10 species (Table 6) within the mainstem and tributaries of the Nottoway River on Fort Pickett (Wolf 2006, 2008; Carey 2014). These include the Atlantic pigtoe, which is federally threatened and state threatened. The 2014 assessment included surveys in tributaries that feed into the Nottoway and sites above the reservoir on Fort Pickett. This assessment found one additional species, the eastern floater, which had not been found in past surveys on Fort Pickett. The USFWS indicates that the range of the dwarf wedgemussel includes Fort Pickett; however, DWR indicates that both known observations were upstream of Fort Pickett in the Nottoway River. The yellow lance has previously been documented in this stretch of the Nottoway (DWR database); however, none have been encountered in the CMI surveys on Fort Pickett. The yellow lance is a Federally threatened species and is listed as Tier IIa (very high conservation need) in the WAP.

In 2018 and 2019 CMI conducted a survey for freshwater mussels within the Nottoway River and its tributaries within Fort Pickett and evaluated instream habitat (Carey, C.S., and V.R. Emrick. 2020). New reaches of Tommeheton and Birchin creeks containing mussels were identified. As in previous studies, the Eastern Elliptio (complex) species was the most abundant species identified. Eight previously identified mussel species were confirmed, however neither the Atlantic pigtoe nor the yellow lance were documented.

The USFWS has designated the Nottoway River as critical habitat for the yellow lance and the Atlantic pigtoe. However, because the 14 river miles (22.5 river km) segment of the Nottoway River that passes through Fort Pickett is subject to the conservation efforts identified in this INRMP, streams on the installation were declared exempt from the critical habitat designation under section 4(a)(3) of the Endangered Species Act.

An invertebrate rapid bioassessment was completed by CMI and the Entomology Department at Virginia Tech in 2005 and 2013 (Wolf 2005c; Wolf and Emrick 2013). Biological survey techniques like the Environmental Protection Agency (EPA) Rapid Bioassessment Protocol (RBP) Benthic Macroinvertebrate Protocols (Barbour *et al.* 1999) can be a fundamental source of information for the evaluation of watershed conditions and for the management of aquatic resources. Please refer to Chapter 5.5 for more information.

3.2.6 Rare, Threatened and Endangered Fauna

Five federally protected species, NLEB, Indiana bat, Roanoke logperch, Atlantic pigtoe, and yellow lance, as well as three additional State protected species, little brown bat, tri-colored bat and Bachman's sparrow occur within the boundaries of Fort Pickett. Table 8 presents the rare, threatened, and endangered species known to occur within the boundaries of Fort Pickett and their federal, state, and Natural Heritage Program classifications. Detailed species accounts and management actions for selected species can be found in Chapter 5.

3.2.7 Non-Native and Invasive Fauna

Recently, feral hogs were detected on Fort Pickett. It is believed these feral hogs had escaped from a neighboring property and are now living on Fort Pickett property. No feral hogs were found on Fort Pickett during the meso-mammal study completed in 2015. It was determined that the above-referenced hogs infrequently visited the site.

Table 8. Summary of rare, threatened, and endangered fauna at Fort Pickett

Common Name	Scientific Name	Federal Status	State Status	Global/ State Rank	WAP
Roanoke logperch	*Percina rex*	Endangered	Endangered	G2/S1S2	IIa
Bachman's sparrow	*Aimophila aestivalis*	n/a	Threatened	G3/S1B	Ia
Little brown bat	*Myotis lucifugus lucifugus*	n/a	Endangered	G3/S1S2	Ia
Tri-colored bat	*Perimyotis subflavus*	n/a	Endangered	G3/S1S2	Ia
Northern long-eared bat	*Myotis septentrionalis*	Threatened	Threatened	G1G2/S1S3	Ia
Indiana bat	*Myotis sodalis*	Endangered	Endangered	G2/S1	Ia
Atlantic pigtoe mussel	*Fusconia masoni*	Threatened	Threatened	G2/S2	Ia
Eastern lampmussel	*Lampsilis radiata*	n/a	n/a	G2/S2	IVa
Yellow lance	*Elliptio lanceolata*	Threatened	n/a	G3/S2S3	IIa
Spotted turtle	*Clemmys guttatta*	Under review	n/a	G5/S4	IIIa

Global and State Ranks: G/S1 - Critically imperiled in the state because of extreme rarity or because of some factor(s) making it especially vulnerable to extirpation from the state. Typically, 5 or fewer populations or occurrences; or very few remaining individuals (<1000). **G/S2** - Imperiled in the state because of rarity or because of some factor(s) making it very vulnerable to extirpation from the state. Typically, 6 to 20 populations or occurrences or few remaining individuals (1,000 to 0). **G/S3-**Vulnerable in the state either because rare and uncommon, or found only in a restricted range (even if abundant at some locations), or because of other factors making it vulnerable to extirpation. Typically, 21 to 100 populations or occurrences (1,000 to 0). **G/S4** - Apparently secure; Uncommon but not rare, and usually widespread in the state. Possible cause of long-term concern. Usually>100 populations or occurrences and more than 10,000 individuals. **G/S5** - Secure; Common, widespread and abundant in the state. Essentially ineradicable under present conditions. Typically, with considerably more than 100 populations or occurrences and more than 10,000 individuals.

WAP Tiers: Tier I- Critical conservation need; **Tier II**- Very high conservation need; **Tier III**- High Conservation Need; **Tier IV**- Moderate Conservation Need;

Conservation Opportunity Ranking (a, b, or c): a -Managers have identified "on the ground" species or habitat management strategies expected to benefit the species; at least some of which can be implemented with existing resources and are expected to have a reasonable chance of improving the species' conservation status; **b** - Managers have only identified research needs for the species or managers have only identified "on the ground" conservation actions that cannot be implemented due to lack of personnel, funding, or other circumstance; **c** - Managers have failed to identify "on the ground" actions or research needs that could benefit this species or its habitat or all identified conservation opportunities for a species have been exhausted.

4.0 MILITARY MISSION

Fort Pickett supports the 56th Stryker Brigade Combat Team (SBCT), 116th Infantry Brigade Combat Team (IBCT), Heavy Brigade Combat Team (HBCT), 329th Regional Support Group (RSG), 29th Infantry Division, 77th Troop Command, Regional Training Institute, 80th Training Division, XVIII Air Corps, 49th Quartermaster Group, 7th Sustainment Brigade, Naval Special Warfare Group 2, Naval Expeditionary Combat Command (NECC), 2nd Marine Division, and National Guard and Reserve Component units from the Mid-Atlantic region. The major training missions include individual and crew served weapons qualification, maneuver training, Training Aids Devices Simulators, and Simulations (TADSS), and logistical support facilities for Inactive Duty Training (IDT), Annual Training (AT), and pre-mobilization training (PMT). Fort Pickett habitually supports the Warrior Training Center Air Assault Course, the Rappel Master Course, and the U.S. Army Forces Command Petroleum Training Module. (RCMP 2017).

4.1 VIRGINIA NATIONAL GUARD MISSION

<u>The federal mission of the VAARNG is:</u>

Provide trained and equipped units to augment the active Army during times of war, national emergency, or Presidential Selected Reserve Call-up.

<u>The state mission of the VAARNG is:</u>

Provide units to assist civil authorities in protecting life and property and preserving peace, order, and public safety during periods of natural or man-made disaster.

The VAARNG has served community, commonwealth, and country since 1607. Many of the 7,500 Soldiers of the VAARNG have recently or are currently serving on active federal duty across the United States and around the world. The VAARNG also continues to answer the call to community and state service as well.

In Virginia, the VAARNG is headquartered at Fort Pickett in Blackstone, Virginia, supporting approximately 99 units which are distributed throughout the Commonwealth at approximately 62 separate locations.

<u>The VAARNG is implementing ARNG 4.0:</u>

ARNG 4.0 prepares the ARNG to quickly and effectively meet the nation's 21st Century security challenges by maintaining higher readiness, prioritizing efforts, and enhancing force capabilities. ARNG 4.0 will enhance current force structure, increase enabler capacity, and invest in future capabilities by increasing select ARNG units beyond the traditional one weekend per month and two weeks during the summertime commitment. These units are expected to increase and maintain the highest levels of personnel and training readiness.

4.2 CURRENT TRAINING LAND CONDITION

Fort Pickett's training lands are conducive to supporting a wide spectrum of military training; everything from heavy armor maneuver to light infantry, including rotary wing and Unmanned Air System (UAS) aviation operation (Figure 11). Through an active Training Requirements Integration process, Fort Pickett managers continually monitor and sculpt maneuver areas to meet the ever-changing mission-scape requirements of Army forces (RCMP 2017).

Fort Pickett will continue to develop the northern maneuver areas as an open-grasslands heavy maneuver box of slow-rolling low hills, interspersed with forested riparian buffers, significant tracts of mature forest, an extensive improved and unimproved road network, a 15-second drop zone, and a dirt surface. This maneuver box is anchored on one end to the Multi-Purpose Range Complex. This allows a maneuver commander to develop a maneuver training plan ranging from full-spectrum to counterinsurgency operations that can culminate in a live-fire exercise (RCMP 2017).

The southern maneuver areas are being maintained as predominately heavily forested, with more distinct rolling hills, cut by stream courses, natural swamps, and the Nottoway River valley. These southern areas are tied to the Infantry Platoon Battle Course (IPBC), which allows a maneuver commander the same flexibility in planning maneuver training that may culminate in live-fire, with the added capability of incorporating live call-for- fire and live close air support into the Dedicated High-Hazard Impact Area. Both the northern and southern areas are interspersed with artillery firing points, helicopter landing zones, and mock villages that support all types of training. The ITAM Program continually maintains these maneuver areas so to keep them available and accessible to training units as much as possible (RCMP 2017).

4.3 HEAVY VEHICLE AND LIGHT INFANTRY MANEUVER TRAINING AREAS

Maneuver training areas provide training acreage for military units that may or may not be force-on-force training. At Fort Pickett, there are 25,130 acres available for light and heavy maneuvers (Range and Training Land Program Development Plan 2001). The northernmost training area (areas 11 through 14) is utilized primarily for heavy maneuver and tactical training. Very few live-fire exercises occur in this area, except for indirect artillery firing.

Areas 40 through 55 contain the southernmost training areas. Live artillery fire mostly occurs in this part of the installation, and many artillery firing points are located throughout these areas. Area 60 is located around the Fort Pickett Reservoir. Riverine training operations are completed on the reservoir for naval units using small watercraft, but for the most part Area 60 receives little activity.

The Cantonment Area is primarily where supply, storage, housing, and office buildings are located. It is the primary business area of Fort Pickett. Some light maneuver training and limited water operations take place here.

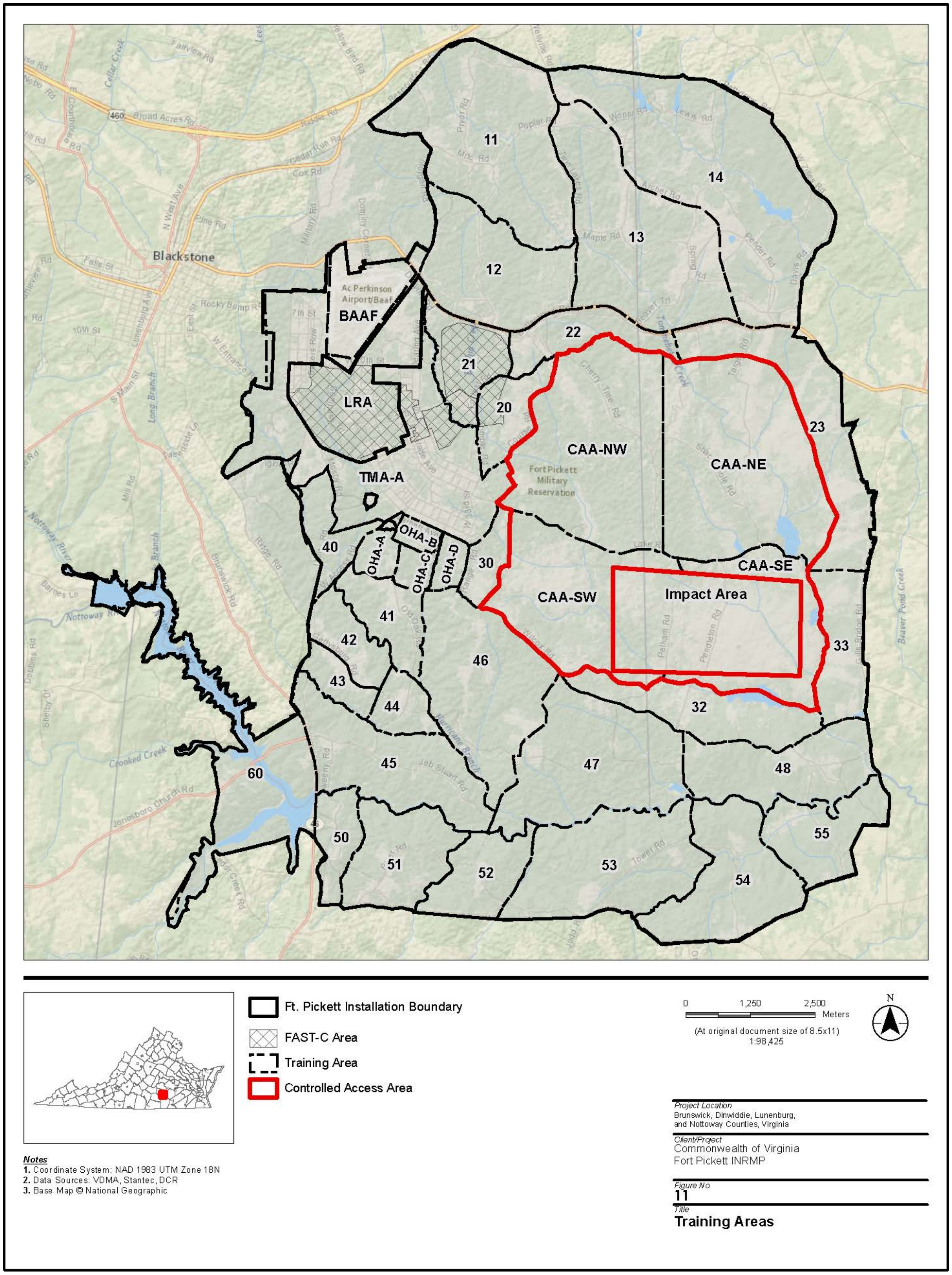

Figure 11. Fort Picket Training Areas

4.4 LIVE FIRE TRAINING

Units training at Fort Pickett are capable of firing all weapons in the Army's inventory apart from air defense weapons in an air defense mode. The Multipurpose Range-Complex (MPRC), located within the CAA, is a multi-lane live-fire maneuver range used to train and qualify individuals, crews, units separately or with other vehicles, units, and/or weapons systems. The MPRC facility consists of multiple vehicle driving and engaging lanes for firing 105 mm and 120 mm tank cannons, 25 mm cannons and TOW missiles. The MPRC is fully automated with state-of-the-art targets and computer scoring. The range is the only MPRC owned and controlled by the Army National Guard in the Mid-Atlantic region. This range has greatly improved the readiness posture of enhanced brigades and other units. There are numerous direct fire training ranges on Fort Pickett, and they are listed in Table 9.

Table 9. Live-fire ranges at Fort Pickett (2020).

Range	Authorized weapons/ammunition
2	5.56 mm and below
3	LAW (SVC, SUBCAL), M203, 40MM HE,AT4 (SVC SUBCAL)
4B	Breaching charge
4Z	5.56 mm and below, 7.62mm sniper
5	9 mm pistols
6	5.56 mm
7	5.56 mm
8	7.62 mm and below
9	5.56 mm and below
10	N/A
11	.50 Cal sniper and below
12	.50 Cal and MK19
13	.50 Cal and below
14	5.56 mm
15 MPRC	120 mm and below
16	120 mm TPT & TPDS, TPDS-T, 105 mm TPT, .50 Cal and below
17/17P	40mm TP only
17 HG	HE Grenades, Claymore Mines
18	7.62 mm and below
18 NS	5.56 mm and below
19	7.62 mm and below, .50 cal sniper
20	.50 cal and below

Range	Authorized weapons/ammunition
21 IPBC	.50 cal and below, 25mm, 40mm TP
CACTF	Blanks/smoke grenades/ booby traps
UAC	5.56 mm and below
Shoothouse	5.56 mm (no EPR) and below
Longstreet Convoy Live Fire	7.62 mm and below
OP-3/FP 32B	TOW/Mortar/ARTY .50 cal and below
OP-4/ FP 33B	TOW/Mortar, .50 cal and below
OP-6/FP 33E	TOW/Mortar, .50 cal and below
MA46 DEMO	Charges up to 58 lbs, no steel cutting
HELO Door Gunnery	2.75 rockets and below
CIED	Blanks/training rounds

4.5 INDIRECT FIRE TRAINING

Fort Pickett has over 75 indirect firing points (Figure 12) capable of supporting mortars, cannon, and multiple launch rocket systems (MLRS).

4.6 AIRBORNE DROP ZONES

Fort Pickett supports a variety of airborne operations at two drop zones (Table 10). Drop zone capabilities include static line (SL), high altitude low opening (HALO), high altitude high opening (HAHO), container delivery system (CDS), heavy equipment (HVYEQ) and low altitude parachute extraction system (LAPES). The Castles drop zone is not regularly maintained.

Table 10. Drop zone capabilities at Fort Pickett

Drop zone	Drop zone capabilities
Blackstone	SL, HALO, HAHO, CDS, HVYEQ, LAPES
Castles	SL, HALO, HAHO, CDS, HVYEQ, LAPES

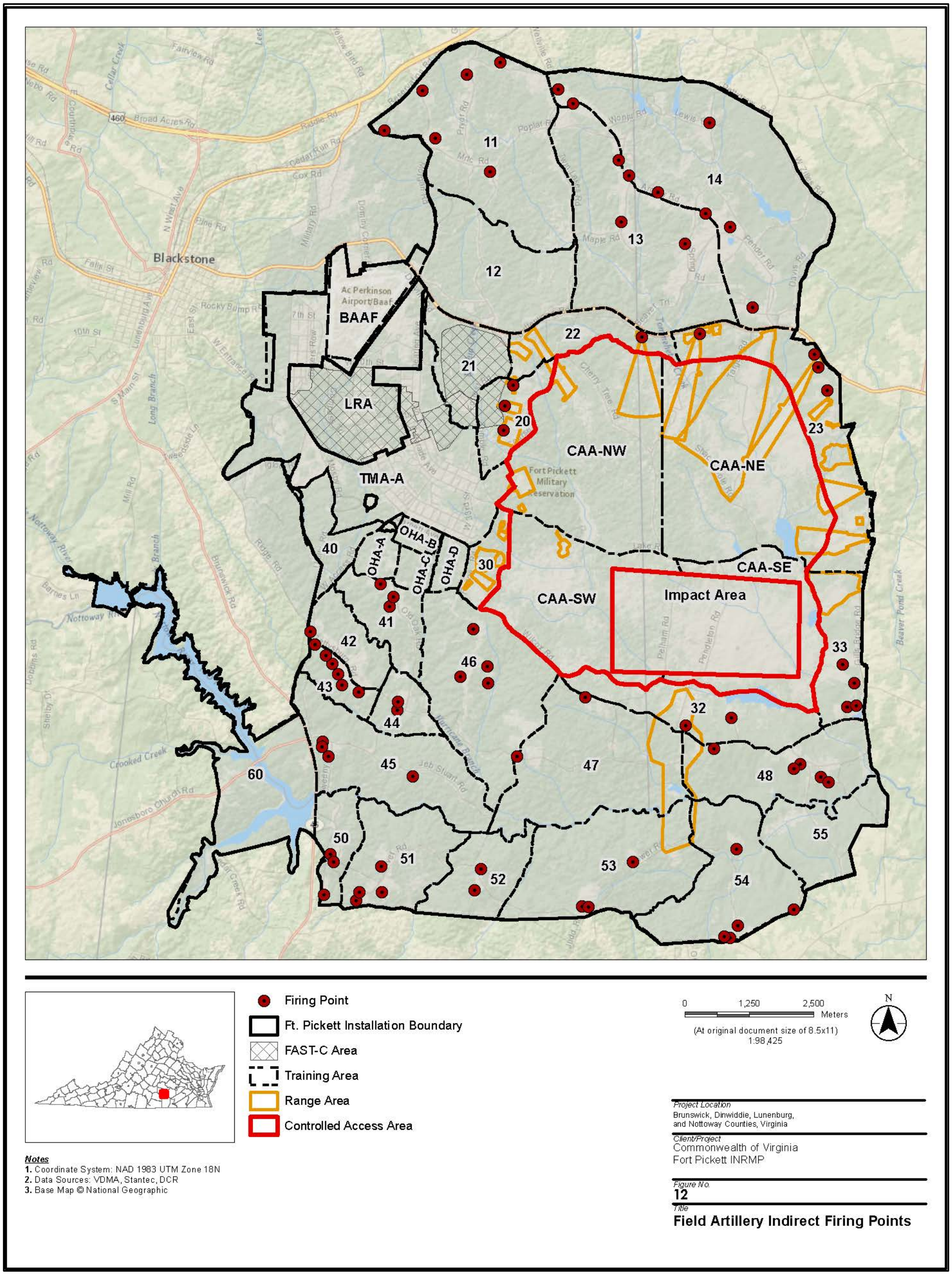

Figure 12. Field Artillery Firing Points

4.7 OTHER MILITARY TRAINING FACILITIES

The main training facilities available on Fort Pickett are described below. Table 11 contains a list of other miscellaneous facilities.

Table 11. Other training facilities at Fort Pickett

Training Facilities
Air Assault Training Site
Call For Fire Trainer III (CFFT)
Confidence Course/Air Assault Obstacle Course
Counter-Improvised Explosive Device Lane (CIED)
Engagement Skills Trainer - EST 2
Engineer Bridge Site/Engineer Training Site
Hand-to-Hand Pit
High-Moblility Multi-purpose Wheeled Vehicle (HMMWV) Egress Assistance Trainer (HEAT)
Mine-Resistant Ambush Protected (MRAP) Egress Trainer (MET)
Land Navigation Expert Infantrymen Badge (EIB)
Land Navigation North
Land Navigation South
Leadership Reaction Course (LRC)
Nuclear, Biological, and Chemical (NBC) Facility
Rappel Tower
Search and Extraction Training Area (SETA)
SMOKE OPERATIONS
Training Villages - Eight (8)
Unmanned Aircraft Systems /Unmanned Aerial Vehicle (UAS/UAV)
Virtual Battlespace 3 (VBS3)

Multipurpose Range-Complex (MPRC)

The MPRC, located within the CAA, is a multi-lane live-fire maneuver range used to train and qualify individuals, crews, units separately or with other vehicles, units and/or weapons systems. The MPRC facility consists of multiple vehicle driving and engaging lanes for firing 105 mm and 120 mm tank cannons, 25 mm cannons and TOW missiles. The range is fully automated with state-of-the-art targets and computer scoring. The range is the only MPRC owned and controlled by the Army National Guard in the Mid-Atlantic region. This range will significantly improve the readiness posture of enhanced brigades and other units.

<u>Infantry Platoon Battle Course (IPBC)</u>

This project was completed in 2007. The IPBC (Range 21) lane is a three by one-kilometer maneuver lane capable of supporting combined arms live-fire exercises. This training is in a live-fire mode, with the use of all supporting arms being brought to bear on the objective. It supports all types of live-fire training, both air and ground, direct and indirect.

<u>Water Purification Training Sites</u>

Fort Pickett has permitted multiple water sites that, through utilization of best management practices, will be capable of supporting water purification training in an environmentally safe manner.

<u>Urban Assault Course (UAC)</u>

The UAC is a five-station facility consisting of an individual and team trainer, a squad and platoon trainer, a grenadier gunnery trainer, an offense and defense house and an underground trainer. The facility is used to train and evaluate individual and small unit collective tasks in an urban environment.

<u>Urban Breach Facility (UBF)</u>

The UBF trains soldiers to enter buildings using various breaching techniques. Mechanical, ballistic, thermal, and explosive breaching may be used in this facility.

<u>Shoothouse</u>

The Shoothouse is a live-fire facility designed to train soldiers in individual and small unit techniques of close quarters combat in an urban environment.

<u>Forward Operating Base (FOB)</u>

The FOB is an approximately 10 to 12-acre earthen wall-contained site designed to train soldiers and units in the conduct of tactical operations when deployed to remote forward operating bases.

<u>Longstreet Light Maneuver Corridor</u>

The Longstreet Light Maneuver Corridor is oriented east to west through Maneuver Areas 50-55 and will allow Light Infantry and wheeled vehicle units to conduct squad/platoon/company operations. Terrain will be manipulated through ITAM and Forestry thinning activities to create a minimum of 50% “GO” terrain through the corridor.

4.8 FUTURE TRAINING REQUIREMENTS AND PLANNED FACILITIES

<u>The Northern Maneuver Areas</u>

Fort Pickett managers will continue to create and expand the open-grasslands type acreage, known as the Wonju Heavy Maneuver Corridor. This is a multi-year, ongoing project that is a highly integrated land reconfiguration process involving close coordination between NGVA-MTC-OP (Range and Training Land Program (RTLP) and ITAM), Forestry, and the Environmental Office. The NGVA-MTC-OP and Range Officer identify areas to be reconfigured from forested to open grasslands. The Forestry Office coordinates and executes the timber harvest. The Environmental Office ensures regulatory compliance. ITAM completes the reconfiguration by mechanically grinding the harvested tracts, stabilizing, and revegetating the mulched areas, installing low water crossings through forested riparian buffers, etc. (RCMP 2017).

<u>Southern Maneuver Areas</u>

Fort Pickett managers will maintain the current balance of open and forested lands, which are geared to primarily support dismounted, light vehicular, and artillery training. The heavily forested southern areas include several tracts of planted pine plantations.

Range Operations coordinated with Forestry to begin a regime of heavy thinning of these pine tracts, with the goal of establishing upland-pine savannahs, with a very low tree density, scattered throughout the mature hardwood forests. This type of cover will be conducive to a fire-based management, and add a unique, very maneuverable component to the forested maneuver training areas. One exception to this management plan for the southern areas was the harvest of approximately 155 acres of timber in Maneuver Area-5 during fiscal year 2011 to enhance and support an unimproved-surface unmanned aircraft system (UAS) flight strip.

<u>Aerial Herbicide Application to Remove Obstructing Vegetation within the Live Fire Impact Area</u>

Fort Pickett prepared an Environmental Assessment (2014) to address the impacts associated with correcting the degradation and possible cessation of artillery operations on the installation. The proposed action was to clear the line of sight by removing obstructing vegetation within the CAA to facilitate artillery operations and military readiness. To effectively use these OPs for observing indirect fire, conducting direct fire, aerial gunnery, and other operations, the removal of obstructing vegetation on approximately 477 acres in the vicinity of the DHHIA is necessary to ensure the military readiness of ground forces. This area is a permanently dudded, high-hazard impact area where methods of mechanical or hand control/clearing would present a risk to human life. The only viable and safe option that the Army has found for removing vegetation from the DHHIA is the aerial application of herbicide. After the encroaching trees are sprayed, they will gradually be eliminated by weather and wildfire and will revert to a predominately shrubby plant community.

<u>Foreign Affairs Security Training Center (FASTC)</u>

The FASTC provides security training for Department of State and other U.S. government staff posted at American embassies overseas along with a small number of foreign security personnel. The U.S. General Services Administration (GSA) and Department of State (DOS) officials began a conversation in 2010 with Fort Pickett and representatives from Nottoway County regarding approximately 1,500 acres of land on and near Fort Pickett as a possible site for FASTC (U.S. Department of State 2011). The final decision to establish the FASTC at Fort Pickett was made in April 2014. A Final Environmental Impact Statement (FEIS) was completed in April 2015 and a Record of Decision was released in May 2015. By February 2016 construction had commenced with the land in phase one being cleared. The FASTC was officially opened on 14 November 2019.

5.0 NATURAL RESOURCES PROGRAM MANAGEMENT

Natural resources management activities on DoD owned or leased lands must follow and adhere to ecosystem management principles while supporting the military training mission (DoDM 4715.03). The Fort Pickett INRMP has been developed and designed to accomplish these mandates and be a blueprint for ecosystem management. As a result, many of the management actions and plans contained within this chapter are complimentary and mutually supportive (e.g., prescribed fire management, endangered species management, and forest management).

The development of this INRMP for Fort Pickett is considered a major federal action and therefore is subject to the NEPA process. The NEPA process has been fully integrated into the development of every management plan. The environmental effects of all management actions, concepts, and activities were considered during the development of this INRMP. As a result, changes were made, concepts altered and/or rejected, and mitigation measures incorporated into the plans before finalization, with the express purpose of ameliorating any negative environmental or ecological effects from the proposed management actions.

This chapter includes monitoring and management practices that directly affect soil, water, vegetation, and fauna. The ecosystem management approach of the Fort Pickett INRMP is designed to foster healthy, native ecological systems using natural cycles, while allowing for human use at levels that do not result in long-term ecological degradation. Adaptive management is an integral part of the ecosystem management approach and involves the implementation of management practices and policies that may have unpredictable short- and long-term results. Management decisions are based on experience, ecological concepts, and scientific inquiry, as well as feedback from ongoing ecosystem monitoring programs.

The purpose of this chapter is to present the natural resources program structure at Fort Pickett and discuss management issues as well as concerns. Resource programs at Fort Pickett are discussed below and include the following:

- Forest Management
- Nongame Wildlife Management
- Rare, Threatened, and Endangered Species & Habitat Management
- Fish and Game Management
- Water Quality Management and Wetland Conservation
- Integrated Pest Management
- Sustainable Range Program
- Recreation Management
- Public Outreach Management
- Cantonment Area Management
- Climate Change
- Enforcement

5.1 FOREST MANAGEMENT

5.1.1 Goals and Objectives

The goals and objectives of forest management on Fort Pickett are summarized in Table 12 below.

Table 12. Forest Management Goals and Objectives

GOALS	OBJECTIVES
Support and enhance the military training mission and meet military natural resource stewardship requirements.	Practice responsible timber harvesting that integrates and supports training land while maintaining a healthy and natural forest ecosystem (i.e., consideration of endangered species, migratory birds, water quality, cultural resources, as well as Watershed and Nottoway River Protection Zones).
	Develop, maintain, and utilize current forest inventory data to effectively manage the forest.
	Incorporate mission-critical issues with forest management.
PRESCRIBED FIRE MANAGEMENT	
Maintain and improve training suitability and sustainability.	Implement prescribed fire on a minimum of 2,000 acres/ year.
Increase and improve rare and endangered species habitat.	Ensure that all Michaux's sumac colonies are subjected to fire (prescribed or training caused) at least once every three years.
Increase overall installation biodiversity.	Ensure that all open grasslands and shrublands are subjected to fire (prescribed or training caused) at least once every three years.
Reduction in natural fuel accumulation.	Use existing vegetation/land-use maps to develop a GIS map of wildland fire-carrying fuel types for Fort Pickett for use in standard fire spread geospatial models.
Improve productivity of forests.	Identify and map critical areas of Fort Pickett where fuel reduction burns are required to maintain safe training conditions and ensure training caused wildfires do not jump to adjacent private property.
	Revise, update, and identify manageable burn units in a geodatabase. Each burn unit will have at least one long- term goal identified.
	Identify Fort Pickett prescribed fire working group.

5.1.2 Introduction

Forest management at Fort Pickett uses the best science available to restore and maintain healthy ecosystems, both their functions and their values. The forested landscapes at Fort Pickett will be managed to support the military training mission by providing ideal military training sites while protecting the health and integrity of the ecosystem and adding successional forest stage diversity to the forested landscape of Fort Pickett. A diverse forest resource is considered as part of effective ecosystem management. The Forestry Department coordinates closely with the ITAM Manager to ensure annual military mission-related land management goals are achieved. Forest products will continue to be removed in commercial quantities to fulfill military training requirements in a manner that maintains ecosystem health. Fort Pickett will continue to be an open installation with adequate forest cover to provide ample maneuver training sites, noise attenuation, wildlife habitat, clean water, and desirable aesthetic conditions. Each of these attributes supports Fort Pickett's mission of preparing troops for real world missions and protecting the natural environment.

In addition to silvicultural activities designed to improve the training environment, prescribed fire will be used and integrated with forest management activities to enhance and maintain valuable training land (see Appendix K: Prescribed Fire Management Program for more details). The use of prescribed fire will create and maintain unique fire-dependent plant communities that are rare in Virginia and the southeastern United States. These plant communities support a wide variety of indigenous flora and fauna, much as they were before European settlement. Fort Pickett shall consult with the USFWS to determine whether activities within the installation may affect a listed endangered or threatened species. If Fort Pickett determines, through a biological assessment (BA) or other review, that an activity is likely to adversely affect a listed species, Fort Pickett shall submit a request for formal consultation to the USFWS. Upon completion of formal consultation, the USFWS will prepare a biological opinion (BO), which will state whether Fort Pickett has insured those activities are not likely to jeopardize the continued existence of a listed species.

Fort Pickett falls entirely within the Piedmont physiographic province. The Piedmont of southside Virginia is an ancient peneplain that gently slopes to the south and east. The installation itself has many broad, gently undulating to nearly level ridgetops that are ideal for active forest management and military training. Near the Nottoway River and other main drainages, several small tributaries have cut deep V-shaped valleys that have narrow steep slopes. These areas are not suitable for mechanized military training and provides challenges to tree harvesting activities due to the difficulty of operating heavy equipment in adverse terrain conditions. The soils of Fort Pickett are generally deep, well-drained loams that overlay granite and granite gneiss bedrock (see Chapter 2 for more information on the soils and bedrock geology). The combination of deep loam soils, a favorable climate and accessibility to large blocks of land makes Fort Pickett ideal for military training and timber production. In addition, its forests are ecologically, culturally, and environmentally significant resources worthy of conservation. Because of multiple demands placed upon the forest resources of Fort Pickett, sound ecosystem-based management of these resources is critical.

In 2015, the USFWS listed the NLEB as threatened throughout its range under the ESA. During their active season they inhabit forests all along the east coast and roost singly or in colonies in trees either underneath bark, in cavities, or in crevices of trees. The final rule issued by the USFWS prohibits incidental take within a hibernaculum and as the result of tree removal within 0.25 miles of a known hibernaculum, or within 150 feet of a known occupied maternity roost tree between June and 31 July. While there are no hibernacula or maternity roost trees known to exist on Fort Pickett, the potential presence of the NLEB in the summer months within many forested areas in Virginia requires that certain actions be taken in order to comply with the ESA. See Section 5.3.4.7 NLEB Management for more information. The Indiana bat (*Myotis sodalis*), an endangered species, has been acoustically identified on the base (Duffey, et al. 2020).

The state endangered little brown bat and tri-colored bats have also been identified on Fort Pickett during the summer months. The DWR recommends no tree removal from 1 April through 1 October of any year and/or coordination with the DWR mammologist, to cover take per the DWR issued "Best Management Practices for Conservation of Little Brown Bats and Tri-colored Bats", a copy of which is included in Appendix O.

5.1.3 History of Forest Management at Fort Pickett

Management of the forest resources on Fort Pickett has occurred since Native Americans used the land for their sustenance. Historically, European settlers practiced subsistence farming and grew tobacco as a cash crop. Timber became an important crop in the early to mid-1930s and was second to tobacco in its economic impact on the region (Godburn 1977).

On 2 January 1942, the United States War Department filed a condemnation suit for the land that is now Fort Pickett (Godburn 1977). According to Hunter (1977), approximately 35% of the land was in an open, non-forested condition at the time of transfer. During the construction phase of the installation, forest fires interrupted the construction of what was then known as Camp Pickett on several occasions. However, there was only one reported instance where a forest fire threatened already completed work (Godburn 1977).

From 1942 to 1948, no records of timber harvests were maintained. Consequently, the quantity of timber harvested to help construct the installation is unknown. During January of 1945, as many as 600 prisoners of war were involved with timber harvest activities, indicating that a significant amount of timber was harvested. In 1948, under the supervision of a technical forester, approximately eight million board feet of timber were harvested by the South Atlantic Division Engineers (Hunter 1977). The logs were milled by the Army-Navy Lumber Agency and the lumber was utilized at Fort Pickett, other government installations within the United States and overseas. Selective harvesting was used from 1957 to 1959 to remove 29,000 cords of pulpwood. From 1960 through 1966, the forest management program was directed by the water filtration plant and sewage treatment plant manager. During this period, firebreaks, right-of-ways and the current impact area were cleared by clear-cutting. Furthermore, a majority of the acreage north of Route 40 was cut using a seed tree method, which left four to eight trees per acre.

In the fall of 1966, a full-time technical forester was hired to serve as the installation forester. This initiated the first intensive forest management and protection program at Fort Pickett, which included a forest inventory and a variety of timber stand improvement measures (Hunter 1977). In 1968, the first site preparation (burning and planting of pine) occurred. Pine plantations were developed at a rate of approximately 200 acres per year; with the bulk of the early pine plantations located in the northern training area. Forest management records indicate that from 1968 through the mid-1980s, selective and pine pulpwood harvests were the predominant silvicultural techniques employed. These harvests were for stand improvement and military training purposes. The militarily-driven harvests were frequently much larger and included harvests designed to create ranges 18, 19, and 20 and to create open training areas in the northern training area. With a few exceptions, the forestry clear-cuts were less than 50 acres. The period from the mid-1980s to the mid-1990s was dominated by forest management cuts of naturally regenerated maturing pine stands.

The Fort Pickett forestry program has historically been responsible for managing forest pests. Fort Pickett experienced severe bark beetle outbreaks from August 1974 to June 1975 and lesser attacks in 1988 and 1994. In 1990 and 1992, attempts were made to control kudzu (*Pueraria lobata*), a non-native invasive vine. These nearly successful attempts at kudzu control fell victim to adjusted priorities after an announcement was made to close the installation under a BRAC action in 1995. However, over the past 5 years, due to persistent efforts, the prevalence of kudzu has declined significantly to the point where kudzu is not considered a key management concern. The mid-1990s to the present has been a time of change, re-evaluation, and planning. As with other land management agencies, the management principle of multiple-use sustained yield forest management evolved into the concept of ecosystem management.

5.1.4 Northern Training Area

The landscape level goal for forest management in the northern training area at Fort Pickett is to increase maneuverability for mechanized training. In addition, stem density reduction of pine plantations of an age and density where thinning is a sound ecological option will occur to further promote the health of those systems. The decrease in density will be based on current and projected military use of the stands. Some will have a basal area reduction to create a pine savannah landscape beneficial to troop movement. These management actions will create a diverse assemblage of fire-maintained plant communities such as woodlands, savannas, and grasslands. These plant communities will benefit military training by providing terrain suitable for mechanized infantry, while also providing habitat for game and nongame species. All major drainages in the northern training area will have designated stream crossings that will be managed appropriately to facilitate safe passage for training units and to protect water quality. Remaining streams and wetlands will remain forested in accordance with the appropriate streamside management zone (SMZ) best practices and the watershed protection zone (WPZ) requirements to discourage mechanized units from traversing these areas (for further details see Section 5.5.6). In addition, the surrounding area will be managed to act as an effective noise and dust barrier through maintenance of a forested buffer when possible and appropriate for force protection and the military mission.

5.1.5 Southern Training Area

The long-term, landscape level goal for forest management in the southern training area is to maintain forested ecosystems while decreasing the acreage of densely forested landscape to improve maneuverability for training units. Silviculture practices are the primary means in which the installation will achieve and maintain this forestry scheme to support the military mission. The main management goal is to improve the growth rate and health of the remaining trees.

This landscape will continue to provide excellent noise attenuation for the southern indirect artillery firing points and good training opportunities for dismounted infantry. The slopes and ridges directly adjacent to the Nottoway River, Hurricane Branch, and other major streams will be maintained as forested to protect the cultural and natural resources of the area. Extreme care will be taken to ensure erosion and other potential negative effects are avoided or mitigated. The forestry department will work directly with NGVA-FMO-ENV to ensure erosion protection strategies are sufficient. Forestry activities are limited to those in support of the military training mission and ecosystem management, including the control of invasive non-native species. Section 5.5

describes the management strategies in place to protect water quality and for wetland conservation.

5.1.6 Harvest Methods

Harvest operations will generally be conducted in accordance with the State of Virginia Best Management Practices (BMPs) (Appendix J) unless the operation is in a designated protection zone, in which case the more stringent restrictions shall apply. The BMPs were researched and developed by the Virginia Department of Forestry to protect soil, waterways, and biological resources from unnecessary degradation from silvicultural activities. All forestry operations will observe the protection zones described in Section 5.5, unless otherwise given permission due to training needs or to allow for clearcutting sections of pine plantations in order to return the land to native mixed hardwood species cover or create habitat for rare/threatened species. The landings and other areas devoid of vegetation within the harvested stand will be reseeded as soon as possible, primarily dependent upon time of year and weather. Standard rehabilitation practices developed through the LRAM program (Section 5.7) will be used to rehabilitate any areas experiencing soil erosion because of silvicultural activities.

The Biological Opinion for the NLEB will be followed or additional consultation with the USFWS will occur prior to all forestry operations.

The vast majority of forestry activities are focused upon improving and modifying the landscape to increase the acreage of terrain suitable for heavy and light maneuver training. The stands harvested to support military training objectives will be maintained in an open state using prescribed fire. Prescribed fire will encourage the establishment of native perennial grasses and the decay of residual woody debris. Prescribed fire may be used after thinning pine plantations to reduce logging slash and for site preparation. The timing of silvicultural prescribed fires is dependent upon local stand and weather conditions and therefore will be implemented at the discretion of the installation forester. The use of prescribed fire will follow all smoke management rules and implementation guidelines described in Appendix K.

There are two basic types of timber methods that will be implemented to accomplish military training and silvicultural purposes: clearcutting and thinning.

<u>Clearcutting</u>

Clearcuts will be used to clear forests for military training, to regenerate pine plantations and to promote native successional forest growth with primarily acceptable native species such as oak and yellow poplar. Clearcut operations carried out for the improvement of military training land will not be reforested. These areas will be treated and reseeded with native perennial species under the auspices of the ITAM program (see Section 5.7). Clearcuts will also be performed to regenerate pine plantations. Clearcut pine plantations will be replanted using native pine species or allowed to naturally regenerate if adequate stocking of desirable crop trees is available to manage for future forestry goals. Pre-commercial thinning operations are typically used in naturally regenerated pine stands to reduce stand density; usually between age 3-7 years. Undesirable hardwood species will be controlled through chemical treatment and/or prescribed fire. Mechanical control of hardwoods will also be used as conditions, time and manpower allow in later stages of growth.

Thinning

Thinning will be performed to improve military training land and for silvicultural purposes. Thinning will be conducted using mechanized operations with a target residual basal area of 40-60 ft^2 for military training and silvicultural cuts. The thinned stands will then be burned two to three years after the harvest to reduce fuel loads. Thinning and burning stands will help to rapidly bring them to a usable condition for bivouacking and training in general. Furthermore, thinning and burning favor native grasses and forbs, thus increasing plant diversity, and improving wildlife habitat in the stands by increasing light penetration and decreasing duff layer thickness. Prescribed fire and chemical control with selective pesticides will also be used to control hardwood competition after all thinning.

5.1.7 Unplanned Forestry Activities

Natural disturbance events (e.g., hurricanes, tornados, insect outbreaks, etc.) that damage forest resources occur with some frequency in the Piedmont of Virginia. Their effects are usually not widespread nor commercially significant. Frequently these climatic disturbances cause small openings in the forest that add to the diversity and richness of species occupying the site. Downed timber is removed usually through firewood sales; however, occasionally the natural episodes become significant and require salvage operations. If salvage operations are required, a record of environmental compliance (REC) check will determine if there are any significant environmental or cultural resources that would be adversely affected by the salvage operations.

Furthermore, additional cuts to support evolving military mission requirements may be required within the cycle of this INRMP. These will be addressed in the yearly INRMP updates.

The Biological Opinion for the NLEB Final 4(d) Rule will be followed or additional consultation with the USFWS will occur prior to all forestry operations, except for hazard tree removal in the NLEB active season. If the trees are considered a threat to human life or will cause the loss of property, the trees will be removed and USFWS will only be informed if bats are observed. In the case of a known roost, VAARNG in coordination with the ARNG Directorate will initiate emergency consultation with USFWS.

Southern Pine Beetles (*Dendroctonus* spp.)

Virginia has not experienced a statewide outbreak of southern pine beetles since 1993. However, it is important to know the signs of a southern pine beetle outbreak and practice preventative measures.

The first indication of southern pine beetle-caused mortality is discolored tree foliage. Needles become yellowish, change to a red hue and within one or two months become brown. Typically, pines are killed in groups ranging from a few trees to those covering several hundred acres. Other indications of southern pine beetle infestation are small, yellowish-white masses of resin (0.64-1. in diameter) marking the points of southern pine beetle attack. A reddish boring dust lodged in bark crevices or in spider webs and leaves of under-story vegetation at the base of an infested tree may be the only indication of attack. Removal of bark from an infested pine will reveal egg galleries that crisscross one another in the inner bark and on the wood surface. Aerial detection of activity is the most effective means of detection. Ground surveillance is adequate though time consuming. When infestations occur, appropriate control measures will be implemented.

Harvests should be planned to avoid operations in outbreak areas during the summer and to minimize damage to the site and to the residual stand. Logging equipment should be operated carefully to minimize scarring the trunks of residual trees, soil compaction, and crushing tree roots. Trees severely damaged by heavy equipment should be salvaged. Newly attacked trees and trees containing southern pine beetle larvae and pupae should be removed next. When a sufficient number of infested trees of merchantable size are available for salvage, they should be removed as quickly as possible along with an adequate buffer strip of green trees in front of the most recently attacked trees. Newly attacked trees and trees containing southern pine beetle larvae and pupae should be removed next. This approach will ensure that further growth of the infestation is stopped and that all infested trees are removed. The cut-and-leave method can be used to reduce the hazard of infestation spread into surrounding stands during the summer months. Where trees cannot be salvaged, infestation spread may be controlled by felling and treating infested trees (Day 1997).

Climatic Events

Damage that is due to wildfire, wind, or ice storms is generally limited in size and scope. Installation salvage sales may be attempted, or the damaged material may be added to an existing timber sale if the impacted timber is determined to be merchantable.

5.1.8 Consideration of the Ecological and Environmental Effects of Forest Management at Fort Pickett

In order to fulfill NEPA process requirements, all timber harvests proposed for the period covered in this section of the INRMP, regardless of their location or purpose, will be evaluated for their potential environmental effects.

All timber harvests will be conducted in accordance with forestry BMP guidelines for the State of Virginia. In addition, all timber harvests will adhere to the 75-foot setback requirements of the Water Protection Zones (WPZ) described in Section 5.5, which are wider than the minimum 50-foot SMZs required by the Virginia Department of Forestry (DOF). All sites within the timber harvest area that are cleared to bare soil will be reseeded using both a fast growing annual, such as wheat, and longer-lived native perennials.

Biotic Impacts

Each block scheduled for harvest will be examined to determine if any federally threatened or endangered species occur within, or close to, the harvest boundaries. Updated endangered species GIS distribution map layers maintained by the NGVA-FMO-ENV will be consulted to determine if federally threatened or endangered species or critical habitat are present with the boundaries of the proposed timber harvests.

With respect to the NLEB, the Biological Opinion for the NLEB Final 4(d) Rule will be followed or additional consultation with the USFWS will occur prior to all forestry operations, except for hazard tree removal in the NLEB active season. See Section 5.3.4.7, NLEB Management, for more information.

The DWR has also designated the Nottoway River and Butterwood Creek as threatened and endangered (TE) waters due to the presence of listed mussels. DWR recommends undisturbed naturally vegetated buffers be maintained on both sides of designated TE waters and their tributaries. They recommend preserving, planting, and/or enhancing an undisturbed naturally vegetated buffer of 100 ft on both sides of all intermittent tributaries; 200 ft on both sides of all perennial tributaries; and/or 300 ft on both sides of the designated waters themselves.

Stands chosen for harvests will be selected in part to create plant communities and habitats within them that are unique to Fort Pickett to support flora and fauna populations dependent upon these uncommon forest habitats. Therefore, the conversion of these stands will not result in irreparable damage to flora and fauna populations dependent upon these common forest habitats. In fact, the thinning of forest stands, in conjunction with prescribed fire, will increase the acreage of relatively rare plant communities and habitats.

The landscape level ecological effects will be ameliorated by rejecting the typical checkerboard approach to forest harvests. The harvests will be designed to expand existing roads and open area corridors, not to create new openings. This approach provides an increased amount of open area while maintaining approximately the same amount of edge.

<u>Abiotic Impacts</u>

Air quality will only be affected during the time in which a harvest is being performed. Forests along the boundaries of Fort Pickett will not be harvested; these forests will provide an effective sound, dust, and visual barrier.

As stated previously, the WPZ buffers will be secure while designing the timber harvests. Crossings will be hardened and will be at a right angle to channels. These design modifications are intended to mitigate and reduce stream bank damage, soil erosion, and stream sedimentation.

To ensure forestry management activities do not adversely affect cultural resources, Phase I cultural resource surveys are required before all forestry cuts that take place in previously unsurveyed areas, with the exception that small land areas (less than five acres) that are previously disturbed may be exempt from this requirement. Consultation with the Cultural Resources Manager (CRM) is required in all cases to make this determination. The CRM will be contacted prior to forestry activities and will make the determination if a Phase I survey is required. If a Phase I survey is required, the CRM will contact the State Historic Preservation Officer (SHPO) and initiate the National Historic Preservation Act (NHPA) Section 106 process. See Chapter 6.0 for more information regarding Cultural Resources protection.

<u>Cumulative Effects</u>

The cumulative long-term environmental effects of the forest management actions will likely be minimal. All harvests will be examined for their individual and landscape level impacts. No threatened or endangered species will be adversely affected by the forest management activities. The stands that are converted to open areas will not harbor any significant or rare natural resources. Final harvests will be dependent upon the successful completion of a Phase I cultural resources survey.

5.1.9 Future Planning

Updated forest inventory information will greatly enhance the forestry program at Fort Pickett. The outlook for years following this INRMP update is the continued support of the training mission at Fort Pickett through active forest management. Water quality will continue to be an important consideration with the Nottoway River corridor and macrobasin receiving substantial protection and attention. Other important program elements to incorporate in forest management activities include protection of threatened and endangered species, cultural resources stewardship, monitoring invasive species, biodiversity preservation and enrichment, and erosion control.

Future plans, such as the INRMP updates, should first be responsive to new paradigms as they become popular. Second, they should honor the investments and efforts implemented in this and previous plans. And third, they should be started early enough to keep the five-year plan system in synchronization. The public perception of the global political environment, economic conditions and value and availability of the various forest products will help drive the formation of new paradigms and vastly impact the next planning cycle.

5.2 NONGAME SPECIES MANAGEMENT

5.2.1 Goals and Objective

The goals and objectives of nongame species management on Fort Pickett are summarized in Table 13 below.

Table 13. Non-Game Species Management Goals and Objectives

GOALS	OBJECTIVES
To comply with federal environmental law and Army regulations.	Incorporate recommendations of the Virginia Wildlife Action Plan into natural resources management on the installation.
To identify trends and biologically significant changes in species diversity and abundance.	Perform monitoring on a regular basis to create a baseline and detect negative trends in a timely manner.
	Focus on endangered species and indicator species.

5.2.2 Introduction

The ecological monitoring program at Fort Pickett has two general goals: 1) to comply with federal environmental law and Army regulations, and 2) to identify trends and biologically significant changes in resource quality and abundance. Ultimately, the effectiveness of any monitoring program is dependent upon the implementation of management actions when trends are detected that negatively affect natural resources. Monitoring is generally performed on a regular basis (years) and often targets endangered species and indicator species of overall ecosystem health.

Data collected in comprehensive replicable surveys can form the basis of a habitat monitoring program by documenting baseline conditions, identifying potentially vital habitat, providing a mechanism for tracking changes in the quality and quantity of the resource, and facilitating compliance with legal mandates, including NEPA and the Clean Water Act (CWA) requirements.

5.2.3 Virginia's State Wildlife Action Plan (WAP)

Virginia's WAP identifies 883 SGCN that are in decline. These species were grouped into four tiers: Critical (I), Very High (II), High (III), and Moderate (IV) based upon their level of imperilment. Of the Plan's SGCN, 23.4 percent are classified as Conservation Opportunity Ranking A; 7.1 percent are classified Conservation Opportunity Ranking B; and 69.5 percent are classified as Conservation Opportunity Ranking C. Additionally, of the 883 SGCN:

- Approximately 25% of the SGCN are already listed as threatened or endangered under the Federal or Virginia Endangered Species Act,
- Approximately 60% are aquatic,
- Approximately 70% are invertebrates, and
- All are impacted by the loss or degradation of their habitats.

As outlined in *Virginia's Wildlife Action Plan*, the majority of issues negatively impacting the SGCN are habitat related. In other words, species are imperiled by issues or circumstances that impair the places they live and limit the opportunities for individual species to survive. Fort Pickett will work to incorporate recommendations of the Virginia Wildlife Action Plan into natural resources management on the installation.

5.2.4 Avian Management

The DoD program Partners in Flight provides lists of species of concern included within a group of priority lists in different regions, as well as guidance on integrating bird conservation strategies into INRMPs. Important steps in avian management include:

1. Inventories and monitoring of bird species and populations on the installation.
2. Conserving habitat, through protection, restoration, and enhancement.
3. Collaboration with federal, state, and local entities to create plans to protect species of concern. Taking part in existing inventories and surveys with other partners, such as universities and research groups as feasible.
4. Cooperation with other federal and state partners to allow reasonable access for studies to be conducted.
5. Outreach to the public should be considered where appropriate, such as on Earth Day, through the creation of checklists of bird species present on the installation, displays, educational handouts and outdoor recreation opportunities if possible.
6. Integration of the previous steps with national and international bird conservation initiatives.
7. Follow all regulations as they pertain to the study of bird populations and follow the DoD Migratory Bird Guidance.

Browder *et al.* (2002) states numerous reasons why birds are excellent indicators for monitoring habitat change: 1) individual bird species are associated with particular habitats; 2) changes in species composition and abundance can be evident relatively quickly after a disturbance; 3) systematic and extensive bird surveys are currently conducted across the United States and southern Canada (Audubon Breeding Bird Survey, Christmas Bird Count, etc.); 4) groups of bird species can be used to develop associations with habitats that are predictive of the relative level of anthropogenic disturbance; and 5) birds are important to a large segment of the public, so the public may relate to concerns about changes in bird communities better than to those of other taxa, such as plants or invertebrates. A list of avian species documented on Fort Pickett can be found in Appendix G.

<u>Neotropical Migrants</u>

Roughly 140 bird species breed within the Mid-Atlantic Piedmont (Carter 2000). Six species have a disproportionately large share of their global populations breeding within the Mid-Atlantic Piedmont. Land management activities in this region have a major role in sustaining their populations over the long-term (Kearney 2003). These species are: wood thrush *(Hylocichla mustelina)*, Acadian flycatcher (*Empidonax virescens)*, scarlet tanager (*Piranga olivacea)*, Louisiana waterthrush (*Parkesia motacilla)*, eastern wood-pewee (*Contopus virens)* a deciduous forest species, and the prairie warbler (*Setophaga discolor)* an early successional species.

<u>Grassland Birds</u>

Virginia's *Wildlife Action Plan* indicates that 29% (4 of 14 species) of the birds listed as Tier I species are early-succession habitat dependent. Native grasslands have been altered to a greater degree than any other biome in North America, including forests (North American Bird Conservation Initiative U.S. Committee 2009). Grassland birds are among the fastest and most consistently declining birds in North America; 48% are of conservation concern and 55% are showing significant declines (North American Bird Conservation Initiative U.S. Committee 2009). Declines in grassland birds have been attributed to conversion of grasslands to cropland, increasingly intensive agricultural practices, and commercial and residential development. Most grassland species in the United States both breed and winter in-country, which makes it easier to determine the causes of these declines (Browder et al. 2002). Much of the grassland habitat within the Mid-Atlantic Piedmont has been converted to other uses and divided among many owners with different management objectives. This has resulted in patches smaller than the ideal size for many grassland birds.

<u>Avian Management Considerations</u>

Riparian and wetland habitats are important habitat for migratory birds. Fort Pickett will strive to prevent the destruction or degradation of wetlands and riparian vegetation, and restore those habitats, when feasible, where they have been degraded. The required 75-foot-wide buffers on all streams and wetlands on the installation, as well as the protection of 4,739 acres of riparian area along the Nottoway River, provide important habitat for migratory birds and other animals.

The USFWS recommends the use of a time-of-year-restriction extending from 15 March through 30 August for avoiding impacts to nesting migratory birds. In areas of the installation undergoing forestry operations, implementation of the time-of-year-restriction for the NLEB from 15 April through 15 September would also benefit migratory birds during the nesting season. Clearing of vegetation should take place early in the year, prior to nesting season.

Managing grasslands for native warm-season grasses can have a great benefit the overall quality of habitats for faunal species and ecological integrity. To manage for grassland bird species, large tracts of grassland habitat should be kept intact. Wolter *et al.* (2008) states the minimum size for productive grassland bird habitat is 20 acres, with 100 acres or larger being optimum. The 2012 grassland bird survey (St. Germain and Schneider 2012) surveyed polygons ≥ 20 acres, one polygon ≥ 100 acres, and 18 polygons < 20 acres on Fort Pickett.

The fields that are fescue dominated or mowed should be minimized where possible. Mowing during the breeding season mid-March through August should not take place when and where possible. Grasses should remain unmowed for the duration of the winter period (until late February) to provide cover and increased foraging potential. If mowing does occur during the wintering period, concealment islands of unmowed areas should be left to provide cover. These islands can then be mowed later in the season. An increased use of soft edges of shrubby growth along the wood line would provide additional habitat for grassland species (especially SGCN) that prefer to have a mix of shrubby intrusion, (e.g. Northern Bobwhite Quail). A buffer of 20 meters (50 feet) would be sufficient for this purpose. More permanent shrubby islands or hedgerows within the larger grasslands would be an added benefit.

5.2.5 Herpetofauna

Amphibians

Frogs and toads, collectively referred to as "anurans", comprise the most diverse and abundant group of amphibians. Anurans are widespread in distribution and occur in essentially all temperate environments (Heyer *et al.* 1994). They may be aquatic, terrestrial, fossorial, arboreal, or some combination thereof. Some species are diurnal, but most are nocturnal. Adults of most species are widely dispersed in the environment except at certain times of year when they congregate at aquatic sites to breed. These breeding periods often provide the best opportunity for efficient sampling.

Annual breeding periods may be explosively episodic (synchronous over one or a few days at a site) or prolonged (spread out over a few weeks or months). Vocalization is an important component of the reproductive behavior of frogs and toads and they use these vocalizations to locate and attract potential breeding partners or to advertise their position to rivals. Vocalizations differ between species and are readily recognizable.

Reptiles

Reptiles have in recent years received ever growing attentions from land management agencies at the federal, state, and local level. Reptiles contribute to local and regional diversity and help regulate ecosystem structure and function. They serve both as an important prey base for many vertebrate predators and help regulate population levels of both vertebrate and invertebrate species. Reptile species assemblages can serve as indices of ecosystem health.

Herpetofauna Management Considerations

The eastern box turtle (*Terrapene carolina carolina)* has traditionally been a commonly encountered reptile species in Virginia, but DWR has included the species as a Tier III species of High Conservation Need in Virginia's *Wildlife Action Plan*. The International Union for Conservation of Nature (IUCN) classifies the species as vulnerable due to widespread, persistent, and ongoing declines that probably exceed 30% over three generations. Box turtles are often killed in vehicle strikes on roadways and during mowing activities, especially in urban areas and in fragmented habitats. Predation of eggs and juveniles by subsidized populations of meso-predators like raccoons, foxes, opossums, and crows are also a problem.

The spotted turtle has previously been located on Fort Pickett, is listed as a Tier III species and is under review by the USFWS for listing under the Endangered Species Act. The IUCN classifies the species as endangered due to widespread encroachment and destruction of suitable habitat coupled with removal of adults from a stable population through mortality or for trade. Existing populations tend to be small and therefore susceptible to localized impacts. Invasive species modifying wetland ecology are also thought to contribute to the spotted turtle population decrease. The DoD Legacy Resource Management Program released guidance in March 2019 entitled *Recommended Best Management Practices for the Spotted Turtle on Department of Defense Installations which was* created by the Department of Defense Partners in Amphibian and Reptile Conservation. The BMP manual includes an assessment protocol specifically designed for spotted turtles which should be used in future herpetological surveys. If the spotted turtle is identified on Fort Pickett in the future, the BMPs should be followed.

The Natural Resources Conservation Service (NRCS-2006) lists several management recommendations that apply to general habitat management for reptiles and amphibians across the country:

- Provide logs, rocks, and brush piles around wetland areas and in upland areas;
- Keep a vegetated buffer (minimum 50 feet) around wetlands and streams;
- Provide upland habitat adjacent to wetland areas (500 feet or wider if possible);
- Ensure that vegetation is not too dense for herpetofauna movement by promoting a variety of native sedges, forbs, and warm- and cool-season grasses;
- Avoid introducing non-native plants or animals, and control any that have already been introduced;
- Avoid altering natural water levels in wetlands, rivers, and streams, particularly from the time herpetofauna migrate to overwintering sites through to spring emergence;
- Maintain shallow water areas or pools for breeding amphibians;
- Plan any prescribed burning activity to avoid times when amphibians and reptiles are particularly active (breeding migrations, dispersal from hibernacula);
- Avoid using pesticides within 100 yards of streams or wetlands;
- Limit pesticide use to those with active ingredients that rapidly decompose after application;
- Avoid off-road vehicle use;
- Avoid building roads in sensitive areas; and
- Avoid fragmenting habitats.

Another simple modification to implement would be raising the height of mowers during the spring and summer in semi-improved and unimproved areas that require mowing. A list of reptile and amphibian species found at Fort Pickett can be found in Appendix F.

5.2.6 Mussels

As an ecologically important and highly imperiled natural resource, freshwater mussel populations require high priority conservation efforts through monitoring of population dynamics, identifying factors responsible for declines, and protecting and expanding suitable habitats. Several species of mussels have been documented on Fort Pickett (Table 6, Section 3.2.5). As mussels continue to cope with habitat degradation and fragmentation. Monitoring species-specific population dynamics such as population size and growth, survival, and recruitment is essential for determining long-term viability and assessing the status of stable and listed populations. Detecting changes in species diversity, abundance, or distribution range may indicate the presence of underlying water quality issues that are contributing to habitat loss. Several substantial factors that contribute to habitat loss include sedimentation and channel modification in their capacity to reduce channel and bank stability, increase water temperatures, and increase nutrient runoff.

Mussel Management Considerations

Of particular importance is the continued monitoring of the Atlantic pigtoe, a species proposed to be federally listed, within the upper reaches of the Nottoway River. These reaches are home to some of the few remaining stable populations of the Atlantic pigtoe in Virginia, making the continued monitoring of this species and its habitat imperative to its conservation. The yellow lance has previously been found by DWR in the Nottoway River and was listed as a threatened species by USFWS in April 2018. An additional species of interest that has historically occurred in the upper Nottoway River and may exist on Fort Pickett is the federally endangered dwarf wedgemussel. Valuable insight into the status of these species and the health of aquatic ecosystems on Fort Pickett can be obtained through biological surveys and habitat assessments.

To protect and increase remaining mussel populations at Fort Pickett, management efforts should focus on conserving and enhancing existing, as well as restoring, suitable mussel habitat. Reduction of sedimentation through the maintenance or establishment of riparian buffer zones 75 feet in width on either side of all streams and wetland areas and the continued avoidance of stream channel modifications can increase the quality and availability of healthy habitats. Not only would these actions have positive implications for mussel fauna, but it would also have cascading effects on the overall aquatic ecosystem.

The DWR has also designated the Nottoway River and Butterwood Creek as threatened and endangered (TE) waters due to the presence of listed mussels. DWR recommends undisturbed naturally vegetated buffers be maintained on both sides of designated TE waters and their tributaries. To best protect the listed aquatic species (and the resources upon which they depend) from harm that may result from nearby agriculture, silviculture, habitat management or restoration, and/or land development within these drainages, DWR recommends preserving, planting, and/or enhancing an undisturbed naturally vegetated buffer of:

- 100 feet on both sides of all intermittent tributaries to TE waters;
- 200 feet on both sides of all perennial tributaries to TE waters; and/or
- 300 feet on both sides of the designated TE waters themselves.

Even with habitat improvements, local mussel populations may still be susceptible to extirpation as a result of reduced reproduction success, demographic stochasticity, and recolonization issues that affect small and fragmented populations. In this circumstance, reintroductions, and augmentations of populations—through translocating wild or releasing captive reproduced individuals—should be considered to reestablish viable populations. Additionally, the presence and availability of species-specific fish hosts required for reproduction should be evaluated on account that in their absence or scarcity, mussel populations would be unable to recruit at self-sustaining levels. Understanding species dynamics in combination with the identification of specific factors responsible for declines can provide resource managers with data required for developing effective management plans. To accomplish these tasks, routine monitoring of freshwater mussel and fish populations and stream habitats are recommended as they will provide a valuable measure of the health of freshwater mussels and the aquatic ecosystem on Fort Pickett.

5.2.7 Nongame Mammals

Bats

Bats have been proposed as good indicators of the integrity of natural communities because they integrate several resource attributes (e.g., roosting, watering, and feeding habits), and thus may show population declines quickly if a resource attribute is missing (Hutson el al. 2001). Some bat populations worldwide are experiencing declines due to adverse effects of human population growth and associated deforestation; conversion of natural habitats to forest and agricultural monocultures; water, soil, and air pollution; and introductions of xenobiotics and exotic species (Kunz and Fenton 2003). A severe decline of eastern bats was documented in New York in 2006-2007. This decline was later determined to be caused by the fungal pathogen, *Pseudogymnoascus destructan,* the agent responsible for white-nosed syndrome (Blehart *et al.* 2009).

The NLEB's population is estimated to have declined 99% due to white-nose syndrome. Similar declines have also been documented on two other once common species on the installation: the little brown bat and the tri-colored bat. A list of known bat species at Fort Pickett can be found in Appendix E.

Bat Management Considerations

An initial field survey for bats at Fort Pickett completed in 2007 indicated that the NLEB was present on the base. Since that time, white-nosed syndrome has spread from New York and devastated bat populations across the eastern United States. A project specific survey on a limited area of the installation was completed in 2014 and another survey was completed in 2016 in the training and direct fire range areas. NLEB were acoustically identified in both surveys. It is important to update these planning level surveys regularly to better reflect the species composition because of the dramatic declines that have occurred in the last 10 years.

Natural resource managers throughout North America have placed increasing emphasis on understanding the impact of forest management practices on populations and behavior of bats (Menzel *et al.* 2005a). Subsequently land managers, both public and private, are increasingly expected to provide habitat to maintain or promote bat community diversity in forested and other natural landscapes (Miller *et al*. 2003). The continued decline of several bat species associated with forested environments underscores the need for an increased understanding of habitat relationships for North American bats (St. Germain 2012, Fenton 1997, and Menzel *et al*. 2005b).

These habitat relationships have been identified as one of the informational gaps hindering our understanding of how to better manage natural systems for bats (Arnett 2003).

Four bat species found on Fort Pickett are considered to be threatened or endangered species. The NLEB and Indiana bat are listed federally as threatened bat species, and the little brown bat and the tri-colored bat are state endangered species. For complete conservation measures see Section 5.3.4: Rare, Threatened and Endangered Species Habitat Management.

Fox Squirrel Monitoring

Fort Pickett has partnered with the DWR and CMI/VA Tech in order to monitor populations of fox squirrels (*Sciurus niger*) in order to study why the fox squirrel has been extirpated from its historically known range that includes Piedmont Virginia. Funding was secured in FY18 to survey Fort Pickett for the presence of the fox squirrel and to build nest boxes in selected habitat areas for monitoring. The nest boxes have been built and monitoring has begun. The second phase of this project conducted in FY19 included trapping fox squirrels in Southampton County, Virginia on Nature Conservancy owned land and then relocating them onto Fort Pickett in selected nest box areas to allow monitoring.

5.3 RARE, THREATENED AND ENDANGERED SPECIES HABITAT MANAGEMENT

5.3.1 Michaux's Sumac (*Rhus michauxii*) Management

5.3.1.1 Goals and Objectives

The goals and objectives of Michaux's sumac (*Rhus michauxii*) management on Fort Pickett are summarized in Table 14 below.

Table 14. Michaux's Sumac (*Rhus michauxii*) Management Goals and Objectives

GOALS	OBJECTIVES
Proactively preserve and enhance the Fort Pickett Michaux's sumac population.	Implement active habitat management and utilize applied research.
Develop management guidelines that are compatible with both mission critical military training and habitat management practices for Michaux's sumac.	Quantitatively and qualitatively monitor the Michaux's sumac population at Fort Pickett on a yearly basis.
Cooperate with state and federal conservation agencies to enhance and establish viable populations outside Fort Pickett in order to further the recovery efforts for Michaux's sumac.	Appropriately Identify and Sign Michaux's Sumac Colonies.

GOALS	OBJECTIVES
Maintain and conserve suitable habitat for Michaux's sumac via military training weapons fire and prescribed burning.	Delineate and Map Michaux's Sumac Colonies.
	Transplant Michaux's Sumac Colonies
	Conservation Banking.

5.3.1.2 Species Information

Distribution

Michaux's sumac or false poison sumac is a small shrub endemic to the inner Coastal Plain and Piedmont of the southeastern United States, where it occupies sandy or rocky savannas and open woods (USFWS 1993). The plant was first discovered on Fort Pickett in 1993 (Fleming and Van Alstine 1994). Until recently, the only known Virginia population occurred entirely on Fort Pickett which is believed to be the largest known population, composed of numerous colonies (Bolin et al. 2011, Burke and Hamrick 2002, Emrick and Jones 2008, Sorrie 2004). In February 2011 Michaux's sumac was discovered by Major James Shaver of the Virginia Army National Guard on private property acquired by the Ward Burton Wildlife Foundation (WBWF) approximately 4 kilometers from the closest known colony on Fort Pickett. The WBWF purchased the 472-acre property, referred to as "Deepwater," in collaboration with Fort Pickett through the Army Compatible Use Buffer (ACUB) program in 2009. The mission of ACUB is to maximize "military readiness while efficiently conserving valuable ecosystems" (USAEC 2009). CMI completed the mapping of all the Michaux's sumac colonies found on Fort Pickett in 2014, though it is not yet known if this population is pure *Rhus michauxii* or a hybrid. They recorded 74 colonies with a total area of 27.9 acres and identified over 6,000 acres of potential habitat on the installation (Emrick *et al*., 2015).

Status

- Federal: Endangered
- Virginia: Threatened/S1S2

Michaux's sumac was designated as endangered by the U.S. Fish and Wildlife Service on 30 October 1989 (USFWS 1993). The USFWS currently recognizes 39 populations of Michaux's sumac (31 occur in North Carolina, 4 in Georgia, and 4 in Virginia), which includes the Michaux's sumac colonies at Fort Pickett (D. Suiter, personal communication, 2012).

Taxonomic Description

Michaux's sumac is an entomophilous, usually dioecious, rhizomatous shrub in the Anacardiaceae family. The entire plant is densely pubescent and typically 0.3 to 0.9 meters in height (Radford et al. 1968, Hardin and Phillips 1985a). Michaux's sumac was first described by Sargent (1895), who considered it one of the most poisonous plants in North America. It has subsequently been found to be non-poisonous, hence one of its colloquial names false poison sumac. The narrow winged or wingless rachis supports 9-to-13 sessile, oblong leaflets that are each four to nine cm long, two to five cm wide and acute to acuminate. Flowering usually begins in June. The small flowers are borne in a dense, erect, terminal cluster, each of which is four to five-parted and greenish-yellow to white in color. The fruit, which is a red, densely short-pubescent drupe, five to six mm broad, is borne on the female plant from August through winter. Michaux's sumac differs from other similar species in its genus by its short stature, dense overall pubescence, and evenly serrated leaflets (Figure 13).

<u>Michaux's Sumac Habitat</u>

Fort Pickett supports more Michaux's sumac than any other known location (Bolin et al 2011, Burke and Hamrick 2002, Emrick and Jones 2008, Sorrie 2004), largely due to the history of disturbance associated with military training (e.g. fire). Before the discovery of the Fort Pickett population, most known Michaux's sumac populations clung to disturbed edges along open brushy fields, power lines, railroads, agricultural clearings, and pine plantations. On Fort Pickett, almost all Michaux's sumac colonies occur within a 4,400-hectare (10,872 acre) CAA that serves as a buffer zone for a variety of military live-fire ranges (Figure 14). Military live-fire training has occurred consistently for over 60 years, resulting in frequent low intensity wildfires throughout the CAA (Emrick 2013). Fire frequencies have historically ranged from one to three years which have resulted in the development of fire-adapted plant communities throughout the years of active military training (Emrick and Jones 2008).

Michaux's sumac is dependent on and adapted to some form of disturbance to maintain habitat conditions that allow it to grow and reproduce (asexually and sexual). Historically, wildfire was the primary disturbance that reduced woody competition and otherwise modified the habitat.

Full or nearly full sunlight is widely thought to be essential to the shade-intolerant Michaux's sumac. Thrush (2002) speculates that ideal light conditions for Michaux's sumac are full sunlight in the morning when photosynthesis is at its peak and partial shade in the afternoon for water conservation. Emrick and Hill (1998) reported that low vegetative cover above three meters resulted in an increase in cover of Michaux's sumac. In addition, Emrick and Jones (2008) found that woody competition is negatively correlated with density of all types of Michaux's sumac, but the effects were not equal among non-flowering, staminate, and pistillate stems. Competition in the two to five strata negatively correlated with pistillate density while showing little or no correlation with staminate density and non-flowering density.

There does not appear to be a consistent aspect or slope that characterizes Michaux's sumac habitat through its range. The majority of the populations in the longleaf pine ecosystem of North Carolina are found in depressions or swales. However, Michaux's sumac populations are not restricted to these sites and occur with some regularity on uplands, and slopes (Pokorski and Emrick 2007). At Fort Pickett, Michaux's sumac colonies occur on slopes and uplands but do not normally occur in swales or depressions. Populations appear to be well suited to xeric conditions in many areas but can also thrive in the more mesic soils found in swales and depressions, where it is thought that abundant sun may prevent rotting and fungus-associated problems that can occur with increased soil moisture (Russo 1993). Michaux's sumac is found in three described community types: longleaf pine/scrub oak/wiregrass woodlands with well-drained, slightly loamy soils as found in the sub mesic swales of the fall line sandhills primarily in North Carolina; oak woodland/open shrubland with granite-derived sandy soils primarily in the eastern Piedmont of Virginia; and clayey soils derived from mafic rock in the central Piedmont of Georgia (Weakley 2006).

Conservation and Threats

The primary threat to the population of Michaux's sumac at Fort Pickett and range wide is the elimination of disturbance, primarily fire. The fires caused by military training have allowed Michaux's sumac to not only survive but to thrive at Fort Pickett. However, severe disturbances (ditching, earthmoving) that result in the removal of soil in Michaux's sumac colonies are detrimental to its continued existence. Other limiting factors include degradation of habitat due to land conversion for agriculture, silviculture, trampling due to timber harvest (Russo 1995), chemical spraying of rights-of-way, and road expansion and construction (USFWS 1993).

Reproduction and Genetic Diversity

Like most members of the sumac genus, this species responds vegetatively to soil disturbance. When aboveground portions are killed by fire or physical injury, coppice stems arise from rhizomes below ground. The primary means of reproduction for Michaux's sumac populations is asexual clonal growth (Sherman-Broyles et al. 1992; Russo 1993; Emrick and Hill 1997). Sexual reproduction in North Carolina sandhill populations is limited because many populations are single sex (Savage and Bucher 1991). However, the Fort Pickett population consists of many colonies that are comprised of both staminate and pistillate individuals and at least one colony containing monoecious individuals (Emrick and Hill 1997). Wilkinson *et al*. (1993) reported that viable seed is being produced in several colonies at Fort Pickett. In addition, many staminate and pistillate flowers contain vestigial structures of the opposite sex (V. Emrick, personal communication, 2009). Cronquist (1981) reported this phenomenon for other species in the Rhus genus, but heretofore has not been reported for Michaux's sumac.

Figure 13. Michaux's sumac in flower in the CAA at Fort Pickett in 2012

Genetic and taxonomic studies have indicated a close phylogenetic relationship between Michaux's sumac and smooth sumac (*Rhus glabra*) (Hardin and Phillips 1985b; Sherman- Broyles *et al*. 1992; Burke and Hamrick 1995). Sherman Broyles *et al*. (1992) suggested that smooth sumac might in fact be the progenitor (direct ancestor) of Michaux's sumac. The flowering times of Michaux's sumac and smooth sumac overlap by approximately a third (Radford *et al.* 1968). An interspecific hybrid has been observed in situ and cultivated and studied in greenhouse experiments (Hardin and Phillips 1985b). Fleming and Van Alstine (1994) and Van Alstine and Smith (1995) identified morphologically intermediate plants at Fort Pickett, believed to be interspecific hybrids. Burke and Hamrick (1995) reported that while hybridization is occurring at Fort Pickett, it seems local in nature. In addition, they noted that the Fort Pickett population was genetically more diverse than the North Carolina Sandhill populations.

5.3.1.3 Management Strategies

The primary population-wide goal for any federally endangered species management is recovery of the population and subsequent delisting of the species. Thus, it is the explicit goal of Fort Pickett to engage in management activities that will aid in the recovery of Michaux's sumac populations. A secondary and important overall goal for Fort Pickett is to reduce encroachment on military training lands and activities resulting from endangered species management. While these two goals may appear to be contradictory, through integrated and careful management each goal can be achieved.

The population of Michaux's sumac at Fort Pickett is the largest currently known population. Therefore, management actions undertaken by Fort Pickett can have significant impacts on the recovery of Michaux's sumac. The DoD considers the presence of endangered species as an encroachment on military training. Though conflicts with military training are generally low, management actions that increase the potential for the recovery and delisting of Michaux's sumac will ultimately reduce encroachment on military training at Fort Pickett. In the interim, management will focus on protection and enhancement of existing colonies on the installation.

5.3.1.4 Off-Site Colony Protection

Fort Pickett will work with state and federal agencies to identify, establish, protect, and manage self-sustaining colonies of Michaux's Sumac on private properties off the installation to contribute to the species' recovery and delisting. To accomplish this end, Fort Pickett will work with DCR to survey for new colonies to inventory species distribution across the native range in the Southside Virginia piedmont region. Fort Pickett will coordinate with local land trust partners, such as Ward Burton Wildlife Foundation, to protect colonies on private property through conservation easements or fee simple purchase funded through the Army Compatible Use Buffer program.

Colonies protected on private lands will be managed for species survival and growth through written Michaux's Sumac Management Plans for each privately-owned property. Implementation of management plans will be coordinated through property owners, who may be eligible to receive assistance from Fort Pickett when legally feasible. Periodic surveys of the colonies will be conducted to verify that management actions are being followed by landowners and that the land management activities are supporting the colonies' growth. Transplanting of rhizomes between properties with single-sex colonies to encourage sexual reproduction will be considered when appropriate and will be coordinated through USFWS.

5.3.1.5 Long-Term Management Goals

- Proactively preserve and enhance the Fort Pickett Michaux's sumac population through active habitat management and applied research.

- Develop management guidelines that are compatible with both mission critical military training and habitat management practices for Michaux's sumac.
- Cooperate with state and federal conservation agencies to enhance and establish viable populations outside Fort Pickett in order to further the recovery efforts for Michaux's sumac.
- Maintain and conserve suitable habitat for Michaux's sumac via military training weapons fire and prescribed burning.

Management Objectives

The following are specific objectives for this 5-year update of the Fort Pickett INRMP that support the overall long-term Michaux's sumac management goals.

- **Habitat Management.** Ensure that woody encroachment is controlled in each Michaux's sumac colony.
- **Delineate and Map Michaux's Sumac Colonies.** Update the distribution and occurrence of Michaux's sumac colonies at Fort Pickett. The locations of colonies of Michaux's sumac at Fort Pickett were last mapped by CMI in 2014.
- **Appropriately Identify and Sign Michaux's Sumac Colonies.** Properly identify and sign all Michaux's sumac colonies.
- **Monitoring.** Quantitatively and qualitatively monitor the Michaux's sumac population at Fort Pickett on a yearly basis.
- **Transplant Michaux's Sumac Colonies**. When applicable and feasible, remove and transplant colonies of Michaux's sumac from active ranges to suitable habitat.

5.3.1.6 Implementation Tasks

The implementation tasks described in this section will help Fort Pickett reach long term management goals through the completion of short-term objectives. Implementation of these tasks will ensure the continued conservation of Michaux's sumac, reduce conflicts with military training, and help take steps toward the recovery and delisting of the species.

Habitat Management

The current habitat management paradigm accepted by most researchers and managers is that disturbance caused by fire reduces woody competition for sunlight, thus benefiting Michaux's sumac. Continued military training, which results in accidental wildfire, is essential to the survival of Michaux's sumac (Fleming and Van Alstine 1994; Emrick and Hill 1998, Emrick and Jones 2008). Michaux's sumac requires relatively open conditions to sustain itself and maintain vigorous growth. As a result, suitable habitat will be managed to reduce woody competition and maintain a canopy cover of less than 40%. Emrick and Jones (2008) found that woody competition is negatively correlated with density of all types of Michaux's sumac but adversely affects pistillate flowering to a greater degree. Fire, prescribed and military training caused, is the most cost effective and ecologically sustainable means of maintaining suitable habitat for Michaux's sumac. In cases where fire is insufficient to maintain habitat, carefully planned mechanical control of woody vegetation will occur. The past and current military use and mission is believed to be primarily responsible for the large size and healthy status of the Fort Pickett Michaux's sumac population. The habitat resulting from disturbance and fire is a direct consequence of military activities and is necessary for the species' survival.

Implementation Tasks

1. Ensure that each Michaux's sumac colony is burned, either from fires resulting from military training or prescribed fire, at a minimum once every 3 years or as directed by Fort Pickett Natural Resources to control woody encroachment. This action will require formal consultation with the USFWS.
2. Implement mechanical control in colonies where either fire intensity was insufficient (or absent) to control woody encroachment.
3. Implement control strategies in all Michaux's sumac colonies adversely impacted by non-native invasive species. Specifically, bicolor lespedeza (*Lespedeza bicolor*), tree of heaven (*Ailanthus altissima*) and autumn olive (*Eleagnus umbellata*) pose a specific threat to several Michaux's sumac colonies.
4. Utilize data from both quantitative and qualitative monitoring to assess the success of fire and/or mechanical control of woody encroachment.

Delineation and Mapping of Michaux's Sumac Colonies

All known Michaux's sumac colonies will be periodically mapped utilizing high accuracy global positioning system (GPS) and maintained in NGVA-FMO-ENV's geodatabase. Additional locations of Michaux's sumac colonies will be delineated and added to the NGVA-FMO-ENV geodatabase as they are discovered. Major updates to the colony location delineation and geodatabase will occur every five to seven years as part of the Michaux's sumac monitoring protocols. All new service work orders to be performed on Fort Pickett are routed through NGVA-FMO-ENV. Personnel with NGVA-FMO-ENV evaluate work orders for potential impacts to all natural resources, including any colonies of Michaux's sumac. Any work orders with the potential to impact Michaux's sumac will be surveyed with field site visits by NGVA-FMO-ENV personnel to ensure that impacts do not occur.

Implementation Tasks

1. Conduct visual surveys for Michaux's sumac colonies annually.
2. Search for additional Michaux's sumac colonies and re-delineate and map all known Michaux's sumac colonies every five to seven years. Updated Michaux's sumac geodatabases will be provided to all Fort Pickett stakeholders.
3. Update colony boundaries and map locations in specific areas to support military mission and construction requirements as needed.
4. All new construction or land clearing activities must have an on the ground search for Michaux's sumac prior to the initiation of the project. If new colonies are detected in areas that may conflict with military operations or construction, NGVA-FMO-ENV will immediately map and delineate the new colonies and inform all Fort Pickett stakeholders.

Appropriately Identify and Sign Michaux's Sumac Colonies

All colonies outside the CAA will be identified and signed using standards conforming to the latest DoD guidance (AR 200-1). Colonies adjacent to roads or range facilities in the CAA that could be affected by routine maintenance work will also be marked accordingly. NGVA-MTC-OP will be kept updated as to the location, size, and distribution of Michaux's sumac colonies occurring in locations where military vehicles and/or other vehicles have the potential to encroach.

Implementation Tasks

1. Assess condition and distribution of signage for each colony as appropriate at minimum once yearly. Identify colonies requiring additional signs and/or replacement signs.
2. Place additional signs on the border of colonies and/or replace signs that have been damaged or destroyed.

Monitoring

Monitoring the status and effects of management actions is an essential part of any sound management plan. Michaux's sumac at Fort Pickett has been historically monitored using both a quantitative and qualitative approach. The quantitative approach uses a series of plots allocated among a randomly selected subset of colonies to determine the non-flowering, flowering (staminate and pistillate) and total density/m^2 of Michaux's sumac. These data are subsequently examined to detect trends across the entire Fort Pickett population and in individual colonies[1].

A pilot quantitative monitoring program was initiated in 1996 and fully implemented in 1999. Since that time the original colonies selected for quantitative monitoring have not changed. Because Michaux's sumac grows in a dynamic ecosystem modified and influenced by disturbance, Teets et al. (2012) recommended that after each systematic delineation and mapping event the colonies selected for quantitative monitoring be updated. Michaux's sumac colonies expand, contract, disappear and appear in response to disturbance patterns thus requiring a period reassessment of the quantitative monitoring sample design. Qualitative monitoring involves visiting every colony, assessing the vigor of the colony using a variety qualitative and semi-quantitative measures, and recommendation of management actions required (if any)[2].

Implementation Tasks

Implement quantitative and qualitative monitoring of the density of Michaux's sumac in selected colonies every five to seven years.

Transplantation of Michaux's Sumac Colonies

At Fort Pickett conflicts between military training and Michaux's sumac are uncommon. However, the dynamic and constantly evolving military mission has resulted in range expansion and alteration thus isolating two small colonies of Michaux's sumac. These ranges are Range 12 and the IPBC (Figure 14). While these colonies have been properly signed and marked, the potential for accidental damage has increased. In addition, range management requires keeping the grass

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[1] See Teets et al. (2012) for a full description of field methods.
[2] See Teets and Emrick (2011) for a full description of methods.

mowed around each colony thus eliminating any possibility for colony expansion through rhizomatous growth, the primary means by which Michaux's sumac expands (Emrick and Jones 2008).

Internal Fort Pickett stakeholder meetings concluded the best management option for these isolated colonies would be to remove and transplant them to an area on Fort Pickett where the potential for military training conflicts is virtually non-existent and the potential for expansion is high.

There are three projects reported where transplanting Michaux's sumac was implemented as the selected management option. In 2003 at Fort Pickett, Virginia a small colony was excavated and transplanted to avoid conflicts with the development of a live fire range (Emrick 2003). In 2006 (Braham et al. 2006) and 2009 (Stanton 2009) projects were initiated to move Michaux's sumac from imperiled sites that were either under threat from road expansion in North Carolina.

At the time of the project at Fort Pickett the standard method for removal and transplantation was to carefully excavate the rhizome during the dormant season, cut the rhizome into 4-6 sections, and plant is prepared soil. While the transplantation project implemented at Fort Picket was successful, the area currently supports a viable colony (Bolin 2012), individual rhizome survivorship was not quantitatively measured. Nevertheless, anecdotal observations indicated that < 25% of the rhizomes planted resulted in above-ground stems. Braham et al (2006) compared series of excavation and propagation techniques including greenhouse studies with different combinations of potting mediums to identify the most successful excavation, propagation, and transplantation techniques. The study concluded that root cuttings were sufficient and that by propagating each cutting for one year in the greenhouse following excavation survivorship was significantly increased after transplanting (Braham et al. 2006).

A project for the excavation, propagation, and transplantation of Michaux's sumac at Fort Pickett from Range 12 and the IPBC to a location with low likelihood of military training conflicts and suitable habitat for expansion has been initiated. As of early 2017, formal consultation with the USFWS has been completed and transplantation efforts have begun.

<u>Compatibility with other Rare and Endangered Species</u>

Actions described for Michaux's sumac management shall be consistent with the conservation and management of other federally listed species that are present on the installation to the maximum extent possible. Furthermore, the effect that management actions have on state rare and endangered species will be considered. Based on opinions of recognized experts and informal consultation with USFWS Field Office, the anticipated effects on other listed species, due to actions of the Endangered Species Management Plan (ESMP) for Michaux's sumac, are minimal. Actions carried out as part of the Michaux's sumac ESMP are expected to have minimal impact on the population and suitable habitat of the Roanoke logperch and Bald eagle.

State rare, threatened and endangered species (Table 4 and Table 7) at Fort Pickett primarily occur with the Nottoway River riparian corridor and macrobasin. The management actions within Michaux's sumac ESMP are not expected to have negative impacts on these species, nor on the Nottoway River riparian corridor and macrobasin. Two rare Virginia Natural Heritage listed species, velvety sedge (*Carex vestita*) and old field milkvine (*Matelea decipiens*), are expected to benefit from the habitat management actions prescribed in the Michaux's sumac ESMP.

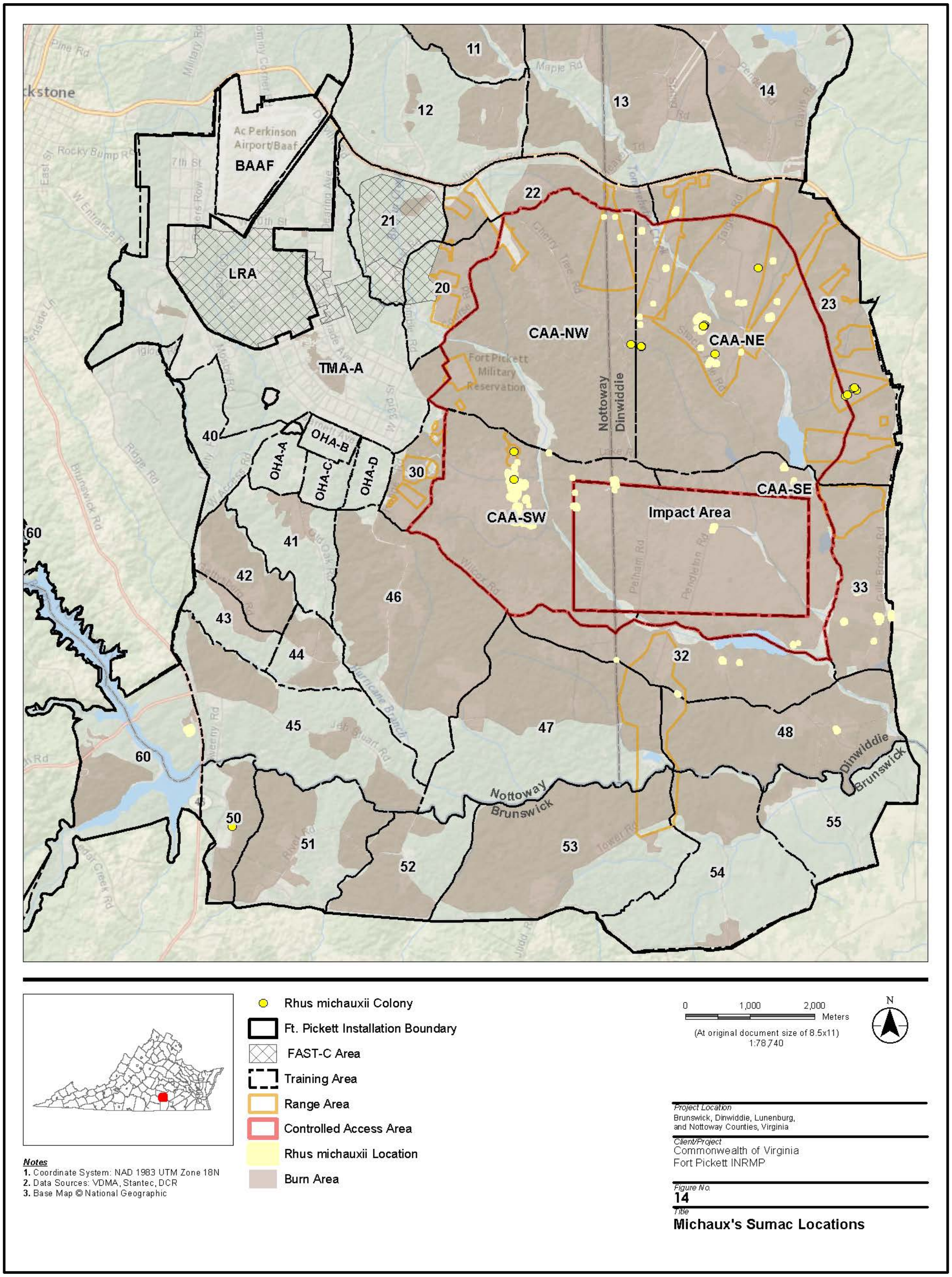


Figure 14. Michaux’s sumac locations on Fort Pickett

Environmental and ecological effects of implementing the *Rhus michauxii* ESMP

The only management action that will result in an environmental and ecological impact will be the implementation of prescribed fire for the maintenance of suitable habitat. These effects were examined in section 5.1.8. Guidelines and training limitations will be determined by the staff of NGVA-MTC-OP/Range Operations, Facilities Engineers and NGVA-FMO-ENV. These guidelines and recommendations will be incorporated into the Fort Pickett training regulations, with provisions to make service members in violation subject to punitive action under the *Uniform Code of Military Justice*. The policy will be to report violations involving training to the Range Operations Office and NGVA-FMO- ENV. Violations of the ESMP by civilians or off-duty military personnel on Fort Pickett will be processed through the Federal Magistrate Court.

5.3.2 Roanoke Logperch (*Percina rex*) Management

5.3.2.1 Goals and Objectives

The goals and objectives of Roanoke Logperch (*Percina rex*) management on Fort Pickett are summarized in Table 15 below.

Table 15. Roanoke Logperch (*Percina rex*) Management Goals and Objectives

GOALS	OBJECTIVES
Proactively preserve the Roanoke Logperch population through active habitat management and applied research.	Prevention of degradation of Roanoke logperch habitat.
	Quantitatively and qualitatively monitor the Roanoke logperch population. Abundance, distribution, and habitat condition should be monitored at least every three to five years.

5.3.2.2 Species Information

Distribution

Until recently, the Roanoke logperch was thought to be endemic to Virginia (Jenkins and Burkhead 1994), with occurrences documented in only the Roanoke and Chowan River drainages. In 2009, the Roanoke logperch was also documented in North Carolina. It occurs in the Smith, Mayo, Dan Rivers in VA and Big Beaver Island Creek, NC. Simonson and Neves (1986) state that the Roanoke logperch occupies 94.9 stream kilometers of the Nottoway River system in the Chowan River drainage, which is reported by the USFWS Roanoke logperch recovery plan (1992) to include a 52 kilometers reach of the mainstem of the Nottoway in Sussex and Greenville counties, Stoney Creek (a tributary of the Nottoway) in Dinwiddie and Sussex counties, and Butterwood Creek (a tributary to Stoney Creek). In the Roanoke River drainage, the Roanoke logperch also occupies the upper Roanoke River system in Roanoke and Montgomery counties, the Pigg River system in Franklin and Henry counties, and the Smith River System in Patrick and Henry counties. These disjunct populations probably represent remnants of much larger populations. Jenkins and Burkhead (1994) found this species to be rare to uncommon and never abundant throughout its range.

The Nottoway River is unique among the river systems used by Roanoke logperch. Rosenberger and Angermeier (2002) found that the Nottoway was the largest and most lowland (low gradient) of the river systems where Roanoke logperch have been documented and is comprised of a greater proportion of wide channels, with a dominance of pool habitats, and smaller substrate sizes. The Nottoway was also found to be the least silted of the rivers used by Roanoke logperch, the least embedded, and relatively pristine with complete riparian zones. The Nottoway also had a higher abundance of aquatic insects preferred by adults, with more large woody debris found in all mesohabitat types (pool, riffle, run) (Rosenberger and Angermeier 2002).

Prior to its discovery on Fort Pickett, Roanoke logperch distribution in the mainstem of the Nottoway was known from Route 619 bridge Sussex County, downstream to just above Route 40 bridge east of Sussex, VA. Here population levels are likely low, as evidenced by collection records that indicate that specimens have been mostly taken as singles or doubles (never in great numbers) (McIninch and Garman 2002). The Roanoke logperch was found on Fort Pickett approximately 1.2 river kilometers upstream of Shacks Hole Road, in the mainstem of the Nottoway River. One individual was first discovered by Natural Heritage biologists in September 1999. A second survey was conducted in September 2000 by several biologists from Virginia Tech, including Dr. Paul Angermeier, in which another individual was observed at approximately the same location as the previous year. McIninch and Garman (2002) used qualitative backpack- based electrofishing sampling to target Roanoke logperch and captured two individuals. While sampling efforts included tributaries, logperch were found only in the mainstem of the Nottoway. One was captured just downstream of the first ford upstream of Gills Bridge/Bailey Bridge Road on September 20, 2001. Another Roanoke logperch was captured downstream of the Tower Road crossing on November 17, 2001. In July of 2013, Roberts and Anderson (2013) captured two Roanoke logperch, one adult at each of two sites in the Nottoway River. Both individuals were captured in swift, rocky rapids adjacent to river fords.

<u>Status</u>

- Federal: Endangered (September 18, 1989)
- Virginia: Endangered/S1S2
- WAP: Tier IIa
- IUCN Red List Category: Vulnerable
- American Fisheries Society Status: Endangered (August 1, 2008)

<u>Description</u>

The body of the Roanoke logperch averages 14 cm in length, making it the largest member of the darter family – *Percidae*. Its body is elongate, cylindrical to slab-sided, with a conical snout and well-developed subocular bar and caudal spot. The back is dark green with darker markings and numerous small saddles that overlap onto the upper sides. Sides are greenish yellow with prominent bar markings usually separated from the dorsal markings. The belly is white to yellowish. The first dorsal fin has a broad yellowish to orange to red-orange band entirely bordered by a narrow black margin above and a broad black base below. The second dorsal, caudal, and large pectoral fins have black spots with a yellowish wash (USFWS 1992).

<u>Habitat</u>

This species occurs in the Nottoway River System (Stony and Butterwood Creeks) and the Roanoke, Chowan, and upper Dan drainage systems. The Roanoke logperch prefers moderate, low gradient streams and rivers and it is an indicator of high-quality streams. Habitat at Fort Pickett at the Shacks Hole site consists of deep pools and riffles. The riffles in which the logperch was observed were extremely complex in terms of velocity and substrate size and were comparatively silt-free (Angermeier 2000). The habitat was similar to other habitats in which the Roanoke logperch has been found.

Rosenberger 2002 observed adult and subadult logperch primarily in pools, occasionally in runs, and rarely in riffles, over sand and gravel in deep, low velocity habitats. That logperch were more likely to be found in pools on the Nottoway than in other mesohabitat types perhaps follows intuitively from the differences in habitat availability found in the Nottoway as compared to elsewhere in their range. Use of pools in other river systems where Roanoke logperch have been found may be precluded by excessive sedimentation, requiring the greater energy costs of navigating faster water habitat to find suitable feeding substrate. Logperch in the Nottoway may be able to take advantage of the relative abundance of pools with slower flow velocities, low silt loads, and the shelter from predators and foraging potential provided by the relative abundance of large woody debris. Logperch were observed consistently over small to large gravel in areas dominated by large gravel to boulders, with loosely embedded substrate and little or no silt cover. Both age classes selected habitat with little to no silt cover. Individuals found in deep pools were often observed near woody debris that may have served as cover from predators and as a source of food. These habitat configurations are common and widespread in the Nottoway River (Rosenberger 2002).

During different phases of life history and season, every major riverine habitat type is utilized by the logperch, and can vary with age class, spawning condition, and seasonal temperature (Burkhead 1983). Adults occupy a greater range of velocity and substrate characteristics and more scoured and fast flowing habitats than other age classes. Adults in the Nottoway occupy locations with faster velocities and less silt cover than subadults. Variations in habitat use by age class in the Nottoway may be due to predation pressure, feeding preferences, swimming ability, and/or stresses related to human activity.

While Burkhead (1983) proposed that logperch make greater use of deep pools for winter habitat, Rosenberger and Angermeier (2002) found less dramatic shifts in seasonal use. Adults were observed in high-velocity, deep microhabitat in riffles and runs over exposed, silt-free gravel in areas dominated by cobble and boulder substrates in both summer and winter. Logperch observed in winter appeared to occupy lower water velocities and were found over substrate less embedded with smaller substrates and less covered with silt. Use of lower water velocities would reduce energy requirements and accommodate potentially diminished swimming ability resulting from colder temperatures and reduced metabolism of winter quiescent individuals. The need for interstitial pockets within cobble and boulders for resting in winter may additionally influence seasonal habitat requirements.

While it is evident that a variety of habitat conditions are required for successful utilization by Roanoke logperch, the unifying feature appears to be their substrate requirements. Current understanding indicates that they require silt-free, exposed substrate for foraging, energetic, and reproductive success. The availability of suitable substrate is the most limiting factor for Roanoke logperch.

Life History/Ecology

The Roanoke logperch is one of only six species of fish that are endemic to Virginia (Jenkins and Burkhead 1994). They are benthic predators that flip over stones on the stream bottom with their pig-like snouts to expose potential prey items that hide in the crevices between the rocks such as aquatic insects, roundworms, young crayfish, etc. They are able to flip stones that are quite large relative to their body size by using their head like a prying lever and pushing up and forward with stout pectoral fins. This feeding behavior exploits prey that may be unavailable to other benthic hunters but is dependent on the availability of loosely embedded substrate. As a result, logperch are especially vulnerable to accumulation of fine sediments that can embed the substrate and fill the tiny interstitial spaces between rocks, depriving them of their source of food. The Roanoke logperch is considered a diurnal, visual predator, and corresponding reductions in visibility from sedimentation likely interfere with foraging success.

Reproduction includes elaborate spawning behaviors and waters muddied by excessive sedimentation may also interfere with reproductive success and egg burying. Spawning occurs in mid-April to early May in medium and large warm streams during the time when increased turbidity from coincident rains can exacerbate the problem. The life span of this species averages five to six years. The maximum age detected is about six and a half years (Burkhead and Jenkins 1991). Males mature in two years; most females mature in three years. All *Percina* species bury their eggs, with no subsequent parental care.

Conservation Threats

The Roanoke logperch is the only federally endangered fish species found within the boundaries of Fort Pickett. The main causes for the decline of this species in the Nottoway River system are excessive siltation and sedimentation caused by agricultural and logging practices.

The Roanoke logperch is endemic to Virginia and North Carolina and is known only to inhabit four locations in Virginia: the upper Roanoke River, Pigg River, Nottoway River, and Smith River. Population density in these areas is low and thus sensitive to changes in the ecosystem. The lifestyle and foraging strategy of the logperch makes it especially vulnerable to the effects of the accumulation of fine sediments that can embed substrate and fill in interstitial spaces used by the benthic prey species upon which it feeds. As a result of this vulnerability, low population densities, and very limited distribution, the Roanoke logperch has been listed as a federally endangered species since 1989. Throughout its range the species is limited by turbidity and siltation, chemical spills and organic pollution, channelization, impoundment, cold water, and small stream size (DWR 2003). The main causes for the decline of this species in the Nottoway River system are excessive siltation and sedimentation caused by agricultural and logging practices (USFWS 1992). The USFWS recommends the enforcement of the Clean Water Act, specifically Section 208, in aiding the recovery of Roanoke logperch (USFWS 1992).

Management Recommendations

Sections of the Nottoway River containing the Roanoke logperch have been protected by providing a 300 meters buffer on either side of the river (Figure 15). Rosenberger and Angermeier

(2002) recommend a watershed-level approach that addresses sediment loading and preserves natural river flow. Human interference should be minimized, such as construction on the riverbank that affects hydrology. It is also important to protect habitat that is important for all age classes, not just for adults.

Management will emphasize the prevention of degradation of Roanoke logperch habitat on Fort Pickett, requiring the following management actions:

- Strictly observe the Roanoke Logperch Protection Zone which prohibits any action that will disturb the stream bank or result in soil erosion within 300m of the Nottoway River (Figure 15).
- No in-stream work within the Logperch Protection Zone between 15 March and 30 June will be conducted to protect spawning adults and newly laid eggs.
- Protect areas identified as potential spawning, incubation, or foraging sites based on most current understanding.
- Maintain integrity of Nottoway riparian corridor and macrobasin in order to protect the Nottoway River from activities that result in soil erosion or stream bank degradation.
- Observe Virginia Department of Forestry's BMPs for silvicultural activities installation-wide to reduce and control soil erosion, including well-marked hardened areas at crossings.
- Observe the wetland and riparian protection zones installation-wide.
- Determine the population status, viability, and distribution throughout the Nottoway River within the boundaries of Fort Pickett.
    - Population levels and habitat condition should be monitored at least every three to five years.
    - Ecological monitoring of habitat should include factors such as substrate type and size, instream flow, and water temperature.
- Utilize GPS to accurately map habitat features and environmental conditions relevant to the protection of Roanoke logperch and habitat.
- With the approval of Fort Pickett's command and the VAARNG HQ review and approval, the installation will cooperate with USFWS to determine the feasibility of rehabilitating habitat in Nottoway River, and/or reintroducing the logperch in appropriate habitat.
- Implement adaptive management strategies identified from population and habitat monitoring.

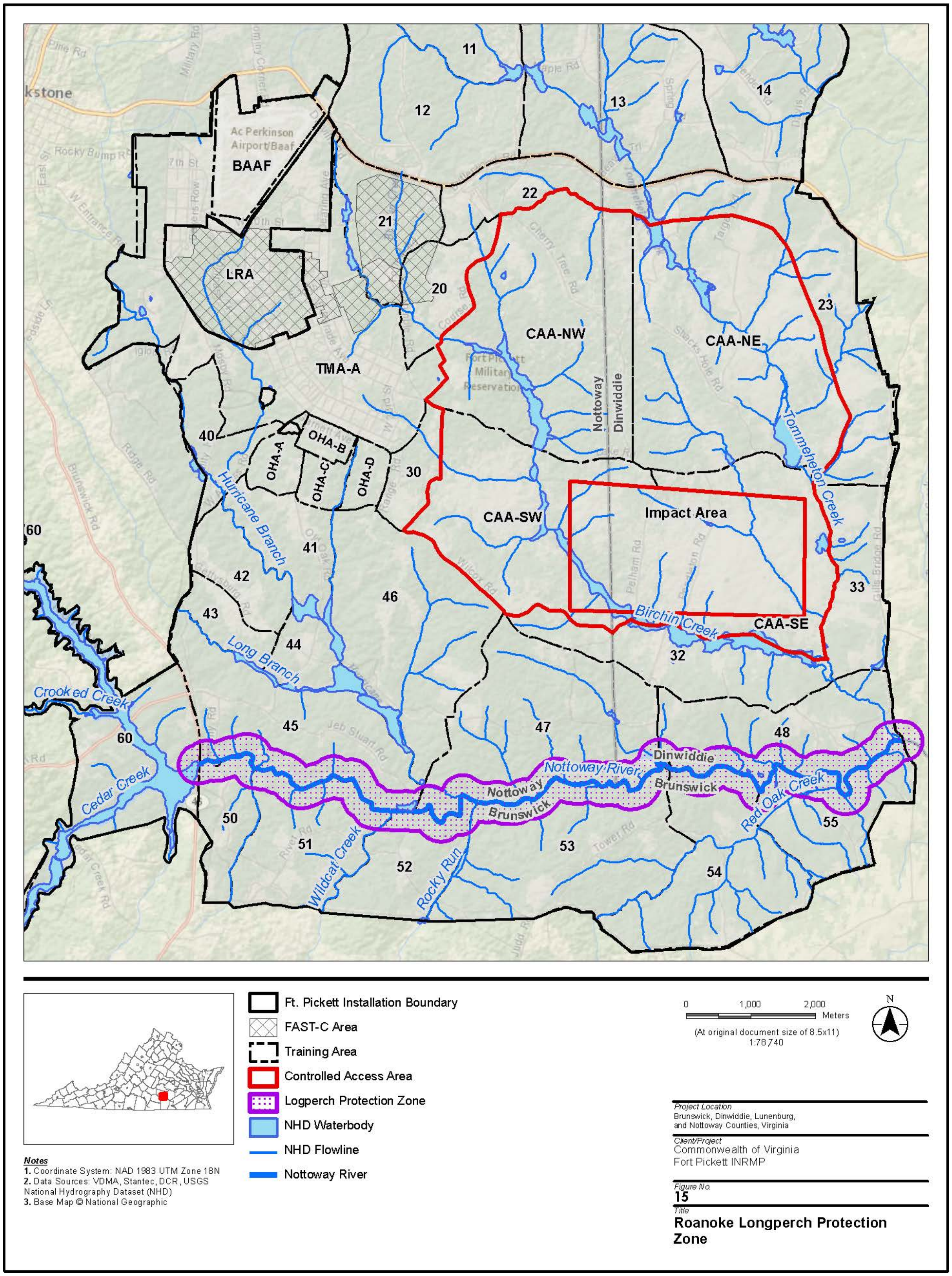


Figure 15. Roanoke Logperch Protection Zone

5.3.3 Bald Eagle (*Haliaeetus leucocephalus*) Management

5.3.3.1 Goals and Objectives

The goals and objectives of bald eagle (*Haliaeetus leucocephalus*) management on Fort Pickett are summarized in Table 16 below.

Table 16. Bald Eagle (*Haliaeetus leucocephalus*) Management Goals and Objectives

GOALS	OBJECTIVES
To maintain current habitat for bald eagles, including nest and perch trees.	Yearly monitoring.
	Ensure that the USFWS *National Bald Eagle Management Guidelines* are followed.

5.3.3.2 Species Information

In Virginia, bald eagle populations declined to less than 100 estimated pairs in 1970 due to the widespread use of pesticides such as Dichlorodiphenyltrichloroethane, commonly referred to as DDT, habitat loss, and other factors (Abbott 1978). Surveys have been conducted in the state for 35 years, and most were focused on the Chesapeake Bay region. It was not until recently that a concerted effort was made to survey and document nests located in the Piedmont and mountain regions (Cumberland Plateau, Ridge and Valley, and Blue Ridge provinces) of the state. Results from those surveys have put the total number of nests in Virginia to over 800 (unpublished data), with approximately 25% located in the Piedmont and mountains.

Kramer *et al.* 2013 conducted aerial and ground surveys of Fort Pickett and the surrounding Nottoway River and confirmed the presence of three bald eagle nests within the boundaries of Fort Pickett. They were unable to identify nests at two locations where eagles had nested historically. Hurricane Branch is the oldest active "nesting" site that is currently within the boundaries of Fort Pickett. The Hurricane Branch nest is reasonably well isolated from human disturbance. The nest located in the proposed FASTC site was previously identified in 2012 and was confirmed via a site visit. The Tommeheton Lake nest was identified on April 3, 2013 (Kramer et al. 2013). Fort Pickett officials identified a new nest in 2017 which was previously undocumented.

Based on information available from the 2013 survey conducted by Kramer *et al*., the Center for Conservation Biology (CCB) Virginia bald eagle nest locator, and observations made by Fort Pickett officials, Stantec conducted new ground and aerial surveys in 2019. The presence of the four previously reported nests was confirmed and no additional nests, including the two historic nests, were identified during the aerial survey within the Fort Pickett installation.

<u>Status</u>

- Federal: Protected under *Bald and Golden Eagle Protection Act* and *Migratory Bird Treaty Act.*
- Virginia: S3S4B, S3S4N
- WAP: N/A
- IUCN Red List Category: Least concern

The bald eagle was removed from the federal endangered species list in July 2007 because of successful conservation efforts that restored its populations to acceptable levels. As of 1 January 2013, the bald eagle was delisted from the Virginia Threatened and Endangered Species list. However, protection will still be provided under the *Bald and Golden Eagle Protection Act* and *Migratory Bird Treaty Act*.

<u>Description</u>

Adults are easily identified by their white head and tail. Immature eagles are dark with blotchy white on underwing, belly and tail (Sibley 2000). Bald eagles need four to five years to reach maturity and full adult plumage.

Grubb and King (1991) found that bald eagles were most easily disturbed while foraging, and that pedestrian traffic is the most disturbing, while boat traffic is the least. Bald eagles living on military bases have been found to tolerate the sound of distant artillery but are most affected by noise early in the breeding season (Grubb and King 1991).

<u>Habitat</u>

The bald eagle is usually found near water, but during migration can be found almost anywhere (Terwilliger 1991).

<u>Life-history/Ecology</u>

Breeding pairs usually return to the nest structure annually and usually begin nest building and maintenance in December and January. Eggs are usually laid between mid-January and mid-March and young fledge by the end of June or early July (Terwilliger 1991). The nest is a massive platform of sticks and vegetation lined with moss and grasses on a cliff ledge or in a fork of a tree 3-55 meters high (Stokes and Stokes 1996).

<u>Conservation Threats</u>

Current threats to bald eagles include habitat loss/destruction, lead poisoning from ammunition, environmental pollution, and collisions with cars and structures.

Human activity can disturb bald eagles, especially during the breeding season. In Virginia, breeding activity initiates in November and lasts through mid-July. There is a great amount of variability in sensitivity to disturbance of bald eagles which can relate to factors such as the visibility, noise level, duration, and size of the disturbance as well as the prior experience and tolerance of individuals. Disturbance to nest sites can cause them to neglect or even abandon their vulnerable young and disturbance to roosting and foraging locations may have negative impacts on the feeding and survival of adults. The *National Bald Eagle Guidelines* (Appendix M) account for a number of these factors and have established buffer zones for many specific activities. These guidelines pertain to active and alternate nests (alternate nests are built or maintained by the eagles but not used for nesting in a given year). If a nest can be proved inactive for the preceding five breeding seasons, then these guidelines may be no longer applicable. However, if the nest is still intact by provisions of *The Bald and Golden Eagle Act* then the nest itself may not be destroyed, whether it is deemed active or not.

<u>Conservation Goals</u>

DWR and the USFWS will continue to work with Fort Pickett to protect the bald eagle and its habitat. The overall conservation goal is to maintain current habitat for bald eagles, including nest and perch trees.

The USFWS published the *National Bald Eagle Management Guidelines* in May of 2007. These new guidelines have replaced the previous primary and secondary protection zones system with system of guidelines that evaluate the level of disturbance of various activities and dictate how far they must be conducted from nests.

<u>Monitoring</u>

Annual monitoring takes place to determine activity in the nest. VAARNG may fly over the bald eagle nest each year beginning 15 November through 15 December to detect initial signs of breeding activity.

During the breeding season, NGVA-FMO-ENV personnel will check from the ground to determine the status of the nest. Surveys may also be conducted in May to count fledglings and to reconfirm nest sites. As long as the nest or any portion of the nest remains in the tree, the nest tree itself cannot be removed.

<u>Management Prescriptions and Actions</u>

The following is an abbreviated summary of the USFWS *National Bald Eagle Management Guidelines*. The full report can be found in Appendix M of this INRMP for reference. Activities are separated into eight categories (A – H) based on the nature and magnitude of impacts to bald eagles that usually result from the type of activity. Activities with similar or comparable impacts are grouped together. The Virginia USFWS field office will be contacted regarding additional information and technical assistance concerning bald eagle management as needed. I f avoidance measures are not possible, a permit for eagle take may be required under 50 CFR 22.

Construction: If construction is visible from the nest site and/or similar activity is taking place within one mile of the nest, the construction may proceed provided it is more than 660 feet from the nest.

Category A: *<u>If construction is not visible from the nest, these categories of activities may take place as close as 330 feet Clearing, external construction, and landscaping between 330 and 660 feet should not be conducted during the breeding season.</u>*

- Building construction, 1 or 2 story, with project footprint of ½ acre or less.
- Construction of roads, trails, canals, power lines, and other linear utilities.
- Agriculture and aquaculture – new or expanded operations.
- Alteration of shorelines or wetlands.
- Installation of docks or moorings.
- Water impoundment.

Category B: <u>These categories of activities should take place no closer than 660 feet from the nest at any time.</u>

- Building construction, 3 or more stories.
- Building construction, 1 or 2 story, with project footprint of more than ½ acre.
- Installation or expansion of marinas with a capacity of 6 or more boats.
- Mining and associated activities.
- Oil and natural gas drilling and refining and associated activities

Category C: <u>Timber Operations and Forestry Practices</u>

- Avoid clear cutting or removal of overstory trees within 330 feet of the nest at any time.
- Avoid timber harvesting operations, including road construction and chain saw and yarding operations, during the breeding season within 660 feet of the nest. The distance may be decreased to 330 feet around alternate nests within a particular territory, including nests that were attended during the current breeding season but not used to raise young, after eggs laid in another nest within the territory have hatched.
- Selective thinning and other silviculture management practices designed to conserve or enhance habitat, including prescribed burning close to the nest tree, should be undertaken outside the breeding season. Precautions such as raking leaves and woody debris from around the nest tree should be taken to prevent crown fire or fire climbing the nest tree.
- If it is determined that a burn during the breeding season would be beneficial, then, to ensure that no take or disturbance will occur, these activities should be conducted only when neither adult eagles nor young are present at the nest tree (i.e., at the beginning of, or end of, the breeding season, either before the particular nest is active or after the young have fledged from that nest). Appropriate Federal and state biologists should be consulted before any prescribed burning is conducted during the breeding season.
- Avoid construction of log transfer facilities and in-water log storage areas within 330 feet of the nest.

Category D: <u>Off-road vehicle use</u>. No buffer is necessary around nest sites outside the breeding season. During the breeding season, do not operate off-road vehicles within 330 feet of the nest. In open areas, where there is increased visibility and exposure to noise, this distance should be extended to 660 feet.

Category F: <u>Non-motorized recreation and human entry</u> (e.g., hiking, camping, fishing, hunting, birdwatching, kayaking, canoeing). No buffer is necessary around nest sites outside the breeding season. If the activity will be visible or highly audible from the nest, maintain a 330-foot buffer during the breeding season, particularly where eagles are unaccustomed to such activity.

Category G. <u>Helicopters and fixed-wing aircraft</u>. Except for authorized biologists trained in survey techniques, avoid operating aircraft within 1,000 feet of the nest during the breeding season, except where eagles have demonstrated tolerance for such activity.

Category H. Blasting and other loud, intermittent noises. Avoid blasting and other activities that produce extremely loud noises within 1/2 mile of active nests, unless greater tolerance to the activity (or similar activity) has been demonstrated by the eagles in the nesting area. This recommendation applies to the use of fireworks classified by the Federal Department of Transportation as Class B explosives, which includes the larger fireworks that are intended for licensed public display.

Recommendations for Avoiding Disturbance at Foraging Areas and Communal Roost Sites

1. Minimize potentially disruptive activities and development in the eagles' direct flight path between their nest and roost sites and important foraging areas.
2. Locate long-term and permanent water-dependent facilities, such as boat ramps and marinas, away from important eagle foraging areas.
3. Avoid recreational and commercial boating and fishing near critical eagle foraging areas during peak feeding times (usually early to mid-morning and late afternoon), except where eagles have demonstrated tolerance to such activity.
4. Do not use explosives within a half mile (or within one mile in open areas) of communal roosts when eagles are congregating, without prior coordination with the USFWS and DWR.
5. Locate aircraft corridors no closer than 1,000 feet vertical or horizontal distance from communal roost sites.

Additional Recommendations to Benefit Bald Eagles

1. Protect and preserve potential roost and nest sites by retaining mature trees and old growth stands, particularly within ½ mile from water.
2. Where nests are blown from trees during storms or are otherwise destroyed by the elements, continue to protect the site in the absence of the nest for up to three (3) complete breeding seasons. Many eagles will rebuild the nest and reoccupy the site.
3. To avoid collisions, site wind turbines, communication towers, and high voltage transmission power lines away from nests, foraging areas, and communal roost sites.
4. Employ industry-accepted best management practices to prevent birds from colliding with or being electrocuted by utility lines, towers, and poles. If possible, bury utility lines in important eagle areas.
5. Where bald eagles are likely to nest in human-made structures (e.g., cell phone towers) and such use could impede operation or maintenance of the structures or jeopardize the safety of the eagles, equip the structures with either (1) devices engineered to discourage bald eagles from building nests, or (2) nesting platforms that will safely accommodate bald eagle nests without interfering with structure performance.
6. Immediately cover carcasses of euthanized animals at landfills to protect eagles from being poisoned.
7. Do not intentionally feed bald eagles. Artificially feeding bald eagles can disrupt their essential behavioral patterns and put them at increased risk from power lines, collision with windows and cars, and other mortality factors.
8. Use pesticides, fertilizers, and other chemicals only in accordance with Federal and state laws.

9. Monitor and minimize dispersal of contaminants associated with hazardous waste sites (legal or illegal), permitted releases, and runoff from agricultural areas, especially within watersheds where eagles have shown poor reproduction or where bioaccumulating contaminants have been documented. These factors present a risk of contamination to eagles and their food sources.

5.3.4 Bat Management

5.3.4.1 Goals and Objectives

The goals and objectives of bat management on Fort Pickett are summarized in Table 17 below.

Table 17. Bat Management Goals and Objectives

GOALS	OBJECTIVES
To maintain habitat for bats, specifically for the Federally listed northern long-eared bat (*Myotis septentrionalis*)and Indiana bat (*Myotis sodalis*) as well as the State listed tri-colored bat (*Perimyotis subflavus*) and Little Brown Bat (*Myotis lucifugus*).	Implement management actions as described in the VDGIF *Best Management Practices for Conservation of Little Brown Bats and Tri-colored bat.*
	Ensure that all the requirements in the *Programmatic Biological Opinion on Final 4(d) Rule for the Northern Long-eared Bat and Activities Excepted from Take Prohibitions* are met.
	Maintain compliance with Section 7 of the Endangered Species Act for federally listed bat species.
	Conduct surveys to monitor the populations of bat species.

5.3.4.2 Introduction

Bats have been proposed as good indicators of the integrity of natural communities because they integrate a number of resource attributes (e.g., roosting, watering, and feeding habits), and thus may show population declines quickly if a resource attribute is missing (Hutson *et al.* 2001). Some bat populations worldwide are experiencing declines due to adverse effects of human population growth and associated deforestation; conversion of natural habitats to forest and agricultural monocultures; water, soil, and air pollution; and introductions of xenobiotics and exotic species (Kunz and Fenton 2003). A severe decline of eastern bats was documented in New York in 2006-2007. This decline was later determined to be caused by the fungal pathogen, *Pseudogymnoascus destructan,* the agent responsible for white-nosed syndrome (Blehart *et al*. 2009).

A Phase III mist net survey was completed by Normandeau Associates, Inc. in 2019 specifically for the NLEB and Indiana bat. No NLEB or Indiana bats were caught during the survey. The most recent acoustic survey of the base identified the presence of 11 species of bat including the Indiana bat at one location and multiple bat calls each for the NLEB, tri-colored bats and little brown bats (Duffey *et al.* 2020).

In 1967, the Indiana bat was listed as a federally endangered species throughout its range under the ESA. This listing was prompted by sharp population declines due to habitat loss and disturbance of hibernacula. Since its discovery, white-nose syndrome has also been attributed to declines in Indiana bat populations. On April 2, 2015, the USFWS listed the NLEB as threatened throughout its range under the ESA. The NLEB's population is estimated to have declined 99% because of the white- nose syndrome. Similar declines have also been documented on two other once common species on the installation: the little brown bat and the tri-colored bat. The DWR has issued "Best Management Practices for Conservation of Little Brown Bats and Tri-colored bats", a copy of which is included in Appendix O. As all four require similar habitat and food sources, and there are no known roosts in Fort Pickett or within 75 miles of the base, the NLEB management strategies will aid in the protection of the Indiana bat, little brown bat and the tri-colored bat.

5.3.4.3 Little Brown Bat (*Myotis lucifugus*)

<u>Distribution</u>

The little brown bat is found in abundance throughout the northern U.S. and into Canada. It is present in lesser numbers in southern states and is absent from the southern Great Plains. Little brown bats are also found in high elevation forests in Mexico. The little brown bat was acoustically detected, and one was captured during the bat survey conducted on Fort Pickett by CMI in 2016 (St. Germain *et al*. 2017).

<u>Status</u>

- Virginia: Endangered
- WAP: Tier Ia

<u>Description</u>

The little brown bat is a small size *Myotis*, with glossy fur that is a dark yellow-brown to olive brown. The face, ears, and membranes are dark, with the membranes sparsely or not furred. The total length ranges from 60-102 millimeters with a wingspan from 222-269 millimeters. The little brown bat has a weight of 5-14 grams and the female is slightly larger than the male. The little brown bat has a life expectancy of six to seven years.

<u>Habitat preferences</u>

Little brown bats may choose hibernacula and summer roosts such as caves, buildings, rocks, trees, wood piles, and under bridges, mines, and tunnels. They may migrate hundreds of miles from their summer habitats to their hibernacula.

<u>Life-history</u>

The mating season usually starts in August and pups are born approximately two months later. At about one month of age, they can fly and catch insects on their own. Each mother has one pup per year. When not hibernating, these bats emerge to forage at late dusk. Moths, midges, mayflies, and aquatic insects are a major part of the little brown bats diet.

5.3.4.4 Tri-colored Bat (*Perimyotis subflavus*)

Distribution

The tri-colored bat is found in abundance throughout the eastern forests of U.S. and the eastern coast of Mexico as well as Northern Central America. The tri-colored bat was acoustically detected during the bat survey conducted on Fort Pickett by CMI in 2016 (St. Germain *et al.* 2017).

Status

- Virginia: Endangered
- WAP: Tier Ia

Description

The tri-colored bat is a small bat. The dorsal color varies from yellowish or grayish brown to reddish brown, with a paler underside. The tri-colored bat can be distinguished from *Myotis* species by its tri-colored fur, the bases and tips of individual hairs are dark while the middle sections are light. The total length ranges from 75-90 mm with a wingspan from 210-260 mm. It has a weight of 4-8 grams. These bats have a typical lifespan of four to eight years in the wild.

Habitat preferences

Tri-colored bats hibernate in caves, mines, and tunnels. While this species is often found hibernating in the same sites as large populations of other bats, tri-colored bats generally roost singly, often in trees, but some males and non-reproductive females also roost in their winter hibernaculum. Maternity roosts are commonly found in trees, rock crevices, barns, and other buildings.

Life-history
Tri-colored bats mate in the fall, and females give birth to litters, usually of two young, in the spring. While the young are growing, the mothers roost in small maternity colonies. They hibernate from October into April. During this time, they enter a state of torpor in which their body temperature drops to that of the surrounding air temperature. Tri-colored bats forage early in the evening and forage mainly over water and near forest edges tending to avoid deep woods or open fields. They eat moths, flies, beetles, ants, and other insects.

5.3.4.5 Indiana Bat (*Myotis sodalis*)

Distribution

The Indiana bat is found in the central, eastern and southeastern U.S. The Indiana bat was identified at Fort Pickett during an acoustic survey conducted in 2020 (Duffey *et al.* 2020).

Status

- Federal: Endangered
- Virginia: Endangered, S1
- WAP: Tier Ia

- Global: G2

Description

The Indiana bat is a medium size bat, with dull, dark gray or dark brown fur that appears tri-colored on the back and short ears. In order to differentiate the Indiana bat from the little brown bat, scientists look for a sharply keeled calcar; dull grayish chestnut back fur and pinkish cinnamon stomach fur. The total body length ranges from 77 mm to 91 mm with a wingspan of 240 mm to 267 mm. These bats have a typical lifespan of up to thirteen years in the wild.

Habitat preferences

The hibernacula of the Indiana bat include caves and mines. They prefer limestone caves with pools and a low temperature below ten (10) degrees centigrade in the winter with humidity at or above 65 percent. During the summer months the Indiana bat roosts singly or in colonies in trees either underneath bark or in the cavities. Males and non-reproductive females may also roost in cooler places, like caves and mines. They rarely roost in human structures like barns and sheds.

Life-history

Indiana bats mate in early October, right before entering hibernation. They employ delayed fertilization. After fertilization in the early spring, pregnant bats migrate north to summer areas where they roost in small colonies and give birth to a single pup in June or July. Summer habitat is usually in a forested or semi-forested area near a medium to large stream. Maternity colonies of females and young generally have 50 to 100 bats although larger maternity colonies have also been observed. Young bats start flying by 25 to 35 days after birth. Indiana bats emerge at night to feed. They primarily fly through forested areas feeding on moths, mayflies, and beetles.

5.3.4.6 Northern long-eared bats (*Myotis septentrionalis*)

Distribution

NLEB is a threatened species found in the eastern and northern forests of the U.S. and southern Canada. The NLEB was acoustically detected, and one was captured during the bat survey conducted on Fort Pickett by CMI in 2016 (St. Germain *et al*. 2017).

Status

- Federal: Threatened
- Virginia: Threatened, S3/S4
- WAP: Tier Ia
- Global: G4

Description

The NLEB is a medium size bat, with medium to dark brown fur on the back and pale-brown on the underside. The total body length ranges from 76 mm to 94 mm with a wingspan of 228 mm to 254 mm. As its name suggests, this bat is distinguished by its long ears, particularly as compared to other bats in its genus, *Myotis*. These bats have a typical lifespan of up to eighteen years in the wild.

Habitat preferences

The hibernacula of the NELB include caves and mines. During the summer months the NLEB roosts singly or in colonies in trees either underneath bark, in cavities, or in crevices of trees. Males and non-reproductive females may also roost in cooler places, like caves and mines. They rarely roost in human structures like barns and sheds.

Life-history

NLEB mate in the late summer to early fall and they employ delayed fertilization. After fertilization, pregnant bats migrate to summer areas where they roost in small colonies and give birth to a single pup. Maternity colonies of females and young generally have 30 to 60 bats although larger maternity colonies have also been observed. Young bats start flying by 18 to 21 days after birth. Northern long-eared bats emerge at dusk to feed. They primarily fly through forested areas feeding on moths, flies, leafhoppers, caddisflies, and beetles.

5.3.4.7 Northern Long-Eared Bat (NLEB) and Indian Bat Management

In the past ten years, white-nosed syndrome has spread from New York and devastated bat populations across the eastern United States. It is important to conduct more frequent planning level surveys to better reflect the bat species composition present on the installation since the dramatic declines that have occurred since the mid-2000's. The last acoustic survey for bats was completed on Fort Pickett in 2020 (Duffey *et al*. 2020) and NLEB were acoustically identified as being present.

Natural resource managers throughout North America have placed increasing emphasis on understanding the impact of forest management practices on populations and behavior of bats (Menzel *et al.* 2005a). Subsequently land managers, both public and private, are increasingly expected to provide habitat to maintain or promote bat community diversity in forested and other natural landscapes (Miller *et al.* 2003). The continued decline of several bat species associated with forested environments underscores the need for an increased understanding of habitat relationships for North American bats (St. Germain 2012, Fenton 1997, and Menzel *et al.* 2005b). These habitat relationships have been identified as one of the informational gaps hindering our understanding of how to better manage natural systems for bats (Arnett 2003).

On 2 April 2015, the USFWS listed the NLEB as threatened throughout its range under the ESA. The final 4(d) rule (81 Federal Register 1900-1922), was issued on 14 January 2016 and became effective 16 February 2016. At the same time, an Intra-Service Programmatic Biological Opinion on the issuance of the final 4(d) rule dated 5 January 2016 was released that provides a mechanism for achieving section 7 compliance for many Federal actions. The final 4(d) rule prohibits incidental take within a hibernaculum and as the result of tree removal within 0.25 miles of a known hibernaculum, or within 150 feet of a known occupied maternity roost tree between 1 June and 31 July.

Due to the potential presence of the NLEB and Indiana bat in the summer months within many forested areas in Virginia, there are several options that facilitate compliance with the ESA with regards to NLEB and Indiana Bat.

1. Implement a time of year restriction of tree removal within the 15 April through 15 September timeframe or complete a survey for the NLEB that has negative results which will allow streamlined consultation with the USFWS.
2. Implement a time of year restriction of tree removal within the 1 April through 15 November timeframe or complete a survey for the Indiana bat that has negative results which will allow streamlined consultation with the USFWS.
3. Implement the previously completed informal programmatic consultation with the USFWS which includes management strategies that can be used to guide Fort Pickett in fulfilling the Section 7(a)(1) responsibilities. A copy is included in Appendix O.
4. Implement the formal programmatic biological opinion for the final 4(d) rule.

All federal activities must conform with the Programmatic Biological Opinion on Final 4(d) Rule for the Northern Long-eared Bat and Activities Excepted from Take Prohibitions. Furthermore, these activities must maintain compliance with Section 7 of the Endangered Species Act for federally listed bat species. Any exceptions must be approved by the Environmental office and the USFWS. A copy of the Programmatic Biological Opinion on Final 4(d) Rule is attached in Appendix O. The VAARNG's goal is to implement management guidelines that will allow the ARNG to accomplish military readiness missions, while concurrently developing and implementing methods to assist in the conservation of the NLEB, Indiana bat, and other protected bat species.

5.3.5 Mussel Management

5.3.5.1 Goals and Objectives

The goals and objectives of mussel management on Fort Pickett are summarized in Table 18 below. Mussels are being affected by water pollution, changing water temperatures, dams and pipes that change flow patterns, fragment the habitat and scour creek bottoms. Mussels are protected within the Nottoway River Corridor and Macrobasin Protection Zone.

Table 18. Mussel Management Goals and Objectives

GOALS	OBJECTIVES
To maintain and improve existing habitat and preserve and enhance existing populations.	Monitor the populations of mussels within the Nottoway River.
	Improve water quality.

5.3.5.2 Management Recommendations

As with the Roanoke logperch, mussel management should emphasize the prevention of degradation of mussel habitat on Fort Pickett by implementing the following management actions:

- Strictly observe the Nottoway River Protection Zone which prohibits any action that will disturb the stream bank or result in soil erosion within 300m of the Nottoway River (Figure 20).
- No in-stream work within the Nottoway River Protection Zone between 15 May and 30 July should be conducted to protect spawning adults and glochidia release.
- Protect areas identified as potential spawning, incubation, or foraging sites based on most current understanding.
- Maintain integrity of Nottoway riparian corridor and macrobasin in order to protect the Nottoway River from activities that result in soil erosion or stream bank degradation.
- Observe Virginia Department of Forestry's BMPs for silvicultural activities installation-wide in order to reduce and control soil erosion, including well-marked hardened areas at crossings.
- Observe the wetland and riparian protection zones installation-wide.
- Determine the population status, viability, and distribution throughout the Nottoway River within the boundaries of Fort Pickett. Population levels and habitat condition should be monitored at least every three to five years.
- Utilize GPS to accurately map habitat features and environmental conditions relevant to the protection of mussel habitat.
- With the approval of Fort Pickett's command and the VAARNG HQ review and approval, the installation should cooperate with USFWS to determine the feasibility of rehabilitating habitat in Nottoway River.
- Implement adaptive management strategies identified from population and habitat monitoring.

5.3.5.3 Atlantic Pigtoe Mussel (*Fusconaia masoni*)

The Atlantic pigtoe mussel has historically been located within the Nottoway River and the species has been listed as a threatened species by the USFWS.

<u>Distribution</u>

Range extends from the Ogeechee River Basin in Georgia north to the James River Basin in Virginia.

<u>Status</u>

- Federal: Proposed threatened
- Virginia: Threatened/S2
- WAP: Tier Ia
- Global: G2 - Imperiled

- IUCN Red List Category: EN - Endangered
- American Fisheries Society Status: Threatened (January 1, 1993)

Description

Lengths of adults rarely exceed 50 mm (Figure 16). With the exception of individuals that reside in headwaters that tend to be elongate, shell shape is subrhomboidal and usually compressed. The anterior margin is rounded, the posterior margin is somewhat angular, and the posterior ridge is distinct. Beaks are positioned fairly anteriorly and elevated above the dorsal margin. Exterior shell color is yellow to dark brown with a parchment like surface. Interior shell colors range from iridescent blue, to salmon, to white, and to orange.

Figure 16. Atlantic Pigtoe at Fort Pickett

Habitat preferences

The Atlantic pigtoe mussel commonly occurs in medium to large streams but is also found in headwater areas. They prefer clean, swift flowing waters with stable substrate composed of coarse sands and gravel. They are often found at the downstream edge of riffles, and are less commonly found in sand, cobble and mixed substrates of sand, silt, and detritus.

The Nottoway River has been designated as critical habitat for the Atlantic pigtoe. However, because the 14 river miles (22.5 river km) segment of the Nottoway River that passes through Fort Pickett is subject to the conservation efforts identified in this INRMP, streams on the installation were declared exempt from the critical habitat designation under section 4(a)(3) of the Endangered Species Act.

Life-history[3]

The Atlantic pigtoe mussel is a short-term brooder (tachytictic) and generally found to be gravid from late June through early July. Wolf and Mair (CMI 2010 unpublished data) reported high fish host transformation success with the longnose dace* (*Rhinichthys cataractae*), creek chub* (*Semotilus atromaculatus*), and the rosefin shiner* (*Lythrurus ardens*) in laboratory experiments. Their results concluded that a collection of minnow species (*Cyprinidae*) are likely suitable fish hosts for the Atlantic pigtoe. Other laboratory studies have collectively reported the white shiner* (*Luxilus albeolus*) satinfin shiner* (*Cyprinella analostana*), bluegill* (*Lepomis macrochirus*) and shield darter *(*Percina peltata*) as potential fish hosts; however, these experiments had limited transformation success.

5.3.5.4 Dwarf Wedgemussel (Alasmidonta heterodon)

The dwarf wedgemussel (Figure 17) has historically been located within the Nottoway River and the species is listed as an endangered species by the USFWS.

Distribution

Range extends from New Hampshire to North Carolina. In Virginia, the dwarf wedgemussel has been found in the Nottaway, Mattaponi, Lower Potomac, and Lower Rappahannock watersheds.

Figure 17. Dwarf Wedgemussel

[3] *=known or likely to occur on Fort Pickett

Status

- Federal: Endangered
- Virginia: Endangered
- WAP: Tier Ia
- Global: G1- Critically Imperiled
- IUCN Red List Category: VU – Vulnerable
- American Fisheries Society Status: Endangered (01Jan1993)

Description

Adult dwarf wedgemussesl less than 45 mm in length (Figure 17) with a height of 25 mm. The shell is subtrapezoidal with a thicker anterior end and female shells are slightly wider. The peristracum is brown to yellowish brown and the inside of the shell is Dwarf wedgemussels have two lateral teeth on the right valve, and only one on the left valve. Because shell growth slows in the winter, growth rings are visible.

Habitat preferences

The dwarf wedgemussel is found in small to large creeks or rivers where the current is slow to moderate on a variety of substrates such as cobble, fine gravel, sand or mud. They may also be found amongst submerged aquatic plants, and along shaded stream edges.

Life-history

Dwarf wedgemussel are long term brooders (bradytictic), which means they spawn from August to September, become gravid in September, and the glochidia mature in November. The glochidia latch on to the gills or fins of fish for feeding and development. Three potential host fish have been identified: the tessellated darter (*Etheostoma olmstedi*); the Johnny darter (*Etheostoma nigrum*); and the mottled sculpin (*Cottus bairdi*).

5.3.5.5 Yellow Lance Mussel (*Elliptio lanceolota*)

The yellow lance mussel has historically been located within the Nottoway River and the species is listed as a threatened species by the USFWS.

Distribution

Range extends from Maryland to South Carolina. In Virginia, the yellow lance has been found in the Upper-James, Middle James-Willis, Lower-Rappahannock, Nottoway, Meherrin, Blackwater, and Albemarle watersheds.

Status

- Federal: Threatened
- Virginia: Threatened/S2S3

- WAP: Tier IIa
- Global: G2 - Imperiled
- IUCN Red List Category: NT - Near threatened
- American Fisheries Society Status: Endangered (01Jan1993)

Description

Lengths of adults average 86 mm (Figure 18) and the shell is elongate and the periostracum of young specimens is bright yellow. While a few brown individuals have been recorded, they have not been discovered with yellow individuals. The posterior ridge is distinctly rounded and curves across the back to the posterior. The left-valve has two lateral teeth, and the right valve has one lateral tooth. The lateral teeth are long and there are two pseudo cardinal teeth on each valve. Interior shell colors range from iridescent blue, to salmon, and to white.

Figure 18. Yellow Lance Mussel

Habitat preferences

Commonly occurs in medium to large streams but can also be found in smaller streams. Prefer slack waters and a stable substrate composed of coarse to medium sands and may sometimes be found in gravel. Found in areas of slack waters. Less commonly found buried in sand.

The Nottoway River has been designated as critical habitat for the yellow lance. However, because the 14 river miles (22.5 river km) segment of the Nottoway River that passes through Fort Pickett is subject to the conservation efforts identified in this INRMP, streams on the installation were declared exempt from the critical habitat designation under section 4(a)(3) of the Endangered Species Act.

Life-history

Very little is known about the life history of the yellow lance. Gravid females have been found during the spring in the James River, Virginia. Gravid females have also been found in the Tar River Basin in June. The glochidia are hookless. Host fish have not been identified to date.

5.3.5.6 Green Floater Mussel (*Lasmigona subviridis*)

The green floater mussel has historically been located within the Nottoway River and the species is listed as threatened in the Commonwealth of Virginia (Figure 19).

Distribution

Range has historically extended from New York to South Carolina. In Virginia, the green floater has been found in the Upper-James, Middle James-Willis, Lower-Rappahannock, Nottoway, Meherrin, New River, Appomattox and Anna River watersheds.

Figure 19. Green Floater Mussel

Status

- Federal: N/A
- Virginia: Threatened/S2
- WAP: Tier IIa
- Global: G3 - Imperiled
- IUCN Red List Category: LC – Least Concern
- American Fisheries Society Status: Threatened (01Jan1993)

Description

Lengths of adults average 40 mm and 30 mm wide, although they can grow up to 65 mm in length. The thin shell is compressed and the periostracum is yellow, tan, dark green, or brown with dark green rays. The left-valve has three teeth: two true lamellate pseudo cardinal teeth and one relatively small interdental tooth. The right valve has one long and thin lateral tooth. Interior shell colors range from white or light blue and may be pink near the beaks.

Habitat preferences

Commonly occurs in small rivers, streams, or canals. It prefers low to medium grade streams with sand and fine gravel bottoms that have slow pools and eddies. They do not tolerate weather extremes such as flooding or drought.

Life-history

The green floater is essentially immobile, however passive movement in currents may occur. They are usually a simultaneous hermaphrodite and a long term brooder. They spawn in August and release glochidia the following June. Host fish have not been identified to date.

5.4 FISH AND GAME MANAGEMENT

5.4.1 Goals and Objectives

The goals and objectives of fish and game management on Fort Pickett are summarized in Table 19 below.

Table 19. Fish and Game Management Goals and Objectives

GOALS	OBJECTIVES
To provide a framework for professional fish and game management which does not interfere with the Fort Pickett military mission.	Provide support for the military mission through adherence to the ecosystem management concepts upon which the Fort Pickett INRMP is based.
To integrate management with other natural and environmental resources.	Provide practical applications of scientific and technical principles to the management of fish and game populations and habitats in order to maintain such populations for recreational, ecological, and/or scientific purposes.
	Conduct analysis and provide reports/findings of fish and game populations and harvests in order to develop regulations that are consistent with population goals necessary for quality hunting and fishing experiences for Fort Pickett personnel and the general public.
	Develop a fish and game management program, which will result in good public relations with the community.

GOALS	OBJECTIVES
	Cooperate with state and federal natural resources agencies to maintain legal compliance with environmental and natural resources laws.
	Develop yearly written fish and game management goals based upon the concepts within the INRMP and findings from fish and game management personnel, specifically analysis and reports on game populations and harvest .

5.4.2 Introduction

The emphasis of the fish and game management program at Fort Pickett is to provide quality over quantity hunting and fishing opportunities. Wildlife is managed primarily through the creation, enhancement, or maintenance of habitat. Habitat availability and quality is the primary factor affecting the abundance and distribution of wildlife across the landscape. Through careful planning and management, the necessary habitat elements (e.g., food, cover, water, and space) can be provided for a diversity of wildlife species.

Management actions that focus on single species at the expense of others run counter to the concepts and intentions of ecosystem management. Often, habitat management practices will involve manipulation of successional stages of plant communities for benefiting an array of wildlife species. Certain management actions and recommendations for game species are appropriate and are described in this section.

Wildlife populations are managed directly to increase, decrease, or stabilize population levels through the establishment of regulated hunting seasons, closed seasons, and population restoration efforts. Unregulated commercial hunting was detrimental to wildlife species until the early 1900s, when the establishment of wildlife management agencies, game laws, and regulated hunting seasons became vital components in the recovery of many of our wildlife species.

At Fort Pickett, the objective of specific wildlife management activities is to maintain optimal levels of all wildlife species as determined by military operations, climatic conditions, habitat quality, social considerations, and biological potential. The following sections provide an overview of management considerations for several game species.

Hunters and trappers must check-in in accordance with procedures in the annual MTC-Fort Pickett Regulation 210-11, Hunting and Fishing Program. Hunting outside of an assigned area is illegal and potentially dangerous. Quotas are set for all areas and an area is closed when the quota is filled.

5.4.3 Fish and Game Management Areas

Habitat types and their associated fish and game species at Fort Pickett are typical for most of this region in Virginia and North Carolina. Major observed differences in landscape composition result primarily from differing land use practices between areas within the installation and those in the surrounding counties. The most significant difference in land use on vs. off the installation is the farming and forestry practices. In addition, the routine burning of areas on the installation, especially in the CAA, has maintained unique fire-adapted vegetative communities, which are uncommon throughout most of Virginia and the southeast.

The numerical designations assigned to the training areas are used for game and fish management purposes and to establish hunter quotas (see Figure 20). Most areas of Fort Pickett are open to some form of hunting, except three blocks in the CAA, which are off-limits to all use because of the presence of unexploded ordnance.

5.4.4 History of Fish and Game Management

The Fish and Game Management Program at Fort Pickett was initiated in 1956 when the Army and the Virginia Commission of Game and Inland Fisheries entered into a Cooperative Plan for the conservation and enhancement of fish and wildlife resources. In 1963, the Department of the Interior USFWS entered the "Cooperative Fish and Wildlife Plan". The USFWS and the Virginia Commission of Game and Inland Fisheries, which later became the DWR, provided equipment, manpower and supplies for the management of fish and game. In 1981, the USFWS was no longer able to provide on- site fisheries management assistance, due to the expiration of the SAIA Sikes Act Amendment of 1978, which authorized funding to carry out fish and wildlife management programs on military lands. In 1985, the Virginia Department of Game and Inland Fisheries (now DWR) added fisheries management as part of their effort under the cooperative agreement. Although the Department of Army had a game and fish management position on staff at Fort Pickett for many years, the first two professionally trained wildlife biologists were hired at Fort Pickett in the mid-1980s. In 1989, the DWR was unable to continue providing manpower and supplies as it had done in the past and its cooperative role changed primarily to consultation.

5.4.5 White-Tailed Deer (*Odocoileus virginianus*)

Harvest Data and Trends

The earliest records of deer harvests are for 1956. That year, 66 deer were taken on Fort Pickett. Deer populations on the installation were high in its early years and in 1962, Virginia biologist Johnny Redd recommended a season-long doe harvest. That year 1,228 deer were taken. The following year a repeat of the harvest strategy resulted in a harvest of 511 deer.

Since the elimination of hunting with dogs at Fort Picket, the number of 6-point or larger deer harvested has increased. The harvest of 6-point or larger deer in 2009 and 2010 seasons was approximately 100 each.

Hunters and trappers must check in at the Fort Pickett Check Station to be assigned a daily bag card and specific hunting area. Hunting outside of the assigned area on the bag card is illegal and potentially dangerous. Hunters may change areas once daily by completing the daily bag card and obtaining a new one at the Fort Pickett Check Station. Quotas are set for each area and an area is closed when the quota is filled. The legal hunting season dates are set by the DWR and change annually.

Seasons

- Archery Season

- Muzzle Loading Season
- General Firearms: Two per day, six per year. Either sex deer hunting on Wednesday & Fridays and 23 November, 30 November, and 23 December through 4 January.

Methods of Take

Legal methods for hunting deer at Fort Pickett include archery, muzzle-loading rifle, and shotgun. Hunting deer with dogs, during the general firearms deer season, was allowed on Fort Pickett until 2001. Due to 9/11 and heightened installation security, the Fort Pickett Command decided to discontinue the use of dogs when hunting deer, fox, and raccoon.

In 2004 and 2005, Fort Pickett received "Damage Control Assistance Program" tags in conjunction with a kill permit to help reduce deer populations in areas receiving high levels of deer damage. These tags are only valid for the harvest of antlerless deer within the area indicated on the permit. Beginning in 2006, the DWR Board approved a regulation change that placed Fort Pickett within the full season either-sex deer hunting category. This regulation change affords Fort Pickett broad latitude in setting and adjusting the number of either-sex hunting days across different areas of the installation to address deer damage concerns and meet deer population size objectives.

Monitoring

Deer population monitoring has historically been accomplished using several techniques, including harvest trend data, hunter pressure data, physical indices of hunter-harvested deer, and spotlight counts. Collectively, these techniques provide data needed by wildlife managers to properly adjust the yearly doe harvest number to maintain the recommended population.

Hemorrhagic Disease

Hemorrhagic disease is common and occurs at some level annually in the Piedmont. There have been five major die-offs due to hemorrhagic disease at Fort Pickett in the falls of 1957, 1962, 1971, 1976, and 1980. Two closely related viruses cause hemorrhagic disease; epizootic hemorrhagic disease (EHD), or bluetongue virus. According to DWR, the disease features produced by these viruses are indistinguishable. A general term, hemorrhagic disease, often is used when the specific virus is unknown. Presently there is little that can be done to prevent or control hemorrhagic disease. Risks can be minimized by maintaining low to moderate deer densities through public hunting programs.

White-tailed Deer Management

White-tailed deer can adapt to a wide variety of conditions, but high-quality forage, water, and cover are essential. Forested lands usually provide good habitat, except where development, large-scale agriculture, and poor forest management practices have limited cover and forage production.

Timber harvests can improve habitat quality for deer if they result in a diversity of vegetative communities and structures. Forests that support a variety of grasses, forbs, fungi, and hard mast producing trees will provide many of their habitat requirements. Large, forested tracts that are composed of at least 50% hard mast producing trees greatly benefit deer.

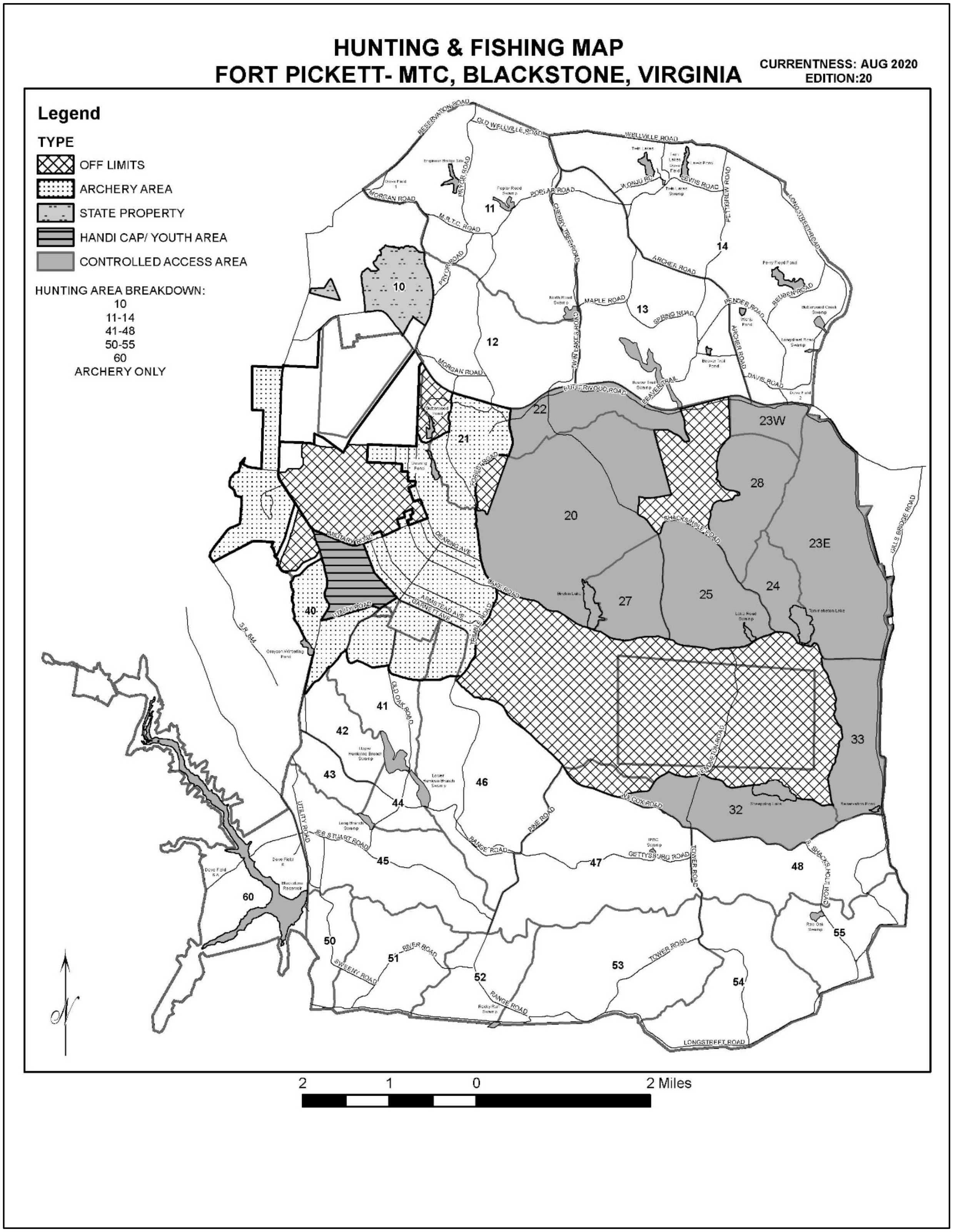


Figure 20. Hunting and fishing areas on Fort Pickett

Woodlands that have been thinned to a residual basal area of 50 to 60 square feet per acre also provide moderate or high-quality habitat. When thinning is coupled with a three to five-year rotational prescribed burning regime, the production of high-quality forage, such as legumes, significantly increases.

Cover is necessary for escape, breeding, rearing of young and for providing concealed resting areas. Brushy areas, thickets, old house sites, and small pockets of dense, volunteer pines all provide excellent cover. When large, forested tracts are harvested, riparian protection zones and watershed protection zones will provide excellent cover for white-tailed deer.

Openings in forested areas encourage the production of preferred plants and may compensate for yearly and seasonal fluctuations in other food supplies, such as acorns. Maintenance of existing openings through prescribed fire will be beneficial to a variety of game and nongame species. Following timber harvesting, old log decks and roads offer excellent sites to create openings and can be planted with a variety of native perennials beneficial to wildlife.

5.4.6 Wild Turkey (*Meleagris gallopavo*)

Harvest Data and Trends

Owing to habitat loss and over-hunting, by 1900 wild turkeys had disappeared from two-thirds of Virginia and had become rare in other areas. The first game laws protecting turkeys in Virginia were enacted in 1912. Between 1929 and 1955, the Virginia Game Commission released over 22,000 pen-reared turkeys in unsuccessful efforts to reestablish wild populations across the state. A new procedure of live-trapping and relocating wild birds began in 1955 and proved to be a highly successful technique in Virginia and elsewhere. Due to these efforts, plus appropriate hunting season restrictions, the wild turkey is abundant in nearly all Virginia counties today.

Wild turkey harvests were low in the early days of the hunting program at Fort Pickett. From 1968 to 1979, the fall hunting season was closed on Fort Pickett to allow the population to rebound. Today, the nine-week fall hunting season and the five-week spring gobbler-hunting season on Fort Pickett are the same as for surrounding counties. The wild turkey population is monitored annually using data derived from reported harvests, reported hunter effort and collection of fall feather samples to assess the age and sex distributions of the harvest (Table 20).

Turkey Management

The wild turkey is omnivorous, with its annual diet consisting of 90 percent plant and 10 percent animal matter. Turkeys have been documented to feed on more than 350 different plant species and 87 different insect species (DGIF 2013). Hard mast, fruits, seeds, greens, and agricultural crops are the principal plant food groups consumed.

Though pine stands provide important cover in the winter, the DWR (DGIF 2013) states that habitat quality for turkeys may decrease with the conversion of hardwood stands to loblolly pine. A mixture of forested and open lands provides the best wild turkey habitat. The size and distribution of open areas are important, with a series of well-dispersed smaller clearings being most favorable. Forested areas, old fields, recently cut forested stands, and early successional habitats with dense herbaceous and shrub cover at ground level are important brood habitat (DGIF 2013).

Management actions that optimize hard and soft mast production and provide a dispersed system of permanent forest openings are beneficial to wild turkeys. The forest management plan should offer a mosaic of old and young stands in order to balance age classes. Wild turkeys will benefit from timber stand improvement activities that leave favorable shrubs and small trees (e.g., dogwood (*Cornus spp*.), grape (*Vitis spp*.), black gum (*Nyssa sylvatica*), American hornbeam, serviceberry, and crabapple (*Malus spp*.).

Existing open areas with grass/forb/legume mixtures are beneficial for young wild turkeys. Prescribed fire encourages native plant diversity and generally improves habitat quality. Prescribed burning and mowing of fields and forest clearings should be avoided, if possible, between 15 April and 1 July, to avoid destruction of nests of wild turkeys and other ground-nesting species. Planting hedgerows of shrubs and trees can improve the quality of large openings to provide corridors to the interior of these areas. Hedgerows will provide access to the unused areas and will increase mast availability and diversity.

5.4.7 Bobwhite Quail (*Colinus virginianus*)

Harvest Data and Trends

The bobwhite quail is a Wildlife Action Plan Tier IV species. The DWR has identified habitat loss as the main factor impacting quail numbers. Other potentially significant causes include disease, herbicide and pesticide use, predation, weather patterns, and climate change (DGIF 2009).

Quail had declined 4.2 percent annually between 1966 and 2007. Surveys over the past 15 years conducted by DWR, have documented a similar decline of 4.0 percent annually (DGIF 2009). At Fort Pickett, quail populations are monitored using data derived from covey count monitoring, reported hunter effort and annual quail call-counts conducted during June and October. This data is then used to adjust hunter quotas per area and/or the allowable number of quails harvested daily.

Quail Management

Bobwhite quail management is essentially the management of early successional habitats and natural plant succession, the series of vegetative stages that occur over time if there is no intervention by man or nature. The greatest abundance of quail has always been found on lands in the early stages of succession, such as those recently tilled, burned, or cut and allowed to recover naturally. A vegetative cover of herbaceous plants, including a mixture of native grasses and forbs with some woody vegetation interspersed, dominates typical quail habitat. A diversity of plant species and cover types ensure the availability of preferred shelter and food in close proximity; plantings will not accomplish all the vegetative diversity that quail require. However, special plantings (e.g., food or cover plantings) may help to satisfy certain needs. The ground beneath the vegetative cover must be open, with plant stems widely enough spaced for quail to pass through easily and the ground itself free of matted vegetation or heavy accumulation of dead plant material. In addition to allowing quail to move easily, bare, or nearly bare ground under overhead cover makes food items easier to find.

One of the first steps to improving habitat quality for quail in open areas is to develop good transition zones between forests and fields. Current land management practices result in hard edges between forest cover and open fields. Hard edges are areas where open fields adjoin a mature forest; however, wildlife species, including quail, tend to prefer a soft edge. Soft edges have a transition zone of tall grasses and weeds with small trees and shrubs between the field and forest.

Prescribed burning

Controlled burning is probably the least expensive and most effective tool for managing quail. Prescribed burns set back succession to its earliest stages, stimulating the growth and germination of heavy seeding annual weeds, which are beneficial to bobwhite quail. Controlled burning for quail was not commonly practiced prior to 1987 and most controlled and uncontrolled burning occurred in the Controlled Access Area. Prescribed burning for quail management benefits several grassland songbird species as well as promoting native grasses and forbs. Burning maintains understory vegetation at a height beneficial to many wildlife species; stimulates the production of grasses, legumes, and forbs beneficial to quail; and improves the nutritional value of the vegetation. Burning also increases oak prevalence in a regenerating clear cut.

Pine management

Pine stands can be managed for quail throughout all growth stages. Pine management for quail begins with site preparation. Prescribed fire is the most effective method because it stimulates the growth of beneficial annual herbaceous species and improves habitat structure for bobwhite quail. Pine stands should be thinned as early and as often as possible, generally 15-18 years after a stand is established. Burning in pine stands should be conducted one to two years after thinning and occur on a three-year rotation. Burning units should be 20 -30 acres in size and all units should not be burned every year.

Hardwood management

Crop tree release and timber stand improvement thinning is an important practice for encouraging mast producing species.

5.4.8 Mourning Doves (*Zenaida macroura*)

Harvest Data and Trends

The mourning dove breeding range includes the lower 48 states and parts of southern Canada and Mexico. On average, a mourning dove will raise three broods during the breeding season that runs from March-September. Mourning doves will generally return to the same area in which they were hatched, year after year. Unlike other game bird species, including the bobwhite quail, woodcock, turkey, and ruffed grouse, mourning doves have adapted to most human conversions of natural habitat to that of “clean farming” and “rural” subdivisions. Mourning doves are an edge species associated with agricultural fields, orchards, pastures, and urban settings.

Mourning dove harvests have declined significantly at Fort Pickett since 3,066 doves were harvested in 1965. Harvest levels currently have been under 400 birds annually. Traditionally, the peak of hunting pressure for doves has been the first two days of the season. Subsequent hunting days normally have few hunters and a reduction in harvest success rate. There are five managed dove fields at Fort Pickett: 6, 6A, 1, 2, and the youth field at Twin Lakes. The fields were selected because they had the highest hunter success rate, and they were on the edge of training areas where conflicts between hunters and troops would be minimized. At Fort Pickett, dove harvests and hunter participation are monitored annually.

Dove Management

The dove management program focuses on the development of the designated fields. These sites are managed to provide dove hunting opportunities and to enhance habitat quality for doves and other wildlife that utilize these fields. Fields are planted in alternating strips using seed-producing varieties such as wheat, the Perdovick variety of sunflowers, millets, and buckwheat. The fields are strip-mowed in late summer to scatter matured seed on the ground; portions of each field remain unmowed to provide food and cover for a variety of wildlife during fall and winter months. When appropriate, fields are also prescribe burned to promote clean ground feeding conditions for easy foraging for seeds.

5.4.9 Waterfowl

Harvest Data and Trends

Hunting pressure for waterfowl on Fort Pickett has been slight compared to that of quail. Wood ducks have been the most significant species found in the hunter's bag. Hunting for wood ducks has been most productive during the October season, prior to migration. After this short wood duck season, some limited hunting of mallards (*Anas platyrhynchos*), diving ducks (*Aythya* spp.), and Canada geese (*Branta canadensis*) occur. Waterfowl harvest levels were highest during the 1970s.

Waterfowl Management

Waterfowl management techniques used on the installation include damming, or allowing beaver to dam, road culverts and making concrete spill ways across tank trails. Because of a lack of personnel, equipment and water level control structures, opportunities for intensive management of many waterfowl species at Fort Pickett are limited.

5.4.10 Black Bear (*Ursus americanus*)

The harvest of black bears has been sporadic over the years, with a harvest quota of only four bears in the 2018 – 2019 season. They are found throughout Virginia and as development encroaches into more natural habitat areas encounters with people have been increasing. Due to DWR has created guidance on to be "Bear Aware" in order to limit potentially dangerous interactions. In residential areas, bears are attracted by food sources. Actions residents can take include securing all food scraps in bear-resistant trash cans or inside a structure; watch bird feeders for signs of activity and, if bears are in the vicinity, remove the bird feeders. Black bears have been scared away using bare hands, rocks and sticks. More information is available on the DWR website at https://dwr.virginia.gov/wildlife/bear/.

5.4.11 Furbearers

Harvest Data and Trends

Trapping pressure on Fort Pickett has been light and sporadic. In the 1960s and 1970s when fur prices were high, a few individuals regularly trapped for beaver (*Castor canadensis*), common otter (*Lontra canadensis*), and fox (*Vulpes* spp.). Low fur prices, increased troop training and gasoline prices probably have contributed to the very limited trapping effort at Fort Pickett.

Furbearer Management

As a group, furbearers include a number of aquatic and terrestrial species as well as predators and prey. Habitat requirements vary widely among furbearing species and maintaining optimum population levels for a wide variety of furbearers requires a diversity of vegetative communities. Fortunately, Fort Pickett is a large installation with good landscape diversity based on topography, soils, management practices, and military operations. Management for furbearers will not be achieved necessarily through managing habitat specifically for them; however, most furbearers will respond favorably to the diversity of conditions that are brought about by managing for the aforementioned game species. Beaver that are not a nuisance are encouraged because of the ecological and natural resources management benefits they provide (e.g., firebreaks and wildlife habitat). Any permits to trap beaver must be approved by the Natural Resources Fish & Wildlife Office.

5.4.12 Fisheries Management

The primary emphasis for fisheries at Fort Pickett has been management of small impoundments (Table 20) for warm water fisheries, specifically bass (*Micropterus* spp.) and bluegill (*Lepomis macrochirus*). Until 1989, the bass harvest limits were eight bass greater than or equal to 30.5 cm. In 1989, after discussion with a state fisheries biologist, all lakes and ponds were managed on an individual basis. The general regulation on Fort Pickett was changed to a five-bass limit, greater than or equal to 35.6 cm. A protective slot limit for bass 30.5 cm to 40.6 cm was placed on the reservoir until 2001 but has since been changed to a 40.6 cm minimum length limit.

Table 20. List of pond and lakes managed by Fort Pickett

Lakes and Ponds	Acreage	Lakes and Ponds	Acreage
Beaver Trail	2.4	Lewis	13.2
Birchin	45	Pryor Road Reservoir	13
Butterwood	8	Reservation	2.5
Dearing	7.2	Tommeheton	51
Engineer Bridge	12.8	Twin Lakes	20
Floyd Pond	45	Winterling	3
Fort Pickett Reservoir	384	Wonju	3

At one time, Butterwood Pond was given a two-bass limit to help the pond recover from an overpopulated bluegill and undersized bass population. The most current creel limits and lengths can be found in the annually published Fort Pickett Regulation 210-11, Hunting and Fishing Program.

Fish Stockings

Numerous experimental fish stockings have been attempted over the years, some of which were more successful than others. Experimental stocking of tiger muskellunge was tried in Fort Pickett Reservoir in 1977. In 1970, 1981-84 and 1996, striped bass (*Morone saxatilis*) were stocked at various impoundments but never successfully developed. Hybrid striped bass (*Morone chrysops x M. saxatilis*) were also stocked at a number of locations but only survived at the Engineer Bridge Site Pond. Because of a state concern over the dilution of pure striped bass genes with those of hybrid, further stocking of these fish was abandoned. In 1990, a stocking of walleye (*Stizostedion vitreum*) was initiated on Engineer Bridge Site Pond to control a stunted bluegill population. In 1992, Rock Quarry Pond was experimentally restocked with bass and hybrid bluegill/green sunfish *(Lepomis macrochirus x L. cyanellus*) but closed to the public due to vandalism and safety concerns. Routine fish stockings include channel catfish stockings on a yearly basis to several Fort Pickett ponds (Butterwood, Dearing, Engineer Bridge, Lewis, Wonju, and Beaver Trail Ponds). Each impoundment may only be stocked every three years as stocking is completed on a rotational basis. Also, each year supplemental catfish are stocked in the lower Twin Lakes Pond for Kid's Fishing Day, a DWR program to encourage children to enjoy the outdoors.

The use of grass carp (*Ctenopharyngodon idella*) to control aquatic vegetation has been attempted on several bodies of water with mixed results. Birchin Lake, which contained a large amount of pond lily, was treated with three years of winter drawdowns with little to no success. The introduction of 30 grass carp into Birchin Lake was followed by a significant improvement in the pond lily population within two years without the elimination of important fish habitat.

Fifty grass carp were also stocked into the reservoir at Cedar Creek to control water milfoil (*Myriophyllum spicatum*), with little noticeable effect. A second stocking of 50 grass carp was conducted in 1991. Results of this stocking are unknown. Grass carp have also been stocked under state permit in Birchin Lake, Engineer Bridge site and the Reservoir.

Management of Impoundments

Fish attractors have been placed in all ponds to provide structure. A variety of materials have been used to make attractors. By far, the most common attractors have been clumps of cedar and Christmas trees. Hinge trees are also used to provide habitat. Shorelines are mowed once each month. Maintenance of the dams is of special concern. Dams are mowed, fertilized and reseeded yearly. Dams that do not have existing trees on them are kept clear to avoid dam failure by rotting tree roots. Historically, several ponds at Fort Pickett have been fertilized during the spring and summer. This practice boosts productivity in the pond and can improve growth of fish species. However, fertilization is costly, time consuming and requires care to ensure it is done correctly. Due to a lack of properly trained field staff, this practice has been discontinued.

Aquatic weed control is accomplished primarily through biological control. Grass carp and maintenance of plankton blooms have been the most successful methods. Pesticides should be used sparingly. Fort Pickett samples the impoundment per guidelines in "Pond Fisheries Sampling Protocol for Army National Guard - Maneuver Training Center Fort Pickett" (Copeland and Emrick 2004).

Fish Harvest Management

Fish harvest management strategies are based on the program goal of providing a quality fishing resources and a diverse recreational opportunity. With these goals in mind, size limits on bass are set annually in Fort Pickett Regulation 210-11 to encourage larger, more balanced sunfish (bream) populations. A minimum size limit is used when fishing pressure is light to moderate, recruitment is low to moderate, but fish growth is fast. The goal is to protect the bass and allow the fish to spawn at least once before they become vulnerable to harvest.

5.4.13 Hunting Permits

Individuals participating in activities on Fort Pickett must have in their possession a current Fort Pickett permit, a valid Virginia hunting, fishing, or trapping license, and a state or federal game stamp, if required by law. All individuals hunting and/or fishing at Fort Pickett must comply with all federal, state, local and installation regulations. The regulations for Fort Pickett are often more restrictive due to the large amount of public hunting and fishing pressure. There is no hunting allowed on Sundays at Fort Pickett.

5.5 WATER QUALITY MANAGEMENT AND WETLAND CONSERVATION

5.5.1 Goals and Objectives

The goals and objectives of water quality management and wetland conservation management on Fort Pickett are summarized in Table 21 below.

Table 21. Water Quality Management and Wetland Conservation Goals and Objectives

GOALS	OBJECTIVES
Protection of surface waters, wetlands and floodplains from sediment.	Minimize the impact of land uses on soil erosion and sedimentation.
Meet all Federal and State permitting requirements for any impacts.	Keep soil sediment, as a pollutant, in wetlands and waterways within compliance limits.
Maintain information on the locations of all surface waters, wetlands and floodplains on Fort Pickett.	Identification and rehabilitation land disturbed by operations and real property management activities.
Ensure that the water quality in surface waters is maintained.	Streams and wetlands protection zones will be enforced to reduce impacts from military land use and improve water quality.
	Perform benthic macroinvertebrate surveys to assess water quality.

5.5.2 Introduction

Any pollutants that drain from Fort Pickett and into the Nottoway River will travel downstream and have the potential to negatively impact water resources owned or used by other individuals or members of the public. State and federal law requires the Virginia Department of Environmental

Quality (DEQ) to produce a biennial report to Virginia's citizens and the EPA on water conditions in the Commonwealth. The waters are evaluated to determine whether five designated uses and goals of the CWA are supported. These five uses include: wildlife, aquatic life, fish consumption, shellfish harvest, and primary contact recreation which includes swimming and boating.

The DEQ released the *Draft 2018 305(b)/303(d) Water Quality Assessment Integrated Report* (Integrated Report) on January 22, 2019. The 2018 Integrated Report is a summary of the water quality conditions in Virginia from 1January 2011, through 31 December 2016. Fort Pickett is within the Upper Chowan (Nottoway) basin. The monitoring of several of the stream segments originating on or crossing the base resulted in the designation of EPA Categories ranging from 2 to 5 for support of aquatic life on stream segments. The Nottoway River below the reservoir was designated as a Category 2, as was Hurricane Branch. Tommeheton Creek and a tributary to Hurricane Branch were designated as Category 5 for dissolved oxygen and *Escherichia coli*. The Fort Pickett Reservoir was designated as a Category 5 for dissolved oxygen and total phosphorous. A Category 5 listing requires the development of a Total Maximum Daily Load (TMDL) Plan for the affected segments. A TMDL is a calculation of the maximum amount of a pollutant that a waterbody can receive and still meet water quality standards. Additional information on the development of TMDLs is available on the DEQ website.

5.5.3 Erosion and Sediment Control

Erosion can alter the texture, density, and composition of soils as mineral and organic matter are transported and re-deposited, resulting in altered soil profiles and infiltration rates, and changes in physical and chemical processes that can impact the ability of the site to support the original plant communities. Materials transported by erosion that are carried into surface water systems increase suspended and depositional sediments, with far-reaching impacts on water quality and dependent biotic communities, as well as risking violation of DoD regulations and state and federal laws. Erosion not only damages the natural resources but can compromise the safety of personnel and impede or restrict critical military training activities (Wolf and Emrick 2013).

The erosion potential of an area is primarily a function of the interaction of topography, soil properties, soil surface conditions, and human activities (Renard and Foster 1983, Gray and Sotir 1996):

Topography: Water velocity tends to be greater on steeper slopes and typically increases with slope length. Steeper slopes are more susceptible to all types of erosion.

Soil properties: The physical properties of the soil are fundamental to erosivity as different soil textures affect the infiltration rate of water into the soil profile. Sandy soils (coarser) tend to be less erosive than finer textured soils as water runoff is decreased (and hence soil transport) when water can more readily infiltrate the soil. Clay-textured soils have low infiltration rates. Higher amounts of organic matter in the soil can increase infiltration rates.

Soil surface conditions: Primarily a function of the structure and amount of vegetation. Presence of vegetation serves to reduce erosion in many ways. Vegetative root systems serve to hold surface and subsurface soils in place, decreasing soil detachment, and improving soil porosity and infiltration rates. Soil texture and absorption is enhanced by the contribution of vegetative organic matter and associated microbial activity, and vegetative transpiration serves to dry out soils between rain events. Above ground biomass protects the soil surface by deflecting and decreasing raindrop impact energy and slowing overland flow velocity. As such, undisturbed forested areas generally have very low erosion rates as compared to non-forested areas (Elliot 2000).

<u>Human Use:</u> The manner and frequency of human use has profound effect on the land upon with it occurs. Movement of anything across a landscape can cause erosion and military lands are subject to disturbance regimes that often vary in type, frequency, and duration. Tracked and wheeled vehicles, range and roadway construction, forest harvest/modification, and land maintenance activities that are also more likely in these areas can serve to exacerbate the influences of all these factors (Wolf and Emrick 2013).

5.5.4 Erosion and Sediment Control Management

Erosion management will be integrated with many other natural resources activities including forestry, prescribed fire, endangered species management (specifically for the Roanoke logperch, yellow lance and Atlantic pigtoe mussels), and ITAM.

As stated in AR 200-1 (December 13, 2007; page 23), *Soil resources:*

(a) Use the INRMP for the planned management of soil resources across the entire installation. The Soil Erosion and Sediment Control Component (SESCC) to the INRMP will address the following soils policy.

(b) Keep soil erosion from water within tolerance limits as defined in soil surveys prepared by the U.S. Department of Agriculture, Natural Resources Conservation Service or as required by Final Governing Standards or host nation authorities.

(c) Keep soil sediment, as a pollutant, in wetlands and waterways within compliance limits.

(d) Minimize the impact of land uses on soil erosion and sedimentation when and where possible, to include:

1. Locating physically intensive land disturbing activities on the least erodible soils.
2. Using climatic/seasonal changes in soil erosion as a factor in scheduling intensive mission operations and real property management activities.
3. Identifying and rehabilitating land disturbed by operations and real property management activities.

Erosion is a naturally occurring process by which the surface of the earth is worn away and soil moved, primarily by the action of water and wind. Translocation of soil particles and aggregates involves some combination of detachment, transportation, and deposition.

- Detachment is when soil particles loosen and detach from the soil surface.
- Transportation is when detached soil particles move down slope (or downwind).
- Deposition is when transported soil particles (now sediment) are deposited at a different location.

While erosion is a natural phenomenon that can occur anywhere soil and water come into contact, a wide range of human activities can accelerate the process. Indications of accelerated erosion include occurrence of sheet and rill or gully erosion.

- Sheet erosion - Surface runoff can occur when soils are saturated or when rainfall rates exceed infiltration rate. These overland flows can detach soil particles and remove broad layers, or "sheets" of soil. Human activities can accelerate this process by mechanically increasing slope gradients, removal of vegetation, soil compaction and concentration of surface flows.
- Rill or gully erosion - Concentrated surface flows can cut small channels, or "rills" into the soil surface. The resulting increase in flow velocity displaces greater amounts of soil than in adjacent areas and rills can grow or combine to form gullies and gully networks.

Accelerated erosion is an escalating process that left unchecked becomes increasingly difficult to mitigate. While rills may be addressed by grading, gullies can grow to lengths, widths and depths that require significant rehabilitation efforts and can pose major safety hazards to military training.

Transported materials that are carried into surface water systems increase suspended and depositional sediments, with far-reaching impacts on water quality and dependent biotic communities and risk violation of Department of Defense regulations and state and federal laws, NEPA, the CWA and the *Soil and Water Conservation Act*. Channel erosion in rivers and streams can also degrade both land and water resources, but by different circumstances and so should be considered separately from rainfall-associated erosion (Gray and Sotir 1996).

The erosion management plan (Wolf 2005b) assesses areas vulnerable to training related accelerated erosion that have the greatest potential to negatively impact surface water systems. Please refer to Wolf (2005b) and Stanton et al. (2001) for more detailed information concerning erosion management on Fort Pickett.

Riparian buffer protection zones have been established or are required along the waterways and wetlands of Fort Pickett as they provide ecosystem services and/or habitat for rare and endangered species (Table 22). Information on specific species-based restrictions can be found in Section 5.3.

Table 22. Protection Zones

Name	Protected Area	Buffer width
Nottoway River Protection Zone (NRPZ)	Roanoke Logperch Management Zone	300 meters (984 ft) from the Nottoway River
	Nottoway River Corridor and Macrobasin	Variable width (300 meters +); area totals 4,739 acres
Watershed Protection Zone (WPZ)	Streams and Wetlands	75 feet from resource

The largest of any of the protection zones is the Nottoway River Corridor and Macrobasin protection zone expanding over 4,000 acres of wildlife habitat adjacent to the Nottoway River. The buffer in this corridor varies but is at least 300 meters in width. The Roanoke Logperch Zone forbids any activity that will create erosion within 300 meters from each bank of the Nottoway

River. The restrictions within the Nottoway River Protection Zone take precedence over the Watershed Protection zones. For more information on the Roanoke logperch management, please review Section 5.3.2. Streams and wetlands have riparian protection zones to reduce impacts from military land use and improve water quality.

5.5.5 Nottoway River Protection Zone (NRPZ)

The NRPZ is comprised of the Roanoke logperch and the Nottoway River Corridor and Macrobasin Protection Zone. The NRPZ limits are set by the extent of the existing Nottoway River Corridor and Macrobasin Protection Zone, which varies in width (Figure 21).

All ground disturbing activity is restricted within this protection zone. All vehicles, military or civilian, are required to cross the Nottoway River at approved ford sites or bridges. Tracked and wheeled vehicle maneuvers are restricted to existing roads and open maneuver areas within the Nottoway riparian areas. Forestry activities are limited to those in support of the military training mission and the control of non-native species.

Any new proposed projects to occur within the NRPZ that are not evaluated within this INRMP will require approval from the VAARNG Environmental Office and USFWS through NEPA consultation.

5.5.5.1 Roanoke Logperch Protection Zone

The Roanoke logperch is the only federally endangered fish species found within the boundaries of Fort Pickett. The main causes for the decline of this species in the Nottoway River system are excessive siltation and sedimentation caused by agricultural and logging practices. The Roanoke logperch is endemic to Virginia and North Carolina and is known only to inhabit four locations in Virginia: the upper Roanoke River, Pigg River, Nottoway River, and Smith River.

Sections of the Nottoway River containing the Roanoke logperch have been protected by providing 300 meters wide buffers on either side of the river. For more information on the Roanoke logperch management, please review Section 5.3.2. These riparian buffers coincide with and are protected within the overall Nottoway River Protection Zone.

5.5.5.2 Nottoway River Corridor and Macrobasin Protection Zone

The Virginia Department of Conservation and Recreation's (DCR) Natural Heritage Program recommends protecting the Nottoway Macrobasin because of its suitability for supporting many rare and endangered species of flora and fauna (Fleming and Van Alstine 1994). Some of these rare and endangered species include freshwater mussel species (Atlantic pigtoe mussel, yellow lance mussel, dwarf wedgemussel, and notched rainbow); rare insects such as sparkling jewelwing (*Calopteryx dimidiate*), smoky rubyspot (*Hetaerina titia*); an endangered fish, Roanoke logperch; and several rare plants including lesser marsh St. John's wort (*Triadenum tubulosum*). According to Natural Heritage biologists, this site has many potential threats to its quality: "Siltation of the river channel, degradation of water quality, maintenance of adequate water flow from the upstream reservoir, and impacts from timber cutting are immediate concerns" (Fleming and Van Alstine 1994). In addition, Seybold (1998) identified the Nottoway corridor and macrobasin as a unique collection of floral and faunal communities' worthy of conservation. He concurred with the management recommendations of Fleming and Van Alstine (1994) that large scale perturbations, such as timber harvesting, should be excluded from the Nottoway corridor and macrobasin.

In addition to the rare species found in the Nottoway River, other species present include: largemouth bass (*Micropterus salmoides*), bluegill, channel catfish *(Ictalurus punctatus*), American eel (*Anguilla rostrata*), daces, chubs, and shiners (Appendix H; Seybold 1998). The dominant tree species in the Nottoway River corridor and macrobasin include loblolly pine, tulip poplar (*Liriodendron tulipifera*), southern sugar maple (*Acer floridanum)*, sycamore (*Platanus occidentalis),* sweet gum (*Liquidambar styraciflua)*, and American beech (*Fagus grandifolia)*. One rare stand of old growth mixed bottomland hardwoods occupies 14.8 acres of the macrobasin.

The Nottoway River corridor and macrobasin encompasses over 4,000 acres of wildlife habitat adjacent to the Nottoway River. The buffer in this corridor varies but is at least 300 meters in width.

5.5.1 Watershed Protection Zone (WPZ)

Riparian (i.e., stream side) buffer strips are used extensively all over the world to control sedimentation, remove excess nutrients from surface runoff, ameliorate surface water temperature flux, and provide habitat and migration corridors for flora and fauna. The Watershed Protection Zone (WPZ) is in place at Fort Pickett to protect water quality by reducing erosion, runoff, and excess nutrients entering streams (Figure 22). WPZs have been instituted around all wetlands and perennial and intermittent streams. The WPZs shown in Figure 22 were created using GIS to buffer all known streams and wetlands.

5.5.1.1 Streams

The protection zone is a 75-foot protection zone on either side of all perennial and intermittent streambanks, measured from the top of the stream bank (150 feet total width) with the same restrictions as the WPZ. The WPZ exceeds the 50-foot SMZ requirement listed in the DOF BMPs (DOF 2011). Within the WPZs, all mechanical clearing is restricted. Any proposed mechanical clearing within the riparian protection zone must undergo an environmental analysis. Silvicultural operations require the completion of an analysis through the NEPA process prior to any disturbance.

5.5.1.2 Wetlands

Wetlands are among the most ecologically important habitats in the world. Properly functioning wetlands improve water quality by removing nutrients, pesticides, sediments, organic materials, toxic metals, biological pathogens, and other pollutants from the water. Wetlands help maintain water quantity within a watershed and can limit the erosion damage caused by floods. Wetlands provide unique habitats for a variety of aquatic and terrestrial species.

There are many definitions of wetlands. For example, while a bog or swamp is readily recognizable as a wetland, some areas that are defined as wetlands are only wet for part of the year and may not be recognizable during dry months. The following is the official Environmental Protection Agency definition of a wetland for regulatory purposes under the CWA: "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically

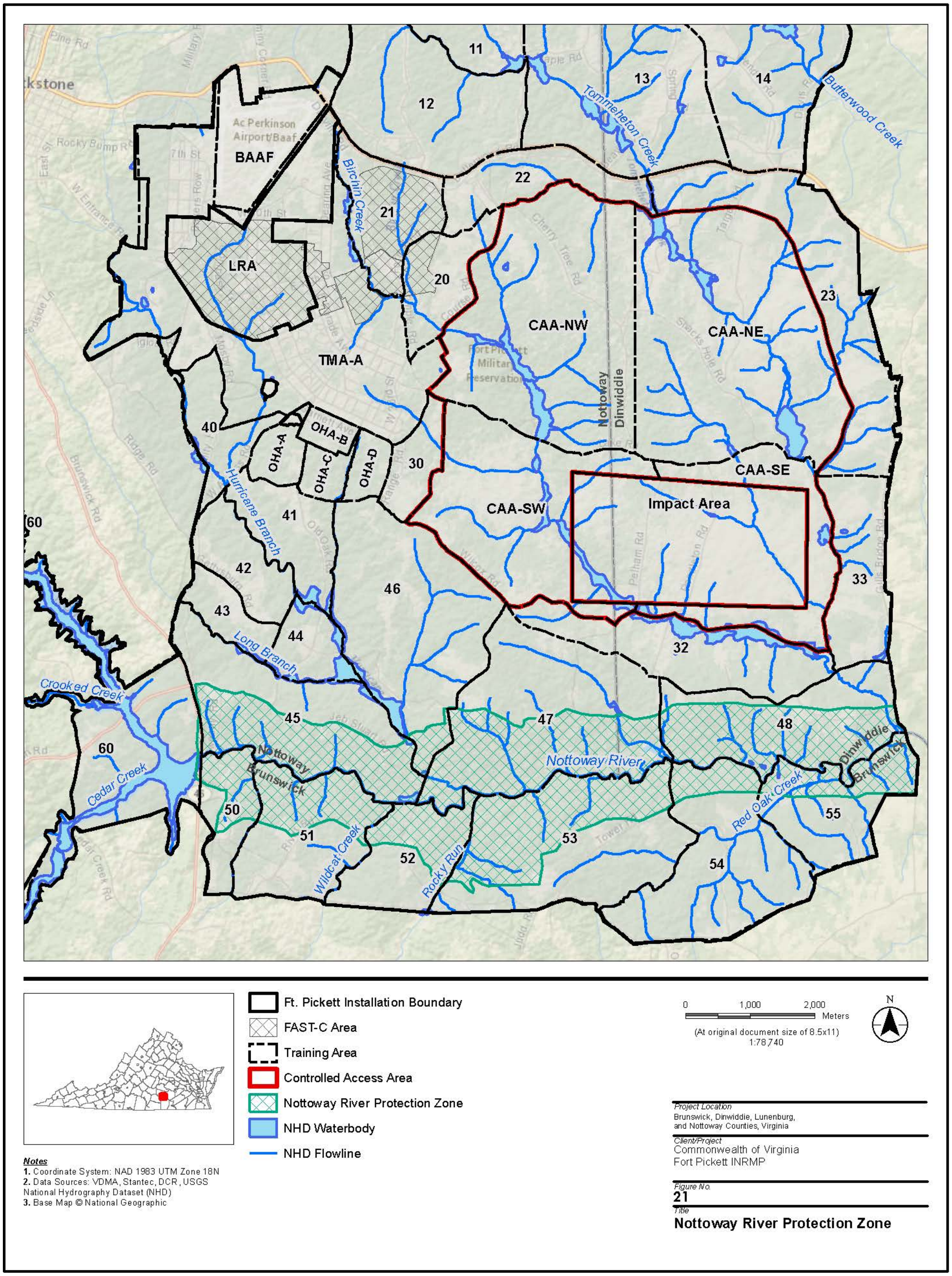


Figure 21. Nottoway River Protection Zone

adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas." (EPA Regulations listed at 40 CFR 230.3(t))

There are many definitions of wetlands. For example, while a bog or swamp is readily recognizable as a wetland, some areas that are defined as wetlands are only wet for part of the year and may not be recognizable during dry months. The following is the official Environmental Protection Agency definition of a wetland for regulatory purposes under the CWA: "those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas." (EPA Regulations listed at 40 CFR 230.3(t))

Because of the overall benefit to the military mission and natural resources management, Fort Pickett has chosen a proactive approach to wetland management. In order to protect wetlands from undue disturbance from military training, a 75-foot WPZ has also been instituted around all wetlands (Figure 22). The WPZ restricts mechanical removal or alteration of vegetation but has no impact on military training. In addition, it will serve to restrict heavy vehicle movement in close proximity to onsite wetlands, except at hardened crossings and roadways. Mechanical clearing of vegetation is restricted within the WPZ. Any land clearing within a protection zone must undergo an environmental analysis and review process.

WPZs provide an additional buffer for wetlands, thus improving their ability to provide environmental and natural resource services for Fort Pickett. The implementation of WPZs will help ensure that future construction or natural resources management projects do not adversely affect wetlands at Fort Pickett.

All projects, either natural resources management driven, or military training driven, will be examined as to their potential effect upon jurisdictional wetlands. Projects with the potential to adversely affect wetlands (e.g., silvicultural actions) were redesigned utilizing GIS to adhere to the WPZs. No wetlands will be disturbed, drained, or filled to accomplish any project within the Fort Pickett INRMP. However, if a proposed natural resources management or construction project cannot avoid negatively impacting wetlands, the proponent of the project may be required to obtain an USACE wetland permit. All proposed projects should be coordinated through NGVA-FMO-ENV to determine through NEPA analysis if a project will negatively impact wetlands. NGVA-FMO-ENV serves as the liaison between Fort Pickett and the USACE wetland permitting office. If wetland delineation is necessary (mandatory for a USACE permit), the proponent must ensure that an accurate delineation is performed.

Executive Order 11990 required that federal agencies, including DoD, minimize actions that adversely affect wetlands. Furthermore, agencies are required to enhance the natural values that wetlands provide and ensure that no net loss occurs. Army actions affecting wetlands require an analysis of the proposed action through the NEPA process. The CWA, Section 404 requires the USACE to issue a permit for the discharge of dredge or fill material within waters of the United States, which includes wetlands.

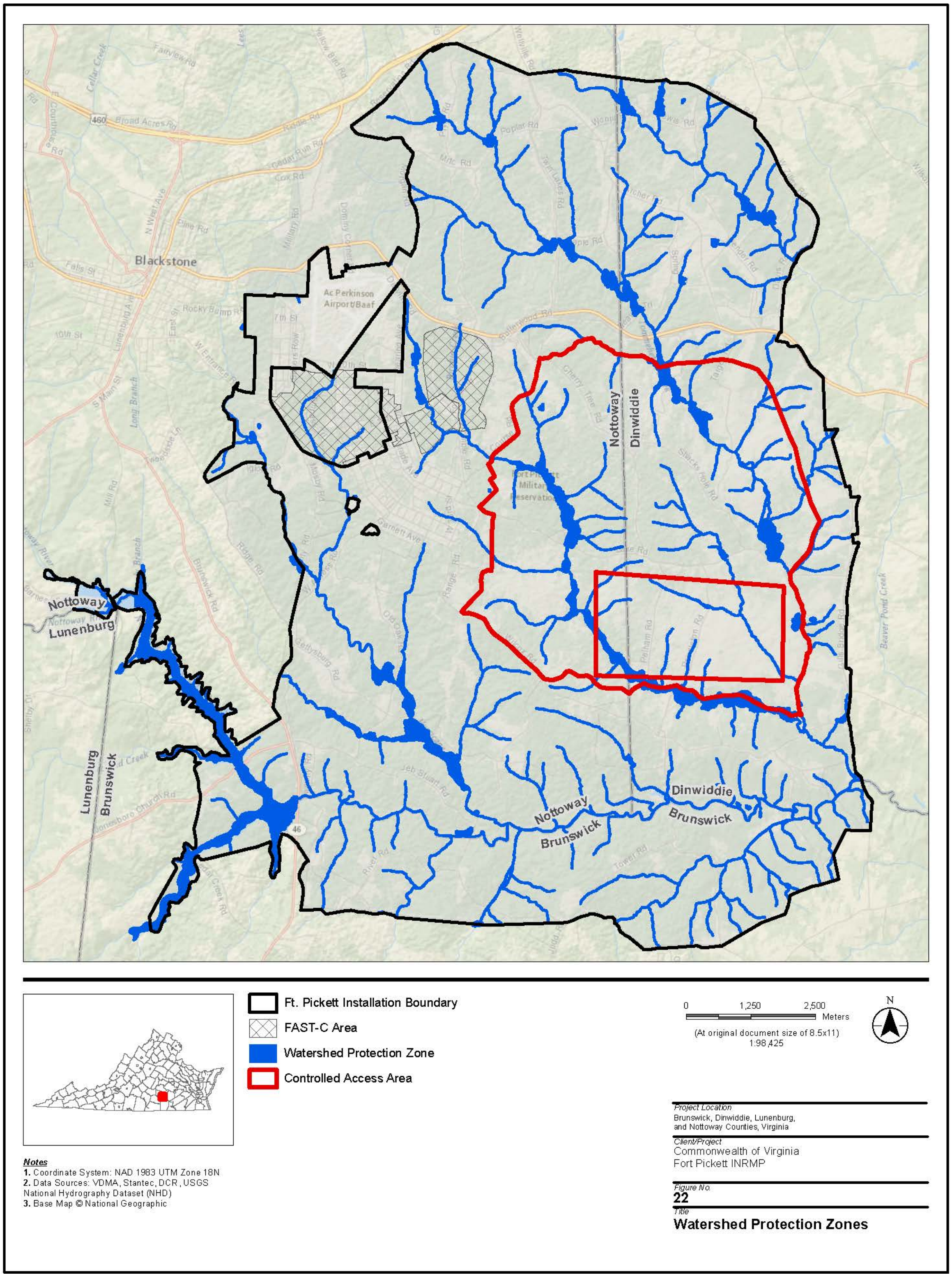


Figure 22. Watershed Protection Zones

5.5.2 Macroinvertebrates

Benthic macroinvertebrate surveys (Barbour et al. 1999) can be a fundamental source of information for the evaluation of watershed conditions, and the management of aquatic resources. Biological communities reflect overall ecological integrity, and bio-survey results can be used to directly assess the status of aquatic systems both locally and on the watershed-level as recommended by Rosenberger and Angermeier (2002). Benthic macroinvertebrate assemblages reflect a broad range of trophic levels, life cycles, and conditional tolerances and so provide strong information for interpreting cumulative effects and are well-suited for assessing site-specific impacts. Macroinvertebrate sampling according to EPA RBPs is a relatively efficient and inexpensive method that is widely accepted as a means to monitor the health of aquatic systems. In addition to supplementing overall habitat assessment, data from regular macroinvertebrate surveys can be used as an important part of management for Roanoke logperch to make inferences about availability of potential prey species, monitor relative siltation levels, and track any spatial or temporal hydrological changes that may impact the suitability of Roanoke logperch habitat on Fort Pickett.

In 2005 CMI calculated Virginia Stream Condition Index (VSCI) scores for 35 randomly selected sites on Fort Pickett and found that the corresponding Aquatic Life Use (ALU) tier classifications were well distributed across categories. Approximately 6 percent (n=2) of those sites were ranked as "Excellent" in the ALU Tier classification system, 20 percent of sites (n=7) were ranked as "Good," 29 percent of sites (n=10) sites were ranked in the "Fair/Gray Zone," 23 percent (n=8) were ranked as under "Moderate Stress," and 23 percent (n=8) were ranked as under "Severe Stress".

However, similar analysis of 37 sites in 2013 showed a marked change in ALU ranking across categories, with a greater percentage of sites surveyed falling in the lower ALU tiers. Of the 37 points sampled in 2013, CMI sampled 24 of the same sites at the same locations that were sampled in 2005 in order to make a direct comparison. The results found a similar shift in the distribution of ALU rankings, with a much higher percentage of streams surveyed in 2013 falling into lower ALU tiers than they did in 2005. VSCI scores declined for 70 percent (n =16) of 23 points surveyed in both years and 30 percent (n=7) increased. Overall average change in VSCI score for points surveyed in both years was a decrease of 10.65 points (Wolf and Emrick 2013).

5.6 INTEGRATED PEST MANAGEMENT PROGRAM

5.6.1 Goals and Objectives

The goals and objectives of the integrated pest management program (IPMP) are listed in Table 23.

Table 23. Integrated Pest Management Program Goals and Objectives

GOALS	OBJECTIVES
Reduction of pest populations through use of integrated combination of techniques.	Identify, prioritize, monitor, and control invasive and noxious species and feral animals on its installations whenever feasible.

5.6.2 Introduction

Fort Pickett will follow the current *the Virginia Army National Guard Integrated Pest Management Plan (2017)*. A copy is included in Appendix P. This plan outlines methods of controlling pests (disease vectors, nuisance organisms, and unwanted vegetation). Without control, these pests could interfere with the military mission, damage real property, damage natural resources, increase maintenance costs, and expose installation personnel to diseases.

As stated in DoDI 4715.3, installations should "Identify, prioritize, monitor, and control invasive and noxious species and feral animals on its installations whenever feasible. Accordingly, native species should be used, where feasible, to restore any habitats from which native species are removed or controlled." Executive Order 13112 (3 February 1999) requires federal agencies to prevent the importation and introduction of invasive species. Fort Pickett will work to ensure to not only prevent the introduction and importation of invasive species, but also to control ones already present on the installation.

Routine pesticide applications are conducted during maintenance of firing ranges, maneuver trails, rights of way, and other facilities on Fort Pickett in accordance with the Integrated Pest Management Plan (2017). Such pesticide applications are performed to control various species of vegetation to maintain line of site to the targets on firing ranges; maintain maneuver trails; control vegetation along right of ways; maintain access to lakes and ponds; and control unwanted vegetation in permitted storm water management basins in accordance with the ITAM Plan and the needs of the training mission. The applications must be performed by a licensed pesticide applicator in the appropriate class for the type of work being performed.

The installation's ITAM and DPW will coordinate such actions with the Integrated Pest Management Coordinator and report all applications with a Pesticide Use Form. Non-standard applications of pesticides, to include aerial applications, applications around wetlands or into surface waters, use of restricted use chemistries, large herbicide applications over one acre, or projects that may affect an endangered species will require NEPA analysis and consultation with the USFWS. All Aerial pesticide applications must be approved by the NGB Pest Consultant with an Aerial Spray Statement of Need in addition to NEPA analysis. The NLEB management guidelines include suggestions for the use of pesticides in areas that may affect the NLEB on Fort Pickett. Please refer to Appendix O for additional information.

5.6.3 Flora

The vast majority of the invasive pests present on Fort Pickett are plants. These undesirable plants include tree of heaven, poison ivy, kudzu, among others. All pesticide applications on Fort Pickett will be administered by State Certified Pesticide Applicators. Pesticide application will be coordinated with the VAARNG Integrated Pest Management Coordinator. Appendix D contains a list of all known invasive plant species to the Piedmont and their level of invasiveness (high, medium, and low) (DCR 2014).

5.6.4 Fauna

There is one documented faunal species that has the potential to adversely affect the Fort Pickett ecosystem: The Asiatic clam (*Corbicula fluminea*). The Asiatic clam is less than 50mm (quarter-sized). The outer shell has concentric ridges, while the inside is purplish with serrated "teeth." It is native to southeast Asia, was introduced to the west coast of the United States in 1938 and has subsequently spread throughout the country (Foster *et al.* 2005). The Asiatic clam is a bottom dweller that lives in sand or mud in rivers and lakes. On Fort Pickett, it is chiefly found in the Nottoway River, streams, and tributaries. The Asiatic clam is a potential threat to all the native mussel species at Fort Pickett. However, currently there are no practical *in situ* control measures.

5.7 SUSTAINABLE RANGE PROGRAM

5.7.1 Goals and Objectives

The goals and objectives of the Sustainable Range Program (SRP) are located in Table 24.

Table 24. Sustainable Range Program Goals and Objectives

GOALS	OBJECTIVES
To improve the way the Army designs, manages and uses ranges to ensure that current and future doctrinal requirements are met.	The integration of facilities management, environmental management, munitions management and safety management to efficiently manage and maximize the capability, availability and accessibility of ranges and training land to support doctrinal requirements, mobilization, and deployments under normal and surge conditions.

5.7.2 Introduction

The Virginia National Guard SRP Goals are to ensure that a safe, effective forward reaching Sustainable Range Program is implemented for Fort Pickett. The key emphasis of this program is Range Modernization, Range Maintenance and Operations, and the Sustainment of Ranges and Training Lands. This will ensure the Commonwealth's ranges and training lands will be able to maintain the ability to sustain training well into the future (RCMP 2017).

SRP was conceived and implemented to improve the way the Army designs, manages, and uses ranges to ensure that current and future doctrinal requirements are met. The military mission is supported by the SRP through the integration of facilities management, environmental management, munitions management and safety management to efficiently manage and maximize the capability, availability, and accessibility of ranges and training land to support doctrinal requirements, mobilization, and deployments under normal and surge conditions (AR 350-19 2005 consolidates AR 210-21 (1 May 1997) and AR 350-4 (8 May 19)).

The SRP gives attention to the increasing problem of encroachment on areas surrounding military installations. Encroachment has the potential to affect the accessibility and capability of the Army to dictate the way the military trains. Because Army installations are in regions that are increasingly urban and agricultural, the relatively natural landscapes found on these installations become islands of biodiversity.

SRP is the Army's roadmap for improving the way it designs, manages, and uses ranges and ensuring that current and future doctrinal requirements are met. The goal of SRP is to maximize the capability, availability and accessibility of ranges and training land to support doctrinal requirements, mobilization, and deployments under normal and surge conditions. The Sustainable Range Program is founded on three tenets:

- Information Excellence,
- Integrated Management, and
- Dedicated Outreach.

There are eight overall objectives/core areas for the SRP that are designed to ensure the availability and accessibility of army training land (AR 350-19 2005). These are:

1. Range Facilities,
2. Range Operations,
3. Range Maintenance,
4. Minimize Encroachment,
5. Environmental Responsibilities,
6. Outreach,
7. Integrated Management, and
8. Professional Development.

The SRP program is the responsibility of the Training Site Commander and is implemented primarily through two components, the Range and Training Land Program (RTLP) and ITAM.

5.7.3 Range and Training Lands Program (RTLP)

5.7.3.1 Goals and Objectives

The goals and objectives of the Range and Training Lands Program (RTLP) are located in Table 25.

Table 25. RTLP Goals and Objectives

GOALS	OBJECTIVES
Provide centralized management and prioritization for planning, programming, design and construction activities for live-fire training ranges and maneuver training lands.	Identify the needs for range projects and training land requirements for live-fire ranges and maneuver areas.
To assist the installation in the integration of mission support and environmental stewardship.	Establish how Fort Pickett's ranges are managed and maintained to support the mission requirements of installation.

5.7.3.2 Program Information

The RTLP provides centralized management and prioritization for planning, programming, design and construction activities for live-fire training ranges and maneuver training lands (AR 350-19). The RTLP process was developed to assist installations in the integration of mission support and environmental stewardship, with regards also to their economic feasibility (HQ Department of Army 2003). In addition, the RTLP identifies the needs for range projects and training land requirements for live-fire ranges and maneuver areas. The RTLP establishes how Army ranges are managed and maintained to support the mission requirements of each installation.

5.7.4 Integrated Training Area Management (ITAM) Program

5.7.4.1 Goals and Objectives

The goals and objectives of the Integrated Training Area Management (ITAM) program are listed in Table 26.

Table 26. ITAM Goals and Objectives

GOALS	OBJECTIVES
Integrate environmental planning procedures into all operations.	The goals of the ITAM program are met through the four different components included below that make up a management and decision-making process that integrates Army training and other mission requirements for land use with sound natural resources management practices.
Protect natural and cultural resources.	
Ensure that operations comply with environmental standards. Receive no notices of violations or fines for non-compliance.	
Prevent future pollution and reduce hazardous waste and toxic releases.	

5.7.4.2 Program Information

The ITAM program serves as a link between the RTLP and Natural Resources Management. It is recognized that the Army must train on land and the intent of the ITAM program is to reconcile this need with the need of sustaining the land for future training and upholding the Army's environmental stewardship responsibility. The ITAM program conceptually views training land as an asset to be conserved. The overall goal of the ITAM program is to provide a consistent uniform training land management strategy for the entire Army (AR 350-19).

The ITAM is the bridge between natural resources management and the training community. ITAM will serve as the vehicle through which natural resources management actions affecting Military training will be applied.

The ITAM program seeks to mitigate soil erosion through informed scheduling of military training activities and the repair of damage caused by these activities. In addition, two general protection zones, Nottoway River Protection Zone and Watershed Protection Zones (see Figure 21 and Figure 22), have been designated to create natural buffers around wetlands and streams. The implementation of these protection zones will use natural processes to mitigate the effects of sedimentation on water quality. There are no restrictions placed on military training within each protection zone. However, mechanical clearing of vegetation (e.g., forestry, mowing) is restricted to those activities permitted in sections 5.5.5 and 5.5.6 above.

National ITAM Mission, Goals, and Objectives

The overall goal of the ITAM program is to provide a consistent uniform training land management strategy for the entire Army. The Chief of Staff of the Army identified four environmental goals that serve as the foundation for the ITAM program (AR 350-19).

1. Integrate environmental planning procedures into all operations.
2. Protect natural and cultural resources.
3. Ensure that operations comply with environmental standards. Receive no notices of violations or fines for non-compliance.
4. Prevent future pollution and reduce hazardous waste and toxic releases.

The intent of the ITAM program is to recognize the Army's need to train on land and to reconcile this with the need to sustain the land for future training and uphold the Army's environmental stewardship responsibility.

Elements of the ITAM program at Fort Pickett

The ITAM program is a management and decision-making process that integrates Army training and other mission requirements for land use with sound natural resources management practices. There are four components:

1. RTLA,
2. TRI,
3. LRAM, and
4. SRA.

The ITAM program conceptually views training land as an asset to be conserved. Eventually the ITAM program will evolve into a proactive approach for conserving training land and natural resources at Fort Pickett.

5.7.4.3 Range and Training Land Assessment (RTLA)

5.7.4.3.1 Goals and Objectives

The goals and objectives of the RTLA are listed in Table 27.

Table 27. RTLA Goals and Objectives

GOALS	OBJECTIVES
Provide centralized management and prioritization for planning, programming, design and construction activities for live-fire training ranges and maneuver training lands.	Identify LRAM projects.
	Ensure that biological considerations are part of the LRAM project prioritization process.
	Determine the effectiveness of LRAM projects.
	Calculate the land condition curves that support the ATTACC methodology.
	Create maps that depict the availability, suitability, accessibility, and capacity of training lands.
	Recommend boundaries and training load distribution for newly acquired and existing training land, so that the capacity of the training land can best support a new or changing training mission, and a new intensity load.
	Conduct internal encroachment assessments by routinely reviewing plans, such as the INRMP, ICRMP, agricultural leases, annual burn plan and timber harvest plan.

5.7.4.3.2 Program Information

The RTLA program (formerly LCTA) is the data-gathering component of the Army's ITAM program. In 1994, the RTLA program was implemented at Fort Pickett. The program is currently administered by the Directorate of Plans, Training, and Security. The RTLA program tracks how different land use patterns affect the natural resources base on Department of Defense lands. The RTLA program "acquires data and assesses information to maximize the capability and sustainability of the land to support live training and testing activities" (AR 350-19). While RTLA protocols are designed to monitor the effects of military training, RTLA data can sometimes have multiple uses such as determining the ecological effects that prescribed fire has upon the plant communities and the long-term effects on selected faunal communities. The overall goals of the RTLA program are to (AR 350-19):

1. Identify LRAM projects;
2. Ensure that biological considerations are part of the LRAM project prioritization process;
3. Determine the effectiveness of LRAM projects;
4. Calculate the land condition curves that support the ATTACC methodology. For example, the cover, land use and load curves;
5. Create maps that depict the availability, suitability, accessibility, and capacity of training lands;

6. Recommend boundaries and training load distribution for newly acquired and existing training land, so that the capacity of the training land can best support a new or changing training mission, and a new intensity load; and
7. Conduct internal encroachment assessments by routinely reviewing plans, such as the INRMP, ICRMP, agricultural leases, annual burn plan and timber harvest plan.

The methods for gathering biotic and abiotic data that affect the natural resources on military installations were standardized so that the data could be compared between installations (Tazik *et al.* 1992); however, the standard RTLA methods did not adequately meet all the stated objectives. Therefore, alternative methods for inventorying and monitoring vegetation were melded into the RTLA program to successfully meet the objectives. Table 28 shows the history of RTLA at Fort Pickett.

Table 28. History of the RTLA (formerly LCTA) program at Fort Pickett

Fiscal Year	Description of work
1994	LCTA II; Focused on open maneuver area community description and monitoring of endangered species; Developed Site Rehabilitation Prioritization.
1995	LCTA II; Refined SRP; Continued monitoring open maneuver areas and endangered species.
1996	BRAC; no LCTA performed.
1997	LCTA II; Monitored endangered species.
1998	LCTA I; Applied standard LCTA methods.
1999	LCTA II; Monitored the effects of increased use of prescribed fire on training land; inventoried a subset of the plots established in 1994.
2000	LCTA II; Monitored the effects of increased use of prescribed fire on training land; inventoried a subset of the plots established in 1994. Performed 5-year bird monitoring.
2001	Bivouac Monitoring.
2002	Open maneuver area damage monitoring.
2003	Development of FARSITE fire model with associated field work.
2004	Implementation of Rapid Bioassessment protocols for monitoring.
2005	Monitoring of all existing LCTA plots. Sampling of munitions damage to forest resources.
2011-2013	RTLA assessments.
2015	Bivouac Monitoring and invasive plant spraying in controlled area of RTLA.

The RTLA monitoring schedule, including methods and data analysis techniques, for the period covered by the INRMP is presented in detail in Chapter 7.

5.7.4.4 Training Requirements Integration (TRI)

5.7.4.4.1 <u>Goals and Objectives</u>

The goals and objectives of the Training Requirements Integration (TRI) are listed in Table 29.

Table 29. TRI Goals and Objectives

GOALS	OBJECTIVES
Ensure accessibility to adequate training lands under natural conditions.	Provide a decision support procedure that integrates training requirements with land management, training management, natural and cultural resources management and data derived from LCTA and Army Conservation Program components.
	Provide military trainers and land managers with the necessary information they need to integrate training with land constraints and carrying capacity.

5.7.4.4.2 <u>Program Information</u>

TRI is the component of the ITAM Program that provides a decision support procedure that integrates training requirements with land management, training management, natural and cultural resources management and data derived from LCTA and Army Conservation Program components (ITAM Procedural Manual 1999).

The goals of TRI component are: 1) ensure accessibility to adequate training lands under natural conditions and 2) provide military trainers and land managers with the necessary information they need to integrate training with land constraints and carrying capacity. The TRI goals are accomplished when both training and environmental requirements are met (ITAM Procedural Manual 1999).

5.7.4.5 Land Rehabilitation and Maintenance (LRAM)

5.7.4.5.1 <u>Goals and Objectives</u>

The goals and objectives of the Land Rehabilitation and Maintenance (LRAM) are listed in Table 30.

Table 30. LRAM Goals and Objectives

GOALS	OBJECTIVES
Provide quality lands for military training, while reducing long-term, negative impacts on the environment using best land management practices.	Identify land maintenance requirements.
	Identify project sites that require restoration, rehabilitation, or reconfiguration to improve access to training areas and increase duration of use.
	Develop a scope of work for the projects that includes a site description, design, resources required, and expected outcome.
	Develop project prioritization lists based on RTLA data, GIS data, input from TRI and other available information.
	Execute projects as resources are made available.

GOALS	OBJECTIVES
	Evaluate the effectiveness of the completed projects.
	Ensure that completed projects receive adequate preventative maintenance.
	Coordinate long-term land maintenance plans with other real property management programs on an installation.

The LRAM program aims to sustain long-term training while combining preventive and corrective land maintenance practices to sustain the overall condition of installation lands.

The goal of the LRAM program is to provide quality lands for military training, while reducing long-term, negative impacts on the environment using best land management practices.

5.7.4.6 Sustainable Range Awareness (SRA)

5.7.4.6.1 Goals and Objectives

The goals and objectives of the Range and Training Land Assessment (RTLA) are listed in Table 31.

Table 31. SRA Goals and Objectives

GOALS	OBJECTIVES
Provide a means to prevent damage to natural and cultural resources through educating military land users.	Minimize resources damage by educating land users of how their activities impact the environment.
	Instill a sense of pride and stewardship responsibility in land users.

5.7.4.6.2 Program Information

The intent of the SRA component is to provide a means to prevent damage to natural and cultural resources through educating military land users. The ITAM SRA component addresses specific environmental sensitivities at the installation level and is targeted toward soldiers, other services using Army lands, installations staff, other land users and the public. The SRA component also informs natural resources professionals of installation activities (ITAM Procedural Manual 1999).

The goals of Fort Pickett's SRA program are to 1) Minimize resources damage by educating land users of how their activities impact the environment and 2) instill a sense of pride and stewardship responsibility in land users. The Fort Pickett SRA component will develop soldier field cards, handouts, briefings, posters, and photos for dissemination to personnel throughout the installation. Specifically, the SRA materials will be distributed to the following user groups:

1. Sustainable range awareness field cards will be distributed to all personnel training (military and civilian) at Fort Pickett.
2. A static sustainable range awareness display will be created to set up meetings, such as the pre-camp conference, where troops are briefed prior to training at Fort Pickett.

3. A sustainable range awareness survey form will also be distributed to selected commanders and troops, asking them to assess the effectiveness of the SRA program. Suggestions will be considered for subsequent sustainable range awareness materials.

5.7.5 ITAM Responsibilities at Fort Pickett

At Fort Pickett, the NGVA-MTC-OP Chief implements and manages the ITAM program and thus is the installation element having primary responsibility. The NGVA-MTC-OP administers RTLA, LRAM, TRI, and SRA. It is responsible for implementing TRI and its component parts, ATTACC and Range Facility Management Support System (RFMSS). The specific management responsibilities and methods used are discussed in Army Regulation 350-19 (2005).

5.7.6 Role of ITAM Program in INRMP Implementation

The Fort Pickett ITAM program will play a critical role in INRMP implementation. Each ITAM component will play a role, with the RTLA and LRAM components playing the largest roles.

<u>RTLA and INRMP Implementation</u>

The RTLA component will be responsible for monitoring the effectiveness of natural resources actions performed in whole or in part to support military training and overall ecosystem management goals. For example, one of the many goals of prescribed fire use is to improve mounted and dismounted infantry mobility by altering the physiognomic structure of the plant communities in selected areas. Part of the purpose of RTLA is to monitor the effect of fire on the structure and composition of the plant communities where prescribed fire has been applied. In addition, RTLA will also monitor the ecological effects that prescribed fire has upon the plant communities and the long-term effects on selected faunal communities. If prescribed fire is not accomplishing the military training and/or ecosystem management goals based upon RTLA data, the management prescriptions can be amended during the yearly updates to the Fort Pickett-INRMP. The RTLA component will also assist in the identification of areas in need of rehabilitation through the LRAM component.

<u>LRAM and INRMP Implementation</u>

The LRAM component of the ITAM program is primarily responsible for implementing land rehabilitation and repair of lands degraded by military training and/or other activities. The reduction of soil erosion, the control of stream sedimentation and the expansion/maintenance of maneuver land are the primary goals of the Fort Pickett INRMP. These goals are addressed in two ways: 1) proactive protection of streams and wetlands through protection zones the use of BMPs in all silvicultural operations (Appendix J), and 2) the repair and rehabilitation of training land through LRAM. The LRAM component serves as the actual program that will perform the physical control of soil erosion resulting from military training and land management activities.

<u>SRA and INRMP Implementation</u>

Though not as critical to the implementation of the Fort Pickett INRMP as RTLA and LRAM, the SRA component of the ITAM program still serves a vital function. By increasing environmental awareness of various user groups, civilian, military, environmental and natural resources, management problems can be reduced and avoided.

TRI and INRMP Implementation

The TRI component, when fully implemented, will help in planning military training events so that the environmental impacts of these events will be minimized without sacrificing training. In addition, proper timing and locating of military training events will increase their realism and consequently improve the overall training environment of Fort Pickett.

5.8 RECREATION MANAGEMENT

5.8.1 Goals and Objectives

The goals and objectives of recreation management are listed in Table 32.

Table 32. Recreation Management Goals and Objectives

GOALS	OBJECTIVES
Provide natural recreational opportunities for military members and other federal and civilian staff.	Ensure that all natural recreational areas are managed with a focus on sustainability of the resources.

5.8.2 Introduction

The training of military units is the primary use of Fort Pickett and is the context in which all other land uses, including recreation, are managed. Recreation concerns and interests are secondary to the fulfillment of the military mission and must be sustainable on an ecosystem basis. Within the context of the military mission, there are a variety of natural resources related outdoor recreational opportunities available at Fort Pickett. Currently Fort Pickett offers a variety of recreational activities to the public.

These include picnicking, nature walks, camping, boating, hunting, and fishing. There are small picnic areas located at Twin Lakes, near the Post Exchange, and the Joy Nature Trail.

5.8.3 Recreation Areas

Twin Lakes

Near the northern boundary in Training Area 14 is Twin Lakes recreation area (refer to Figure 6), where there are scattered tables and a pavilion. Mechanized military vehicle training is not allowed at Twin Lakes. Access to the picnic area is primarily by reservations and is free of charge. These reservations can be made at NGVA-MTC-OP.

Joy Nature Trail

Joy Nature Trail is located within the cantonment area, just off Dearing Avenue. It is designed as a self-guided tour with 27 stations distributed along a quarter-mile trail.

These stations explain many aspects of the ecology of Fort Pickett and promote respect and appreciation of natural resources. This trail was constructed by the 4-H Wilderness Challenge Club of Nottoway County, the 4-H Young Sportsman Club and employees of Fort Pickett Natural Resources Fish & Wildlife Office.

<u>Boating and Fishing</u>

Boating and fishing are allowed on base with appropriate permits and licenses. All state requirements and licenses must be obtained in conjunction with Fort Pickett permits. These can be procured at the Fort Pickett Game Check Station, or at alternate locations as posted. Installation permits are obtained by completing an Application for Services. If under 18, a parent or legal guardian must sign this application. Temporary, disabled, and young angler permits are available, as well as special permits for Armed Forces Personnel stationed on Temporary Active Duty and special boating permits. The Fort Pickett Fitness Center also rents a limited number of jonboats and canoes for public use. Rentals are handled through the Fitness Center offices located on the corner of Military and Garnett Avenues.

Fishing at Fort Pickett consists primarily of small impoundments best suited for warm water fishing (see Section 6.5 for more information about fishing at Fort Pickett). The most popular game fish include largemouth bass, black crappie, bluegill, chain pickerel, channel catfish, red-ear sunfish and white crappie. Some fish stocking occurs each year, primarily of fingerlings.

Boating on the Fort Pickett Reservoir is restricted to speed limits of 25 miles per hour. All other waterbodies have no wake/ idle restrictions as speed restrictions. No personal watercraft is allowed at Fort Pickett except by authorized personnel.

<u>Hunting and Trapping</u>

Hunting and trapping are recreational activities permitted at Fort Pickett. These activities require that proper permits be acquired in the same manner as the boating and fishing permits. All state licenses must be obtained from DWR and Fort Pickett permits through the Natural Resources Fish & Wildlife Office. Special permits are also available for temporary, disabled, and young hunters, as well as for stationed Armed Services personnel. There are permanent hunting stands located within the cantonment area. In addition, there are also disabled hunter stands, all with concrete platforms and some with roofs. See Section 5.4 for more information about hunting and trapping at Fort Pickett.

<u>Fee Distribution</u>

Fort Pickett Natural Resources Fish & Wildlife Office is responsible for collecting fees from permit sales. All fees collected from hunting and fishing permit sales will be used to improve fish and wildlife habitat at Fort Pickett.

<u>Other Recreation</u>

Urban recreational resources are also available. Some of the facilities located on Fort Pickett include a fitness center, softball fields, and leisure center.

5.8.4 Limits to Recreation

<u>Military Mission Related</u>

The self-guided nature trail, the campsites, the urban resources listed and most of the picnic areas are not greatly affected by military training activities. The boating, fishing, hunting and trapping are affected by training in the different training areas on Fort Pickett. Military training can limit access to some areas depending on the type of training being conducted. Hunting outside of the assigned area is illegal and potentially dangerous.

Anglers may fish in the managed fishing ponds at any time but other ponds and bodies of water will be open to fishing as military training allows. Areas may be closed at any time because of military training. Areas that are closed during operational hours will be posted at the game check station.

Natural Resources Management Related

Certain areas may be closed due to active natural resources management activities, including erosion control measures, endangered, and threatened species management and controlled burning. Severe erosion on stream banks could pose limitations on angling. The presence of federally endangered and threatened species often requires the creation of buffer zones that limit activities in those areas. Execution of prescribed fires will limit access to certain areas while operations are underway. Maintenance of firebreaks could also pose limitations, such as a prohibition of beaver trapping in specific areas to maintain certain wetlands.

Effects on Military Mission by Recreation

Currently, the effects of recreation activities on the military mission are minimal. Recreation is secondary to the fulfillment of the military mission of Fort Pickett and will not be allowed to alter or adversely affect the military mission of Fort Pickett.

Effects on Natural Resources by Recreation

Outdoor recreational activities always exert pressure on natural resources. Increased traffic, pressure on wildlife populations, declining water quality and the introduction of pest species are just a few examples. Quotas, permits, bag limits and creel limits are an effort to minimize these pressures. Outdoor recreational activities could be detrimental in sensitive areas with threatened or endangered species. In these areas, buffer zones prohibit all activities that could adversely affect these resources, including recreation. Recreation will not be allowed to interfere with natural resources management activities that are performed in direct support of the military mission.

5.8.5 Recreation Management

Overall, there is very little need to change or amend recreation management at Fort Pickett. Current recreation guidelines and regulations that have the potential to affect the Fort Pickett ecosystem, such as fish and wildlife recreation, already take into account the effects that harvest have on game populations.

The following tasks will maintain and improve the quality of recreation opportunities offered at Fort Pickett.

1. Boating, fishing, and hunting should continue to be monitored for impacts on natural resources. Quotas and limits should continue to be evaluated on a regular basis and reset, as needed, in cooperation with DWR. Restricting hunting to daylight hours may be indicated during certain times of the year to protect the NLEB.

2. Standard operating procedures (SOPs) for implementing safety requirements should be developed for each activity in coordination with the Installation Safety Office. This access will include safety requirements and military security. The Post Commander will determine access, primarily based on impairment of the military mission.

5.9 PUBLIC OUTREACH

5.9.1 Goals and Objectives

The goals and objectives of public outreach are listed in Table 33.

Table 33. Public Outreach Goals and Objectives

GOALS	OBJECTIVES
Increase the public's awareness of environmental programs on Fort Pickett.	Education of the public through informational publications, presentations and encouraging public participation in special events.

5.9.2 Program Information

Outreach is important for increasing the public's awareness of all the components of Fort Pickett's environmental programs. Education of the public through informational publications, presentations and public participation in special events are important components of an outreach program. Fort Pickett's Environmental Office participates in National Public Lands Day, Earth Day, and Fishing is Fun Day. In 2013, Fort Pickett and Camp Pendleton personnel participated in the first Earth Day event at SMR Camp Pendleton. Dune fencing and debris collection took place at this inaugural event.

5.10 CANTONMENT AREA MANAGEMENT

5.10.1 Goals and Objectives

The goals and objectives of the Range and Training Land Assessment (RTLA) are listed in Table 34.

Table 34. Cantonment Area Management Goals and Objectives

GOALS	OBJECTIVES
Control and treat stormwater in order to reduce the pollutants discharged into aquatic systems.	Improve water quality in aquatic ecosystems and wetlands.

5.10.2 Location

The cantonment area generally contains the most developed areas in the north west area of Fort Pickett. The area includes housing, offices, and recreational uses. The main impacts within this area would be limited to development projects.

5.10.3 Stormwater Management and Erosion and Sediment Control

As land is developed and covered with impervious surfaces like roofs, roads, and parking lots, infiltration capacity of large areas can be lowered to zero with runoff rates dramatically increased. Changes in runoff rates can also come as the result of other development activities including vegetation clearing, soil compaction, altered drainage patterns, ditching, and channelization on remaining soil-covered lands, shifting what historically may have been a predominately subsurface flow pattern to a predominantly surface flow pattern (Booth and Jackson 1997). This can profoundly alter the magnitude, intensity, and duration of water discharges associated with precipitation events and result in the delivery of sediment and excess nutrient loads and pollutants into surface water systems by many orders of magnitude (Wolman and Schick 1967). There is currently minimal impervious surface on Fort Pickett.

Any development within the cantonment area will be in compliance with the Virginia Stormwater Management Program (VSMP) regulations. Construction activities may require a construction general permit to be issued prior to any clearing and grading on a site. If a permit is required, the operator would be required to develop a site-specific Stormwater Pollution Prevention Plan (SWPPP).

The Virginia erosion and sediment control program contains accepted Minimum Standards and training and certification programs that are in place today as part of the Virginia Erosion and Sediment Control Law (VESCL). Regulated construction activities generally include projects with over 10,000 square feet of disturbance. Fort Pickett manages all land clearing operations on the installation in accordance with the VESCL.

5.11 CLIMATE CHANGE

5.11.1 Goals and Objectives

The goals and objectives of the climate change response are listed in Table 35.

Table 35. Climate Change Goals and Objectives

GOALS	OBJECTIVES
To undertake adaptation and resilience planning in order to incorporate potential climate change impacts in future plans and projects.	The development of potential alternatives that may be used to address the physical impacts of climate change to both existing infrastructure and the natural environment.

5.11.2 Overview

The VAARNG understands that there is a potential for climate change, on a local level, to impact the ability of the military to sustain the training of soldiers. Any adverse change to the vegetation of the training area could impact the training areas, promoting noxious weed infestations, or compromising wildlife habitat, such as loss of roosting sites supporting migratory birds. VAARNG will support adaptation and resilience planning in order to incorporate potential climate change impacts in future plans and projects. VAARNG will look at existing regional plans, partnerships, or other reports that other agencies, universities, or non-profits are conducting in Virginia or nearby states on assessing, developing, and implementing climate change adaptation strategies and incorporate management strategies as appropriate. In general, VAARNG will identify and implement sound natural resources strategies that provide benefits to the ecosystem, regardless of how climate changes occur.

Existing DoD guidance on the topic includes the "Climate Change Planning Handbook Installation Adaptation and Resilience" created by Naval Facilities Engineering Command (NAVFAC)(Leidos, 2017) which provides instruction on the preparation of installation plans which identify and rank action alternatives that may be used to deal with different aspects of climate change. The VAARNG will identify and implement sound natural resources strategies that provide benefits to the ecosystem, regardless of how climate changes occur.

5.12 ENFORCEMENT NATURAL RESOURCE LAWS AND REGULATIONS

The proper enforcement of natural resource laws and regulations is critical to the successful implementation of ecosystem management through the Fort Pickett INRMP. Table 36 describes the areas of enforcement and responsibilities in more detail.

Table 36. Areas of enforcement and responsibility at Fort Pickett

AREA	RESPONSIBILITY
Federal Threatened and Endangered Species	The NGVA-FMO-ENV is the installation entity responsible for the enforcement of compliance with the ESA. If an action occurs, that potentially affects a species protected under the ESA; personnel with the NGVA- FMO-ENV will investigate the occurrence. If the action appears to have negatively impacted the species in question, the NGVA-FMO-ENV will officially notify the USFWS immediately.
Wetland/Section 404 Regulations	The NGVA-FMO-ENV is responsible for the adherence to and enforcement of jurisdictional wetland regulations and permits. If a potential violation occurs or a permit is required, NGVA-FMO-ENV will inform in writing the appropriate personnel with the USACE.
Water Quality	The enforcement of water quality regulations is the responsibility of the NGVA-FMO-ENV. This enforcement includes spill responses and erosion control related to forestry, facilities, NGVA-MTC-PW, and NGVA-MTC-OP by both military and civilian personnel.
Forestry	The adherence to the Fort Pickett Water Quality and Nottoway River Protection Zones, in addition to DOF BMPs is the responsibility of Forestry Program Manager.

AREA	RESPONSIBILITY
ITAM	Enforcement of ITAM regulations is the responsibility of the NGVA-MTC-OP.
Fish and Game	At Fort Pickett hunting, trapping, and fishing regulations adhere to all Commonwealth of Virginia regulations. In addition, there are specific Fort Pickett regulations. Fort Pickett Natural Resources Fish & Wildlife Office game warden is responsible for the enforcement of all hunting, trapping and fishing regulations at Fort Pickett. In addition, DWR may provide seasonal assistance for enforcement of all hunting, trapping. and fishing regulations at Fort Pickett. All hunting regulations are available from the game check station located in the installation.

5.13 MONITORING

In order to successfully integrate natural resource management and implement ecosystem management at Fort Pickett, the effectiveness of several management actions must be assessed, and conditions monitored. The purpose of this section is to provide detailed background and information necessary to implement ecological monitoring deemed necessary to fulfill the objectives of ecosystem management at Fort Pickett.

The ecological monitoring program at Fort Pickett has three general goals: 1) monitoring is the means by which compliance with federal environmental law and Army regulations will be demonstrated, 2) monitoring will seek to identify trends and biologically significant changes in resource quality and abundance, and 3) monitoring will attempt to understand the underlying reasons for trends and changes in resource abundance. Ultimately the effectiveness of any monitoring program is dependent upon the implementation of management actions when trends are detected that negatively affect natural resources (Menges and Gordon 1996).

5.13.1 RTLA Monitoring

The Army's overall approach to manage and sustain training and testing ranges is the SRP. The ITAM program is an essential component of the SRP. Officially, the mission of the RTLA program is to "Inform the process of military land management to maximize the capability and sustainability of land to meet the Army training and testing mission."

The RTLA monitoring plan for Fort Pickett is one part of a larger land management strategy for Fort Pickett and is integrated with the updated Fort Pickett INRMP. The most important issue currently facing Fort Pickett ITAM program is the rehabilitation of recently cleared fields, forests, and woodlands to increase maneuver terrain. Thus, the RTLA Monitoring Plan focuses on the impacts of military derived disturbance and the testing of techniques to rehabilitate land after disturbance. The RTLA program at Fort Pickett serves as the data-gathering component of the ITAM program and range operations. The RTLA program will be flexible and adaptive to respond to changing needs and priorities at Fort Pickett.

RTLA will provide data in three critical program areas:

1. Maintaining the acreage of maneuver area. The RTLA program will develop dynamic GIS based system to track and monitor the changes in terrain suitable for military maneuvers.

2. The rehabilitation and re-vegetation of training areas for sustained use. The LRAM program is investigating the use of alternative methods (organic soil amendments) to increase soil fertility. The methods include using composted leaf materials and manures to not only increase soil fertility but also build long-term soil structure. The RTLA program will measure the effectiveness of using these alternative soil amendments
3. Expansion of existing training lands to improve the efficiency and effectiveness of the time spent here training in each required category from small arms fire to operating large, tracked vehicles and navigating large vehicles through maneuver corridors is now a priority for Fort Pickett.
4. Rehabilitation of mechanically cleared maneuver areas. The RTLA program will test a variety of scenarios that will seek to determine the most cost-effective treatments for establishing vegetative cover on sites that have been harvested and the slash and stumps ground in place. Native warm season grasses will be planted in rehabilitated areas.

The implementation of the RTLA monitoring protocols will be a greater understanding of the role of organic matter in facilitating rehabilitation of training areas at Fort Pickett. In addition, the costs and benefits of using commercial fertilizers will be assessed and the findings used to update land rehabilitation techniques. The creation and yearly updates of maneuver terrain will facilitate future planning and serve as valuable information when planning for INRMP updates.

<u>RTLA at Fort Pickett</u>

The primary purpose of the RTLA is to support military training and testing through the long-term sustainment of ranges. The RTLA monitoring plan for Fort Pickett is one part of a larger land management strategy for Fort Pickett and is integrated with the updated Fort Pickett INRMP. The INRMP is based upon adaptive management principles and explicitly integrates military training and testing requirements into the overall ecosystem management context. In addition, the RTLA monitoring plan and the INRMP are on the same schedule, which further integrates natural resource management in support of the military mission. The RTLA monitoring plan will build upon previous LCTA projects, which were an integral part of the original Fort Pickett INRMP (Emrick and Murray 2001). More information can be found in the Fort Pickett ITAM Plan (Ford 2013).

5.13.2 Development of Species-Specific Monitoring Methods

Several critical steps are necessary to develop an effective ecological monitoring program. First, it is crucial to determine and understand the goals of the monitoring program. An explicit statement of goals will allow investigators to develop an accurate and focused research plan that will be able to detect ecologically significant changes in natural resource quality and abundance. Secondly, it is necessary to determine what parameters will be measured to detect change. The selection of parameters that are difficult to measure because of economic or time constraints can doom the monitoring effort. Thirdly, determine the level of precision needed to detect ecologically significant changes. For example, if a change of 1 percent vegetative cover is considered significant for a rare plant species, a method that measures cover in intervals of 5 percent should not be used. Finally, once the appropriate methods are selected, adhere to them throughout the monitoring effort (Bonham 1989).

The intensity of an ecological monitoring program is dependent upon the management goals. Menges and Gordon (1996) describe three levels of monitoring that vary in intensity:

<u>Level One Monitoring</u>

Level one monitoring seeks to determine the distribution of targeted populations and is the least intense. The information gained is primarily descriptive and is typically summarized in the form of distribution maps and geostatistics. The use of GPS and GIS to map the changes in the boundaries of Michaux's sumac colonies is an example of level one monitoring.

<u>Level Two Monitoring</u>

Level Two monitoring seeks to measure trends within populations and is moderately intense. The information acquired is used to determine trends and conditions in populations. The RTLA plant community-monitoring program is an example of level two monitoring.

<u>Level Three Monitoring</u>

Level Three monitoring is the most intense and designed to predict population trends through demographic monitoring of individuals. The data gained from level three monitoring is useful in determining population viability of individual species. The monitoring of the bald eagles nesting on Hurricane Branch flowage is an example of level three monitoring.

5.13.3 Threatened and Endangered Species Monitoring

5.13.3.1 Michaux's Sumac

The monitoring of Michaux's sumac colonies at Fort Pickett is an integral part of the overall endangered species management program. Two types of monitoring are used to assess population trends in Michaux's sumac colonies at Fort Pickett: 1) colony boundary mapping and 2) density and frequency monitoring. Both types of monitoring are conducted every three years. Other management and research will occur as needed. For more information, refer to Section 5.3.1.

5.13.3.2 Bald Eagle

Personnel with the Fort Pickett and NGVA-FMO-ENV will monitor active nests annually to document use. Currently there are four nests identified on Fort Pickett.

5.13.3.3 Bats

The presence of the NLEB and the Indiana bat have been confirmed through acoustical studies. VAARNG follows guidance on conservation measures and activities from USFWS for all NLEB effects determinations in accordance with the Programmatic Biological Opinion on the Final 4(d) Rule of 2016. More information can be found in Section 5.3.4. The monitoring of bats at Fort Pickett is conducted every three years and will be completed using the Indiana Bat Summer Survey Guidance. Bat monitoring was last performed in 2016.

5.13.3.4 Roanoke Logperch

Ecological monitoring relevant to Roanoke logperch should include both habitat and biological monitoring components. Stream habitat inventories are a fundamental source of information for the evaluation of watershed conditions and the management of aquatic resources. Data collected in comprehensive replicable surveys form the basis of habitat monitoring and serve to document baseline conditions, identify potentially critical habitat, provide a mechanism for monitoring changes in the quality and quantity of the resource, and facilitate compliance with legal mandates, including the National Environmental Protection Act; ESA; SAIA; AR-200-1 and USFWS Recovery Plan requirements. In addition to the knowledge that can be gained by documenting habitat use or directly observing animals as they interact with their surroundings, the monitoring of biological communities can be used to help assess the overall ecological integrity of a system. Population levels and habitat condition should be monitored at least every 3-5 years. All applicable laws and regulations pertaining to monitoring and collection activities of the Roanoke logperch will be coordinated with DWR. For more in-depth monitoring information and protocols please consult Wolf 2005a and Appendix N.

Habitat monitoring can serve in the identification of potential use areas of the Roanoke logperch and to identify potential impacts of management and military training actions. Because the Roanoke logperch is difficult to detect in the Nottoway River and on Fort Pickett, habitat data can be used to target subsequent search efforts and assess overall habitat suitability. Identification and protection of suitable habitat not only preserves the potential for future population expansion but will also help protect any existing meta-population structure.

Initial baseline stream habitat inventory surveys took place summer 2004 and summer 2005. This survey utilizes relevant features of the EPA RBP (Barbour et al. 1999) to gather topographic, hydrological, descriptive, and locational data along the length the Nottoway on Fort Pickett to establish a general representation of stream structure, habitat characteristics, and establish a baseline for reference in future habitat assessments. This survey additionally sought to identify specific areas of potential use by Roanoke logperch based on criteria observed in areas of use documented elsewhere on the Nottoway by Rosenberger (2002). The limits of the habitat parameters utilized by Roanoke logperch in the Nottoway are not clearly defined, and use can vary by age-class and include a variety of depths, velocities, and substrates. Consequently, the criteria for selecting areas of potential use must be broad, with the slit-cover criterion as the most important variable. A hierarchical approach should be used in identification of suitable habitat using the following guidelines:

1. Select mesohabitats deemed most potentially suitable from the results of the EPA RBP survey of the Nottoway River on Fort Pickett.
2. Select a random subset of these potentially suitable areas for more detailed assessment of microhabitat characteristics that can then be compared with habitat characteristics of areas used by Roanoke logperch elsewhere in the Nottoway as documented by Rosenberger (2002).
3. Select a random subset of areas with habitat parameters most consistent with observed use areas for actual survey for Roanoke logperch. Since the limits of suitable habitat are not clearly defined, inclusion of some sub-optimal or marginally suitable areas in the survey efforts will provide a more complete picture and help refine suitable habitat parameters.

It is significant to note that areas identified as within the suggested potential habitat range in May 2004 no longer satisfied those same criteria when revisited in June 2005. Substrate classified as mixed small gravel in 2004 was classified as sand in 2005. This observation suggests that substrate composition and other conditions in the Nottoway can fluctuate widely from area to area and from season to season. It is reasonable to suggest that substrate materials are redistributed, dispersed, or concentrated by the highly variable stream flows exhibited by the Nottoway River on Fort Pickett, resulting in a fluid spatial distribution of suitable habitat. Considering this phenomenon and given the lack of clearly defined localized habitat parameters, it is necessary that the entire Nottoway corridor on Fort Pickett, including a buffer of 300 meters from each bank be considered in its entirety as the Roanoke Logperch Protection Zone. Additionally, while RBA data provides a useful starting point for future logperch surveys, areas identified therein must not be viewed as the only existing potentially suitable habitat units, and search efforts should be distributed in other areas as well.

It is very important to note that restrictions related to areas of documented logperch use or isolated habitat units, while very important, cannot alone be considered adequate protection for the Roanoke logperch on Fort Pickett. Awareness of potential negative impacts to logperch habitat, primarily from sedimentation, must be extended to the Nottoway macrobasin as a whole, and the integrity of the entire Logperch Protection Zone must be observed.

It is also important to note that failure to observe Roanoke logperch as the result of a survey based on habitat composition is insufficient to support the conclusion that Roanoke logperch are not present in a given area. The objective is to maximize the effectiveness of any sampling efforts, and to identify habitat areas that are most likely suitable for potential use.

6.0 CULTURAL RESOURCES

The Cultural Resources Program focuses on areas of cultural and/or historic significance on Fort Pickett. These programs will not be discussed in detail in the INRMP as there are separate documents which have been prepared to outline how these resources should be treated and maintained. Fort Pickett will follow the most current Integrated Cultural Resources Management Plan (ICRMP) for Facilities of the Virginia Army National Guard, pertaining to cultural resources on the installation, which will be updated annually according to guidance from the NGB.

The ICRMP is designed to support the military mission by meeting the legal compliance requirements of federal historic preservation laws and regulations in a manner consistent with the sound principles of cultural resources stewardship. The ICRMP establishes priorities for the identification and evaluation of historic properties at VAARNG facilities. Historic properties include districts, sites, structures, buildings, and objects dating to the prehistoric and historic periods that are eligible for listing in the National Register of Historic Places (NRHP). The significance of such resources relative to the NHPA, Native American Graves Protection and Repatriation Act (NAGPRA), and/or eligibility for inclusion in the NRHP is considered using the ICRMP regulations and procedures set forth in 36 CFR 800, which implements Section 106 of the NHPA, as amended. Section 106 requires federal agencies with jurisdiction over federal, federally-assisted, or federally-licensed undertakings to consider the effects of undertakings on properties in or eligible for inclusion in the NRHP; and, prior to approval of the proposed action, to afford the Advisory Council on Historic Preservation an opportunity to comment. The information that follows was largely excerpted from the FY 2014-2018 ICRMP (Versar 2013).

The VAARNG, with guidance from the NGB, consulted with the SHPO, the Advisory Council on Historic Preservation, federal tribes, and other consulting parties, and a Programmatic Agreement (PA) for cultural resources management at VAARNG properties state-wide has been approved and is being implemented. The PA seeks to streamline the Section 106 review process and is intended to govern routine actions at facilities that will result in findings of "No Historic Properties Affected" or "No Adverse Effect" according to Section 106 of the NHPA.

6.1 INTEGRATION WITH NATURAL RESOURCES MANAGEMENT

The cultural resources at Fort Pickett are of great importance on both a local and national level. Fort Pickett's motto of "Preserving the past and protecting the future" demonstrates Fort Pickett's commitment to protecting our nation's prehistoric and historic cultural heritage. As stated in DoDI 4715.03, "Cultural resources under the control of the Department of Defense shall be identified, protected, curated, and interpreted through a comprehensive program that complies with legally-mandated requirements and results in sound and responsible cultural resources stewardship."

NGVA-FMO-ENV will consider all-natural resources management activities that have the potential to affect cultural resources. Prior to the start of any of these activities, pertinent information should be gathered, and activities should be discussed with the CRM. Enough time should be allowed for consultation with the SHPO, if needed. More time will be required if a Phase I survey is needed or if the SHPO needs more information. Table 37 lists all management actions in the INRMP and their cultural resources considerations.

Table 37. Activities that require cultural resources consideration.

Management Area	Activities That May Affect Cultural Resources
ITAM	LRAM activities including: Drum chopping, contouring and shaping, earth moving and filling
Troop Training Activities	All ground-disturbing and excavation activities
Forestry	All ground-disturbing and excavation activities
Prescribed Fire	Creation of fire breaks
Recreation	Trail maintenance and construction
Wetlands and Water Quality	Wetland construction
Pest and Invasive Species	Treatment of kudzu sites
Cantonment Area	Landscaping and planting; soil disturbance
Endangered Species	Groundbreaking activity that might occur when transplanting Michaux's sumac; controlled burning

6.1.1 Integrated Training Area Management (ITAM)

As shown in Table 15, ITAM activities have the potential to impact cultural resources. Projects under ITAM include earthmoving activities such as drumchopping, contouring, shaping, and filling. Prior to commencement, and with sufficient time allowed to complete all cultural resources requirements before activities begin, all projects will be reviewed by the CRM who will determine if a Phase I survey is required.

6.1.2 Forestry

To ensure forestry management activities do not adversely affect cultural resources, Phase I archeological surveys are required before all forestry cuts that take place in previously unsurveyed areas, with the exception that small land areas (less than five acres) that are previously disturbed may be exempt from this requirement. Consultation with the CRM is required in all cases to make this determination. The CRM will be contacted prior to forestry activities and will make the determination if a Phase I survey is required. If a Phase I survey is required, the CRM will contact the SHPO and initiate the NHPA Section 106 process.

6.1.3 Other Activities

The potential for affecting cultural resources is less likely in recreation, endangered species, prescribed fire, cantonment area, pest, and invasive species management. They could all potentially affect cultural resources if any groundbreaking activities take place. All actions will be evaluated to determine the potential for effects on cultural resources.

6.2 INTEGRATION WITH MILITARY MISSION

The effects of military training on cultural resources can be wide ranging (Table 38). The objective of this section is to identify military activities that may affect culturally significant areas so as to avoid impacts. The CRM should be contacted whenever a military training activity may affect cultural resources. Fort Pickett Range Operations should ensure that all activities that disturb the soil are conducted in areas that are not near identified cultural sites and are in areas that have been subjected to Phase I testing and completion of consultation with the SHPO on survey findings. Soil disturbing activities will not take place in unsurveyed areas.

The potential for effects on cultural resources is based on levels of soil disturbance. Activities with medium to high potential to cause impacts should have Phase I investigations completed prior to any soil disturbing activity. The CRM must be contacted prior to beginning soil disturbing activities, and the CRM will determine whether a Phase I investigation is needed. Phase I survey is a time-consuming process, and sufficient time must be allowed to conduct this work and to consult with SHPO on findings.

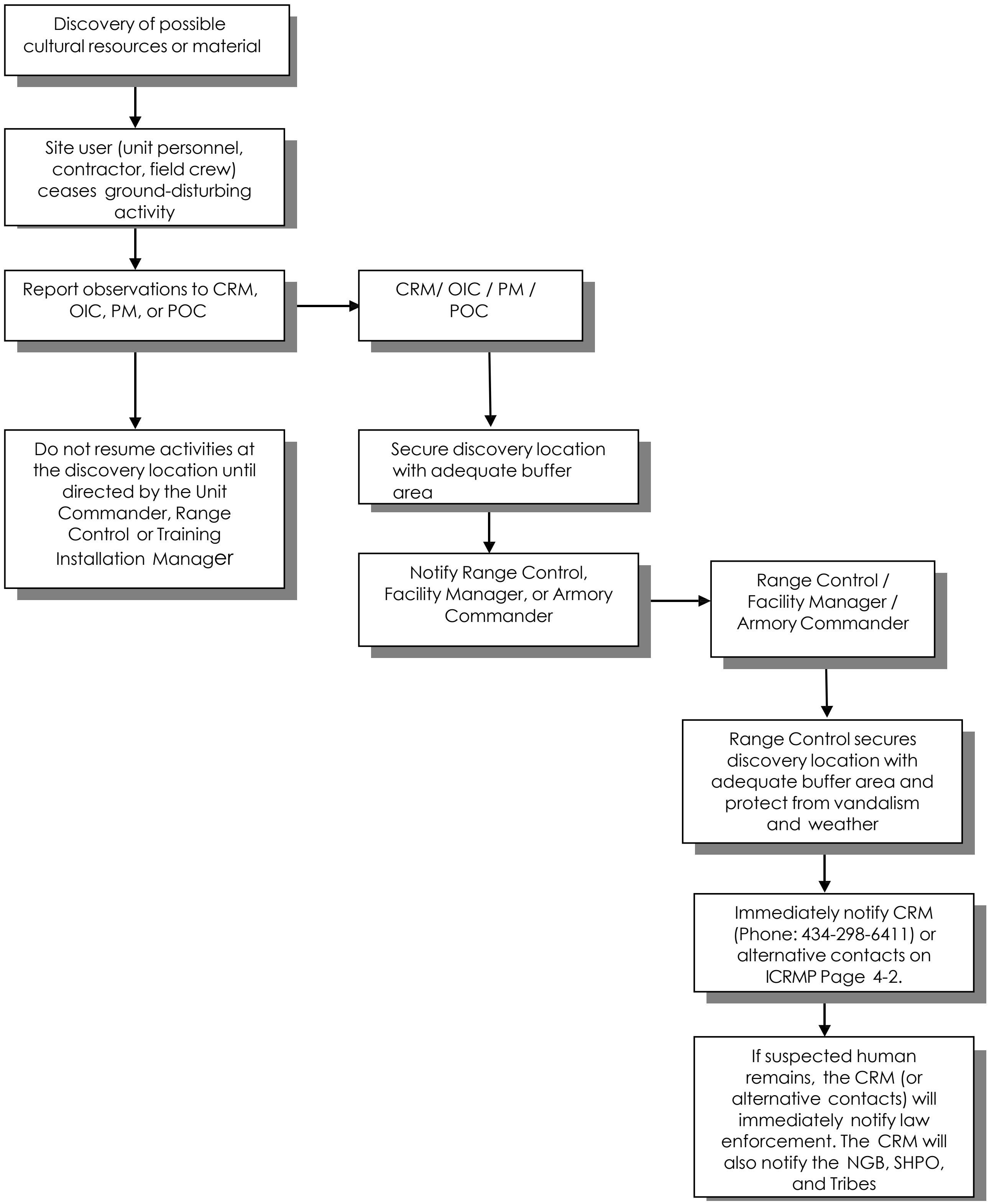
Table 38. Potential for effects on cultural resources at Fort Pickett.

Type of Training	Effects on Cultural Resources
Infantry, light infantry	Low
Engineer Activities	High
Track Vehicle Maneuvers	High
Wheeled Vehicle Maneuvers	Medium
Artillery	Medium
Aviation	Low
Support	Medium
Direct and indirect fire	Low

6.3 STANDARD OPERATING PROCEDURES (SOP) FOR DETERMINING SECTION 106 COMPLIANCE FOR ACTIONS & ACTIVITIES NOT COVERED IN THIS CHAPTER

The CRM will be contacted if any cultural materials, including artifacts, are found. No materials shall be removed from the location. Please refer to the SOP for Inadvertent Discovery of Cultural Materials in the ICRMP. The flow chart (see Figure 23) is intended to be used by unit/activity level personnel, unit commanders, and similar personnel as a decision-making guide when inadvertent discoveries are made as described under the applicability section of this SOP (Versar 2013).

Figure 23. Flow chart for the inadvertent discovery of potential cultural resource (Versar 2013).



7.0 IMPLEMENTATION

Full implementation of the ecological management strategy outlined in the Fort Pickett INRMP will not occur over the five years that this plan covers. In fact, many ecosystem processes work on scales that are beyond the lifetime of any individual. The success or failure of integrating natural resources management, and thus ecosystem management, will be assessed by how effectively military mission objectives are supported while simultaneously accomplishing natural resources stewardship objectives.

The goals and objectives outlined in this document guide for natural resources planning and management at Fort Pickett that express a vision for a desired future condition for the period covered by the INRMP (2022-2026). The goals and objectives listed are policy statements that provide the overall program direction (goals) and specific management instruction (objectives) for the natural resources management program consistent with regulatory requirements, the current condition of the natural resources on the installation, and a consideration of the value of these resources to the people who live and work on the installations and surrounding community as approved by NGB and as appropriate funding allows.

Each INRMP goal is supported by objectives that outline the strategy that will be used to achieve a stated goal. An objective supports a written goal by proclaiming more specifically the management actions that must occur to accomplish each goal. As a final step, the INRMP goals and objectives are put into action by formulating and implementing specific projects. Projects are the "steps" for achieving each objective. A project can be completed using in-house resources, through cooperative agreements with other agencies and partners, or by contract action. Projects can be defined as specific budget line items that will be programmed into the VAARNG Environmental budget for funding. Consequently, the goals and objectives become management targets that will allow for quantitatively tracking the progress towards implementation of the INRMP.

7.1 ENVIRONMENTAL/NATURAL RESOURCES

The natural resources program receives funding through the implementation of the Status Tool for the Environmental Program (STEP).

7.1.1 Status Tool for the Environmental Program (STEP)

The Status Tool for the Environmental Program (STEP) was developed to support the project management functions of the State Environmental Offices as well as the resource responsibilities of the Environmental Division of the National Guard Bureau (NGB-ARE). The STEP tool includes the functionalities listed below.

- Facilitate State Project Identification;
- Single electronic repository for environmental documents;
- NGB-ARE Review/Validation of environmentally funded projects and NEPA;
- Develop Environmental State Operating Budgets (ESOB);

- Determine appropriate distribution of funds to support must fund requirements across all 54 States and Territories;
- List Unfunded Requirements;
- Support accurate reimbursement through the Master Cooperative Agreement Appendix 2;
- Ensure adherence to DA policy eligibility for environmental funding; and
- Provide analysis of budgeting and execution.

7.1.1.1 STEP Tool Importance

Developing requirements for projects managed by the environmental branch is extremely important. Projects must be documented early and completely in STEP according to current policies to request and defending funds to manage and sustain the ARNG environmental program. Funds provided to the ARNG must be defended in the programming and budget processes; the quality of STEP projects impacts the degree of integrity the ARNG maintains with the DA, DoD and Congress.

The data maintained in STEP is used by NGB-ARE to support the functions listed below:

- Cooperative Agreement Appendix 2 submissions for accurate reimbursement.
- Distribution of funds to support critical must funds between all 54 States and Territories.
- Adherence to DA policy on what is eligible for environmental funding.
- Analysis of execution to ensure that POM requirements are accurate.

7.1.1.2 Operations and Maintenance Environmental Funds

Environmental funds (VENQ) are a special category of Operations and Maintenance (O&M) funds and are controlled by the Status Tool for Environmental Program (STEP) budget process. They are special in that they are restricted by the DOD solely for environmental purposes, but they are still subject to restrictions of O&M funds. Compliance with appropriate laws and regulations is the key to securing environmental funding. The program heavily favors funding high priority projects with a goal of achieving compliance with federal or state laws, especially if non-compliances are backed by Notices of Violation or other enforcement agency action.

ARNG is the primary source of funding that supports the management of natural resources. Environmental funds typically can be used for core natural resources activities and projects and guidance is provided in funding documents issued yearly. DoDI 4715.03 also describes activities and projects that may be funded with Environmental funds. Projects paid for with environmental funds should be submitted through the Status Tool for the Environmental Program (STEP) maintained by the ARNG G9.

In addition to Environmental funds, Installation and ITAM funds can be used to implement INRMP activities and projects. Installation funds support facilities operation and maintenance, including facility planning, maintenance of roads, vegetation management, wildfire management, pest management, construction, and master planning. All activities have an impact on natural resources. Installation funds can also be used for pest and noxious weed control, invasive species control, facilities vegetation control, and controlled burns to manage vegetation and fuels on training areas and ranges. ITAM funds can be used for monitoring, maintenance of trails, vegetation restoration, land management, and water quality improvements related directly to military training.

The following natural resources management areas can be addressed with multiple funding sources:

- Erosion control,
- invasive species management, and
- wildland fire.

The type of funding used for these management areas depends on purpose. Current guidance should be referred to annually to determine the most appropriate source of funding for a specific activity or project.

7.2 ITAM PROGRAM

The NGVA-MTC-OP formulates the ITAM workplans, known as the installation WAM, on a five-year cycle. ITAM related projects that are required to implement the Fort Pickett-INRMP will be identified in the yearly workplans (Ford 2013).

7.3 ANALYSIS OF CURRENT NATURAL RESOURCE INFORMATION

All original Fort Pickett's planning level surveys have been completed. The planning level surveys represent only part of the natural resources' information available for management decisions. There are a number of peer reviewed papers, agency reports, white paper reports and memos specifically related to ecology and natural resource management at Fort Pickett (see work cited for chapters 3 and 5). As a result, there is sufficient information to meet compliance requirements. Nevertheless, there are projects that would improve scientific knowledge of the Fort Pickett ecosystem which will further installation training requirements and limit encroachment. Planning level surveys for faunal species should occur every three to five years.

7.4 ACTIONS REQUIRED TO MEET FORT PICKETT AND ARMY STEWARDSHIP OBJECTIVES

The management actions and prescriptions described in Chapter 5, Natural Resources Program Management, must be implemented to meet military mission support Army stewardship objectives.

7.5 IMPLEMENTATION SCHEDULE FOR THE FORT PICKETT INRMP

The Fort Pickett INRMP must be updated no later than five years from the initial approval. In addition, yearly reviews and updates must take place. The task implementation schedule for the FY 2022-2026 Fort Pickett INRMP is included as Appendix A.

7.6 LABOR REQUIREMENTS FOR INRMP IMPLEMENTATION

The labor requirements may change based upon yearly INRMP updates. Implementation requires the coordination of multiple departments and programs. The following labor requirements for INRMP implementation were developed by Fort Pickett stakeholders, with seasonal staff as needed:

- Environmental Program Manager,
- Environmental Protection Specialist,
- Natural Resources Program Manager,
- GIS Technician,
- Cultural Resources Manager and Staff,
- General Environmental Assistant, and
- NEPA Program Manager.

The following are labor requirements based on the required forestry management actions and objectives of the Department of Public Works program:

- Professional Forester,
- Forestry Technician,
- Forestry Assistant(s), and
- Entomologist.

At least one Forestry personnel staff member must be a heavy equipment operator; all must be certified to respond to wildfire and to conduct controlled burning.

The following are labor requirements for implementing INRMP management actions and objectives through the ITAM program:

- ITAM Program Manager,
- LRAM Coordinator,
- ITAM GIS Coordinator,
- Seasonal LRAM personnel,
- RTLA Coordinator/coordination, and
- Seasonal RTLA field technician(s).

All programs and organizations shall acquire, through appropriate funding mechanisms, and maintain all equipment for proper implementation of the INRMP objectives.

7.7 FUTURE PROJECTS

This is a list of future projects which have been included in the Natural Resources Management Tasks spreadsheet under the following categories:

7.7.1 General

1. Carbon Banking

   The "banking" of carbon sources to be used as credit against those that produce carbon dioxide is a growing program in the United States. Burning fossil fuels for energy and deforestation for wood products causes the emission of carbon dioxide. Carbon dioxide is a greenhouse gas attributed with increasing/accelerating the global warming process. Since trees capture carbon dioxide, the premise of carbon banking is to grow trees in a sustainable way as an offset for industries that are creating carbon dioxide. The credit generated from a stand of trees in the United States could be traded to a company in an open market to be used toward their debit anywhere in the world. Therefore, a "bank" is created where carbon credits and debits are exchanged globally. The end goal is that for every debit created, there is a credit that will offset it, thus mitigating the total effect of carbon dioxide released. Since Fort Pickett has large tracts of land that are managed in a sustainable manner as forested ecosystems, there is the potential for the installation to investigate registering them as carbon credits as a way to generate additional revenue and promote carbon banking as an ecosystem management tool.

7.7.2 Forest Management

1. Prescribed Fire Plan Implementation.

   Additional funds would assist in the implementation and expansion of the use of prescribed fire. Prescribed fire serves two critical functions at Fort Pickett. Prescribed fire is the most cost-effective method of maintaining and improving training land for mechanized infantry maneuvers. In addition, the prescribed fire plan will be developed and implemented in accordance with the *Rhus michauxii* endangered species management plan and is in harmony with DoD ecosystem management regulations.

2. Investigation of the Long-term Effects of Prescribed Fire and other disturbance on Training Land at Fort Pickett.

   RTLA data would be used to assess the effectiveness of the prescribed fire program at Fort Pickett on several training and ecological variables. These variables include horizontal cover, vertical cover, overstory density and composition, plant community changes, invasive species, soil processes (fertility, arthropod community) and biodiversity.

7.7.3 Rare, Threatened and Endangered Species Habitat Management

1. Assessment of Aquatic Communities in the Nottoway River.

   Very little is known about the aquatic communities within the Nottoway River. Because of the occurrence of the federally protected Roanoke logperch and the potential for other rare and endangered species (e.g., dwarf wedgemussel), the proper management of this vital habitat is required by the ESA. A complete understanding of the aquatic communities occurring within the Nottoway River will allow for proactive management and thus reduce the possibility of military training restrictions. The USFWS has indicated support for the implementation of this project.

2. Michaux's Sumac

   A stated goal of the Michaux's sumac Endangered Species Management Plan is delisting. Delisting Michaux's sumac will not only benefit the species but will reduce encroachment on Fort Pickett and Fort Bragg. In order to accomplish delisting of Michaux's sumac, the USFWS requires that 19 self-sustaining populations be established "…that are protected in order to such a degree that the species no longer qualifies for protection under the ESA" (USFWS 1993).

   As with many rare species, whose preferred habitat is also rare and widely scattered, natural recolonization is virtually impossible. Therefore, active programs to establish populations are required to recover Michaux's sumac. The population of Michaux's sumac at Fort Pickett is the largest and most genetically diverse population known, thus an ideal population from which to develop a nursery. The Michaux's sumac plants form this nursery could be used to establish additional populations throughout the region to facilitate delisting. In addition, propagation techniques developed will be useful for other researchers trying to establish populations thus further facilitating the ultimate goal of delisting.

3. Bat Species Monitoring Plan

   Establishing a monitoring program for bat species listed as threatened and endangered would allow natural resource managers to address management concerns prior to any proposed projects, especially silvicultural operations and prescribed burns. Monitoring program could coincide with the areas of planned forestry and burn operations in any given year. The four species of bat that would require monitoring are the NLEB, Indiana bat, tri-colored bat, and little brown bat. See Section 5.3.4 for more information on the bats and the NLEB management plan.

4. Rare Mussel Monitoring Plan

   Establishing a proactive monitoring program for aquatic species of greatest conservation need would help natural resource managers address management concerns prior to any USFWS listing. Three species that would be specifically targeted in this plan are the Atlantic pigtoe, dwarf wedgemussel and yellow lance mussel. The USFWS has indicated support for the implementation of this optional project.

5. Pollinator Habitat Restoration

   Pollinators (such as bees, butterflies, moths, birds, and bats) provide critical "ecosystem services" by pollinating wild and agricultural plant species through their foraging for nectar. Pollination is essential in producing the majority of fruits, vegetables, nuts, and seeds that we eat every day. As a result, pollinator health and diversity are directly related to the success of most agricultural systems. The abundance and diversity of pollinators are in severe decline. Human induced factors like habitat loss, pesticide use, disease, and introduction of pest species have all been cited as contributing to the decline. Fort Pickett can join a growing number of programs that encourage the reduction of pesticide use and wildflower plantings along highways and unused fields across the country to provide more habitat for pollinators.

7.7.4 Integrated Pest Management

1. Mapping and Monitoring the Effectiveness of Control Measures for Non-Native Species

   Invasive and alien species are detrimental to training land and have adverse impacts on the ecosystem. Control measures have been instituted and an assessment of the effectiveness of control measures will help natural resource managers develop better control measures.

7.8 COORDINATION WITH OUTSIDE ORGANIZATIONS

In many instances, implementation of natural resource management actions must be coordinated with outside government and non-government organizations. This section will discuss procedures through which this coordination will take place. In general, when there is an issue regarding natural resource management that requires coordination with outside organizations, the appropriate Fort Pickett administrator will either initiate the contact or designate personnel to do so.

The following management areas require to some degree coordination with outside agencies:

- Federally Threatened and Endangered Species,
- Wetlands Management and Compliance,
- Wildfire (Accidental/Prescribed),
- Forestry Operations,
- Fish and Game Management, and
- Stormwater, Erosion and Sediment Control.

7.8.1 Federally Threatened and Endangered Species

All federally threatened and endangered species management issues occurring on Fort Pickett are coordinated through the NGVA-FMO-ENV. NGVA-FMO-ENV will coordinate with the USFWS and appropriate state agencies to adjust any management actions or prescriptions. NGVA-FMO-ENV shall consult with the USFWS to determine whether activities within the installation may affect a listed endangered or threatened species. If it is determined, through a biological assessment (BA) or other review, that an activity is likely to adversely affect a listed species, a request for formal consultation to the USFWS shall be submitted. Upon completion of formal consultation, the USFWS will prepare a biological opinion (BO), which will state whether Fort Pickett has insured that activities are not likely to jeopardize the continued existence of a listed species. Additionally, NGVA-FMO-ENV will work with DWR concerning management actions and WAP species.

7.8.2 Wetlands/Section 404 Compliance

Permits for the draining or filling of jurisdictional wetlands are obtained through the USACE. NGVA-FMO-ENV coordinates the request for permits with the USACE. Coordination often must also occur with DEQ and the Virginia Marine Resources Commission (VMRC).

7.8.3 Prescribed Fire

The following entities must be contacted when performing prescribed burning operations:

1. NGVA-MTC-PW main office,
2. Range Operations,
3. Fort Pickett Fire Department, and
4. Appropriate Virginia Department of Forestry Office.
5. If the prescribed fire is close to Blackstone, Route 40, or the Blackstone airfield, contact the Town of Blackstone.
6. If the prescribed fire is on the edge of Fort Pickett, contact the appropriate County Dispatcher/Sheriff.

7.8.4 Forestry Operations

The installation forester will coordinate all timber sales with either the USACE or with the United States Property and Fiscal Officer (USPFO) contracting office. This coordination will include updating the Memorandum of Agreement between Fort Pickett and the USACE. Forestry must also coordinate with NGVA-FMO-ENV.

7.8.5 Fish and Game Management

The management of fish and game resources at Fort Pickett requires a high degree of coordination with the DWR. The DWR sets hunting and fishing bag quotas. Whereas the Fort Pickett Range Operation and Safety Office, in coordination with the Natural Resources Fish and Wildlife Office, sets hunter quotas based upon military mission safety requirements.

7.8.6 Stormwater, Erosion, and Sediment Control

Water quality is everyone's concern and in the 1980's the Commonwealth of Virginia expanded the original water quality and erosion control program to include state and local governments since issues with land clearing and water quality are controlled by these agencies. The state agency with oversight on the stormwater management and erosion and sediment control programs is DEQ.

The Virginia Stormwater Management Program (VSMP) regulations allow DEQ and a number of localities to administer the Virginia Pollutant Discharge Elimination System (VPDES) permitting program which regulates point source pollution. Construction activities may require a construction general permit to be issued prior to any clearing and grading on the site. If a permit is required, the operator would be required to develop a site-specific Stormwater Pollution Prevention Plan (SWPPP).

The erosion and sediment control program contain accepted minimum standards and training and certification programs that are in place today as part of the VESCL. The VESCL provides for different levels of enforcement for the individual homeowner or farmer through the construction contractor and various state agencies that are responsible for managing land development and land clearing operations. Fort Pickett manages all land clearing operations on the installation in accordance with the VESCL.

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9.0 APPENDICES

APPENDIX A: NATURAL RESOURCES MANAGEMENT TASKS

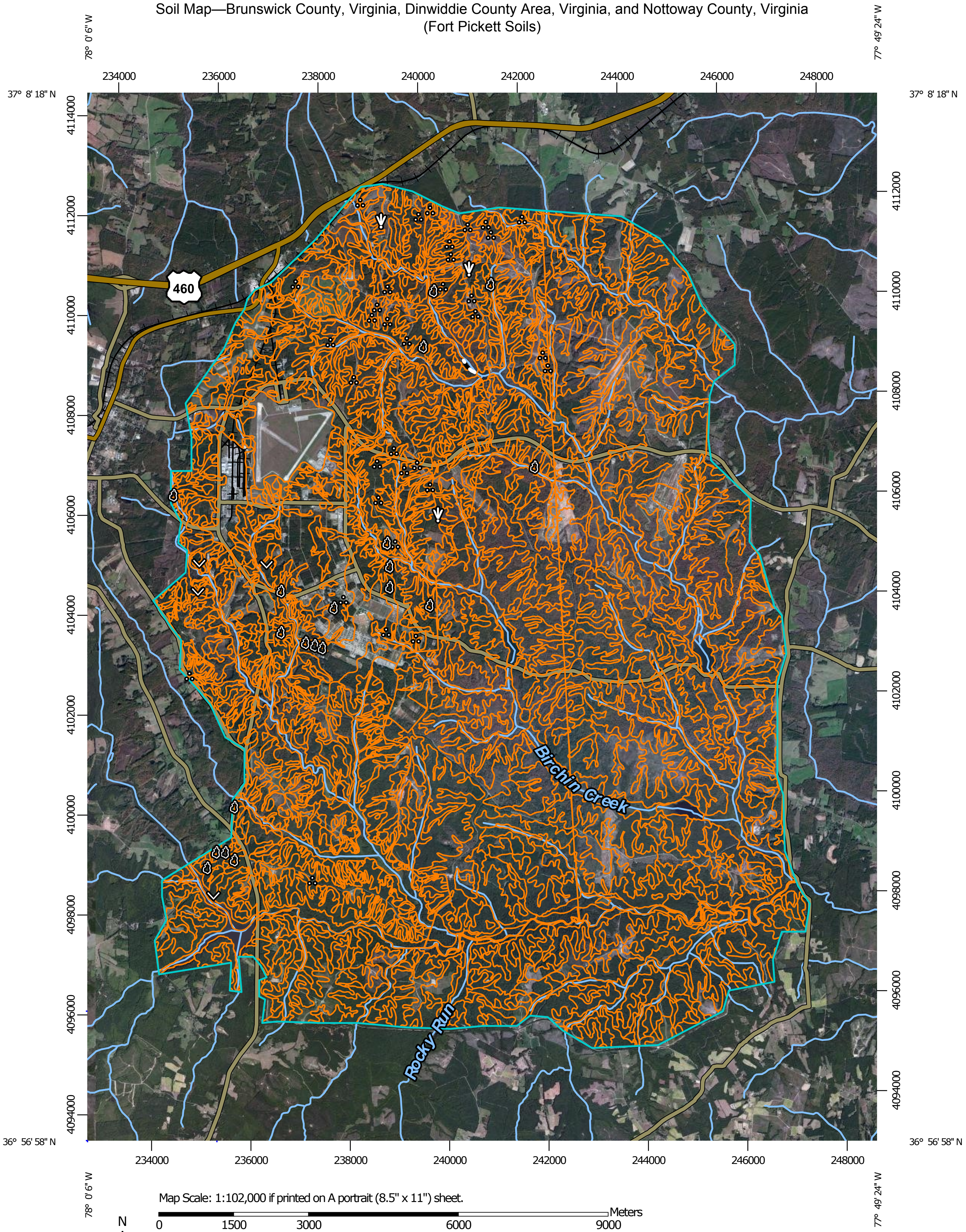
Goals and Objectives	Management Task		Responsible Entities	Funding Priority	Active Year 2022	2023	2024	2025	2026	Cycle	INRMP Section
	GENERAL										
	Updates to INRMP		ENV - Natural Resources Manager	1 Must Fund	☑	☑	☑	☑	☑	Annually and every 5 years	1.1
	Research carbon banking of forest resources.		ENV - Natural Resources Manager	3	☐	☐	☐	☐	☑	As needed	7.7.1
1	**FOREST MANAGEMENT**										5.1; Appendix J
	Unplanned events: Environmental assessments required prior to action.		NEPA Propgram Manager	1 Must Fund	☑	☑	☑	☑	☑	As needed	5.1.7
	Evaluation of proposed timber harvests for potential environmental effects.		Forestry Program Manager	2	☑	☐	☑	☐	☑	As Needed	5.1.8
	Initiate forest inventory update.		Forestry Program Manager	1 Must Fund	☑	☑	☑	☑	☑	Annually	5.1.9
	Update forest management section of INRMP with data from new forest inventory information		ENV - Natural Resources Manager	2	☑	☑	☑	☑	☑	Annually	5.1.9
	Inform cultural resources of forested stands that need to be harvested.		Forestry Program Manager	N/A	☑	☑	☑	☑	☑	As Needed	6.1.2
	Implement all prescribed fire for training land maintenance and endangered species management.		DPW - Natural Resources Manager	1 Must Fund	☑	☑	☑	☑	☑	Annually	
	Prescribed fire management.		DPW - Natural Resources Manager	1 Must Fund	☑	☑	☑	☑	☑	Annually	Appendix K; Appendix L
	Update prescribed fire management plan.		DPW - Natural Resources Manager	1 Must Fund	☐	☐	☐	☐	☑	Every 5 years	
2	**NON-GAME SPECIES MANAGEMENT**										5.2
	Ecological monitoring, biological surveys and habitat assessments.		ENV - Natural Resources Manager	1 Must Fund	☑	☑	☑	☑	☑	Annually and every 5 years	5.2.2
	Managing grasslands		ENV - Natural Resources Manager	2	☐	☐	☑	☐	☐	Every 5 years as needed	5.7.6
3	**RARE, THREATENED AND ENDANGERED SPECIES HABITAT MANAGEMENT**										5.3
	Assessment of Aquatic Communities in the Nottoway River.			1 Must Fund	☑	☐	☐	☐	☑	Every 5 Years	5.3.2; 5.3.5
	Conduct surveys for major faunal groups (birds, bats, mussels)		ENV - Natural Resources Manager	1 Must Fund	☐	☑	☐	☐	☐	Every 5 Years	5.3
	Establish a rare mussel monitoring plan.			1 Must Fund	☑	☐	☐	☐	☑	Every 5 Years	7.7.3
	Pollinator habitat restoration.			1 Must Fund	☑	☐	☐	☐	☑	Every 5 Years	7.7.3
3.A	**Michaux's Sumac (*Rhus michauxii*) Management**										5.3.1
	Habitat management.	Insure that each Michaux's sumac colony is burned, either from fires resulting from military training or prescribed fire, at a minimum once every 3 years to control woody encroachment.	ENV - Natural Resources Manager	2 As needed	☑	☐	☐	☑	☐	Every 3 years as needed	
		Implement mechanical control in colonies where either fire intensity was insufficient (or absent) to control woody encroachment.		3 As needed	☑	☑	☑	☐	☐	Every 5 years as needed	
		Implement control strategies in all Michaux's sumac colonies adversely impacted by non-native invasive species.	Env - Natural Resources Manager	1 Must Fund	☐	☑	☐	☐	☑	Every 2 years as needed	
		Utilize data from both quantitative and qualitative monitoring to assess the success of fire and/or mechanical control of woody encroachment.		3	☑	☑	☑	☑	☑	Annually	
	Delineation and mapping of colonies.	Conduct visual surveys for Michaux's sumac colonies annually.	ENV - Natural Resources Manager	1 Must Fund	☑	☑	☑	☑	☑	Annually	
		Search for additional Michaux's sumac colonies and re-delineate and map all known Michaux's sumac colonies every five to seven years.		2	☐	☑	☐	☐	☑	Every 2 to 3 years	5.3.1
		Update colony boundaries and map locations in specific areas to support military mission and construction requirements as needed.		1 Must Fund	☑	☐	☑	☐	☑	Every 2 to 3 years	
		All new construction or land clearing activities must have an on the ground search for Michaux's sumac prior to the initiation of the project.		1 Must Fund	☐	☑	☐	☐	☑	As needed	
	Identify and sign Michaux's Sumac Colonies.	Assess condition and distribution of signage for each colony as appropriate at minimum once yearly. Identify colonies requiring additional signs and/or replacement signs.	ENV - Natural Resources Manager	3	☑	☑	☑	☑	☑	Annually as needed	
		Place additional signs on the border of colonies and/or replace signs that have been damaged or destroyed.	ENV - Natural Resources Manager	3	☐	☐	☐	☐	☐	As needed	

	Monitor	Implement quantitative and qualitative monitoring of the density of Michaux's sumac in selected colonies every three years.	ENV - Natural Resources Manager	1 Must Fund	☑	☐	☐	☑	☐	Every 3 years	5.3.1
	Transplant Michaux's Sumac Colonies.	Continue to manage Michaux's sumac mitigation areas for successful propagation of the species.	ENV - Natural Resources Manager	2 As approved	☑	☑	☑	☑	☑	As needed	
	Off-Site Michaux's Sumac Colony Protection.	Off-site surveys coordinated with DCR.	ENV - Natural Resources Manager	Not yet active	☐	☐	☐	☐	☐	N/A	
		Protection of populations.		Not yet active	☐	☐	☐	☐	☐	N/A	
		Create management plans.		Not yet active	☐	☐	☐	☐	☐	N/A	
		Implement management plans.		Not yet active	☐	☐	☐	☐	☐	N/A	
3.B	**Roanoke Logperch (*Percina rex*) Management**										5.3.2
	Implement management actions as described in Section 4.2 of the *Endangered Species Management Plan for The Roanoke Logperch (Percina rex) at Army National Guard Maneuver Training Center Fort Pickett, Virginia.*		ENV - Natural Resources Manager	1 Must Fund	☐	☐	☑	☐	☐	Every 5 Years	Appendix N
3.C	**Bald Eagle (*Haliaeetus leucocephalus*) Management**										5.3.3
	Annual monitoring.		ENV - Natural Resources Manager	1 Must Fund	☐	☐	☐	☑	☐	Every 5 years	5.3.3
	Implement management actions as described in the USFWS National Bald Eagle Management Guidelines.		ENV - Natural Resources Manager	1 Must Fund	☑	☑	☑	☑	☑	Annually as needed	Appendix M
3.D	**Bat Management**										5.3.4
	Implement management actions as described in the VDGIF *Best Management Practices for Conservation of Little Brown Bats and Tri-colored bat.*		ENV - Natural Resources Manager	3	☐	☐	☐	☑	☐	Every 5 years	Appendix O
	Insure compliance with the Intra-Service Programmatic Biological Opinion on the issuance of the final NLEB 4(d) rule to achieve section 7 compliance, implement the *Informal Consultation and Management Guidelines for the Northern Long-eared Bat Involving Ongoing Operations on Army National Guard Property* or coordinate with the USFWS.		ENV - Natural Resources Manager	1 Must Fund	☑	☑	☑	☑	☑	Annually	5.3.4; Appendix O
	Establishing a monitoring program for bat species listed as threatened and endangered would allow natural resource managers to address management concerns prior to any proposed projects, especially silvicultural operations and prescribed burns.		ENV - Natural Resources Manager	1 Must Fund	☐	☑	☐	☐	☐	Every 5 years	7.7.3
3.E	**Mussel Management**										5.3.5
	Conduct surveys to monitor the populations of mussels within the Nottoway River.		ENV - Natural Resources Manager	1 Must Fund	☑	☐	☐	☐	☑	Every 5 years	7.7.3
	Retain riparian buffers on the Nottoway River and tributaries.		ENV - Natural Resources Manager	3	☑	☑	☑	☑	☑	Continuous	5.5.5; 5.5.6
4	**FISH AND GAME MANAGEMENT**										5.4
	Population monitoring of game species.		DPW - Natural Resources Manager	3	☐	☐	☐	☐	☑	Every 5 to 10 years	5.4.2
	Create and implement a Fish and Wildlife Management Plan		DPW - Natural Resources Manager	3	☐	☐	☐	☐	☑	Every 5 to 10 years	5.4.3
	Impoundment monitoring and maintenance.		DPW - Natural Resources Manager	3	☑	☑	☑	☑	☑	Annually	5.4.12
5	**WATER QUALITY MANAGEMENT AND WETLAND CONSERVATION**										5.5
	Review of proposed projects for impacts to waters/wetlands.		ENV - Natural Resources manager	2	☐	☑	☐	☑	☐	As needed	5.5.2
	Implement BMP measures to repair erosion sites		ENV - Natural Resources Manager	3	☐	☐	☐	☑	☐	As needed	5.5.4
	Macroinvertebrate survey.		ENV - Natural Resources Manager	1 Must Fund	☐	☑	☐	☐	☐	Every 5 years	5.5.7
6	**INTEGRATED PEST MANAGEMENT**										5.6; Appendix P
	Continue control measures for invasive species		ENV - Natural Resources Manager	2	☐	☐	☑	☐	☑	As needed	5.6
	Conduct Invasive Species and Pest Management Plan Update		ENV - Natural Resources Manager	3	☐	☐	☐	☐	☑	As needed	
	Mapping and Monitoring the Effectiveness of Control Measures for Non-Native Species.		ENV - Natural Resources Manager	3	☐	☐	☐	☑	☐	As needed	
7	**SUSTAINABLE RANGE PROGRAM**										5.7
7.A	**Range and Training Lands Program (RTLP)**										5.7.3
	RTLP implementation.		ITAM/ENV-NGVA-FMO	3	☐	☐	☐	☑	☐	As needed	5.7.3
7.B	**Integrated Training Area Management (ITAM)**										5.7.4
	Develop and update ITAM workplans.		ITAM	N/A	☐	☐	☐	☐	☑	Every 5 years	5.7.4
	Perform scheduled RTLA inventory and monitoring.		ITAM	N/A	☑	☐	☑	☐	☑	As needed	
	Vegetate stands harvested to create open maneuver areas.		ITAM	N/A	☑	☐	☑	☐	☑	As needed	
	Complete LRAM tasks identified in the ITAM workplan.		ITAM	N/A	☑	☐	☑	☐	☑	As needed	
	Use RTLA data to investigate the Long-term Effects of Prescribed Fire and other disturbance on Training Land.		NGVA-FMO-ENV / ITAM/DPW	N/A	☑	☐	☑	☐	☑	As needed	
	Maintain and update GIS database.		NGVA-FMO-ENV / ITAM	2	☐	☑	☐	☑	☐	As needed	

	All activities must be reviewed by cultural resources prior to commencement.	ENV - Cultural Resources Manager	N/A	☑	☑	☑	☑	☑	As needed	6.1.1
8	**RECREATION MANAGEMENT**									5.8
	Monitor boating, fishing, and hunting for impacts on natural resources. Quotas and limits should continue to be evaluated on a regular basis and reset, as needed, in cooperation with VDGIF. Restricting hunting to daylight hours may be indicated during certain times of the year to protect the NLEB.	ENV - Natural Resources Manager	3	☑	☑	☑	☑	☑	Annually	5.8.5
	SOPs for implementing safety requirements should be developed for each activity in coordination with the Installation Safety Office.	ENV - Natural Resources Manager	3	☑	☑	☑	☑	☑	As needed	
9	**PUBLIC OUTREACH**									5.9
	Engaging and educationg the public.	NGVA-FMO-ENV/DPW		☑	☑	☑	☑	☑	Annually	5.9.2
10	**CANTONMENT AREA MANAGEMENT**									5.10
	Compliance with Virginia Stormwater Management Program.	ENV - Compliance Program Manager	Funded through NGB	☑	☑	☑	☑	☑	As needed	5.10.3
	Compliance with Virginia Erosion and Sediment Control Program.	ENV - Compliance Program Manager	Funded through NGB	☑	☑	☑	☑	☑	As needed	
11	**CLIMATE CHANGE**									5.11
	The development of potential alternatives that may be used to address the physical impacts of climate change to both existing infrastructure and the natural environment.	ENV - Natural Resources Manager	3	☐	☐	☐	☐	☑	Every 5 years	5.11.2
12	**MONITORING**									5.13
	RTLA monitoring	ITAM	Funded through NGB	☑	☑	☑	☑	☑	As needed	5.13.1
	Rehabilitation of mechanically cleared maneuver areas.	ITAM	Funded through NGB	☑	☑	☑	☑	☑	As needed	
	Develop species specific monitoring methods.	ENV - Natural Resources Manager	2	☐	☑	☐	☐	☑	As needed	5.13.2
	Monitoring of threatened and endangered species.	ENV - Natural Resources Manager	1 Must Fund	☐	☐	☑	☐	☐	Every 5 years	5.13.3

APPENDIX B: SOILS

Soil Map—Brunswick County, Virginia, Dinwiddie County Area, Virginia, and Nottoway County, Virginia
(Fort Pickett Soils)



Map Scale: 1:102,000 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 1500, 3000, 6000, 9000

Feet: 0, 4500, 9000, 18000, 27000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:20,000 to 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Brunswick County, Virginia
Survey Area Data: Version 7, Sep 26, 2016

Soil Survey Area: Dinwiddie County Area, Virginia
Survey Area Data: Version 3, Sep 26, 2016

Soil Survey Area: Nottoway County, Virginia
Survey Area Data: Version 11, Sep 26, 2016

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 4, 2010—Nov 8, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Brunswick County, Virginia (VA025)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
1C	Appling sandy loam, 8 to 15 percent slopes	35.1	0.1%
2B	Appling-Mattaponi complex, 2 to 8 percent slopes	167.6	0.4%
3D	Ashlar-Rock outcrop complex, 15 to 25 percent slopes	357.4	0.8%
3E	Ashlar-Rock outcrop complex, 25 to 45 percent slopes	94.0	0.2%
5B	Cecil sandy loam, 2 to 8 percent slopes	853.2	1.9%
5C	Cecil sandy loam, 8 to 15 percent slopes	24.9	0.1%
6B3	Cecil sandy clay loam, 2 to 8 percent slopes, severely eroded	92.1	0.2%
6C3	Cecil sandy clay loam, 8 to 15 percent slopes, severely eroded	886.6	2.0%
8A	Chewacla silt loam, 0 to 2 percent slopes, occasionally flooded	26.1	0.1%
9A	Chewacla and Wehadkee soils, 0 to 2 percent slopes, frequently flooded	28.6	0.1%
10B	Emporia sandy loam, 2 to 8 percent slopes	0.9	0.0%
16B	Helena sandy loam, 2 to 8 percent slopes	69.8	0.2%
16C	Helena sandy loam, 8 to 15 percent slopes	78.6	0.2%
22C	Pacolet sandy loam, 8 to 15 percent slopes	5.7	0.0%
22D	Pacolet sandy loam, 15 to 25 percent slopes	531.5	1.2%
23B	Rion sandy loam, 2 to 8 percent slopes	461.8	1.0%
23D	Rion sandy loam, 15 to 25 percent slopes	353.9	0.8%
24C	Rion-Ashlar sandy loam, 8 to 15 percent slopes	1,160.2	2.6%
25A	Riverview loam, 0 to 2 percent slopes, occasionally flooded	143.2	0.3%
26B	Santuc sandy loam, 2 to 8 percent slopes	9.7	0.0%

Brunswick County, Virginia (VA025)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
29C	Wedowee gravelly sandy loam, 8 to 15 percent slopes	27.0	0.1%
30A	Wehadkee silt loam, 0 to 2 percent slopes, frequently flooded	458.6	1.0%
W	Water	146.7	0.3%
Subtotals for Soil Survey Area		**6,013.3**	**13.6%**
Totals for Area of Interest		**44,089.4**	**100.0%**

Dinwiddie County Area, Virginia (VA653)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
2B	Appling sandy loam, 2 to 7 percent slopes	54.9	0.1%
2C	Appling sandy loam, 7 to 15 percent slopes	25.8	0.1%
4B	Cecil sandy loam, 2 to 7 percent slopes	0.2	0.0%
4C	Cecil sandy loam, 7 to 15 percent slopes	3.2	0.0%
16A	Roanoke loam, 0 to 2 percent slopes, occasionally flooded	4.1	0.0%
902B	Appling-Mattaponi complex, 2 to 8 percent slopes	3,133.8	7.1%
903D	Ashlar-Rock outcrop complex, 15 to 25 percent slopes	53.3	0.1%
903E	Ashlar-Rock outcrop complex, 25 to 45 percent slopes	140.3	0.3%
905B	Cecil sandy loam, 2 to 8 percent slopes	365.3	0.8%
906B3	Cecil sandy clay loam, 2 to 8 percent slopes, severely eroded	266.1	0.6%
906C3	Cecil sandy clay loam, 8 to 15 percent slopes, severely eroded	402.1	0.9%
908A	Chewacla silt loam, 0 to 2 percent slopes, occasionally flooded	35.4	0.1%
909A	Chewacla and Wehadkee soils, 0 to 2 percent slopes, frequently flooded	325.9	0.7%
916B	Helena sandy loam, 2 to 8 percent slopes	606.7	1.4%
916C	Helena sandy loam, 8 to 15 percent slopes	31.4	0.1%
922D	Pacolet sandy loam, 15 to 25 percent slopes	59.1	0.1%

Dinwiddie County Area, Virginia (VA653)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
923B	Rion sandy loam, 2 to 8 percent slopes	249.5	0.6%
923D	Rion sandy loam, 15 to 25 percent slopes	328.7	0.7%
924C	Rion-Ashlar sandy loam, 8 to 15 percent slopes	968.6	2.2%
925A	Riverview loam, 0 to 2 percent slopes, occasionally flooded	50.2	0.1%
926B	Santuc sandy loam, 2 to 8 percent slopes	52.3	0.1%
929C	Wedowee gravelly sandy loam, 8 to 15 percent slopes	3,964.7	9.0%
929D	Wedowee gravelly sandy loam, 15 to 25 percent slopes	652.1	1.5%
930A	Wehadkee silt loam, 0 to 2 percent slopes, frequently flooded	955.9	2.2%
931B	Worsham silt loam, 2 to 8 percent slopes	2.9	0.0%
UdC	Udorthents, loamy, 2 to 8 percent slopes	100.5	0.2%
W	Water	213.0	0.5%
Subtotals for Soil Survey Area		**13,045.9**	**29.6%**
Totals for Area of Interest		**44,089.4**	**100.0%**

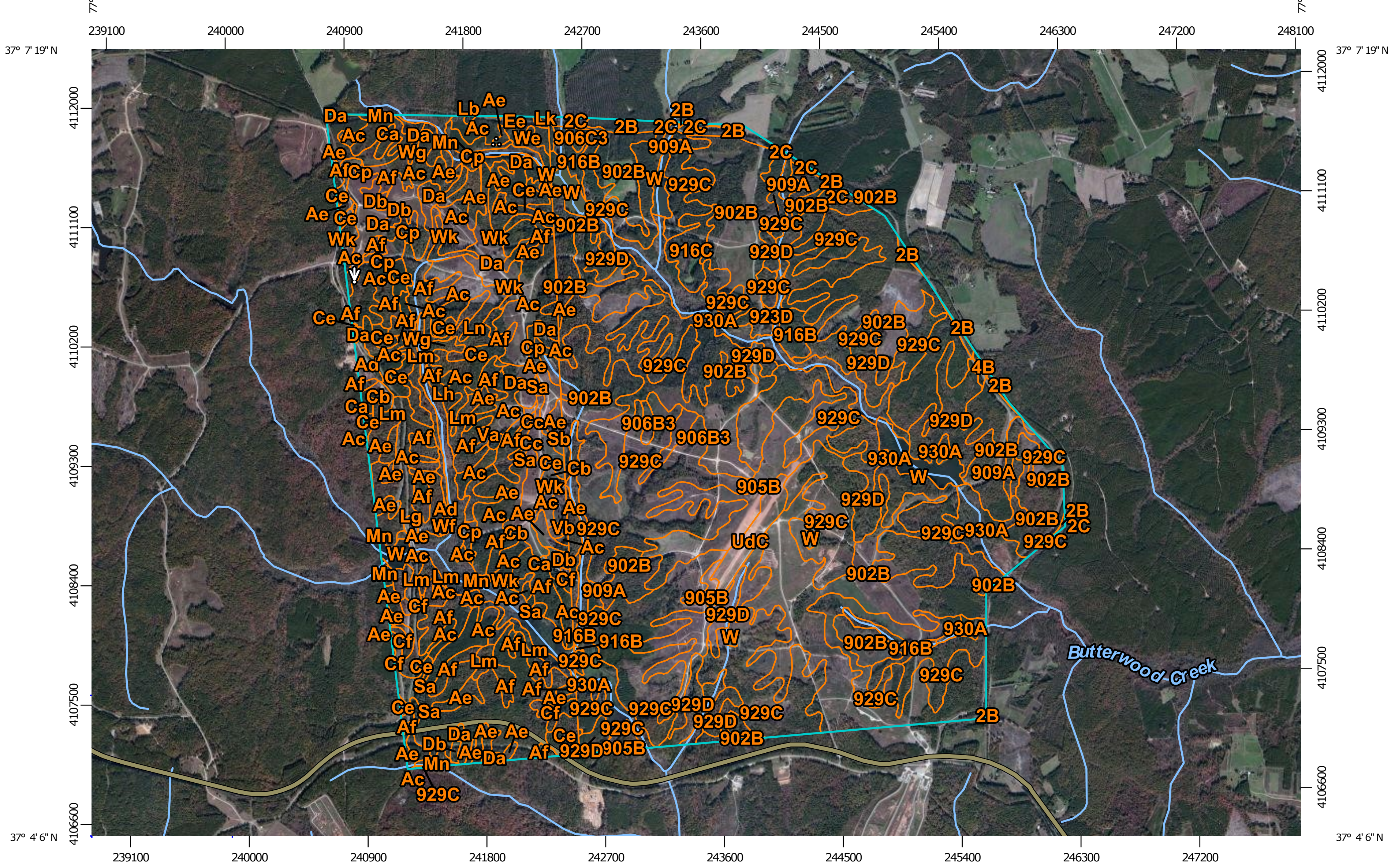
Nottoway County, Virginia (VA135)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
902B	Appling-Mattaponi complex, 2 to 8 percent slopes	1,225.0	2.8%
903E	Ashlar-Rock outcrop complex, 25 to 45 percent slopes	147.6	0.3%
905B	Cecil sandy loam, 2 to 8 percent slopes	208.1	0.5%
906B3	Cecil sandy clay loam, 2 to 8 percent slopes, severely eroded	326.2	0.7%
906C3	Cecil sandy clay loam, 8 to 15 percent slopes, severely eroded	701.1	1.6%
908A	Chewacla silt loam, 0 to 2 percent slopes, occasionally flooded	106.5	0.2%
909A	Chewacla and Wehadkee soils, 0 to 2 percent slopes, frequently flooded	129.2	0.3%
916B	Helena sandy loam, 2 to 8 percent slopes	284.0	0.6%

Nottoway County, Virginia (VA135)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
916C	Helena sandy loam, 8 to 15 percent slopes	14.2	0.0%
922D	Pacolet sandy loam, 15 to 25 percent slopes	82.8	0.2%
923B	Rion sandy loam, 2 to 8 percent slopes	9.5	0.0%
923D	Rion sandy loam, 15 to 25 percent slopes	319.5	0.7%
924C	Rion-Ashlar sandy loam, 8 to 15 percent slopes	179.2	0.4%
925A	Riverview loam, 0 to 2 percent slopes, occasionally flooded	92.2	0.2%
926B	Santuc sandy loam, 2 to 8 percent slopes	16.1	0.0%
929C	Wedowee gravelly sandy loam, 8 to 15 percent slopes	2,039.1	4.6%
929D	Wedowee gravelly sandy loam, 15 to 25 percent slopes	314.6	0.7%
930A	Wehadkee silt loam, 0 to 2 percent slopes, frequently flooded	261.9	0.6%
931B	Worsham silt loam, 2 to 8 percent slopes	6.1	0.0%
Ab	Appling angular cobbly sandy loam, rolling phase	4.2	0.0%
Ac	Appling coarse sandy loam, undulating phase	5,010.8	11.4%
Ad	Appling coarse sandy loam, eroded undulating phase	290.4	0.7%
Ae	Appling coarse sandy loam, rolling phase	2,792.4	6.3%
Af	Appling coarse sandy loam, eroded rolling phase	2,081.2	4.7%
Ag	Appling fine sandy loam, 2 to 7 percent slopes	56.4	0.1%
Ah	Appling fine sandy loam, eroded undulating phase	9.4	0.0%
Ak	Appling fine sandy loam, rolling phase	7.3	0.0%
An	Appling and Herndon very fine sandy loams, rolling phases	1.8	0.0%
Ao	Augusta loam	4.1	0.0%
Ca	Cecil clay loam, eroded undulating phase	32.6	0.1%
Cb	Cecil clay loam, eroded rolling phase	91.2	0.2%

Nottoway County, Virginia (VA135)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Cc	Cecil clay loam, severely eroded rolling phase	16.2	0.0%
Ce	Cecil coarse sandy loam, undulating phase	1,607.5	3.6%
Cf	Cecil coarse sandy loam, rolling phase	282.0	0.6%
Cg	Cecil coarse sandy loam, hilly phase	22.2	0.1%
Ch	Cecil fine sandy loam, undulating phase	4.0	0.0%
Cp	Colfax sandy loam, undulating phase	276.4	0.6%
Da	Durham coarse sandy loam, undulating phase	921.5	2.1%
Db	Durham coarse sandy loam, rolling phase	117.6	0.3%
Dc	Durham fine sandy loam, undulating phase	1.8	0.0%
Ee	Enon-Vance-Helena soils, undulating phases	12.9	0.0%
Eg	Enon-Vance-Helena soils, rolling phases	6.7	0.0%
Ga	Gullied land	0.8	0.0%
Ha	Helena fine sandy loam, undulating phase	6.3	0.0%
Lb	Lloyd clay loam, eroded rolling phase	1.5	0.0%
Lg	Louisburg sandy loam, undulating phase	16.9	0.0%
Lh	Louisburg sandy loam, rolling phase	187.8	0.4%
Lk	Louisburg sandy loam, eroded rolling phase	42.3	0.1%
Lm	Louisburg sandy loam, hilly phase	859.1	1.9%
Ln	Louisburg sandy loam, eroded hilly phase	193.0	0.4%
Ma	Madison clay loam, eroded undualting phase	0.0	0.0%
MDL	Made land	993.7	2.3%
Mf	Madison sandy loam, undulating phase	3.8	0.0%
Mh	Madison sandy loam, rolling phase	2.8	0.0%
Mn	Mixed alluvial land	1,334.6	3.0%
Sa	Seneca sandy loam	129.2	0.3%

Nottoway County, Virginia (VA135)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Sb	Starr loam	4.2	0.0%
Sc	Stony land	8.4	0.0%
UdC	Udorthents, loamy, 2 to 8 percent slopes	94.4	0.2%
Va	Vance fine sandy loam, undulating phase	7.1	0.0%
Vb	Vance fine sandy loam, rolling phase	1.9	0.0%
W	Water	188.4	0.4%
We	Wilkes sandy loam, rolling phase	47.2	0.1%
Wf	Wilkes sandy loam, eroded rolling phase	35.6	0.1%
Wg	Wilkes sandy loam, hilly phase	58.2	0.1%
Wh	Wilkes sandy loam, eroded hilly phase	190.0	0.4%
Wk	Worsham sandy loam	499.9	1.1%
Wl	Worsham silt loam	9.4	0.0%
Subtotals for Soil Survey Area		**25,030.2**	**56.8%**
Totals for Area of Interest		**44,089.4**	**100.0%**

Soil Map—Dinwiddie County Area, Virginia, and Nottoway County, Virginia
(Fort Pickett NE)



Map Scale: 1:41,900 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 500, 1000, 2000, 3000

Feet: 0, 2000, 4000, 8000, 12000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:20,000 to 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Dinwiddie County Area, Virginia
Survey Area Data: Version 3, Sep 26, 2016

Soil Survey Area: Nottoway County, Virginia
Survey Area Data: Version 11, Sep 26, 2016

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 4, 2010—Nov 8, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

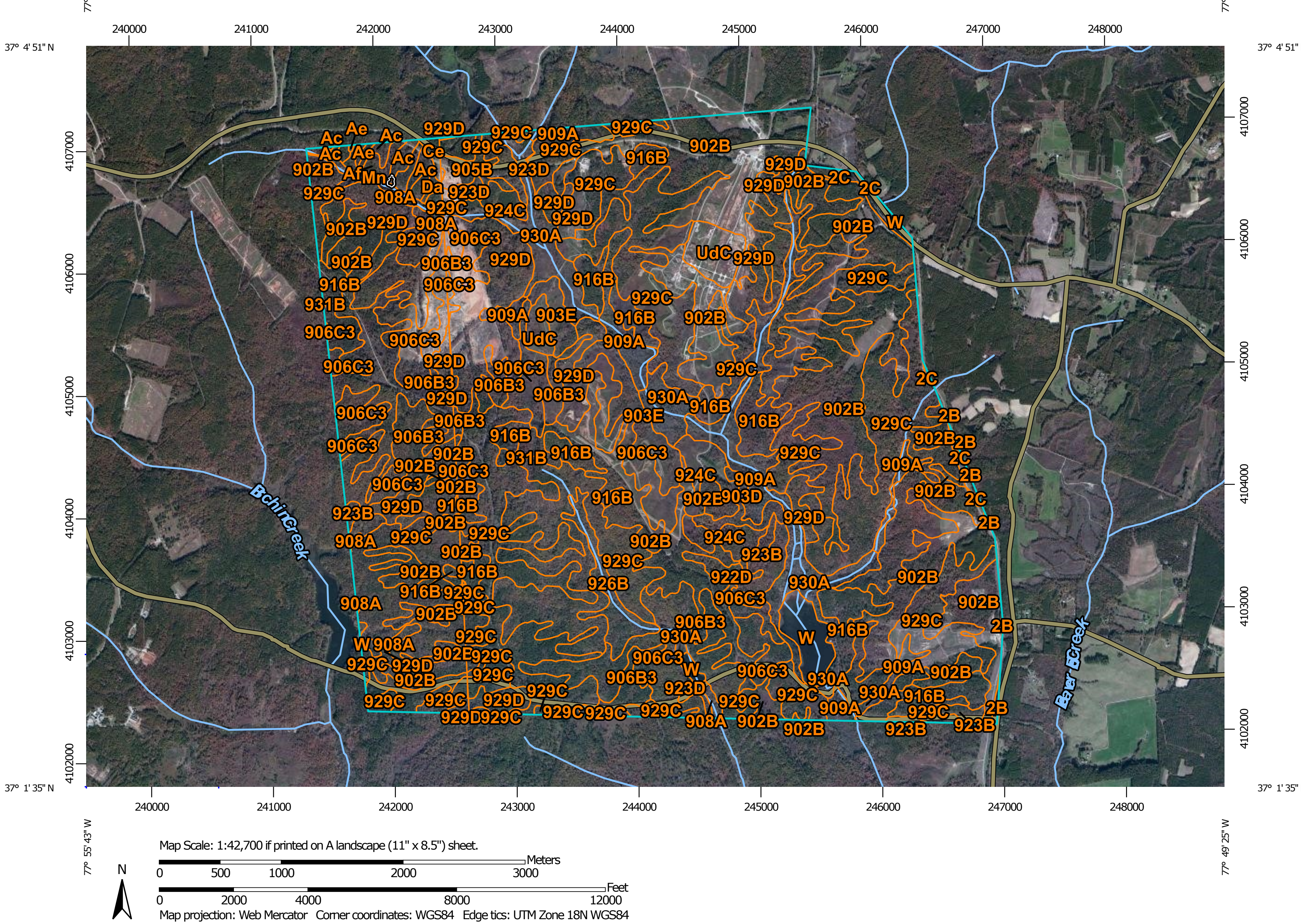
Map Unit Legend

Dinwiddie County Area, Virginia (VA653)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
2B	Appling sandy loam, 2 to 7 percent slopes	34.0	0.6%
2C	Appling sandy loam, 7 to 15 percent slopes	9.6	0.2%
4B	Cecil sandy loam, 2 to 7 percent slopes	0.8	0.0%
4C	Cecil sandy loam, 7 to 15 percent slopes	3.8	0.1%
902B	Appling-Mattaponi complex, 2 to 8 percent slopes	1,181.4	22.3%
905B	Cecil sandy loam, 2 to 8 percent slopes	132.9	2.5%
906B3	Cecil sandy clay loam, 2 to 8 percent slopes, severely eroded	18.3	0.3%
906C3	Cecil sandy clay loam, 8 to 15 percent slopes, severely eroded	23.2	0.4%
909A	Chewacla and Wehadkee soils, 0 to 2 percent slopes, frequently flooded	74.0	1.4%
916B	Helena sandy loam, 2 to 8 percent slopes	38.7	0.7%
916C	Helena sandy loam, 8 to 15 percent slopes	31.4	0.6%
923D	Rion sandy loam, 15 to 25 percent slopes	13.0	0.2%
924C	Rion-Ashlar sandy loam, 8 to 15 percent slopes	0.0	0.0%
929C	Wedowee gravelly sandy loam, 8 to 15 percent slopes	1,424.3	26.9%
929D	Wedowee gravelly sandy loam, 15 to 25 percent slopes	204.6	3.9%
930A	Wehadkee silt loam, 0 to 2 percent slopes, frequently flooded	204.3	3.9%
UdC	Udorthents, loamy, 2 to 8 percent slopes	34.8	0.7%
W	Water	64.7	1.2%
Subtotals for Soil Survey Area		**3,493.8**	**65.9%**
Totals for Area of Interest		**5,298.1**	**100.0%**

Nottoway County, Virginia (VA135)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
908A	Chewacla silt loam, 0 to 2 percent slopes, occasionally flooded	0.0	0.0%
929C	Wedowee gravelly sandy loam, 8 to 15 percent slopes	0.5	0.0%
Ac	Appling coarse sandy loam, undulating phase	676.3	12.8%
Ad	Appling coarse sandy loam, eroded undulating phase	10.6	0.2%
Ae	Appling coarse sandy loam, rolling phase	156.6	3.0%
Af	Appling coarse sandy loam, eroded rolling phase	290.8	5.5%
Ca	Cecil clay loam, eroded undulating phase	8.8	0.2%
Cb	Cecil clay loam, eroded rolling phase	15.8	0.3%
Cc	Cecil clay loam, severely eroded rolling phase	6.2	0.1%
Ce	Cecil coarse sandy loam, undulating phase	126.0	2.4%
Cf	Cecil coarse sandy loam, rolling phase	15.3	0.3%
Cp	Colfax sandy loam, undulating phase	31.1	0.6%
Da	Durham coarse sandy loam, undulating phase	118.6	2.2%
Db	Durham coarse sandy loam, rolling phase	12.8	0.2%
Ee	Enon-Vance-Helena soils, undulating phases	10.9	0.2%
Lb	Lloyd clay loam, eroded rolling phase	0.9	0.0%
Lg	Louisburg sandy loam, undulating phase	2.9	0.1%
Lh	Louisburg sandy loam, rolling phase	26.0	0.5%
Lk	Louisburg sandy loam, eroded rolling phase	0.1	0.0%
Lm	Louisburg sandy loam, hilly phase	69.9	1.3%
Ln	Louisburg sandy loam, eroded hilly phase	9.6	0.2%
Mn	Mixed alluvial land	131.4	2.5%
Sa	Seneca sandy loam	8.9	0.2%
Sb	Starr loam	1.2	0.0%
Sc	Stony land	2.2	0.0%

Nottoway County, Virginia (VA135)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Va	Vance fine sandy loam, undulating phase	4.0	0.1%
Vb	Vance fine sandy loam, rolling phase	1.9	0.0%
W	Water	11.2	0.2%
We	Wilkes sandy loam, rolling phase	8.9	0.2%
Wf	Wilkes sandy loam, eroded rolling phase	2.3	0.0%
Wg	Wilkes sandy loam, hilly phase	15.6	0.3%
Wk	Worsham sandy loam	27.0	0.5%
Subtotals for Soil Survey Area		**1,804.3**	**34.1%**
Totals for Area of Interest		**5,298.1**	**100.0%**

Soil Map—Dinwiddie County Area, Virginia, and Nottoway County, Virginia
(Fort Pickett E)



MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:20,000 to 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Dinwiddie County Area, Virginia
Survey Area Data: Version 3, Sep 26, 2016

Soil Survey Area: Nottoway County, Virginia
Survey Area Data: Version 11, Sep 26, 2016

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 4, 2010—Nov 8, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

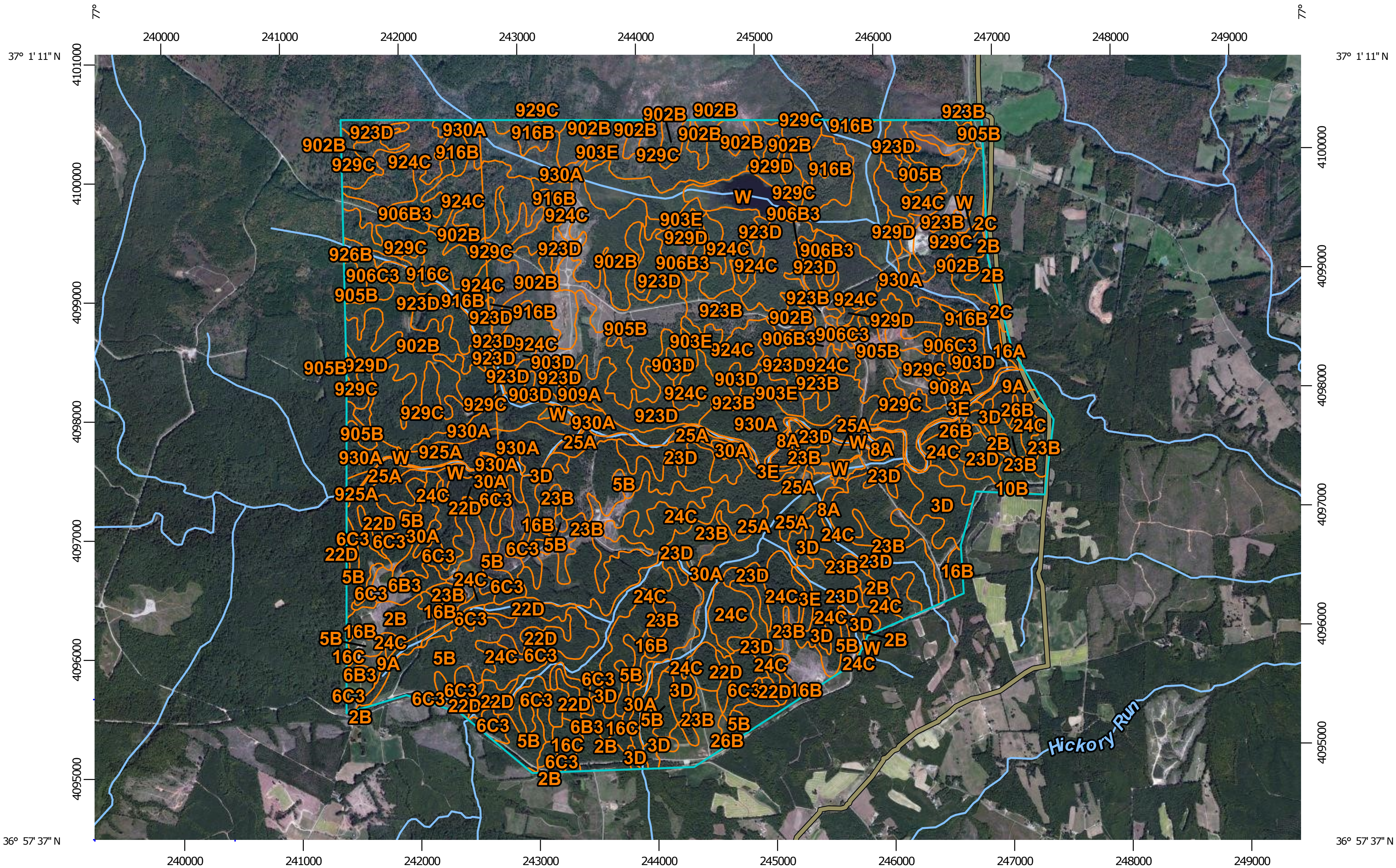
Map Unit Legend

Dinwiddie County Area, Virginia (VA653)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
2B	Appling sandy loam, 2 to 7 percent slopes	26.9	0.5%
2C	Appling sandy loam, 7 to 15 percent slopes	7.3	0.1%
902B	Appling-Mattaponi complex, 2 to 8 percent slopes	1,328.3	22.3%
903D	Ashlar-Rock outcrop complex, 15 to 25 percent slopes	26.0	0.4%
903E	Ashlar-Rock outcrop complex, 25 to 45 percent slopes	94.1	1.6%
905B	Cecil sandy loam, 2 to 8 percent slopes	27.0	0.5%
906B3	Cecil sandy clay loam, 2 to 8 percent slopes, severely eroded	184.8	3.1%
906C3	Cecil sandy clay loam, 8 to 15 percent slopes, severely eroded	344.4	5.8%
908A	Chewacla silt loam, 0 to 2 percent slopes, occasionally flooded	6.4	0.1%
909A	Chewacla and Wehadkee soils, 0 to 2 percent slopes, frequently flooded	204.7	3.4%
916B	Helena sandy loam, 2 to 8 percent slopes	247.0	4.2%
922D	Pacolet sandy loam, 15 to 25 percent slopes	59.1	1.0%
923B	Rion sandy loam, 2 to 8 percent slopes	23.6	0.4%
923D	Rion sandy loam, 15 to 25 percent slopes	34.8	0.6%
924C	Rion-Ashlar sandy loam, 8 to 15 percent slopes	90.6	1.5%
926B	Santuc sandy loam, 2 to 8 percent slopes	52.3	0.9%
929C	Wedowee gravelly sandy loam, 8 to 15 percent slopes	1,416.2	23.8%
929D	Wedowee gravelly sandy loam, 15 to 25 percent slopes	319.1	5.4%
930A	Wehadkee silt loam, 0 to 2 percent slopes, frequently flooded	216.4	3.6%
931B	Worsham silt loam, 2 to 8 percent slopes	2.9	0.0%

Dinwiddie County Area, Virginia (VA653)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
UdC	Udorthents, loamy, 2 to 8 percent slopes	65.7	1.1%
W	Water	58.3	1.0%
Subtotals for Soil Survey Area		**4,835.9**	**81.3%**
Totals for Area of Interest		**5,945.2**	**100.0%**

Nottoway County, Virginia (VA135)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
902B	Appling-Mattaponi complex, 2 to 8 percent slopes	116.4	2.0%
906B3	Cecil sandy clay loam, 2 to 8 percent slopes, severely eroded	165.1	2.8%
906C3	Cecil sandy clay loam, 8 to 15 percent slopes, severely eroded	204.7	3.4%
908A	Chewacla silt loam, 0 to 2 percent slopes, occasionally flooded	11.3	0.2%
916B	Helena sandy loam, 2 to 8 percent slopes	37.7	0.6%
923B	Rion sandy loam, 2 to 8 percent slopes	4.4	0.1%
929C	Wedowee gravelly sandy loam, 8 to 15 percent slopes	289.3	4.9%
929D	Wedowee gravelly sandy loam, 15 to 25 percent slopes	183.2	3.1%
931B	Worsham silt loam, 2 to 8 percent slopes	0.2	0.0%
Ac	Appling coarse sandy loam, undulating phase	31.6	0.5%
Ae	Appling coarse sandy loam, rolling phase	7.5	0.1%
Af	Appling coarse sandy loam, eroded rolling phase	18.9	0.3%
Ce	Cecil coarse sandy loam, undulating phase	7.2	0.1%
Da	Durham coarse sandy loam, undulating phase	9.9	0.2%
Db	Durham coarse sandy loam, rolling phase	0.0	0.0%
Mn	Mixed alluvial land	21.7	0.4%
W	Water	0.2	0.0%
Subtotals for Soil Survey Area		**1,109.3**	**18.7%**
Totals for Area of Interest		**5,945.2**	**100.0%**

Soil Map—Brunswick County, Virginia, Dinwiddie County Area, Virginia, and Nottoway County, Virginia
(Fort Pickett SE)



Map Scale: 1:46,500 if printed on A landscape (11" x 8.5") sheet.

N

0 500 1000 2000 3000 Meters

0 2000 4000 8000 12000 Feet

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:20,000 to 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Brunswick County, Virginia
Survey Area Data: Version 7, Sep 26, 2016

Soil Survey Area: Dinwiddie County Area, Virginia
Survey Area Data: Version 3, Sep 26, 2016

Soil Survey Area: Nottoway County, Virginia
Survey Area Data: Version 11, Sep 26, 2016

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 4, 2010—Nov 8, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Brunswick County, Virginia (VA025)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
1C	Appling sandy loam, 8 to 15 percent slopes	10.3	0.2%
2B	Appling-Mattaponi complex, 2 to 8 percent slopes	161.2	2.4%
3D	Ashlar-Rock outcrop complex, 15 to 25 percent slopes	152.5	2.3%
3E	Ashlar-Rock outcrop complex, 25 to 45 percent slopes	21.8	0.3%
5B	Cecil sandy loam, 2 to 8 percent slopes	319.7	4.7%
6B3	Cecil sandy clay loam, 2 to 8 percent slopes, severely eroded	60.2	0.9%
6C3	Cecil sandy clay loam, 8 to 15 percent slopes, severely eroded	296.4	4.4%
8A	Chewacla silt loam, 0 to 2 percent slopes, occasionally flooded	26.1	0.4%
9A	Chewacla and Wehadkee soils, 0 to 2 percent slopes, frequently flooded	32.7	0.5%
10B	Emporia sandy loam, 2 to 8 percent slopes	2.2	0.0%
16B	Helena sandy loam, 2 to 8 percent slopes	53.9	0.8%
16C	Helena sandy loam, 8 to 15 percent slopes	25.6	0.4%
22D	Pacolet sandy loam, 15 to 25 percent slopes	195.3	2.9%
23B	Rion sandy loam, 2 to 8 percent slopes	363.6	5.4%
23D	Rion sandy loam, 15 to 25 percent slopes	120.8	1.8%
24C	Rion-Ashlar sandy loam, 8 to 15 percent slopes	824.0	12.2%
25A	Riverview loam, 0 to 2 percent slopes, occasionally flooded	76.1	1.1%
26B	Santuc sandy loam, 2 to 8 percent slopes	11.0	0.2%
30A	Wehadkee silt loam, 0 to 2 percent slopes, frequently flooded	268.9	4.0%
W	Water	11.1	0.2%

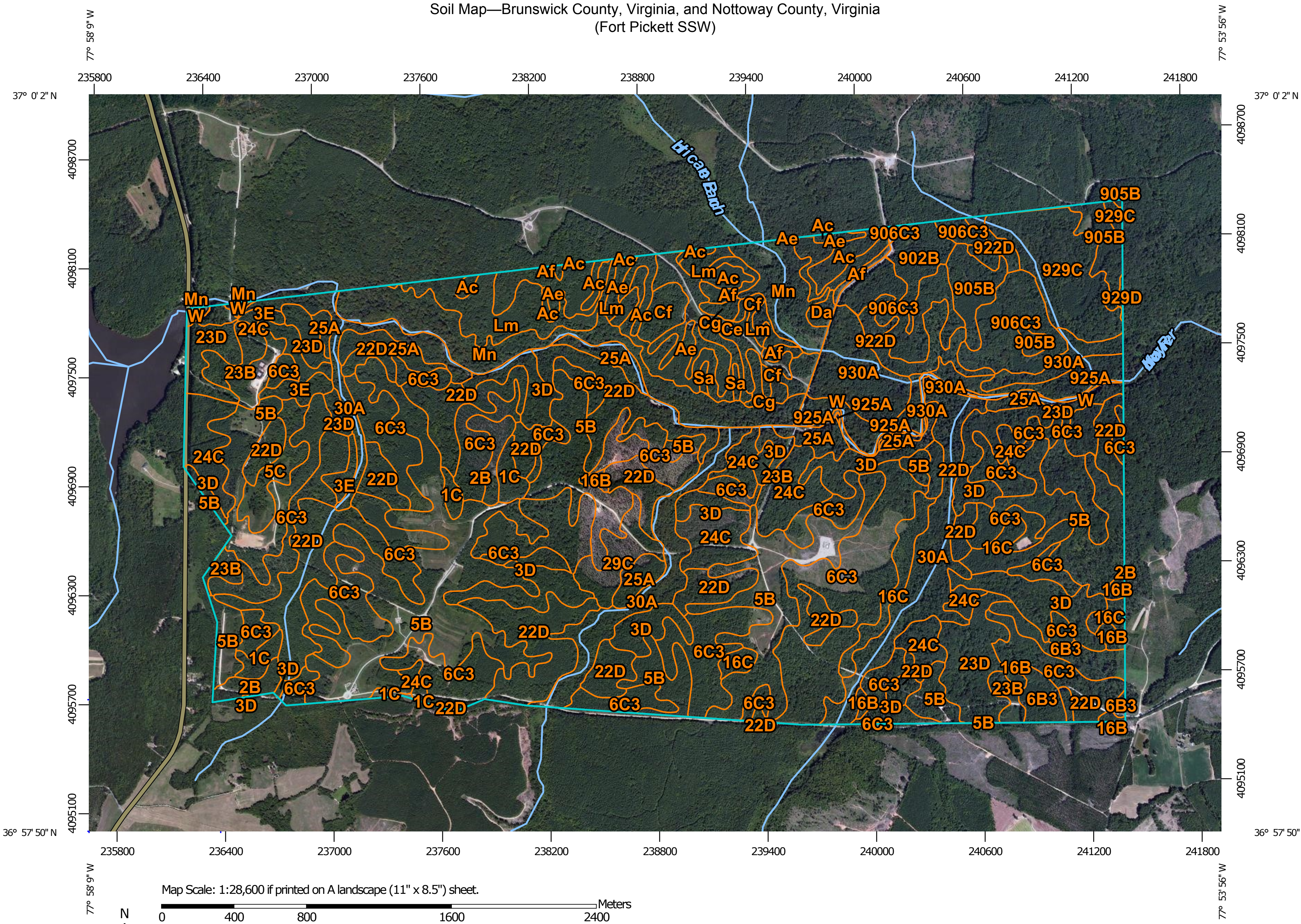
Brunswick County, Virginia (VA025)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Subtotals for Soil Survey Area		**3,033.2**	**44.9%**
Totals for Area of Interest		**6,754.5**	**100.0%**

Dinwiddie County Area, Virginia (VA653)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
2B	Appling sandy loam, 2 to 7 percent slopes	0.5	0.0%
2C	Appling sandy loam, 7 to 15 percent slopes	5.7	0.1%
16A	Roanoke loam, 0 to 2 percent slopes, occasionally flooded	6.3	0.1%
902B	Appling-Mattaponi complex, 2 to 8 percent slopes	218.8	3.2%
903D	Ashlar-Rock outcrop complex, 15 to 25 percent slopes	27.2	0.4%
903E	Ashlar-Rock outcrop complex, 25 to 45 percent slopes	46.2	0.7%
905B	Cecil sandy loam, 2 to 8 percent slopes	199.5	3.0%
906B3	Cecil sandy clay loam, 2 to 8 percent slopes, severely eroded	50.3	0.7%
906C3	Cecil sandy clay loam, 8 to 15 percent slopes, severely eroded	32.5	0.5%
908A	Chewacla silt loam, 0 to 2 percent slopes, occasionally flooded	3.6	0.1%
909A	Chewacla and Wehadkee soils, 0 to 2 percent slopes, frequently flooded	10.7	0.2%
916B	Helena sandy loam, 2 to 8 percent slopes	96.8	1.4%
923B	Rion sandy loam, 2 to 8 percent slopes	139.0	2.1%
923D	Rion sandy loam, 15 to 25 percent slopes	229.4	3.4%
924C	Rion-Ashlar sandy loam, 8 to 15 percent slopes	800.4	11.9%
925A	Riverview loam, 0 to 2 percent slopes, occasionally flooded	50.2	0.7%
929C	Wedowee gravelly sandy loam, 8 to 15 percent slopes	313.5	4.6%
929D	Wedowee gravelly sandy loam, 15 to 25 percent slopes	58.2	0.9%
930A	Wehadkee silt loam, 0 to 2 percent slopes, frequently flooded	455.2	6.7%

Dinwiddie County Area, Virginia (VA653)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
W	Water	90.0	1.3%
Subtotals for Soil Survey Area		**2,833.9**	**42.0%**
Totals for Area of Interest		**6,754.5**	**100.0%**

Nottoway County, Virginia (VA135)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
902B	Appling-Mattaponi complex, 2 to 8 percent slopes	149.4	2.2%
905B	Cecil sandy loam, 2 to 8 percent slopes	22.7	0.3%
906B3	Cecil sandy clay loam, 2 to 8 percent slopes, severely eroded	50.0	0.7%
906C3	Cecil sandy clay loam, 8 to 15 percent slopes, severely eroded	18.3	0.3%
916B	Helena sandy loam, 2 to 8 percent slopes	47.9	0.7%
916C	Helena sandy loam, 8 to 15 percent slopes	14.2	0.2%
923D	Rion sandy loam, 15 to 25 percent slopes	18.6	0.3%
924C	Rion-Ashlar sandy loam, 8 to 15 percent slopes	144.0	2.1%
925A	Riverview loam, 0 to 2 percent slopes, occasionally flooded	41.8	0.6%
926B	Santuc sandy loam, 2 to 8 percent slopes	10.2	0.2%
929C	Wedowee gravelly sandy loam, 8 to 15 percent slopes	284.8	4.2%
929D	Wedowee gravelly sandy loam, 15 to 25 percent slopes	33.7	0.5%
930A	Wehadkee silt loam, 0 to 2 percent slopes, frequently flooded	46.5	0.7%
W	Water	5.2	0.1%
Subtotals for Soil Survey Area		**887.4**	**13.1%**
Totals for Area of Interest		**6,754.5**	**100.0%**

Soil Map—Brunswick County, Virginia, and Nottoway County, Virginia
(Fort Pickett SSW)



Map Scale: 1:28,600 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 400, 800, 1600, 2400

Feet: 0, 1000, 2000, 4000, 6000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:20,000 to 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Brunswick County, Virginia
Survey Area Data: Version 7, Sep 26, 2016

Soil Survey Area: Nottoway County, Virginia
Survey Area Data: Version 11, Sep 26, 2016

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 4, 2010—Sep 10, 2010

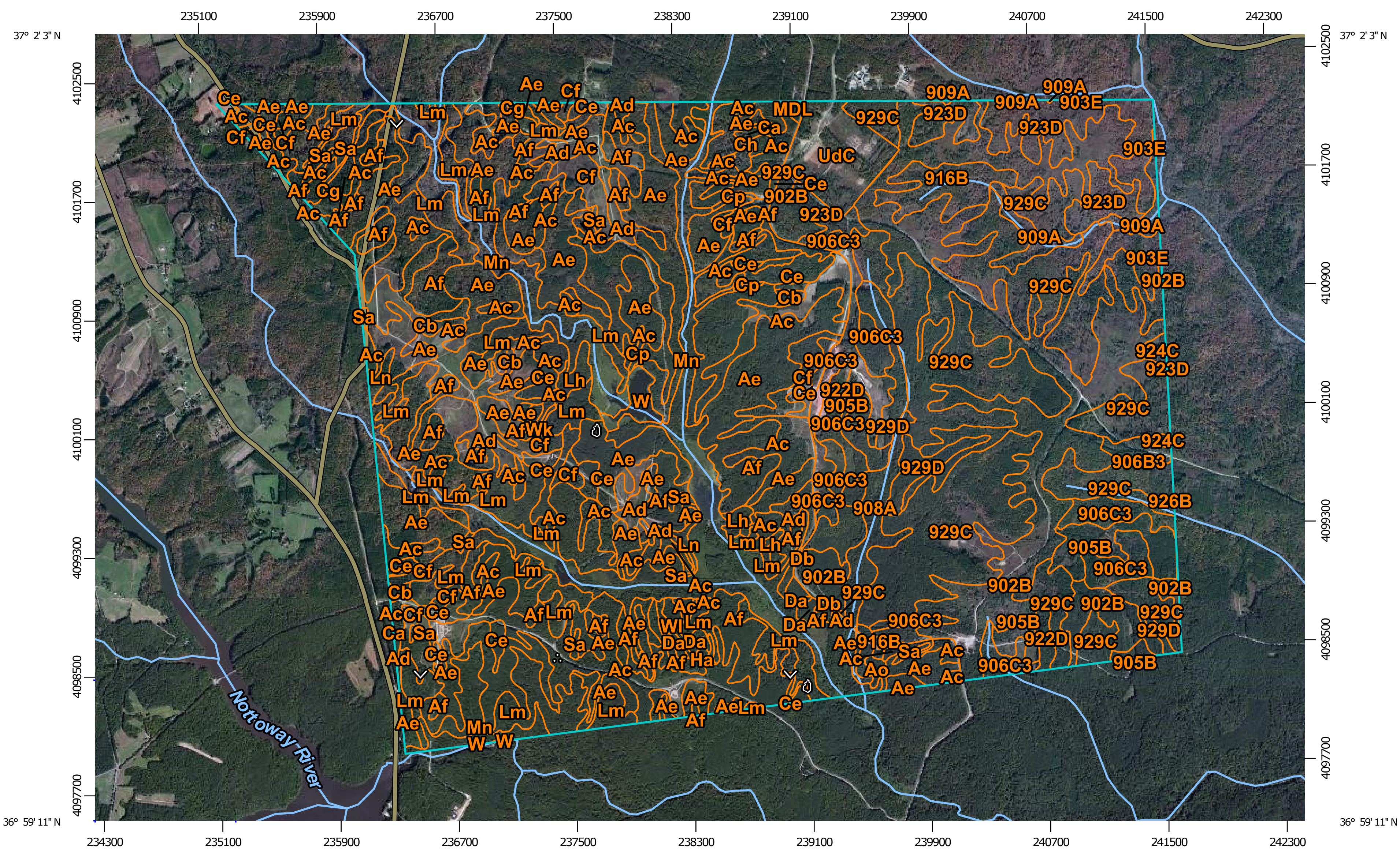
The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Brunswick County, Virginia (VA025)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
1C	Appling sandy loam, 8 to 15 percent slopes	24.6	0.8%
2B	Appling-Mattaponi complex, 2 to 8 percent slopes	22.9	0.7%
3D	Ashlar-Rock outcrop complex, 15 to 25 percent slopes	137.8	4.3%
3E	Ashlar-Rock outcrop complex, 25 to 45 percent slopes	20.1	0.6%
5B	Cecil sandy loam, 2 to 8 percent slopes	515.8	16.1%
5C	Cecil sandy loam, 8 to 15 percent slopes	24.9	0.8%
6B3	Cecil sandy clay loam, 2 to 8 percent slopes, severely eroded	36.7	1.1%
6C3	Cecil sandy clay loam, 8 to 15 percent slopes, severely eroded	604.5	18.9%
16B	Helena sandy loam, 2 to 8 percent slopes	15.2	0.5%
16C	Helena sandy loam, 8 to 15 percent slopes	55.2	1.7%
22D	Pacolet sandy loam, 15 to 25 percent slopes	322.9	10.1%
23B	Rion sandy loam, 2 to 8 percent slopes	33.4	1.0%
23D	Rion sandy loam, 15 to 25 percent slopes	127.5	4.0%
24C	Rion-Ashlar sandy loam, 8 to 15 percent slopes	145.8	4.6%
25A	Riverview loam, 0 to 2 percent slopes, occasionally flooded	67.0	2.1%
29C	Wedowee gravelly sandy loam, 8 to 15 percent slopes	27.0	0.8%
30A	Wehadkee silt loam, 0 to 2 percent slopes, frequently flooded	179.8	5.6%
W	Water	3.1	0.1%
Subtotals for Soil Survey Area		**2,364.4**	**73.8%**
Totals for Area of Interest		**3,202.0**	**100.0%**

Nottoway County, Virginia (VA135)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
902B	Appling-Mattaponi complex, 2 to 8 percent slopes	25.0	0.8%
905B	Cecil sandy loam, 2 to 8 percent slopes	48.0	1.5%
906C3	Cecil sandy clay loam, 8 to 15 percent slopes, severely eroded	99.5	3.1%
922D	Pacolet sandy loam, 15 to 25 percent slopes	37.9	1.2%
925A	Riverview loam, 0 to 2 percent slopes, occasionally flooded	50.1	1.6%
929C	Wedowee gravelly sandy loam, 8 to 15 percent slopes	75.9	2.4%
929D	Wedowee gravelly sandy loam, 15 to 25 percent slopes	1.1	0.0%
930A	Wehadkee silt loam, 0 to 2 percent slopes, frequently flooded	69.0	2.2%
Ac	Appling coarse sandy loam, undulating phase	37.1	1.2%
Ae	Appling coarse sandy loam, rolling phase	82.4	2.6%
Af	Appling coarse sandy loam, eroded rolling phase	15.0	0.5%
Ce	Cecil coarse sandy loam, undulating phase	38.3	1.2%
Cf	Cecil coarse sandy loam, rolling phase	30.3	0.9%
Cg	Cecil coarse sandy loam, hilly phase	12.1	0.4%
Da	Durham coarse sandy loam, undulating phase	4.8	0.1%
Lm	Louisburg sandy loam, hilly phase	61.9	1.9%
Mn	Mixed alluvial land	135.0	4.2%
Sa	Seneca sandy loam	3.5	0.1%
W	Water	10.8	0.3%
Subtotals for Soil Survey Area		**837.7**	**26.2%**
Totals for Area of Interest		**3,202.0**	**100.0%**

Soil Map—Brunswick County, Virginia, and Nottoway County, Virginia
(Fort Pickett SW)



Map Scale: 1:37,400 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 500, 1000, 2000, 3000

Feet: 0, 1500, 3000, 6000, 9000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:20,000 to 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Brunswick County, Virginia
Survey Area Data: Version 7, Sep 26, 2016

Soil Survey Area: Nottoway County, Virginia
Survey Area Data: Version 11, Sep 26, 2016

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 4, 2010—Nov 8, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

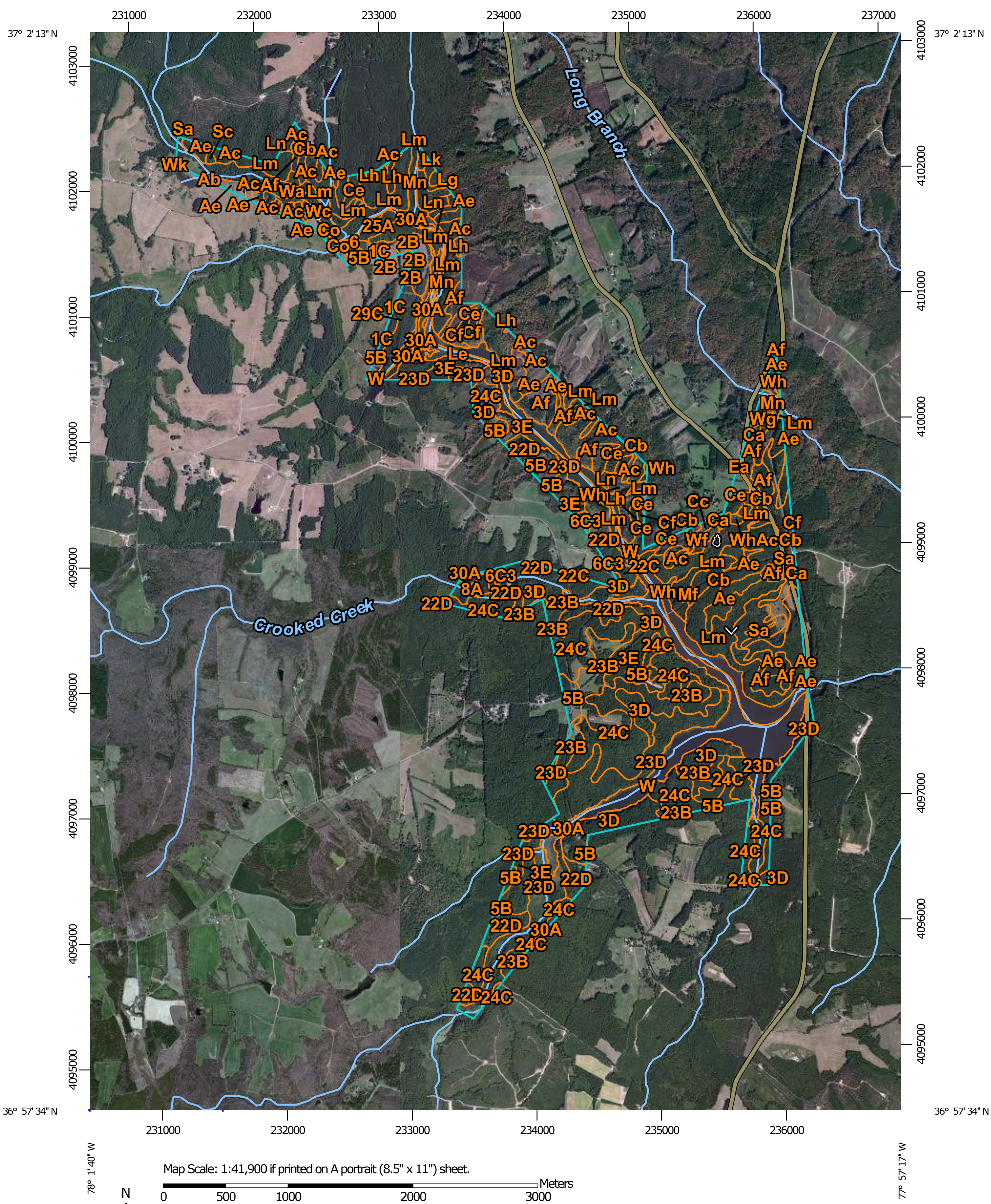
Brunswick County, Virginia (VA025)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
30A	Wehadkee silt loam, 0 to 2 percent slopes, frequently flooded	0.5	0.0%
W	Water	0.1	0.0%
Subtotals for Soil Survey Area		**0.6**	**0.0%**
Totals for Area of Interest		**5,535.5**	**100.0%**

Nottoway County, Virginia (VA135)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
902B	Appling-Mattaponi complex, 2 to 8 percent slopes	602.8	10.9%
903E	Ashlar-Rock outcrop complex, 25 to 45 percent slopes	60.8	1.1%
905B	Cecil sandy loam, 2 to 8 percent slopes	139.4	2.5%
906B3	Cecil sandy clay loam, 2 to 8 percent slopes, severely eroded	16.7	0.3%
906C3	Cecil sandy clay loam, 8 to 15 percent slopes, severely eroded	159.1	2.9%
908A	Chewacla silt loam, 0 to 2 percent slopes, occasionally flooded	49.1	0.9%
909A	Chewacla and Wehadkee soils, 0 to 2 percent slopes, frequently flooded	37.7	0.7%
916B	Helena sandy loam, 2 to 8 percent slopes	58.0	1.0%
922D	Pacolet sandy loam, 15 to 25 percent slopes	42.4	0.8%
923D	Rion sandy loam, 15 to 25 percent slopes	136.2	2.5%
924C	Rion-Ashlar sandy loam, 8 to 15 percent slopes	7.9	0.1%
926B	Santuc sandy loam, 2 to 8 percent slopes	8.7	0.2%
929C	Wedowee gravelly sandy loam, 8 to 15 percent slopes	757.1	13.7%
929D	Wedowee gravelly sandy loam, 15 to 25 percent slopes	62.3	1.1%
Ac	Appling coarse sandy loam, undulating phase	624.6	11.3%

Nottoway County, Virginia (VA135)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Ad	Appling coarse sandy loam, eroded undulating phase	62.6	1.1%
Ae	Appling coarse sandy loam, rolling phase	1,192.3	21.5%
Af	Appling coarse sandy loam, eroded rolling phase	283.4	5.1%
Ao	Augusta loam	4.1	0.1%
Ca	Cecil clay loam, eroded undulating phase	2.9	0.1%
Cb	Cecil clay loam, eroded rolling phase	14.5	0.3%
Cc	Cecil clay loam, severely eroded rolling phase	3.0	0.1%
Ce	Cecil coarse sandy loam, undulating phase	91.3	1.6%
Cf	Cecil coarse sandy loam, rolling phase	96.8	1.7%
Cg	Cecil coarse sandy loam, hilly phase	5.1	0.1%
Ch	Cecil fine sandy loam, undulating phase	4.0	0.1%
Cp	Colfax sandy loam, undulating phase	7.4	0.1%
Da	Durham coarse sandy loam, undulating phase	15.6	0.3%
Db	Durham coarse sandy loam, rolling phase	13.4	0.2%
Ha	Helena fine sandy loam, undulating phase	1.8	0.0%
Lg	Louisburg sandy loam, undulating phase	1.1	0.0%
Lh	Louisburg sandy loam, rolling phase	20.6	0.4%
Lm	Louisburg sandy loam, hilly phase	354.9	6.4%
Ln	Louisburg sandy loam, eroded hilly phase	12.7	0.2%
MDL	Made land	4.4	0.1%
Mh	Madison sandy loam, rolling phase	1.3	0.0%
Mn	Mixed alluvial land	431.1	7.8%
Sa	Seneca sandy loam	24.2	0.4%
UdC	Udorthents, loamy, 2 to 8 percent slopes	89.2	1.6%
W	Water	17.8	0.3%
Wk	Worsham sandy loam	7.2	0.1%

Nottoway County, Virginia (VA135)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Wl	Worsham silt loam	9.4	0.2%
Subtotals for Soil Survey Area		**5,534.9**	**100.0%**
Totals for Area of Interest		**5,535.5**	**100.0%**

Soil Map—Brunswick County, Virginia, Lunenburg County, Virginia, and Nottoway County, Virginia
(Fort Pickett SW2)



Map Scale: 1:41,900 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0, 500, 1000, 2000, 3000

Feet: 0, 2000, 4000, 8000, 12000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at scales ranging from 1:20,000 to 1:24,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Brunswick County, Virginia
Survey Area Data: Version 7, Sep 26, 2016

Soil Survey Area: Lunenburg County, Virginia
Survey Area Data: Version 9, Sep 26, 2016

Soil Survey Area: Nottoway County, Virginia
Survey Area Data: Version 11, Sep 26, 2016

Your area of interest (AOI) includes more than one soil survey area. These survey areas may have been mapped at different scales, with a different land use in mind, at different times, or at different levels of detail. This may result in map unit symbols, soil properties, and interpretations that do not completely agree across soil survey area boundaries.

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: May 10, 2010—Apr 4, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Brunswick County, Virginia (VA025)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
1C	Appling sandy loam, 8 to 15 percent slopes	18.2	0.8%
2B	Appling-Mattaponi complex, 2 to 8 percent slopes	1.8	0.1%
3D	Ashlar-Rock outcrop complex, 15 to 25 percent slopes	145.5	6.6%
3E	Ashlar-Rock outcrop complex, 25 to 45 percent slopes	92.4	4.2%
5B	Cecil sandy loam, 2 to 8 percent slopes	34.8	1.6%
6C3	Cecil sandy clay loam, 8 to 15 percent slopes, severely eroded	5.4	0.2%
8A	Chewacla silt loam, 0 to 2 percent slopes, occasionally flooded	9.7	0.4%
22C	Pacolet sandy loam, 8 to 15 percent slopes	6.9	0.3%
22D	Pacolet sandy loam, 15 to 25 percent slopes	83.6	3.8%
23B	Rion sandy loam, 2 to 8 percent slopes	84.5	3.9%
23D	Rion sandy loam, 15 to 25 percent slopes	177.5	8.1%
24C	Rion-Ashlar sandy loam, 8 to 15 percent slopes	223.8	10.2%
25A	Riverview loam, 0 to 2 percent slopes, occasionally flooded	9.2	0.4%
29C	Wedowee gravelly sandy loam, 8 to 15 percent slopes	27.5	1.3%
29D	Wedowee gravelly sandy loam, 15 to 25 percent slopes	0.1	0.0%
30A	Wehadkee silt loam, 0 to 2 percent slopes, frequently flooded	115.9	5.3%
W	Water	184.2	8.4%
Subtotals for Soil Survey Area		**1,221.0**	**55.7%**
Totals for Area of Interest		**2,193.8**	**100.0%**

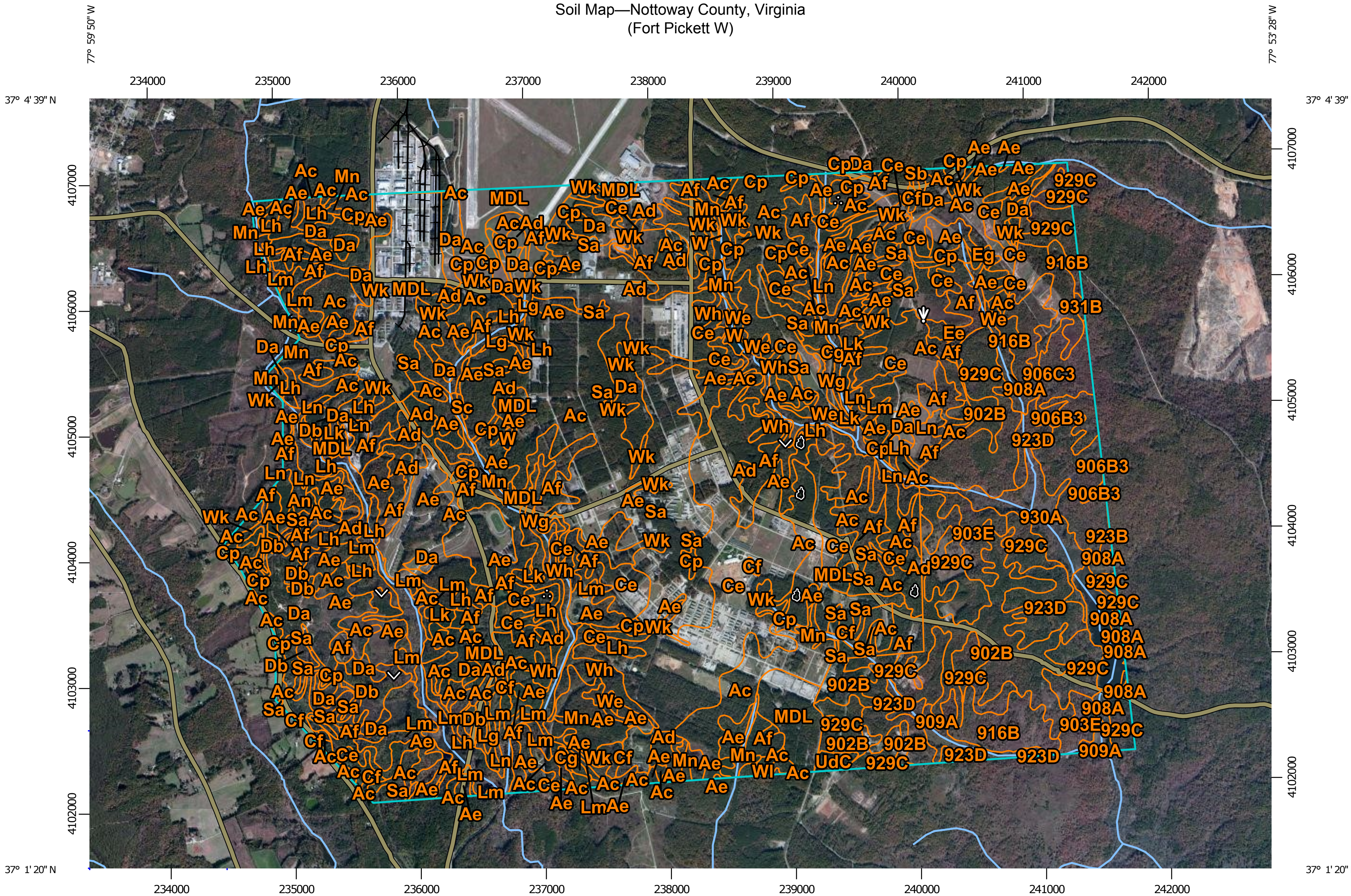
Lunenburg County, Virginia (VA111)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
2D	Ashlar loamy coarse sand, 15 to 25 percent slopes	2.8	0.1%

Lunenburg County, Virginia (VA111)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
6	Chewacla, Toccoa, and Augusta loams, frequently flooded	1.5	0.1%
14B2	Madison sandy loam, 2 to 7 percent slopes, eroded	2.6	0.1%
Subtotals for Soil Survey Area		**6.9**	**0.3%**
Totals for Area of Interest		**2,193.8**	**100.0%**

Nottoway County, Virginia (VA135)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Ab	Appling angular cobbly sandy loam, rolling phase	0.2	0.0%
Ac	Appling coarse sandy loam, undulating phase	97.0	4.4%
Ae	Appling coarse sandy loam, rolling phase	145.9	6.7%
Af	Appling coarse sandy loam, eroded rolling phase	105.4	4.8%
Ak	Appling fine sandy loam, rolling phase	5.4	0.2%
Ca	Cecil clay loam, eroded undulating phase	5.2	0.2%
Cb	Cecil clay loam, eroded rolling phase	15.5	0.7%
Cc	Cecil clay loam, severely eroded rolling phase	2.5	0.1%
Ce	Cecil coarse sandy loam, undulating phase	29.6	1.3%
Cf	Cecil coarse sandy loam, rolling phase	19.3	0.9%
Cg	Cecil coarse sandy loam, hilly phase	4.5	0.2%
Co	Chewacla silt loam	1.3	0.1%
Ea	Enon fine sandy loam, undulating phase	0.1	0.0%
Ga	Gullied land	0.8	0.0%
Le	Lloyd loam, rolling phase	1.6	0.1%
Lg	Louisburg sandy loam, undulating phase	2.5	0.1%
Lh	Louisburg sandy loam, rolling phase	12.4	0.6%
Lk	Louisburg sandy loam, eroded rolling phase	7.3	0.3%
Lm	Louisburg sandy loam, hilly phase	214.8	9.8%

Nottoway County, Virginia (VA135)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Ln	Louisburg sandy loam, eroded hilly phase	65.2	3.0%
Mf	Madison sandy loam, undulating phase	1.0	0.0%
Mn	Mixed alluvial land	19.3	0.9%
Sa	Seneca sandy loam	4.3	0.2%
Sc	Stony land	3.8	0.2%
W	Water	87.8	4.0%
Wa	Wehadkee silt loam	58.8	2.7%
Wc	Wickham fine sandy loam	9.1	0.4%
Wf	Wilkes sandy loam, eroded rolling phase	2.7	0.1%
Wg	Wilkes sandy loam, hilly phase	3.8	0.2%
Wh	Wilkes sandy loam, eroded hilly phase	39.0	1.8%
Wk	Worsham sandy loam	0.0	0.0%
Subtotals for Soil Survey Area		**965.9**	**44.0%**
Totals for Area of Interest		**2,193.8**	**100.0%**

Soil Map—Nottoway County, Virginia
(Fort Pickett W)



Map Scale: 1:43,200 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 500, 1000, 2000, 3000

Feet: 0, 2000, 4000, 8000, 12000

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Nottoway County, Virginia
Survey Area Data: Version 11, Sep 26, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 4, 2010—Nov 8, 2010

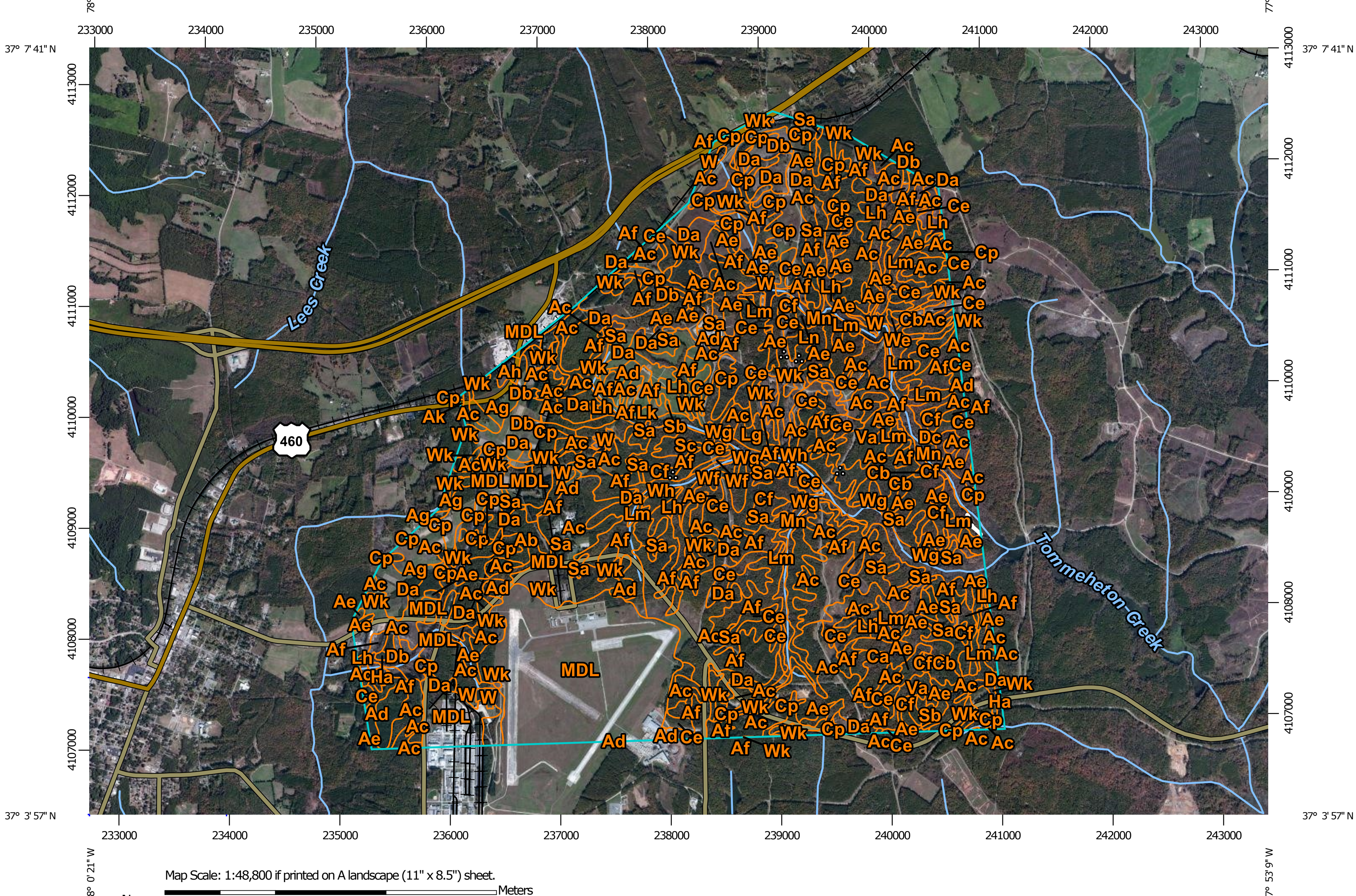
The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Nottoway County, Virginia (VA135)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
902B	Appling-Mattaponi complex, 2 to 8 percent slopes	271.7	3.5%
903E	Ashlar-Rock outcrop complex, 25 to 45 percent slopes	67.8	0.9%
906B3	Cecil sandy clay loam, 2 to 8 percent slopes, severely eroded	90.5	1.2%
906C3	Cecil sandy clay loam, 8 to 15 percent slopes, severely eroded	191.6	2.5%
908A	Chewacla silt loam, 0 to 2 percent slopes, occasionally flooded	40.2	0.5%
909A	Chewacla and Wehadkee soils, 0 to 2 percent slopes, frequently flooded	44.0	0.6%
916B	Helena sandy loam, 2 to 8 percent slopes	95.8	1.2%
923B	Rion sandy loam, 2 to 8 percent slopes	2.6	0.0%
923D	Rion sandy loam, 15 to 25 percent slopes	135.7	1.7%
929C	Wedowee gravelly sandy loam, 8 to 15 percent slopes	446.6	5.7%
930A	Wehadkee silt loam, 0 to 2 percent slopes, frequently flooded	83.6	1.1%
931B	Worsham silt loam, 2 to 8 percent slopes	3.2	0.0%
Ac	Appling coarse sandy loam, undulating phase	1,813.1	23.2%
Ad	Appling coarse sandy loam, eroded undulating phase	129.3	1.7%
Ae	Appling coarse sandy loam, rolling phase	844.1	10.8%
Af	Appling coarse sandy loam, eroded rolling phase	644.8	8.3%
An	Appling and Herndon very fine sandy loams, rolling phases	1.8	0.0%
Ca	Cecil clay loam, eroded undulating phase	1.8	0.0%
Cb	Cecil clay loam, eroded rolling phase	12.8	0.2%
Cc	Cecil clay loam, severely eroded rolling phase	3.0	0.0%

Nottoway County, Virginia (VA135)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Ce	Cecil coarse sandy loam, undulating phase	850.1	10.9%
Cf	Cecil coarse sandy loam, rolling phase	29.9	0.4%
Cg	Cecil coarse sandy loam, hilly phase	5.8	0.1%
Cp	Colfax sandy loam, undulating phase	101.0	1.3%
Da	Durham coarse sandy loam, undulating phase	285.3	3.7%
Db	Durham coarse sandy loam, rolling phase	71.2	0.9%
Ee	Enon-Vance-Helena soils, undulating phases	1.6	0.0%
Eg	Enon-Vance-Helena soils, rolling phases	6.7	0.1%
Lg	Louisburg sandy loam, undulating phase	9.9	0.1%
Lh	Louisburg sandy loam, rolling phase	81.9	1.0%
Lk	Louisburg sandy loam, eroded rolling phase	30.2	0.4%
Lm	Louisburg sandy loam, hilly phase	151.5	1.9%
Ln	Louisburg sandy loam, eroded hilly phase	82.7	1.1%
MDL	Made land	378.8	4.9%
Mn	Mixed alluvial land	342.6	4.4%
Sa	Seneca sandy loam	47.8	0.6%
Sb	Starr loam	1.0	0.0%
Sc	Stony land	3.2	0.0%
UdC	Udorthents, loamy, 2 to 8 percent slopes	10.4	0.1%
W	Water	62.2	0.8%
We	Wilkes sandy loam, rolling phase	30.2	0.4%
Wg	Wilkes sandy loam, hilly phase	10.7	0.1%
Wh	Wilkes sandy loam, eroded hilly phase	105.0	1.3%
Wk	Worsham sandy loam	175.1	2.2%
Wl	Worsham silt loam	0.5	0.0%
Totals for Area of Interest		**7,799.0**	**100.0%**

Soil Map—Nottoway County, Virginia
(Fort Pickett NW)



Map Scale: 1:48,800 if printed on A landscape (11" x 8.5") sheet.

Meters: 0, 500, 1000, 2000, 3000

Feet: 0, 2000, 4000, 8000, 12000

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features

- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features

- Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Nottoway County, Virginia
Survey Area Data: Version 11, Sep 26, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 4, 2010—Nov 8, 2010

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Nottoway County, Virginia (VA135)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Ab	Appling angular cobbly sandy loam, rolling phase	4.2	0.1%
Ac	Appling coarse sandy loam, undulating phase	1,665.8	28.6%
Ad	Appling coarse sandy loam, eroded undulating phase	74.9	1.3%
Ae	Appling coarse sandy loam, rolling phase	393.8	6.8%
Af	Appling coarse sandy loam, eroded rolling phase	763.6	13.1%
Ag	Appling fine sandy loam, 2 to 7 percent slopes	54.4	0.9%
Ah	Appling fine sandy loam, eroded undulating phase	9.3	0.2%
Ak	Appling fine sandy loam, rolling phase	9.5	0.2%
Ca	Cecil clay loam, eroded undulating phase	10.3	0.2%
Cb	Cecil clay loam, eroded rolling phase	28.9	0.5%
Cc	Cecil clay loam, severely eroded rolling phase	3.7	0.1%
Ce	Cecil coarse sandy loam, undulating phase	470.6	8.1%
Cf	Cecil coarse sandy loam, rolling phase	110.2	1.9%
Cp	Colfax sandy loam, undulating phase	129.7	2.2%
Da	Durham coarse sandy loam, undulating phase	473.9	8.1%
Db	Durham coarse sandy loam, rolling phase	19.1	0.3%
Dc	Durham fine sandy loam, undulating phase	1.9	0.0%
Ha	Helena fine sandy loam, undulating phase	4.2	0.1%
Lg	Louisburg sandy loam, undulating phase	3.0	0.1%
Lh	Louisburg sandy loam, rolling phase	49.8	0.9%
Lk	Louisburg sandy loam, eroded rolling phase	12.1	0.2%
Lm	Louisburg sandy loam, hilly phase	142.3	2.4%

Nottoway County, Virginia (VA135)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
Ln	Louisburg sandy loam, eroded hilly phase	50.1	0.9%
MDL	Made land	599.9	10.3%
Mf	Madison sandy loam, undulating phase	2.8	0.0%
Mn	Mixed alluvial land	242.7	4.2%
Sa	Seneca sandy loam	41.9	0.7%
Sb	Starr loam	2.1	0.0%
Sc	Stony land	3.0	0.1%
Va	Vance fine sandy loam, undulating phase	3.1	0.1%
W	Water	33.7	0.6%
We	Wilkes sandy loam, rolling phase	7.9	0.1%
Wf	Wilkes sandy loam, eroded rolling phase	30.4	0.5%
Wg	Wilkes sandy loam, hilly phase	23.2	0.4%
Wh	Wilkes sandy loam, eroded hilly phase	57.2	1.0%
Wk	Worsham sandy loam	290.8	5.0%
Totals for Area of Interest		**5,823.7**	**100.0%**

APPENDIX C: FLOODPLAIN MAPS

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0 foot North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Virginia State Plane South zone. The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov.

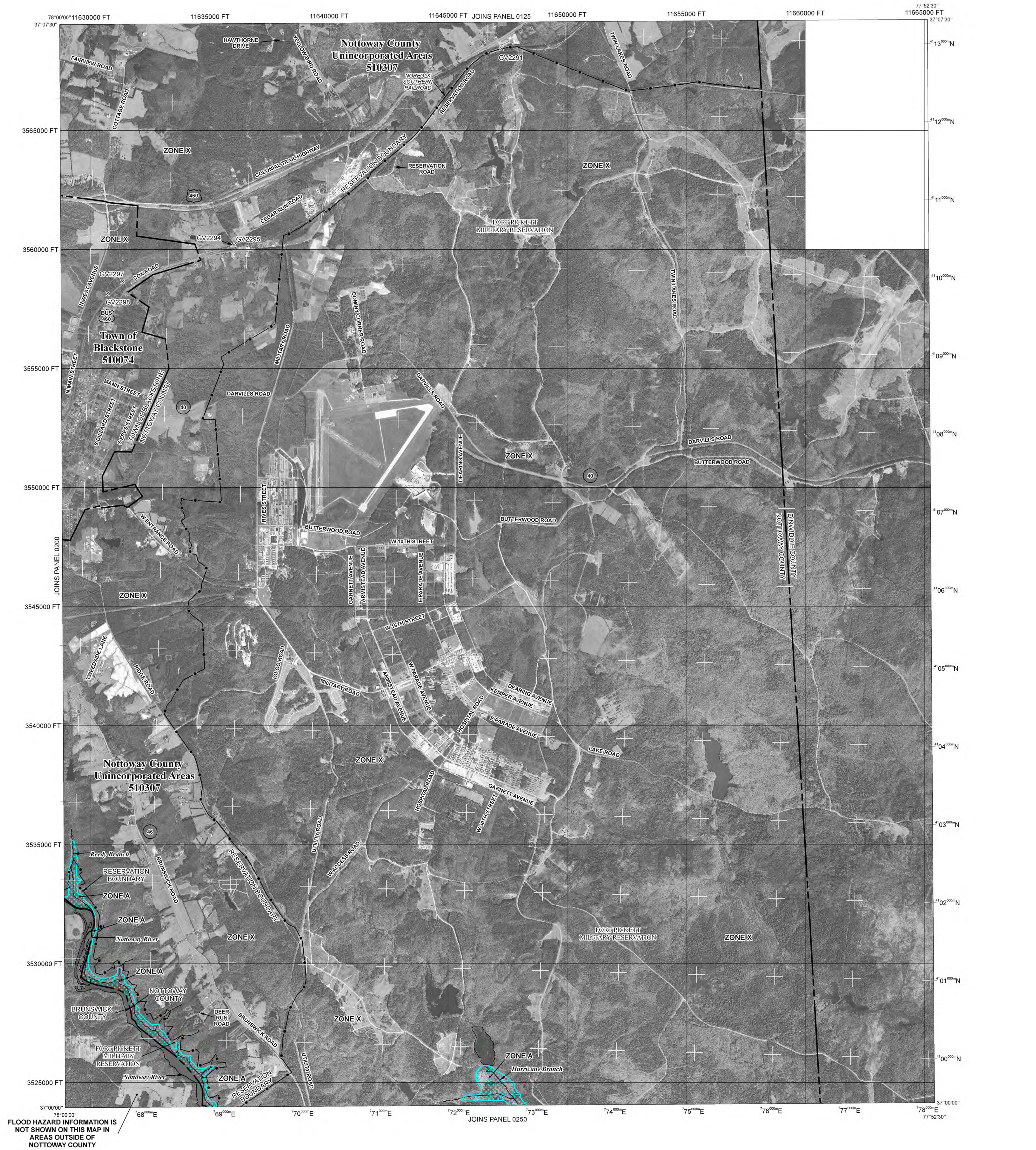
Base map information shown on this FIRM was provided in digital format by the Commonwealth of Virginia, through the Virginia Geographic Network Division of its Department of Technology Planning (VGIN). These data were produced at a scale of 1:4,800 from two-foot resolution digital orthoimagery flown in Spring 2002.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://msc.fema.gov.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.



LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X	Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X	Areas determined to be outside the 0.2% annual chance floodplain.
ZONE D	Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

	1% annual chance floodplain boundary
	0.2% annual chance floodplain boundary
	Floodway boundary
	Zone D boundary
	CBRS and OPA boundary
	Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

A — A	Cross section line
23 - - - 23	Transect line
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
$^{24}76^{000m}$N	1000-meter Universal Transverse Mercator grid values, zone 17
600000 FT	5000-foot grid ticks: Virginia State Plane coordinate system, South zone (FIPSZONE 4502), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
●M1.5	River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
June 2, 2009

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET

600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0225C

FIRM
FLOOD INSURANCE RATE MAP

NOTTOWAY COUNTY, VIRGINIA
AND INCORPORATED AREAS

PANEL 225 OF 250

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
NOTTOWAY COUNTY	510307	0225	C

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
51135C0225C

EFFECTIVE DATE
JUNE 2, 2009

Federal Emergency Management Agency

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

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Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Virginia State Plane South zone. The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

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NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was provided in digital format by the Commonwealth of Virginia, through the Virginia Geographic Network Division of its Department of Technology Planning (VGIN). These data were produced at a scale of 1:2,400 from two-foot resolution digital orthoimagery flown in 2007.

Based on updated topographic information, this map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables for Appomattox River and Reedy Creek No. 1 in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. Also, the road to floodplain relationships for unrevised streams may differ from what is shown on previous maps.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

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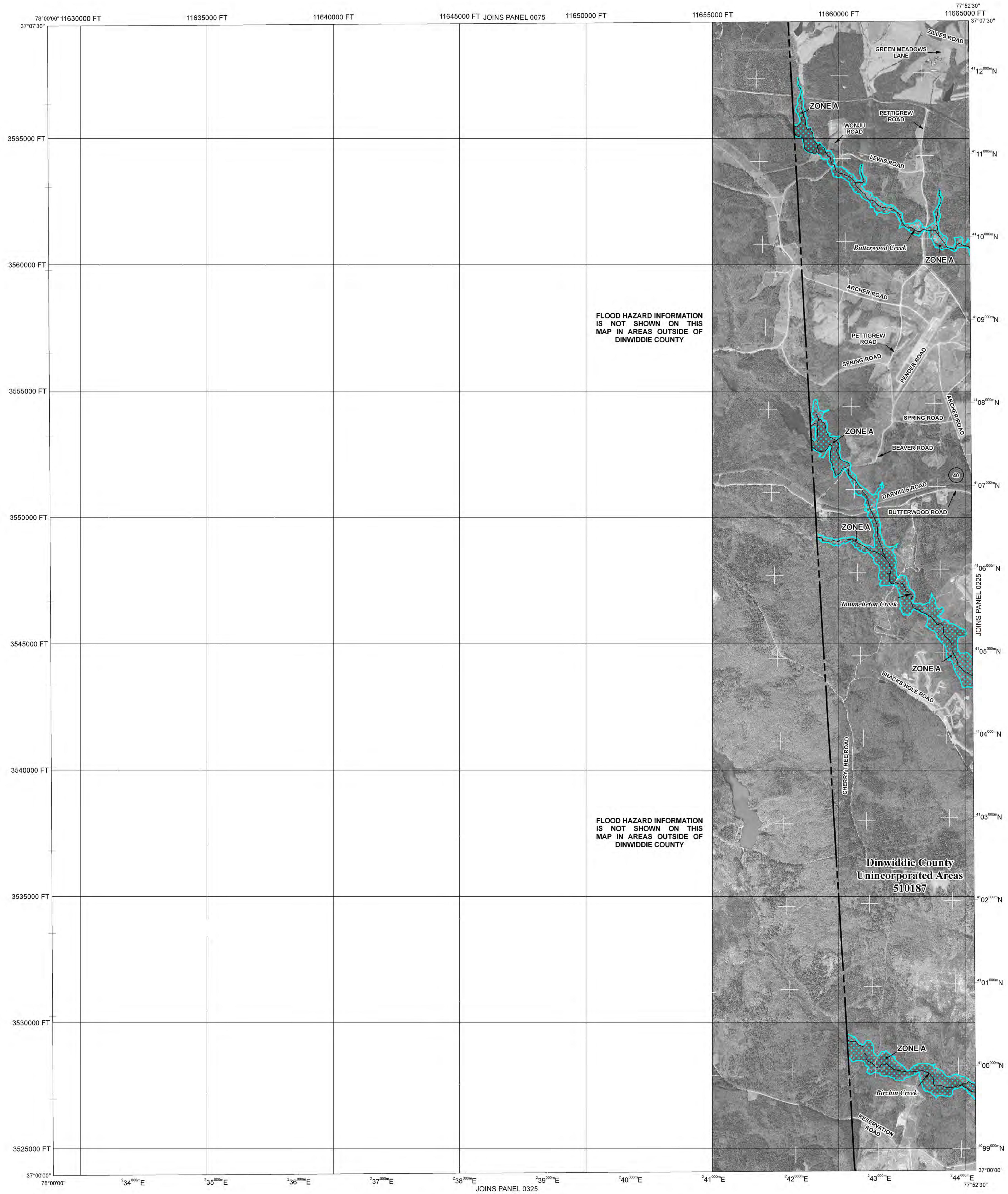

LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary

0.2% annual chance floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

Limit of Moderate Wave Action

~~ 513 ~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

(A)———(A)	Cross section line
(23)- - - - - -(23)	Transect line
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
$^{24}76^{000m}$N	1000-meter Universal Transverse Mercator grid values, zone 18
600000 FT	5000-foot grid values: Virginia State Plane coordinate system, South zone (FIPSZONE 4502), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
● M1.5	River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
June 16, 2011

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET

600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0200B

FIRM
FLOOD INSURANCE RATE MAP

DINWIDDIE COUNTY, VIRGINIA
AND INCORPORATED AREAS

PANEL 200 OF 450

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
DINWIDDIE COUNTY	510187	0200	B

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
51053C0200B

EFFECTIVE DATE
JUNE 16, 2011

Federal Emergency Management Agency

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1315 East-West Highway
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(301) 713-3242

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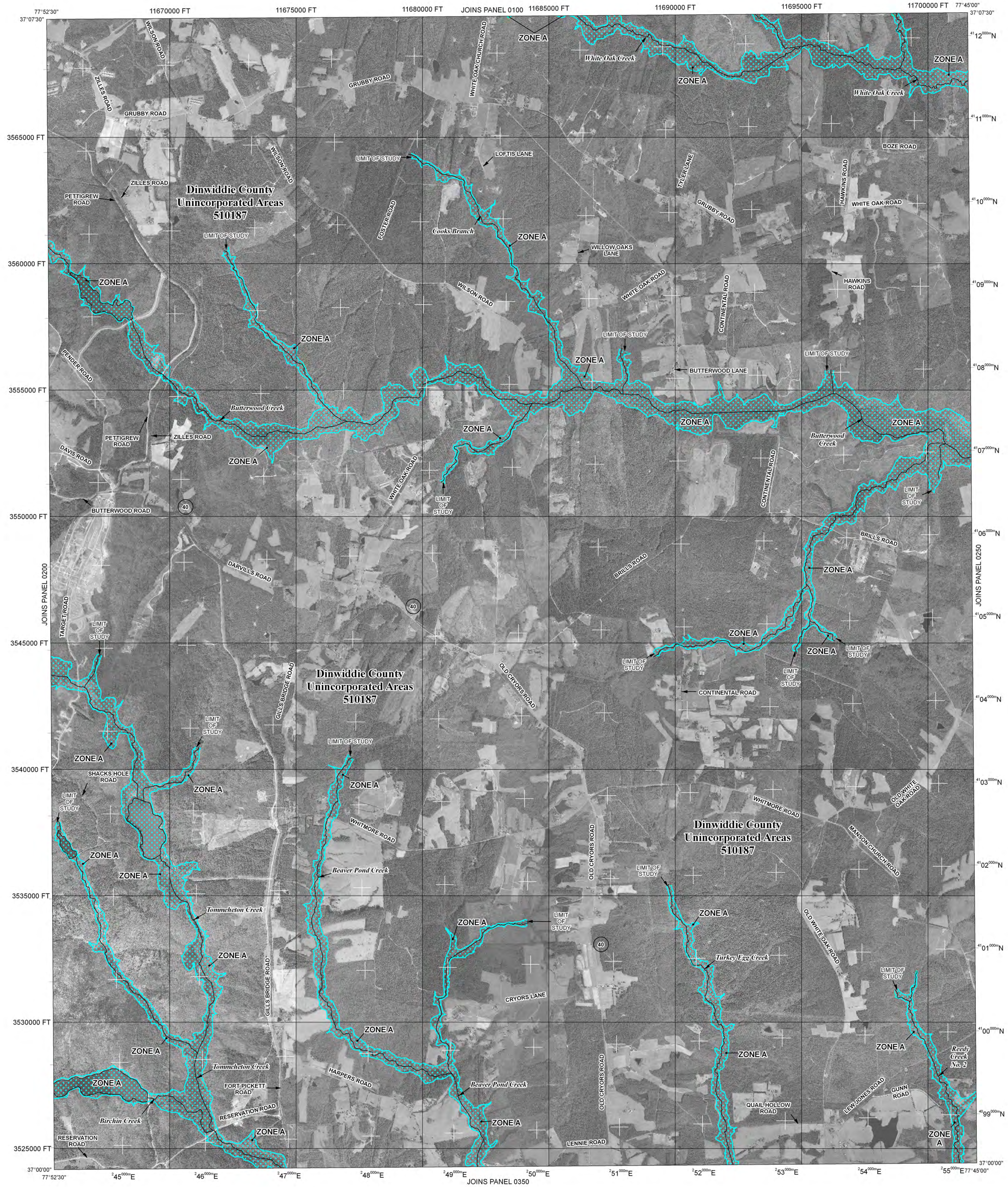

LEGEND

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ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
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ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

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OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
Limit of Moderate Wave Action

~~ 513 ~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

A — A	Cross section line
23 - - - - 23	Transect line
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
$^{24}76^{000m}$N	1000-meter Universal Transverse Mercator grid values, zone 18
600000 FT	5000-foot grid values: Virginia State Plane coordinate system, South zone (FIPSZONE 4502), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
June 16, 2011

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

N

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET

600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0225B

FIRM
FLOOD INSURANCE RATE MAP

DINWIDDIE COUNTY, VIRGINIA
AND INCORPORATED AREAS

PANEL 225 OF 450

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
DINWIDDIE COUNTY	510187	0225	B

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
51053C0225B

EFFECTIVE DATE
JUNE 16, 2011

Federal Emergency Management Agency

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0 foot North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Virginia State Plane South zone. The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov.

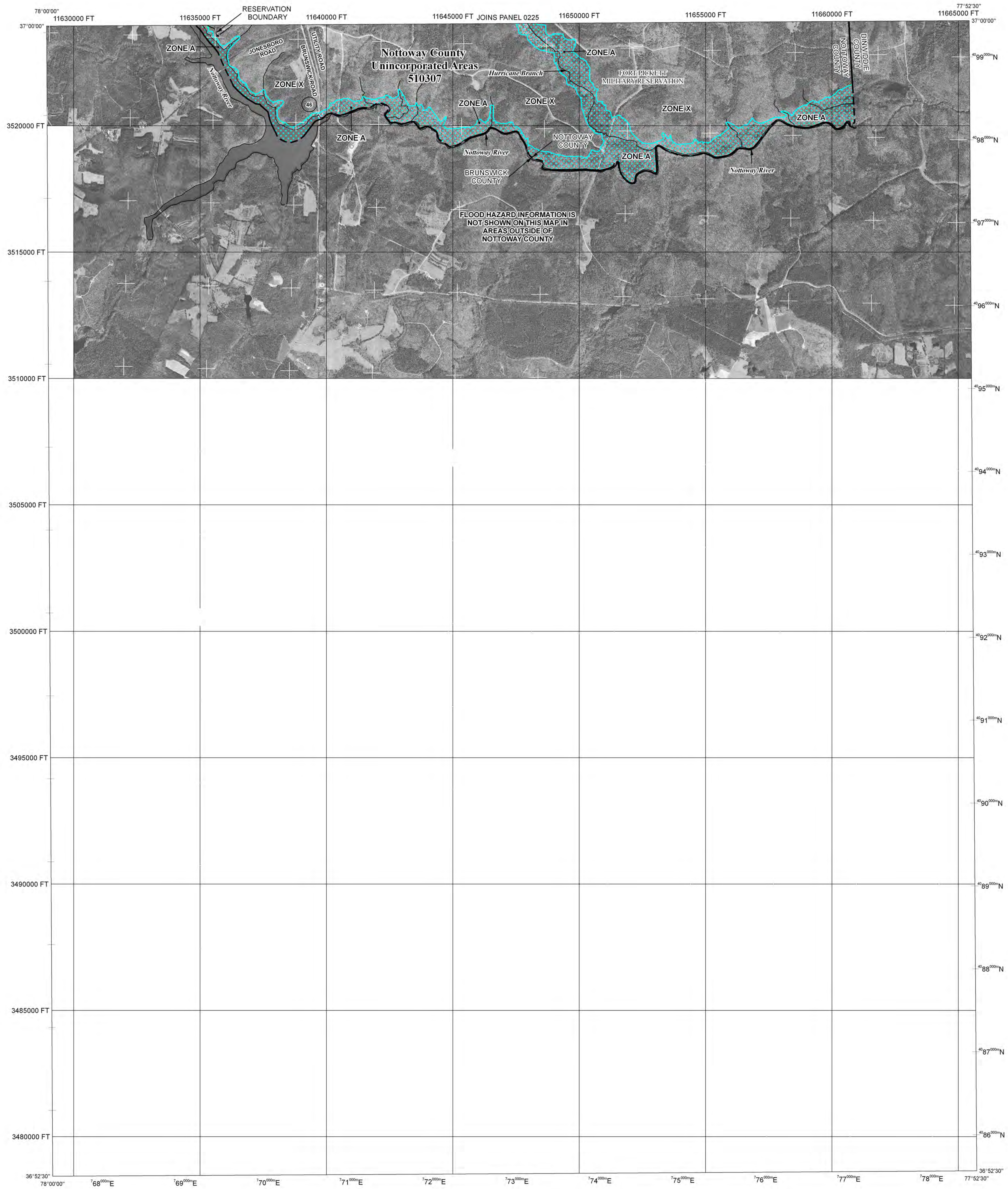
Base map information shown on this FIRM was provided in digital format by the Commonwealth of Virginia, through the Virginia Geographic Network Division of its Department of Technology Planning (VGIN). These data were produced at a scale of 1:4,800 from two-foot resolution digital orthoimagery flown in Spring 2002.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://msc.fema.gov.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at http://www.fema.gov/business/nfip.



LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

- 1% annual chance floodplain boundary
- 0.2% annual chance floodplain boundary
- Floodway boundary
- Zone D boundary
- CBRS and OPA boundary
- Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

(A)———(A)	Cross section line
(23)- - - - -(23)	Transect line
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
$^{24}76^{000m}$N	1000-meter Universal Transverse Mercator grid values, zone 17
600000 FT	5000-foot grid ticks: Virginia State Plane coordinate system, South zone (FIPSZONE 4502), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
●M1.5	River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
June 2, 2009

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET

600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0250C

FIRM
FLOOD INSURANCE RATE MAP

NOTTOWAY COUNTY, VIRGINIA
AND INCORPORATED AREAS

PANEL 250 OF 250

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
NOTTOWAY COUNTY	510307	0250	C

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
51135C0250C

EFFECTIVE DATE
JUNE 2, 2009

Federal Emergency Management Agency

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0' North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations tables in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations tables should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Virginia State Plane South zone. The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was provided in digital format by the Commonwealth of Virginia, through the Virginia Geographic Network Division of its Department of Technology Planning (VGIN). These data were produced at a scale of 1:2,400 from two-foot resolution digital orthoimagery flown in 2007.

Based on updated topographic information, this map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables for Appomattox River and Reedy Creek No. 1 in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map. Also, the road to floodplain relationships for unrevised streams may differ from what is shown on previous maps.

Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels; community map repository addresses; and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

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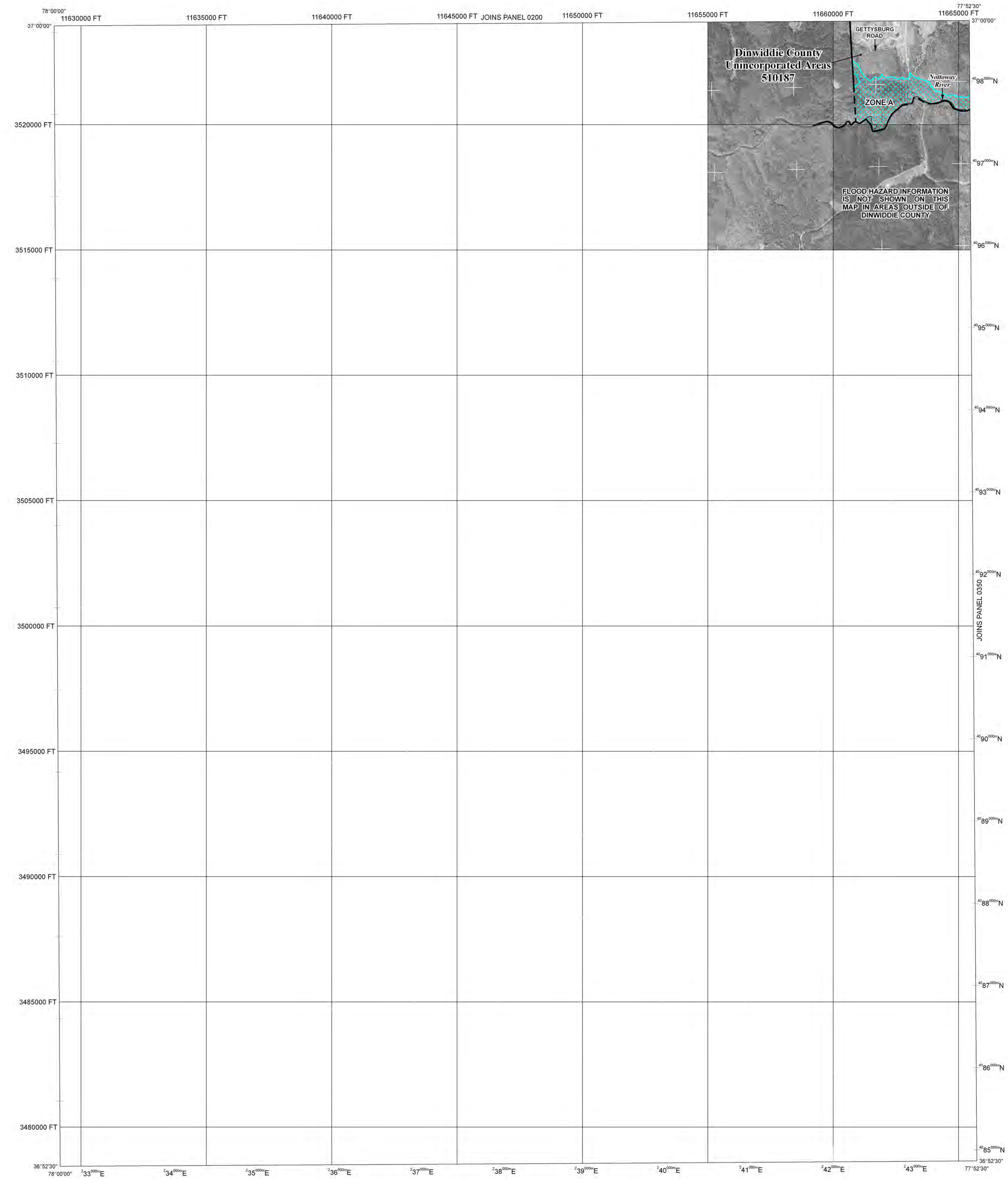

LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X — Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X — Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D — Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary

0.2% annual chance floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

Limit of Moderate Wave Action

~~ 513 ~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

(A)———(A)	Cross section line
(23)- - - - - -(23)	Transect line
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
²⁴76⁰⁰⁰ᵐN	1000-meter Universal Transverse Mercator grid values, zone 18
600000 FT	5000-foot grid values: Virginia State Plane coordinate system, South zone (FIPSZONE 4502), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
• M1.5	River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
June 16, 2011

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

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MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET

600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0325B

FIRM
FLOOD INSURANCE RATE MAP

DINWIDDIE COUNTY, VIRGINIA
AND INCORPORATED AREAS

PANEL 325 OF 450

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
DINWIDDIE COUNTY	510187	0325	B

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
51053C0325B

EFFECTIVE DATE
JUNE 16, 2011

Federal Emergency Management Agency

NOTES TO USERS

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Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
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National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov.

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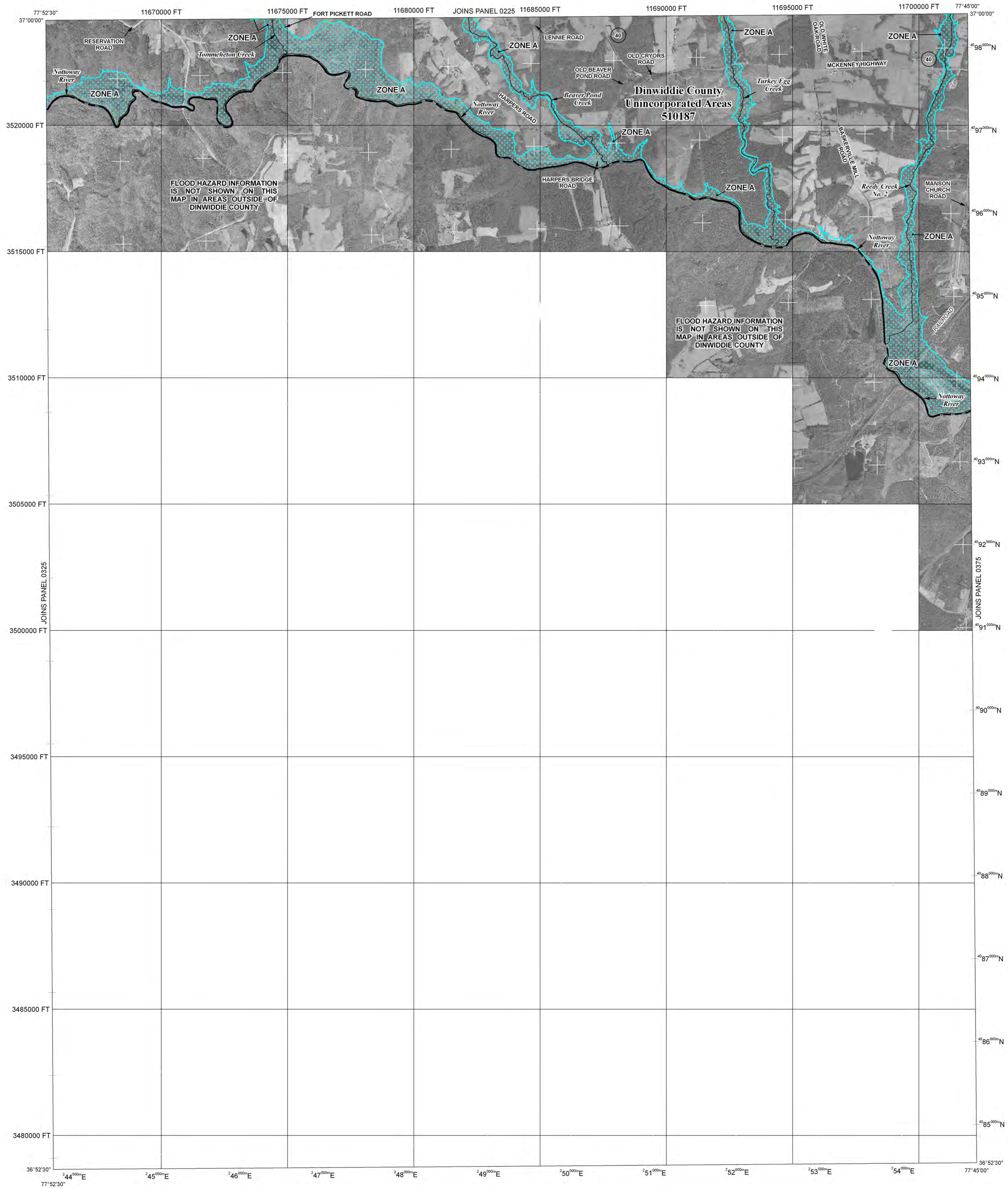

LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary

0.2% annual chance floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

Limit of Moderate Wave Action

~~ 513 ~~~	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

(A)———(A)	Cross section line
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87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
$^{24}76^{000m}$N	1000-meter Universal Transverse Mercator grid values, zone 18
600000 FT	5000-foot grid values: Virginia State Plane coordinate system, South zone (FIPSZONE 4502), Lambert Conformal Conic projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
● M1.5	River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
June 16, 2011

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

N

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET

600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0350B

FIRM

FLOOD INSURANCE RATE MAP

DINWIDDIE COUNTY, VIRGINIA
AND INCORPORATED AREAS

PANEL 350 OF 450

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
DINWIDDIE COUNTY	510187	0350	B

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
51053C0350B

EFFECTIVE DATE
JUNE 16, 2011

Federal Emergency Management Agency

NOTES TO USERS

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To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Coastal Base Flood Elevations shown on this map apply only landward of 0.0 foot North American Vertical Datum of 1988 (NAVD 88). Users of this FIRM should be aware that coastal flood elevations are also provided in the Summary of Stillwater Elevations table in the Flood Insurance Study report for this jurisdiction. Elevations shown in the Summary of Stillwater Elevations table should be used for construction and/or floodplain management purposes when they are higher than the elevations shown on this FIRM.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Virginia State Plane South zone. The **horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or State Plane zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at http://www.ngs.noaa.gov or contact the National Geodetic Survey at the following address:

NGS Information Services
NOAA, N/NGS12
National Geodetic Survey
SSMC-3, #9202
1315 East-West Highway
Silver Spring, Maryland 20910-3282
(301) 713-3242

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at **(301) 713-3242**, or visit its website at http://www.ngs.noaa.gov.

Base map information shown on this FIRM was provided in digital format by the Commonwealth of Virginia, through the Virginia Geographic Network Division of its Department of Technology Planning (VGIN). These data were produced at a scale of 1:4,800 from two-foot resolution digital orthoimagery flown in Spring 2002.

This map reflects more detailed and up-to-date **stream channel configurations** than those shown on the previous FIRM for this jurisdiction. The floodplains and floodways that were transferred from the previous FIRM may have been adjusted to conform to these new stream channel configurations. As a result, the Flood Profiles and Floodway Data tables for Great Creek and Roses Creek in the Flood Insurance Study Report (which contains authoritative hydraulic data) may reflect stream channel distances that differ from what is shown on this map.

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Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at http://msc.fema.gov.

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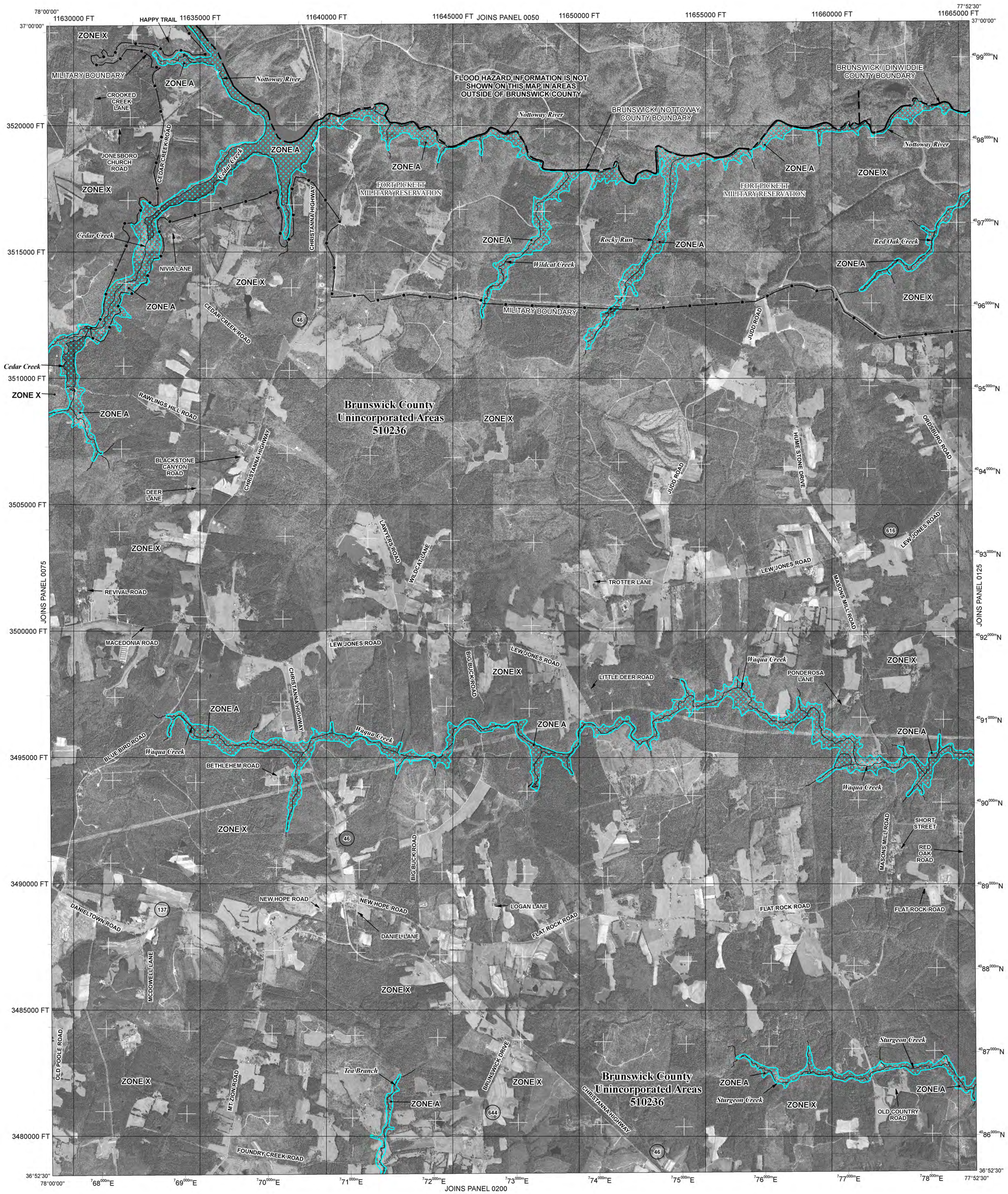

LEGEND

SPECIAL FLOOD HAZARD AREAS SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A	No Base Flood Elevations determined.
ZONE AE	Base Flood Elevations determined.
ZONE AH	Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.
ZONE AO	Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.
ZONE AR	Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.
ZONE A99	Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.
ZONE V	Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.
ZONE VE	Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAs)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary

0.2% annual chance floodplain boundary

Floodway boundary

Zone D boundary

CBRS and OPA boundary

Boundary dividing Special Flood Hazard Area Zones and boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.

513	Base Flood Elevation line and value; elevation in feet*
(EL 987)	Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

A —— A	Cross section line
23 - - - - 23	Transect line
87°07'45", 32°22'30"	Geographic coordinates referenced to the North American Datum of 1983 (NAD 83), Western Hemisphere
$^{24}76^{000m}$N	1000-meter Universal Transverse Mercator grid ticks, zone 17
600000 FT	5000-foot grid values: statename State Plane coordinate system, spzone (FIPSZONE fipszone), spherename projection
DX5510 ×	Bench mark (see explanation in Notes to Users section of this FIRM panel)
●M1.5	River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
July 7, 2009

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.

To determine if flood insurance is available in this community, contact your Insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

N

MAP SCALE 1" = 2000'

1000 0 2000 4000 FEET

600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0100D

FIRM

FLOOD INSURANCE RATE MAP

BRUNSWICK COUNTY, VIRGINIA
AND INCORPORATED AREAS

PANEL 100 OF 450

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
BRUNSWICK COUNTY	510236	0100	D

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
51025C0100D

EFFECTIVE DATE
JULY 7, 2009

Federal Emergency Management Agency

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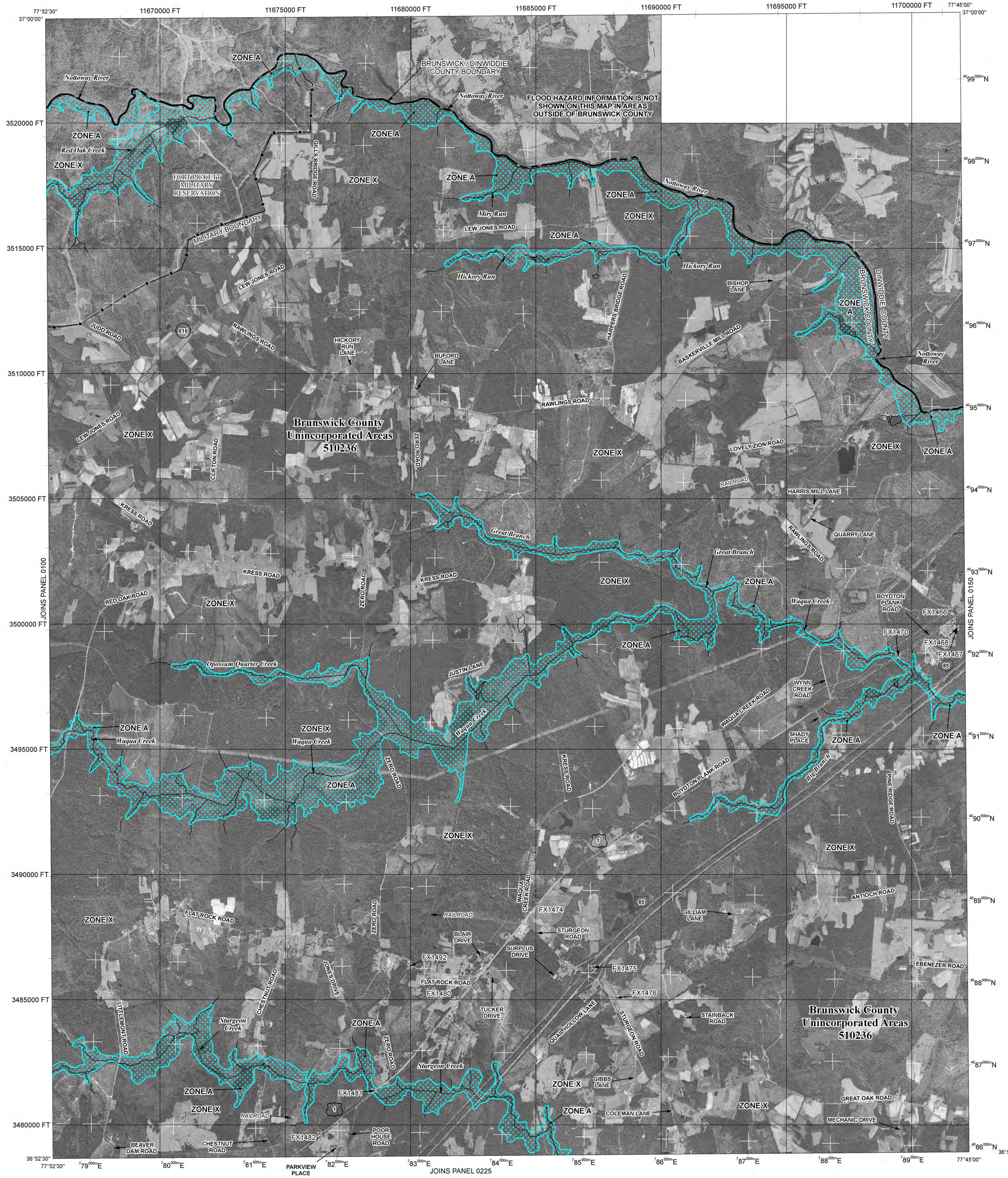

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MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE
FLOOD INSURANCE RATE MAP
July 7, 2009

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL

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N

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600 0 600 1200 METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0125D

FIRM
FLOOD INSURANCE RATE MAP

BRUNSWICK COUNTY, VIRGINIA
AND INCORPORATED AREAS

PANEL 125 OF 450

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
BRUNSWICK COUNTY	510236	0125	D

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
51025C0125D

EFFECTIVE DATE
JULY 7, 2009

Federal Emergency Management Agency

APPENDIX D: PLANTS

E-1: PLANTS ON ARNG-MTC FORT PICKETT BLACKSTONE, VIRGINIA

c =collected
r = recorded in community sampling or assoc. spp. notes
o = observed

FERNS

ASPLENIACEAE
Asplenium platyneuron (L.) BSp. (r)

BLECHNACEAE
Woodwardia areolata (L) Moore (o)
Woodwardia virginica (L.) J.E. Smith (c)

DENNSTAEDTIACEAE
Pteridium aquilinum (L.) Kuhn. (r)

DRYOPTEPACEAE
Athyrium asplenioides (Michx.) A. Eat. (r)
Dryopteris celsa (Palmer) Knowlton (c)
Onoclea sensibilis L. (o)
Polystichum acrostichaides (Michx.) Schott (r)
Woodsia obtusa (Spreng.) Torr. (r)

LYCOPODIACEAE
Diphasiastrum digitatum (A.Br.) Holub. (o)
Lycopopdium digitatum A.Br. (o)
Lycopodiella alopecuroides (L.) Cranf (c)
Lycopodiella appressa (Chapm.) Cranf. (c)

OPHIOGLOSSACEAE
Botrychium bitematum (Say.) Underw. (c)
Botrychium dissectum Spreng. (o)
Botrychium virginianum (L.) Swartz (r)

OSMUNDACEAE
Osmunda cinnamomea (L.) (r)
Osmunda regalis (Willd) Gray (o)

THELYPTERIDACEAE
Thelypteris palustris Schott var. *pubescens* (Laws.) Fem. (r)

GYMNOSPERMS

CUPRESSACEAE
Juniperus virginiana L. (r)

PINACEAE
Pinus echinata Mill. (o)
Pinus taeda L. (r)
Pinus virginiana Mill. (r)
Pinus elliotii Engelm. (o)

MONOCOTYLEDONS

ARACEAE
Arisaema traphyllum (L.) Schott ssp. *pusillum* (Peck) Huttleston (r)
Peltandra virginica (L.) Schott (o)
Symplocarpus foetidus (L.) Salisb. ex Nutt. (o)

COMMELINACEAE
Commelina diffuse Burm. f. (c)
Commelina virginica L. (c)

CYPERACEAE
Bulbostylis capillaris (L.) Clarke (r)
Carex albicans Willd. (c)
Carex amphibola Steud. (r)
Carex atlantica Bailey (c)
Carex blanda Dewey (r)
Carex cephalophora Muhl. (r)
Carex complanata Torr. & Hook. (r)
Carex crinita Lam. (r)
Carex debilis Michx. (c)
Carex festucacea Schk. (c)
Carex flaccosperma Dewey (c)
Carex frankii Kunth (r)
Carex glaucodea Tuckerm.
Carex gracillima Schwein. (c)
Carex laevivaginata (Kuk.) Mackenz. (c)
Carex laxiculmis Schwein. (c)
Carex leptalea Wahl. (c)
Carex lupulina Muhl. ex Willd. (o)
Carex lurida Wahl. (o)
Carex normalis Mackenz. (r)
Carex pensylvanica Lam.(r)
Carex retroflexa Muhl. (r)
Carex rosea Schk. (r)
Carex scoparia Schk. (r)
Carex striatula Michx. (c)
Carex stricta Lam. (o)
Carex styloftexa Buckley (c)
Carex tribuloides Wahlenb. var. *tribuloides* (r)
Carex typhina Michx. (c)
Carex umbellate Schk. (r)

Carex vestita Willd. (c)
Cyperus erythrorhizos Muhi. (c, r)
Cyperus lupulinus (Spreng.) Marcks (c)
Cyperus polystachyos Roth var. *texensis* (Torr.) Fem.(c)
Cyperus retrofractus (L.) Torr. (c)
Cyperus dipsacifonnis Fem. Cyperus strigosus L. (r)
Eleocharis acicularis (L.) Roemer & J.A. Schultes (r)
Eleocharis quadrangulata (Michx.) R.& S. (c)
Eleocharis tenuis (Willd.) J.A. Schultes (o)
Eleocharis tortilis (Link) Schultes (c)
Eleocharis vivipara Link (o)
Fimbristylis annua (All.) R.& S. (c)
Fimbristylis autumnalis (L.) R.& *S.* (c)
Rhynchospora capitellata (Michx.) Vahl (r)
Rhynchospora chalarocephala Fern. & Gale (o)
Rhynchospora comiculata (Lam.) Gray (c)
Rhynchospora globularis (Chapm.) Small var. *recognita* Gale (c)
Rhynchospora glomerata (L.) Vahi (r)
Rhynchospora gracilenta Gray (r)
Schoenoplectus tabernaemontani (K.C. Gmel.) Palla (o)
Scirpus cyperinus (L.) Kunth (r)
Scirpus divaricatus Ell. (o)
Scirpus georgianus Harper (c)
Scieria oligantha Michx. (c)
Scieria pauciflora Willd. (c)
Scieria reticularis Michx. (c)
Scieria triglomerata Michx. (r)

DIOSCOREACEAE
Dioscorea villosa L. (c)

HYPOXIDACEAE
Hypoxis hirsuta (L.) Coy. (r)

IRIDACEAE
Iris cristata Ait. (r)
Sisyrinchium mucronatum Michx. (r)

JUNCACEAE
Juncus canadensis Laharpe (r)
Juncus coriaceus Mackenz. (c)
Juncus dichotomus Ell. (r)incl. *J. platyphviltis* (Wieg.) Fem.
Juncus diffusissimus Buckley (c)
Juncus effusus L. (o)
Juncus gerardii Loisel. (o)
Juncus marginatus Rostk. (r)
Juncus scirpoides Lam. (r)
Juncus secundus Poir. (r)
Juncus subcaudatus (Engelm.) Cov. & Blake (c)
Juncus tenuis Willd. (r)
Luzula bulbosa (Wood) Rydb. (c)
Luzula echinata (Small) F.J. Herm. (r)
Luzula multiflora (Retz.) Lej. (r)

LILIACEAE
Allium vineale L. (o)
Erythronium umbillilicatum Parks & Hardin (c)
Maianthemum racemosum (L.) Link (r)
Smilacina racemosa (L.) Desf.
Neianthium virginicum L. (c)
Polygonatum biflorum (Walt.) Ell. (r)
Uvulaxia perfoliata L. (r)
Uvularia sessilifolia L. (c)

ORCHIDACEAE
Aplectrum hyemale (Muhl ex. Willd) Torrey (o)
Cypripedium acaule Aiton (o)
Isotria verticiliata Raf. (c)
Goodyera pubescens (Willd) R. Brown (o)
Orchis spectabiis (L.) (o)
Piatanthera sp. (r)
Spiranthes ceznua (L.) Rich. (c)
Spiranthes lacera (Raf.) Raf. var. *gracilis* (Bigel.) Luer (c)
Tipularia discolor (Pursh) Nuttall (o)

POACEAE
Agrostis gigantea Roth (o)
Agrostis hyemalis (Walt.) BSP.
Agrostis perennans (Walt.) Tuckerm. (r)
Aira caryophyliacea L. (c)
Aira elegantissima Schur. (c)
Aira elegans Gaud.
Andropogon glomeratus (Walt.) BSP. (c)
Andropogon gyrans Ashe (c)
Andropogon eiliotii Chapm. (o)
Andropogon tenarius Michx. (o)
Andropogon virginicus L. (r)
Aristida curtisii (Gray) Nash (r)
Aristida dichotoma Michx. (r)
Aristida longespica Poir. (c)
Aristida purpurascens Poir. (c)
Brachyelytrum erectum (Spreng.) Beauv. (r)
Bromus racemosus L. (r)
Caiamagrostis cinnoides Bart. (r)
Chasmanthium latifolium (Michx.) Yates (r)
Chasmanthium laxum (L.) Yates (r)
Cinna arundinacea L. (r)
Dactylis giomerata L. (r)
Danthonia spicata (L.) R.& S. (r)
Dichanthelium acicuiare (Poir.) G.& C. (c)
Dichanthelium acuminatum (Swartz) G.& C. (r)
Dichanthelium boscii (Poir.) G.& C. (r)
Dichanthelium clandestinum (L.) Gould (r)
Dichanthelium commutatum (Schultes) Gould (r)
Dichanthelium depauperatum (MuM.) Gould (c)

Dichanthelium dichotomum (L.) Gould (r)
Dichanthelium ensifolium (Baldw. Ex E11) Gould (r)
Dichanthelium laxiflorum (Lam.) Gould (c)
Dichanthelium scoparium (Lam.) Gould (r)
Echinochioa crusgalii (L.) Beauv. (o)
Echinochloa muricata (Beauv.) Fern. var. *muricata* (o)
Elymus virginicus L. (r)
Eragrostis capillaris (L.) Nees (r)
Eragrostis hirsute (Michx.) Nees (o)
Eragrostis refracta (Muhl.) Scribn. (c)
Eragrostis spectablis (Pursh) Steud. (r)
Erianthus alopecuroides (L.) Ell. (c)
Erianthus contortus Ell. (c)
Erianthus giganteus (Walt.) Muhi. (c)
Festuca eiatior L. (r)
Festuca myuros L.
Festuca octoftora Walt.
Festuca subverticiliata (Pers.) Alexeev. (r)
Festuca obtusa Biehl.
Glvceria striata (Lam.) Hitchc. (r)
Gymnopogon ambiguus (Michx.) BSP. (c)
Leersia oryzoides (L.) Swartz (o)
Leersia virginica Willd. (r)
Nelica mutica Walt. (r)
Microstegium vimineum (Trin.) A. Camus (r)
Muhlenbergia schreberi J.F. Gmel. (c)
Muhlenbergia sylvatica (Tom) Gray (r)
Panicum anceps Michx. (r)
Panicum dichotomiflorum Michx- (o)
Panicum rigidulum Nees (o)
Panicum verrucosum Muhl. (r)
Paspalum fluitans (Ell.) Kunth (c)
Paspalum setaceum Michx. (c)
Piptochaetium avenaceum (L.) Parodi (r)
Stipa avenacea (L.) (o)
Poa cuspidata Nutt. (r)
Poa pratensis L. (c)
Schizachyrium scoparium (Michx.) Nash (r)
Sorghastrum elliottii (Mohr) Nash(c)
Sorghastrum nutans (L.) Nash (r)
Sphenopholis nitida (Biehi.) Saibn. (r)
Sphenopholis obtusata (Michx.) Saibn. (c)
Sphenopholis x pallens (Biehl.) Scribn. (c)
Sphenopholis pensylvanica (L.) Hitchc. (c)
Sporobolus indicus (L.) R.Br. (c)
Tridensfiavus (L.) Hitchc. (r)
Vuipia myuros (L.) Gmel. (c)
Vuipia octoflora (Walt.) Rydb. (r)

PONTEDERIACEAE
Pontederia cordata L. (r)

POTAMOGETONA CEAE
Potamogeton diversifolius Raf (c)

SMILACACEAE
Smilax bona-nox L. (o)
Smilax glauca Walt. (r)
Smilax herbacea L. (r)
Smilax rotundifolia L. (r)
Smilax walteri Pursh (o)

TYPHACEAE
Typha latifolia L. (r)

XYRIDACEAEXYR IDACEAE
Xyris torta Smith (c)

DICOTYLEDONS

ACANTHACEAE
Ruellia pedunculata Ton. (c)
Ruema purshmna Fem.

ANACARDIACEAE
Rhus aromatics Ail. (c)
Rhus X ashei (Small) Greene (c)
Rhus copallinum L. (c)
Rhus giabra L. (r)
Rhus michauxii Sarg. (c)
Toxicodendron radicans (L.) Kuntze (r)
Toxicodendron vemix (L.) Kuntze (r)

ANNONACEAE
Asimina triloba (L.) Dunal (r)

APIACEAE
Angelica venenosa (Greenw.) Fem. (c)
Chaerophylium procumbens (L.) Crantz (c)
Cicuta maculata L. (r)
Ciyptotaenia canadensis (L.) DC. (r)
Ligusticum canadense (L.) Britt. (c)
Oxypolis rigidior (L.) Raf. (c)
Sanicula canadensis L. (r)
Sanicula smallii Bickn. (c)
Sium suave Walt. (o)
Zizia aptera (Gray) Fem. (c)

APOCYNACEAE
Apocynum cannabinum L. (r)
Asciepias tuberose L. (r)
Asciepias variegate L. (c)
Matelea carolinensis (Jacq.) Woods. (c)
Matelea decipiens (Alex.) Woods. (c)

AQUIFOLIACEAE
Ilex decidua Walt. (c)
Ilex opaca Ail. (r)

ARISTOLOCHIACEAE
Aristolochia sexpentaria L. (r)
Asarum canadense L. (r)
Hexastylis virginica (L.) Small (c)

ASTERACEAE
Achillea miliefolium L. (r)
Ageratina aromatica (L.) Spach
Ambrosia artemisiifolia L. (r)
Antennaria piantaginifolia (L.) Rich. (c)
Arnica acaulis (Walt.) BSP. (C)
Amogiossum atriplicifolium (L.) Robins. (r)
Cacalia atriplicifolia L.
Aster concolor L. (c)
Aster divaricatus L. (c)
Aster dumosus L. (r)
Aster grandiflorus L. (r)
Aster infimus Michx. (c)
Aster laterifiorus (L.) Britt. (c)
Aster linarifolius L. (c)
Aster pilosus Willd. (r)
Aster unduiatus L. (r)
Bidens comosa (Gray) Wieg
Bidens connata Muhl. (c)
Bidens discoidea (T.& G.) Britt. (c)
Bidens frondosa L.(o)
Bidens polylepis Blake (o)
Bidens connata Muhl. (c)
Chrysanthemum leucanthemum L.
Chrysogonum virginianum L. (r)
Chrysopsis mariana (L.) Ell. (r)
Heterotheca mariana L.
Cirsium discolor (Muhi.) Spreng. (c)
Cirsium pumilum (Nutt.) Spreng. (r)
Coreopsis verticiliata L. (r)
Eclipta prostrate (L.) L. (c)
Eclipta aiba (L.) Hassk.
Elephantopus carolinianus Willd. (o)
Elephantopus nudatus Gray (c)
Elephant opus tomentosus L. (r)
Erechtites hieracifolia (L.) Rai. (r)
Erigeron annuus (L.) Pers. (r)
Erigeron pulchellus Michx. var. *pulchellus* (c, o)
Erigeron strigosus Muhl. (r)
Eupatorium album L. (o)
Eupatorium capillifolium (Lam.) Small (o)
Eupatorium fistulosum Barratt (o)
Eupatorium godfreyanum Cronq. (r)
Eupatorium hyssopifolium L. (r)
Eupatorium. hyssopifolium var. laciniatum Gray
Eupatorium mohrii Greene (c)
Eupatorium perfoliatum L. (r)
Eupatorium pilosum Walt. (c)
Eupatorium pubescens Willd. (c)
Eupatorium purpureum L. var. *purpureum* (o)
Eupazoium rotundifolium ssp. ovatum (Sigel-) M.& F.
Eupatorium rotundifolium L. (c)
Eupatorium saituense Fem. (c)
Eupatorium sessilifolium L. (c)
Eupatorium torreyanum Short (c)
*Gamochaeta purpurea (*L.) Cabrera (r)
Gnaphalium purpureum L.
Gnaphalium obtusifolium L. (r)
Helenium amarom (Raf) Rock (o)
Helenium flexuosum Raf (c)
Helianthus angustifolius L. (r)
Helianthus atrorobens L. (r)
Helianthus divaricatus L (r)
Helianthus giganteus L. (o)
Helianthus strurnosus L. (c)
Hieracium gronovii L. (r)
Hieracium venosum L. (r)
Kuhnia eupatorioides L. (c)
Lactuca canadensis L. (r)
Lactuca floridana (L.) Gaertn. (o)
Liatris graminifolia Willd. (c)
Packera tomentosa (Michx.) C. Jeffrey (o)
Parthenium auriculatum Britt. (c)
Piuchea camphorate (L.) DC. (c)
Prenanthes altissima L. (r)
Prenanthes serpentaria Pursh (c)
Rudbeckia fulgida Ait. (c)
Senecio anonymus Wood (r)
Sericocarpus asteroides (L.) BSP. (r)
Sericocarpus linifolius (L.) BSP. (c)
Silphium compositum Michx. (c)
Silphium trifoliatum L. (r)
Solidago arguta Ait. (c)
Solidago bicolor L. (c)
Solidago caesia L. (r)
Solidago graminifolia (L.) Salish.
Solidago tenuifolia Pursh
Solidago canadensis L. var. *scabra* T.& G.
Solidago erecta Pursh (r)
Solidago juncea Ait. (r)
Solidago nemoralis Ait. (c)
Solidago odora Ait. (r)
Solidago pinetorum Small (r)
Solidago rugosa Mill. (r)
Taraxacum officinaie Weber (o)
Verbesina alternifolia (L.) Britt. (c)
Vernonia glauca (L.) Willd. (c)
Vernonia noveboracensis (L.) Michx. (r)

BALSAMINACEAE
Impatiens capensis Meerb. (r)

BERBERIDACEAE
Podophyllum peltatum L. (r)

BETULACEAE

Ainus serrulata (Ait.) Willd. (r)
Betula nigra L. (r)
Carpinus caroliniana Walt. (r)
Corylus americans Walt. (o)

BIGNONIACEAE

Bignonia capreoiata L. (r)
Campsis radicans (L.) Seemann (r)

BORAGINACEAE

Cynogiossum virginianum L. (c)
Myosotis macrosperma Engelm. (c)

BRASSICACEAE

Cardamine hirsuta L. (r)

CABOMBACEAE

Brasenia schreberi J.F. Gmel. (r)

CAMPANULACEAE

Lobelia georgiana McVaugh (c)
Lobelia nuttallii R.& S. (c)
Lobelia siphilitica L. (o)
Triodanis perfoliata (L.) Nieuwl. (r)
Triodanis biffora (Ruiz & Pavon) Greene (c)

CAPRIFOLIACEAE

Lonicerajaponica Thunb. (r)
Sambucus canadensis L. (r)
Triosteurn angustifolium L. (c)
Viburnum dentatum L. (r)
Viburnum nudum L. (r)
Viburnum prunifolium L. (r)
Viburnum rafinesquianum Schultes (c)

CARYOPHYLLACEAE

Arenaria serpyliifolia L. (r)
Cerastium viscosum L. (r)
Cerastium giomeratum Thuill.
Dianthus arrneria L. (r)
Minuartia glabra (Walt.) Mattf. (c)
Silene caroliniana Walt. (r)
Stellaria pubera Michx. (r)

CELASTRACEAE

Euonymus americanus L. (r)

CISTACEAE

Lechea racemuiosa Michi. (r)
Lechea tenuifolia Michx. (c)

CONVOLVULACEAE

Lipomoea pandurata (L.) G.F. Mey. (r)

CORNACEAE

Comus amomum Mill. (r)
Cornus florida L. (r)
Cornus stricta Lam.

CONVOLVULACEAE

Cuscuta compacta Juss. (c)

EBENACEAE

Diospyros virginiana L. (r)

ELAEAGNACEAE

Elaeagnus umbellata Thunb. (c)

ERICACEAE

Chimaphila maculata (L.) Pursh (o)
Gaylussacia baccata (Wang.) K. Koch (r)
Gaylussacia dumosa (Andr.) Torr. & Gray (o)
Kaimia latifolia L. (o)
Lyonia ligustrina (L.) DC. (r)
Lyonia mariana (L.) D. Don (c)
Monotropa hypopitys L. (c)
Oxydendrum arboreum (L.) DC. (r)
Rhododendron periclymenoides (Michx.) Shinners (o)
Vaccinium corymbosum L. (r)
Vaccinium formosum Andr. (o)
Vaccinium pallidum Ait. (r)
Vaccinium stamineum L. (r)

EUPHORBIACEAE

Acalypha gracilens Gray (r)
Acalypha rhomboidea Raf (r)
Euphorbia coroliate L. (r)
Phylianthus caroliniensis Walt. (c)

FABACEAE

Amphicarpaea bracteata (L.) Fern. (r)
Apios americans Meclik. (r)
Cercis canadensis L. (r)
Chamaecrista fascicuiata (Michx.) Greene (r)
Chamaecrista nictitans (L.) Moench (r)
Clitoria mariana L. (c)
Coronilla varia L. (o)
Desmodium ciliare (Willd.) DC. (c)
Desmodium glutinosum (Willd.) Wood (r)
Desmodium laevigatum (Nutt.) DC. (c)
Desmodium mariiandicum (L.) DC. (r)
Desmodium nudiflorum (L.) DC. (r)
Desmodium nuttallii (Schindl.) Schub. (c)
Desmodium panicuiatum (L.) DC. (r)
Desmodium pauciflorum (Nutt.) DC.(c)
Desmodium perpiexum Schub. (r)
Desmodium rotundifolium DC. (r)
Galactia volubifis (L.) Britt. (r)

Stantec

Galactia regularis (L.) BSP.of Atlas
Lespedeza bicolor Turcz. (c)
Lespedeza cuneata (Dumont) G. Don (c)
Lespedeza hirta (L.) Homem. (r)
Lespedeza intermedia (Wats.) Britt. (c)
Lespedeza procumbens Michx. (c)
Lespedeza repens (L.) Bart. (r)
Lespedeza stuevei Nutt. (c)
Lespedeza virginica (L.) Britt. (r)
Phaseolus polystachios (L.) BSP. (r)
Rhynchosia tomentosa (L.) Hook. & Am. (c)
Robinia hispida L. var. *kelseyi* (Hutchins) Isely (c)
Senna hebecarpa (Fem.) Irwin & Bameby (c)
Stylosanthes biflora (L.) BSP. (r)
Tephrosia spicata (Walt) T.& G. (c)
Tephrosia virginiana (L.) Pers.(c)
Trifolium campestre Schreb. (r)

FAGACEAE
Fagus grandifolia Ehrh. (r)
Quercus alba L. (r)
Quercus bicolor Willd. (o)
Quercus coccinea Muenchh. (r)
Quercus falcata Michx. (r)
Quercus imbricaria Michx. (c)
Quercus marilandica Muencch. (r)
Quercus michauxii Nutt. (c, r)
Quercus montana Wilkf. (o)
Quercus muehlenbergii Engelm. (o)
Quercus pagoda Raf (r)
Quercus falcata var. pagodifoiia Eli.
Quercus phelios L. (r)
Quercus rubra L. (r)
Quercus stellata Wang. (r)
Quercus velutina Lam. (c)

GENTIANACEAE
Bartonia panicuiata (Michx.) Muhl. (c)
Gentians saponaria L, (c)
Gentians villosa L. (c)

GERANIACEAE
Geranium carolinianum L. (r)
Geranium maculatum L. (r)

HAMAMELIDACEAE
Liquidambar styraciflua L. (r)

HIPPOCASTANACEAE
Aesculus sylvatica Bartr. (c)

HYPERICACEAE
Hypericum crux-andreae (L.) Crantz (r)
Hypericum gentianoides (L.) BSP. (r)
Hypericum hypericoides L. var. muiricaule (Wilid.) Fem.
Hypericum mutilum L. (o)
Hypericum punctatum Lam. (r)
Hypericum stragulum Adams & Robs. (r)
Triadenum tubulosum (Walt.) Gl. (c)
Triadenum walteri (J.M. Gmel.) Gl. (c)

JUGLANDACEAE
Carya aiba (L.) Ell. (r)
Carya tomentosa (Poir.) Nutt.
Carya cordifonnis (Wang.) K. Koch (r)
Carya giabra (Mill.) Sweet (c)
Carya ovalis (Wang.) Sarg. (c)
Carya ovata (Mill.) K. Koch (c)
Juglans nigra L. (r)

ITEACEAE
Itea virginica L. (c)

LAMIACEAE
Cunila origanoides (L.) Britt. (r)
Lycopus americanus Muhl. ex W. Bart. (r)
Lycopus rubeilus Moench (c)
Lycopus virginicus L. (o)
Prunella vulgaris L. (r)
Pycnanthemum incanum (L.) Michx. (r)
Pycnanthemum tenuifolium Schrad. (c)
Pycnanthemum torrei Benth. (c)
Salvia lyrata L. (o)
Salvia urticifolia L. (c)
Scuteilaria elliptica Muhl. (c)
Scuteilaria integrifolia L. (c)
Trichostema dichotomum L. (r)

LAURACEAE
Lindera benzoin (L.) Blume (r)
Sassafras albidum (Nutt.) Nees (r)

LENTIBULARIACEAE
Utricularia subulata L. (c)

LINACEAE
Linum striatum Walt. (r)

MAGNOLIACEAE
Liriodendron tulipifera L. (r)
Magnolia virginiana L. (r)

MALVACEAE
Hibiscus moscheutos L. (c)

MELASTOMATACEAE
Rhexia mariana L. (r)
Rhexia virginica L. (r)

MORACEAE
Morus rubra L. (r)

MYRICACEAE
Morella cerifera (L.) Small (o)

NELUMBONICEAE
Nelumbo lutea Willd. (c, o)

NYMPHAEACEAE
Nuphar advena Ait. (r)
Nuphar lutea (L.) Sm. ssp. *advena* (Ait.) Kartesz & Gandhi (o)
Nymphaea odorata Ait. (r)

NYSSACEAE
Nyssa sylvatica Marsh. (r)

OLEACEAE
Chionanthus virginicus L. (r)
Fraxinus americans L. (c)
Fraxinus pennsyivanica Marsh. (r)

ONAGRACEAE
Circaea canadensis (L.) Hill
Circaea luteriana L. ssp- *canadensis* (L-) Asch. & Magnus
Ludwigia alternifolia L. (0)
Ludwigia paiustris (L.) Ell. (o)
Oenothera speciosa Nutt. (C)

OROBANCHACEAE
Epifagus virginiana (L.) Bart. (c)
Agalinis purpurea (L.) Pennell (r)
Aureolaria flava (L.) Farw. (r)
Aureolaria virginica (L.) Pennell (r)

OXALIDACEAE
Oxalis stricta L. (r)
Oxalis violacea L. (r)

PASSIFLORACEAE
Passiflora lutea L. (r)

PETIVERIACEAE
Mimulus alatus Ait. (c)

PLANTAGINACEAE
Plantago lanceolata L. (r)
Plantago virginica L. (r)
Chelone glabra L. (c)
Chaenorrhinum minus (L.) Lange (c)
Gratiola pilosa Michx. (r)
Gratiola virginiana L. (c)
Gratiola visciduia Pennell (c)
Nuttallanthus canadensis (L.) DA Su
Penstemon laevigatus Ait- (c)
Veronica arvensis L. (r)
Veronicastrum virginicum (L.) Farw

PLATANACEAE
Platanus occidentalis L. (r)

POLEMONIACEAE
Phlox pilosa L. (c)

POLYGALACEAE
Polygala lutea L. (c)
Polygala sanguinea L. (c)

POLYGONACEAE
Polygonum arifolium L. (o)
Polygonum cespitosum Blume var. *longisetum* (DeBruyft) Stew. (c)
Polygonum densiflorum Meissn. (c)
Polygonum hydropiperoides Michx. var. *setaceum* (Baldw.) Gl. (c)
Polygonum setaceum Eli.
Polygonum lapathifolium L. (c, o)
Polygonum punctatum Ell. (r)
Polygonum sagittatum L. (o)
Polygonum virginianum L. (r, o)
Rumex acetoselia L. (r)

PORTULACACEAE
Claytonia virginica L. (r)
Talinum teretifolium Pursh (r)

PRIMULACEAE
Lysimachia ciliata L. (r)
Lysimachia lanceoiata Walt. (r)
Lysimachia quadrifolia L. (r)

RANUNCULACEAE
Aconitum uncinatum L. (c)
Clematis ochroleuca Ait. (c)
Ranunculus pusilius Poir. (c, o)
Ranunculus recurvatus Poir. (r)
Thalictrum dioicum L (r)
Thalictrum revolutum DC. (c)

ROSACEAE
Agrimonia pubescens Wailr. (C)
Agrimonia rosteliata Walk. (r)
Amelanchier arborea (Michx. f.) Fem. (r)
Aronia arbutifolia (L.) Pers. (r)
Fragaria virginiana Duchesne (r)
Geum canadense Jacq. (r)
Geum virginianum L. (c)

Potentilia canadensis L.
Potentilia simplex Michx. (r)
Prunus angustifolia Marsh. (o)
Prunus serotina Ehrh. (r)
Rosa carolina L. (r)
Rosa palustris Marsh. (r)
Rubus argutus Link (r)
Rubus flagellaris Willd. (r)
Rubus hispidus L. (r)
Rubus occidentalis L. (r)
Spiraea tomentosa L. (c)

RUBIACEAE
Diodia teres Walt. (r)
Galium aparine L. (r)
Galium circaezans Michx. (c)
Galium obtusum Bigel. (r)
Galium pilosum Ait. (r)
Galium triflorum Michx. (c)
Galium uniflorum Michx. (c)
Houstonia caerulea L. (r)
Houstonia purpurea L. (r)
Houstonia tenuifolia Nutt. (c)

SALICACEAE
Populus alba L. (c)
Salix humilis Marsh. (r)
Salix nigra Marsh. (o)
Salix sericea Marsh. (r)

SAPINDACEAE
Acer barbatum Michx. *(c)*
Acer negundo L. *(r)*
Acer rubrum L. (r)

SAURURACEAE
Saururus cemua L. (r)

SAXIFRAGACEAE
Heuchera americans L. (r)
Saxifraga virginiensis Michx. (r)

SCROPHULARIACEAE
Agalinis obtusifolia Raf. (c)
Mimulus alatus Ait. (o)

SOLANACEAE
Physalis heterophylla Nees (c)
Staphylea trifolia L. (r)

ULMACEAE
Ulmus alata Michx. (r)
Ulmus americans L. (r)

ULMACEAE
Celtis occidentalis L. (r)

URTICACEAE
Boehmeria cylindrica (L.) Swartz (r)
Laportea canadensis (L.) Wedd. (c, o)
Pilea pumila (L.) Gray (c, o)

VALERIANACEAE
Valerianeila radiata (L.) Dufr. (c)

VERBENACEAE
Phryma leptostachya L. (c)

VIOLACEAE
Viola primulifolia L. (r)
Viola palmata L. (c, o)
Viola triloba Schwein.
Viola pubescens Ait. (r)
Viola sororia Willd. (r)

VISCACEAE
Phoradendron leucarpum (Raf.) Reveal & M.C. Johnst. (r)
Phoradendron serotinwn (Raf) M.C. Johnst.

VITACEAE
Ampelopsis arbores (L.) Koehne (c)
Parthenocissus quinquefolia (L.) Planch. (r)
Vitis aestivalis Michx. (r)
Vitis labrusca L. (r)
Vitis vulpina L. (r)

* List is primarily based upon Van Aistine et al (1996) with some additions made from data provided by studies on Fort Pickett: WEG *Wetland Vascular Species Checklist* (2007); AMEC Draft Environmental Impact Statement for *The Transformation of the Pennsylvania Army National Guard's 56th Brigade into a Stryker Brigade Combat Team* (2005).

E-2: VIRGINIA PIEDMONT INVASIVE PLANT SPECIES LIST 2014

Scientific Name	Common Name	VA Invasiveness Rank
Ailanthus altissima	Tree-of-heaven	High
Alliaria petiolata	Garlic Mustard	High
Ampelopsis brevipedunculata	Porcelain-berry	High
Celastrus orbiculatus	Oriental Bittersweet	High
Centaurea stoebe ssp. micranthos	Spotted Knapweed	High
Cirsium arvense	Canada Thistle	High
Dioscorea polystachya	Cinnamon Vine	High
Elaeagnus umbellata	Autumn Olive	High
Euonymus alatus	Winged Euonymus	High
Ficaria verna	Lesser Celandine	High
Hydrilla verticillata	Hydrilla	High
Iris pseudacorus	Yellow Flag	High
Lespedeza cuneata	Sericea Lespedeza	High
Ligustrum sinense	Chinese Privet	High
Lonicera japonica	Japanese Honeysuckle	High
Lonicera maackii	Amur Honeysuckle	High
Lonicera morrowii	Morrow's Honeysuckle	High
*Ludwigia grandiflora ssp. hexapetala**	Large flower primrose willow	High
Lythrum salicaria	Purple Loosestrife	High
Microstegium vimineum	Japanese Stiltgrass	High
Murdannia keisak	Marsh dewflower	High
Myriophyllum aquaticum	Parrot Feather	High
Myriophyllum spicatum	Eurasian Water-milfoil	High
*Oplismenus hirtellus ssp. undulatifolius**	Wavyleaf Grass	High
Persicaria perfoliata	Mile-a-minute	High
Phragmites australis ssp. australis	Common Reed	High
Pueraria montana var. lobata	Kudzu	High
Reynoutria japonica	Japanese knotweed	High
Rosa multiflora	Multiflora Rose	High
Rubus phoenicolasius	Wineberry	High
Sorghum halepense	Johnson Grass	High
Urtica dioica	European Stinging Nettle	High
Acer platanoides	Norway Maple	Medium
Agrostis capillaris	Colonial bent-grass	Medium

Scientific Name	Common Name	VA Invasiveness Rank
Akebia quinata	Five-leaf Akebia	Medium
Albizia julibrissin	Mimosa	Medium
Arthraxon hispidus var. hispidus	Joint Head Grass	Medium
Berberis thunbergii	Japanese Barberry	Medium
Cirsium vulgare	Bull Thistle	Medium
Dipsacus fullonum	Wild Teasel	Medium
Egeria densa	Brazilian Waterweed	Medium
Euonymus fortunei	Winter Creeper	Medium
Glechoma hederacea	Gill-over-the-ground	Medium
Hedera helix	English ivy	Medium
*Heracleum mantegazzianum**	Giant Hogweed	Medium
Holcus lanatus	Common Velvet Grass	Medium
Humulus japonicus	Japanese Hops	Medium
*Ipomoea aquatica**	Water spinach	Medium
Ligustrum obtusifolium var. obtusifolium	Border privet	Medium
Lonicera tatarica	Tartarian Honeysuckle	Medium
Lysimachia nummularia	Moneywort	Medium
Miscanthus sinensis	Chinese Silvergrass	Medium
Najas minor	Brittle Naiad	Medium
Paulownia tomentosa	Royal Paulowina	Medium
Persicaria longiseta	Long-bristled Smartweed	Medium
Phyllostachys aurea	Golden Bamboo	Medium
Poa compressa	Flat-stemmed Bluegrass	Medium
Poa trivialis	Rough Bluegrass	Medium
Pyrus calleryana	Callery Pear	Medium
Rhodotypos scandens	Jetbead	Medium
Rumex acetosella	Sheep sorrel	Medium
*Salvinia molesta**	Giant Salvinia	Medium
*Solanum viarum**	Tropical Soda Apple	Medium
Spiraea japonica	Japanese Spiraea	Medium
Stellaria media	Common Chickweed	Medium
Veronica hederifolia	Ivy-leaved Speedwell	Medium
Viburnum dilatatum	Linden arrow-wood	Medium
Wisteria sinensis	Chinese Wisteria	Medium
Commelina communis	Asiatic Dayflower	Low
Elaeagnus pungens	Thorny Olive	Low

Scientific Name	Common Name	VA Invasiveness Rank
Lespedeza bicolor	Shrubby Bushclover	Low
Lonicera fragrantissima	Winter Honeysuckle	Low
Melia azedarach	Chinaberry	Low
Morus alba	White Mulberry	Low
Perilla frutescens	Beefsteak Plant	Low
Phleum pratense	Timothy	Low
Populus alba	Silver Poplar	Low
Rumex crispus ssp. crispus	Curly dock	Low
Securigera varia	Crown-vetch	Low
Ulmus pumila	Siberian Elm	Low
Vinca major	Greater Periwinkle	Low
Vinca minor	Periwinkle	Low
Wisteria floribunda	Japanese Wisteria	Low

*Information from http://www.dcr.virginia.gov/natural-heritage/invsppdflist.

APPENDIX E: MAMMALS

MAMMALS ON ARNG-MTC FORT PICKETT BLACKSTONE, VIRGINIA

Order	Common Name	Scientific Name
ARTIODACTYLA		
	White-tailed deer	*Odocoileus virginianus (C)*
CARNIVORA		
	Red fox	*Vuipes vulpes*
	Gray fox	*Urocyon cinereoargenteus*
	Coyote	*Canis latrans*
	Black Bear	*Ursus americanus*
	Raccoon	*Procyon lotor (C)*
	River otter	*Lutra camadensis (C)*
CHIROPTERA		
	Big brown bat	*Eptesicus fuscus*
	Tricolored bat	*Pipistrellus subflavus*
	Evening bat	*Nycticeius humeralis*
	Hoary bat	*Lasiurus cinereus*
	Northern long-eared bat	*Myotis septentrionalis*
	Little brown bat	*Myotis lucifugus*
	Silver-haired bat	*Lasionycteris noctivagans*
	Eastern red bat	*Lasiurus borealis (C)*
INSECTIVORA		
	Least shrew	*Cryptotis parva (C)*
	Northern short-tailed shrew	*Blarina brevicauda(C)*
	Southeastern shrew	*Sorex longirostris*
	Southern short-tailed shrew	*Blarina carolinensls(C)*
	Eastern mole	*Scalopus aquaticus(C)*
LAGOMORPHA		
	Eastern cottontail	*Sylvilagus floridanus*
MARSUPIALIA		
	Opossum	*Dideiphis marsupialis(C)*
RODENTIA		
	Eastern chipmunk	*Tanuas striatus (C)*
	Gray Squirrel	*Sciurus carolinensis (C)*
	Woodchuck	*Marmota monax (C)*
	Southern flying squirrel	*Glaucomys volans*
	Beaver	*Castor Canadensis (C)*
	Eastern harvest mouse	*Reithrodontomys humulis*
	Meadow vole	*Microfus pennsylvanicus*
	Hispid cotton rat	*Sigmodon hispidus*
	Golden mouse	*Ochrotomys nuttalli (C)*
	White-footed mouse	*Peromyscus leucopus*
	Woodland vole	*Microfus pinetorum*
	Muskrat	*Ondantra zibethica*
	Norway rat	*Rattus norvegicus*
	House mouse	*Mus musculus (C)*
	Black rat	*Rattus rattus*
	Meadow jumping mouse	*Zapus hunsonius*

*Adapted from: AMEC Draft Environmental Impact Statement for *The Transformation of the Pennsylvania Army National Guard's 56th Brigade into a Stryker Brigade Combat Team* (2005).

APPENDIX F: HERPTOFAUNA

Stantec

HERPTOFAUNA FOUND ON ARNG-MTC FORT PICKETT BLACKSTONE, VIRGINIA

Scientific Name	Common Name	2016	2006	2005	2003
Acris crepitans	Northern Cricket Frog	X	X	X	X
Anaxyrus a. americanus[1]	American Toad	X	X	X	X
Anaxyrus fowleri[2]	Fowler's Toad	X	X	X	X
Gastrophryne carolinensis	Eastern Narrow-mouthed Toad	X	X	X	X
Hyla chrysoscelis	Cope's Gray Treefrog	X	X	X	X
Hyla cinerea	Green Treefrog	X			
Hyla femoralis	Pine Woods Treefrog		X		
Hyla versicolor	Gray Treefrog	X	X	X	X
Lithobates catesbeianus[3]	American Bullfrog	X	X	X	X
Lithobates clamitans[4]	Green Frog	X	X	X	X
Lithobates palustris[5]	Pickerel Frog	X	X	X	X
Lithobates sphenocephalus[6]	Southern Leopard Frog	X	X	X	X
Pseudacris crucifer	Spring Peeper	X	X	X	X
Pseudacris feriarum	Upland Chorus Frog	X	X	X	X
Ambystoma maculatum	Spotted Salamander	X	X		X
Ambystoma opacum	Marbled Salamander	X	X	X	X
Amphiuma means	Two-toed Amphiuma	X			
Desmognathus fuscus	Northern Dusky Salamander	X	X	X	X
Eurycea cirrigera	Southern Two-lined Salamander	X	X	X	X
Eurycea guttolineata	Three-lined Salamander			X	
Hemidactylium scutatum	Four-toed Salamander			X	
Necturus punctatus	Dwarf Waterdog				X
Notophthalmus v. viridescens	Red-spotted Newt	X	X	X	X
Plethodon chlorobryonis[7]	Atlantic Coast Slimy Salamander				
*Plethodon glutinosus**	Northern Slimy Salamander	X	X	X	
Pseudotriton m. montanus	Eastern Mud Salamander	X	X	X	
Pseudotriton r. ruber[7]	Northern Red Salamander				

[1] Formerly *Bufo americanus*

[2] Formerly *Bufo fowleri*

[3] Formerly *Rana catesbeiana*

[4] Formerly *Rana clamitans melanota*

[5] Formerly *Rana palustris*

[6] Formerly *Rana phenocephala*

[7] Last identified in 1953.

Scientific Name	Common Name	2016	2003	1999
Chelydra serpentina	Snapping Turtle	X	X	X
Chrysemys p. picta	Eastern Painted Turtle	X	X	X
Clemmys guttata	Spotted Turtle		X	X
Kinosternon s. subrubrum	Eastern Mud Turtle	X		
Pseudemys c. concinna	Eastern River Cooter	X	X	
Pseudemys rubriventris	Northern Red-bellied Cooter	X	X	
Sternotherus odoratus	Eastern Musk Turtle	X	X	
Terrapene c. carolina	Eastern Box Turtle	X		X
Trachemys s. scripta	Yellow-bellied Slider		X	
Aspidoscelis s. sexlineata	Eastern Six-lined Racerunner	X		X
Plestiodon fasciatus[1]	Common Five-lined Skink	X	X	
Plestiodon inexpectatus[2]	Southeastern Five-lined Skink			X
Plestiodon laticeps[3]	Broad-headed Skink	X		
Sceloporus undulatus	Eastern Fence Lizard	X	X	X
Scincella lateralis	Ground Skink	X		X
Agkistrodon contortrix mokasen	Northern Copperhead	X		X
Carphophis a. amoenus	Eastern Wormsnake	X		
Cemophora coccinea copei	Northern Scarletsnake			X
Coluber c. constrictor	Northern Black Racer	X	X	
Diadophis punctatus edwardsii	Northern Ring-necked Snake	X		
Diadophis p. punctatus	Southern Ring-necked Snake			
Haldea striatula	Rough Earthsnake	X		
Heterodon platirhinos	Eastern Hog-nosed Snake		X	X
Lampropeltis calligaster rhombomaculata	Northern Mole Snake			X
Lampropeltis getula	Eastern Kingsnake	X		X
Nerodia s. sipedon	Northern Watersnake	X	X	X
Opheodrys aestivus	Northern Rough Greensnake		X	
Pantherophis alleghaniensis	Eastern Ratsnake	X	X	X
Regina septemvittata	Queensnake			X
Storeria d. dekayi	Northern Brownsnake	X		
Storeria o. occipitomaculata	Northern Red-bellied Snake	X		X
Thamnophis s. sauritus	Common Ribbonsnake	X		X
Thamnophis s. sirtalis	Eastern Gartersnake		X	

[1] Formerly *Eumeces fasciatus*

[2] Formerly *Eumeces inexpectatus*

[3] Formerly *Eumeces laticeps*

*Lists based upon information in the following studies:

Herpetological Survey 2016 ARNG-MTC Fort Pickett Blackstone, Virginia. Stantec Consulting Services, Richmond, Virginia. 2017.

Mitchell, J.C. and K.K. Reay. 1999. Atlas of Amphibians and Reptiles in Virginia. Special Publication Number 1, Virginia Department of Game and Inland Fisheries, Richmond, VA. 122 pp.

Roble, S.M., A.C. Chazal, K.L. Derge, and C.S. Hobson. 2003. Records of amphibians and reptiles from Fort Pickett, Virginia. Catesbeiana 23(2): 35-60.

St. Germain, M. 2005b. Assessing the species richness of amphibians at Army National Guard Maneuver Training Center Fort Pickett, Blackstone, VA. Conservation Management Institute- Military Lands Division, College of Natural Resources, Virginia Polytechnic Institute and State University, Blacksburg, VA. CMI-MLD R-36.

St. Germain, M. J.; A.A. Roberts, and J.L. Rote. 2007. Species Richness of Amphibians at Army National Guard Maneuver Training Center - Fort Pickett, Blackstone, Virginia. Conservation Management Institute - Military Lands Division, College of Natural Resources, Virginia Polytechnic Institute and State University, Blacksburg, Virginia CMI-MLD R-57 20070710.

Herpetological Survey 2016 ARNG-MTC Fort Pickett Blackstone, Virginia. Stantec Consulting Services, Richmond, Virginia.

APPENDIX G: BIRDS

BIRDS ON ARNG-MTC FORT PICKETT, BLACKSTONE, VIRGINIA

Table G-1: Migratory Birds

Common Name	Scientific name	Seasons
American bittern	*Botaurus lentiginosus*	Wintering
Bald eagle	*Haliaeetus leucocephalus*	Year-round
Fox sparrow	*Passerella iliaca*	Wintering
Kentucky warbler	*Oporornis formosus*	Breeding
Least bittern	*Ixobrychus exilis*	Breeding
Peregrine falcon	*Falco peregrinus*	Wintering
Pied-billed grebe	*Podilymbus podiceps*	Year-round
Prairie warbler	*Dendroica discolor*	Breeding
Prothonotary warbler	*Protonotaria citrea*	Breeding
Red-headed woodpecker	*Melanerpes erythrocephalus*	Year-round
Rusty blackbird	*Euphagus carolinus*	Wintering
Short-eared owl	*Asio flammeus*	Wintering
Wood thrush	*Hylocichla mustelina*	Breeding
Worm eating warbler	*Helmitheros vermivorum*	Breeding

*List is based upon information retrieved from: U.S. Fish and Wildlife Service (USFWS). Information for Planning and Conservation (IPAC). Accessed December 14, 2016. https://ecos.fws.gov/ipac/

Table G-2: Birds Identified on Fort Pickett

Common Name	Species
Acadian Flycatcher	*Empidonax virescens*
American Crow	*Corvus brachyrhynchos*
American Goldfinch	*Spinus tristis*
American Kestrel	*Falco sparverius*
American Robin	*Turdus migratorius*
Bald Eagle	*Haliaeetus leucocephalus*
Barn Swallow	*Hirundo rustica*
Belted Kingfisher	*Megaceryle alcyon*
Black-and-white Warbler	*Mniotilta varia*
Blue Grosbeak	*Passerina caerulea*
Blue Jay	*Cyanocitta cristata*
Blue-gray Gnatcatcher	*Polioptila caerulea*
Brown Thrasher	*Toxostoma rufum*
Brown-headed Cowbird	*Molothrus ater*
Canada Goose	*Branta canadensis*
Carolina Chickadee	*Poecile carolinensis*
Carolina Wren	*Thryothorus ludovicianus*
Cedar Waxwing	*Bombycilla cedrorum*
Chimney Swift	*Chaetura pelagica*

Common Name	Species
Chipping Sparrow	*Spizella passerina*
Common Yellowthroat	*Geothlypis trichas*
Cooper's Hawk	*Accipiter cooperi*
Dark-eyed Junco	*Junco hyemalis*
Downy Woodpecker	*Picoides pubescens*
Eastern Bluebird	*Sialia sialis*
Eastern Kingbird	*Tyrannus tyrannus*
Eastern Meadowlark	*Sturnella magna*
Eastern Phoebe	*Sayornis phoebe*
Eastern Towhee	*Pipilo erythrophthalmus*
Eastern Wood-Pewee	*Contopus virens*
European Starling	*Sturnus vulgaris*
Field Sparrow	*Spizella pusilla*
Fish Crow	*Corvus ossifragus*
Golden-crowned Kinglet	*Regulus satrapa*
Grasshopper Sparrow	*Ammodramus savannarum*
Gray Catbird	*Dumetella carolinensis*
Great Blue Heron	*Ardea herodias*
Great Crested Flycatcher	*Myiarchus crinitus*
Hairy Woodpecker	*Leuconotopicus villosus*
Hermit Thrush	*Catharus guttatus*
Hooded Warbler	*Setophaga citrina*
Horned Lark	*Eremophila alpestris*
House Finch	*Haemorhous mexicanus*
Indigo Bunting	*Passerina cyanea*
Killdeer	*Charadrius vociferus*
Mallard	*Anas platyrhynchos*
Merlin	*Falco columbarius*
Mississippi Kite	*Ictinia mississippiensis*
Mourning Dove	*Zenaida macroura*
Northern Bobwhite	*Colinus virginianus*
Northern Cardinal	*Cardinalis cardinalis*
Northern Flicker	*Colaptes auratus*
Northern Harrier	*Circus cyaneus*
Northern Mockingbird	*Mimus polyglottos*
Northern Rough-winged	*Stelgidopteryx serripennis*
Swallow	*Hirundinidae*
Orchard Oriole	*Icterus spurius*
Osprey	*Pandion haliaetus*
Ovenbird	*Seiurus*
Palm Warbler	*Setophaga palmarum*
Pileated Woodpecker	*Hylatomus pileatus*
Pine Warbler	*Setophaga pinus*

Common Name	Species
Prairie Warbler	*Setophaga discolor*
Purple Martin	*Progne subis*
Red-bellied Woodpecker	*Melanerpes carolinus*
Red-eyed Vireo	*Vireo olivaceus*
Red-headed Woodpecker	*Melanerpes erythrocephalus*
Red-shouldered Hawk	*Buteo lineatus*
Red-tailed Hawk	*Buteo jamaicensis*
Red-winged Blackbird	*Agelaius phoeniceus*
Ruby-crowned Kinglet	*Regulus calendula*
Ruby-throated Hummingbird	*Archilochus colubris*
Savannah Sparrow	*Passerculus sandwichensis*
Scarlet Tanager	*Piranga olivacea*
Scissor-tailed Flycatcher	*Tyrannus forficatus*
Song Sparrow	*Melospiza melodia*
Summer Tanager	*Piranga rubra*
Swamp Sparrow	*Melospiza georgiana*
Tree Swallow	*Tachycineta bicolor*
Tufted Titmouse	*Baeolophus bicolor*
Turkey Vulture	*Cathartes aura*
White-breasted Nuthatch	*Sitta carolinensis*
White-crowned Sparrow	*Zonotrichia leucophrys*
White-eyed Vireo	*Vireo griseus*
White-throated Sparrow	*Zonotrichia albicollis*
Wild Turkey	*Meleagris gallopavo*
Winter Wren	*Troglodytes hiemalis*
Wood Thrush	*Hylocichla mustelina*
Yellow-billed Cuckoo	*Coccyzus americanus*
Yellow-breasted Chat	*Icteria virens*
Yellow-rumped Warbler	*Setophaga coronata*
Yellow-throated Vireo	*Vireo flavifrons*
Yellow-throated Warbler	*Setophaga dominica*

*List is based upon information from: St. Germain, M. J. and R. M. Schneider. 2012. Grassland bird density and diversity on ARNG-MTC Ft. Pickett, Blackstone, Virginia. Conservation Management Institute- Military Lands Division, College of Natural Resources, Virginia Polytechnic Institute and State University, Blacksburg, Virginia.

MEMORANDUM OF UNDERSTANDING
BETWEEN THE

U.S. DEPARTMENT OF DEFENSE
AND THE
U.S. FISH AND WILDLIFE SERVICE

TO PROMOTE THE CONSERVATION OF MIGRATORY BIRDS

This Memorandum of Understanding (MOU) is entered into between the U.S. Department of Defense (DoD) and the U.S. Fish and Wildlife Service (FWS) (hereinafter "the Parties").

A. Purpose and Scope

This MOU is entered into pursuant to Executive Order 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds* (66 FR 3853 [January 17, 2001]). The purpose of this MOU is to promote the conservation of migratory bird populations while sustaining the use of military managed lands and airspace for testing, training, and operations.

This MOU does not address incidental take resulting from military readiness activities or active DoD airfield operations. Military readiness activities are covered by 50 CFR 21.15 (Authorization of take incidental to military readiness activities). Bird-related management activities with a potential to affect airfield operations or safety will be managed according to DoDI 4165.57 and the airfield's Bird/Wildlife Aircraft Strike Hazards (BASH) Program.

Installation commanders responsible for military airfields will not implement wildlife conservation prescriptions set forth in this MOU if they conclude that such actions will negatively impact military mission or combat capability, or if such action will increase the possibility of aircraft-wildlife strikes. Should installation commanders choose to implement wildlife conservation measures, they must follow BASH guidelines, and consider military mission impacts and elevated risk to aircraft and aircrew.

This MOU specifically pertains to the following categories of DoD activities:

1) Natural resource management activities, including, but not limited to, habitat management, erosion control, forestry activities, hunting, fishing, agricultural outleasing, conservation law enforcement, invasive-weed management, and prescribed burning;[1]

2) Installation support activities, including, but not limited to, administration, retail sales, food service, health care, water and sewage treatment, supply and storage, education, housing, equipment maintenance, base transportation, laundry and dry cleaning, recreation, and religious activities;

3) Operation of industrial activities;

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[1] Vegetation management within the airfield environment shall be governed by the installation Integrated Natural Resource Management Plans (INRMP) and associated Bird/Wildlife Aircraft Strike Hazard (BASH) Plan.

4) Construction, maintenance, renovation, or demolition of facilities that support the activities described in items 1 through 3; and

5) Prevention or abatement of pollution or detrimental alteration of the environment for the benefit of migratory birds, as practicable.

This MOU identifies specific activities where cooperation between the Parties will contribute substantially to the conservation of migratory birds and their habitats. This MOU does not alter or waive any responsibilities of DoD or FWS, as applicable, under the Migratory Bird Treaty Act (MBTA), the Bald and Golden Eagle Protection Act (Eagle Act), and the Endangered Species Act (ESA); nor does it authorize the take of migratory birds.

B. Authorities

The Parties' responsibilities under the MOU are authorized by provisions of the following laws and authorities:

- Alaska National Interest Lands Conservation Act of 1980 (16 U.S.C. 410hh-3233)
- Bald and Golden Eagle Protection Act of 1940, as amended (16 U.S.C. 668-668d)
- Endangered Species Act of 1973, as amended (16 U.S.C. 1531-1544)
- Executive Order 13186: Responsibilities of Federal Agencies to Protect Migratory Birds, 2001 (66 FR 3853 [January 17, 2001])
- Fish and Wildlife Act of 1956, as amended (16 U.S.C. 791a *et seq.*)
- Fish and Wildlife Conservation Act of 1980, as amended (16 U.S.C. 2901-2911)
- Fish and Wildlife Coordination Act of 1980, as amended (16 U.S.C. 661-667)
- Migratory Bird Conservation Act of 1929, as amended (16 U.S.C. 715 *et seq.*)
- Migratory Bird Treaty Act, of 1918, as amended (16 U.S.C. 703-711)
- National Environmental Policy Act of 1969 (42 U.S.C. 4321-4347)
- Sikes Act Improvement Act of 1997 (16 U.S.C. 670a-670o)
- Agreements to limit encroachments and other constraints on military training, testing, and operations (10 U.S.C. 2684a)

C. Background

Department of Defense

The DoD mission is to provide for the Nation's defense. DoD's Natural Resources Program works to ensure continued access to land, air, and water resources for realistic military training and testing, while ensuring that the natural and cultural resources entrusted to DoD's care are sustained in a healthy condition.

The DoD is an active participant in international bird conservation partnerships including Partners in Flight (PIF) and the North American Bird Conservation Initiative (NABCI). Through PIF and NABCI, DoD works in partnership with numerous federal and state agencies and nongovernmental organizations to conserve migratory and resident birds and to enhance their survival. Military lands frequently provide some of the best remaining habitat for migratory and resident bird species, and DoD plans to continue supporting bird conservation activities.

Integrated Natural Resources Management Plans (INRMPs) offer a coordinated approach for incorporating habitat conservation efforts into installation management. INRMPs provide significant baseline information that can be used when preparing National Environmental Policy Act (NEPA) documents for all DoD management activities. This linkage helps to ensure that appropriate conservation and mitigation measures are identified in NEPA documents and committed to, when appropriate, in final decision documents.

The DoD develops INRMPs cooperatively with the FWS and appropriate state fish and wildlife agencies. DoD's strategy focuses on inventorying and long-term monitoring to determine changes in migratory bird populations on DoD installations. Effective on-the-ground management may then be applied to those areas identified as having the highest conservation value. DoD's goal is to support military training and testing by providing for no net loss of an installation's military readiness capability and capacity. DoD implements cooperative projects and programs on military lands to benefit the health and well-being of birds and their habitats, when consistent with the military mission, military readiness, and the safety of DoD personnel.

The DoD has a cooperative network of natural resources personnel and others from military installations across the United States that provides technical assistance, including how to incorporate landbird, shorebird, and waterbird habitat management efforts into INRMPs. These bird conservation experts work collaboratively to conserve migratory and resident birds and their habitats on DoD lands.

The DoD implements bird inventories and monitoring programs in numerous ways, including Next Generation Radar (NEXRAD) for studying bird movements in the atmosphere, and maintains an integrated pest management (IPM) program designed to reduce the use of pesticides, herbicides, fungicides, etc. In addition, the management of natural resources on DoD properties benefits migratory birds through efforts such as invasive-species control, habitat enhancement/restoration, water-quality improvement, and wetland conservation.

Fish and Wildlife Service

As a federal agency within the U.S. Department of the Interior, the FWS mission is to work with others to conserve, protect, manage, and enhance fish, wildlife, plants, and their habitats for the continuing benefit of the American people. The FWS Migratory Bird Program serves as a focal point in the United States for policy development and strategic planning, program implementation, and evaluation of actions designed to conserve migratory birds and their habitats.

The FWS is legally mandated to implement the conservation provisions of the MBTA, which includes responsibilities for managing migratory bird populations, domestic and international coordination, and the development and enforcement of regulations that govern authorized take of migratory birds. The Migratory Bird Conservation Act established the Migratory Bird Conservation Commission to approve land acquisition with Migratory Bird Conservation Funds. The Fish and Wildlife Coordination Act (FWCA) requires consultation under certain circumstances and added provisions to recognize the important contribution of wildlife resources to the Nation. The FWCA requires consideration and coordination of wildlife conservation, including habitat protection, through acquisition, enhancement, and/or management and avoidance and minimization of avian stressors related to federal activities.

The following FWS programs have responsibilities with regards to bird conservation activities:

1) The Division of Migratory Bird Management and the Migratory Bird Programs in FWS Regional Offices serve as focal points for policy development and strategic planning. These offices develop and implement monitoring and management initiatives that help maintain healthy populations of migratory birds and their habitats, and provide continued opportunities for citizens to enjoy bird-related recreation.

2) The Division of Bird Habitat Conservation is instrumental in supporting habitat conservation partnerships through the administration of bird conservation grant programs and development of Joint Ventures that serve as major vehicles for implementing the various bird conservation plans across the country.

3) Ecological Services Field Offices across the country serve as the primary contacts for technical assistance and environmental reviews involving migratory bird issues. The Field Offices coordinate with the Regional Migratory Bird Offices, as necessary, regarding permits and overall migratory bird conservation coordination.

4) The Office of Law Enforcement is the principal FWS program that enforces the legal provisions of the MBTA, Eagle Act, ESA, and other laws pertaining to migratory birds.

5) The National Wildlife Refuge (NWR) System manages NWRs and Waterfowl Production Areas across the country, many of which were established to protect and conserve migratory birds. NWRs not only protect important bird habitat, but also focus on monitoring migratory bird populations, restoring and maintaining native habitats, and educating the public on recreational and economic benefits of migratory birds.

6) The Science Applications program works with other FWS programs and partners to ensure that the necessary science, tools, and capacity are available for planning and implementing the most efficient and effective conservation actions to protect fish and wildlife, including migratory birds. The office facilitates regional self-directed science management partnerships called Landscape Conservation Cooperatives to develop and apply shared science capacity to conservation.

D. Statement of Mutual Interest and Benefit

The Parties have a common interest in the conservation and management of America's natural resources. The Parties agree that migratory birds are important components of biological diversity, and that the conservation of migratory birds will help sustain ecological systems and help meet the public demand for conservation education and outdoor recreation, such as wildlife viewing and hunting opportunities. The Parties also agree that it is important to focus on reducing stressors on bird populations, restore and enhance habitat where actions can benefit specific ecosystems and migratory birds dependent upon them, and recognize that actions taken to benefit some migratory bird populations may adversely affect other migratory bird populations. The Parties also agree that while it is the FWS' aim to ensure biologically diverse, thriving habitat for migratory birds away from airfields, it is DoD's aim to ensure flight safety by making airfield environments as unattractive as possible to migratory birds while supporting FWS' efforts away from airfields.

E. Responsibilities of Both Parties

The Parties agree that this MOU shall be implemented to the extent permitted by law and in harmony with evolving requirements of agency missions, subject to the availability of appropriations and budgetary limits. Both Parties shall:

1) Support the conservation intent of Executive Order 13186, and the migratory bird conventions by:

    a) Integrating bird conservation principles, measures, and practices into agency planning and actions; and

    b) Avoiding or minimizing, to the extent practicable, the exposure of birds and their resources to avian stressors that result in take.

2) Emphasize an interdisciplinary, collaborative approach to migratory bird conservation in cooperation with other governments, state and federal agencies, and non-federal partners within the geographic framework of the NABCI Bird Conservation Regions.

3) Work to protect, restore, and enhance migratory bird habitats, as practicable, on DoD-managed lands, in ways that do not conflict with or impede military training and testing, by:

    a) Designing and executing actions to minimize, to the extent practicable and consistent with the military mission, avian stressors on migratory bird populations, including impacts to breeding, migration, or wintering habitats; and by developing and implementing, as appropriate, conservation measures that could reduce the take of migratory birds or enhance the quality of the habitats they use;

    b) Working to identify, conserve, and manage significant bird conservation sites that occur on DoD-managed lands;

    c) Preventing or abating pollution or detrimental alteration of the environment for the benefit of migratory birds, as practicable; and

    d) Preventing the introduction and establishment of, and controlling and reducing the spread of existing, non-native invasive species that may be harmful to native flora and fauna, including migratory bird populations, as required by Executive Order 13112 on Invasive Species.

4) Work with willing landowners to prevent or minimize the loss or degradation of migratory bird habitats on lands adjacent or near military installation boundaries. This cooperative conservation may include:

    a) Participating in efforts to identify, protect, and conserve important migratory bird habitats or other significant bird conservation sites and ecological conditions that occur in landscapes or watersheds that may be of conservation value to migratory birds found on DoD lands, and that also buffer one or more installations from adverse impacts to DoD mission or resource-management activities;

b) Providing information on migratory bird resources found on DoD lands for partners to include and integrate into their outreach and education materials and activities; and

c) Using available authorities to enter into agreements with federal, state, tribal, or other governmental entities, or nongovernmental organizations to conserve and enhance habitats in a manner compatible with military operations.

5) Promote collaborative projects such as:

a) Developing or using existing inventory and monitoring programs, at appropriate scales, with national or regional standardized protocols, to assess the status and trends of bird populations and habitats, including migrating, breeding, and wintering birds;

b) Designing management studies and research/monitoring projects using national or regional standardized protocols and programs to identify the habitat conditions needed by applicable species of concern, to understand interrelationships of co-existing species, and to evaluate the effects of management activities on habitats and populations of migratory birds;

c) Sharing inventory, monitoring, research, and study data for breeding, migrating, and wintering bird populations and habitats in a timely fashion with national data repositories such as the Avian Knowledge Network, National Point Count Database, and Monitoring Avian Productivity and Survivorship (MAPS);

d) Working in conjunction with each other and federal and state agencies to develop reasonable and effective conservation measures for actions that reduce the exposure of birds and their habitats to avian stressors;

e) Participating in or promoting the implementation of existing regional or national inventory and monitoring programs such as Breeding Bird Survey (BBS), Christmas Bird Counts, bird atlas projects, or game-bird surveys (e.g., mid-winter waterfowl surveys) on DoD lands where practicable and feasible;

f) Using existing partnerships and exploring opportunities for expanding and creating new partnerships to facilitate combined funding for inventory, monitoring, management studies, and research; and

g) Improving habitat on lands adjacent to DoD-managed lands through programs such as the DoD Readiness and Environmental Protection Integration and Land and Water Conservation Fund programs.

6) Work cooperatively to identify and utilize existing conservation measures to avoid or minimize the effects of avian stressors, and develop new conservation measures as

needed.

7) Per Executive Order 13186 (Sec. 3(12)), provide training opportunities to appropriate personnel on responsibilities under the MBTA, the Eagle Act, and other regulations protecting birds, current processes for coordination on bird conservation issues, strategies for properly assessing how actions effect bird populations, and recommended approaches on how to avoid or minimize the exposure of birds and their habitats to avian stressors.

8) Participate annually in the interagency Council for the Conservation of Migratory Birds. The duties of the Council include the following:

    a) Sharing resource information to help conserve and manage migratory birds;

    b) Fostering partnerships to further the goals of Executive Order 13186;

    c) Reporting annually on Executive Order accomplishments and recommendations; and

    d) Selecting an annual recipient of a Presidential Migratory Bird Federal Stewardship Award.

9) Promote migratory bird conservation nationally and internationally through activities such as National Public Lands Day and International Migratory Bird Day.

F. Department of Defense Responsibilities

1) Follow all migratory bird permitting requirements for intentional take under 50 CFR 21.22 (banding or marking), 21.23 (scientific collecting), 21.26 (special Canada Goose permit), 21.27 (special purposes), or 21.41 (depredation). Though no permit is required to take birds in accordance with 50 CFR 21.43 - 21.47 (depredation orders), follow all regulatory requirements set forth in those sections when applicable.

2) Consistent with military mission requirements, encourage incorporation of comprehensive migratory bird management objectives into relevant DoD planning documents, including INRMPs, Integrated Pest Management Plans (IPMPs), Installation Master Plans, NEPA analyses, and other relevant documents. Comprehensive planning efforts for migratory birds include PIF Bird Conservation Plans, the North American Waterfowl Management Plan, U.S. Shorebird Conservation Plan, North American Waterbird Conservation Plan, and associated regional plans where available.

3) Consistent with current and emerging mission requirements, manage military lands and non-military readiness activities in a manner that supports migratory bird conservation, habitat protection, restoration, and enhancement.

4) Inventory and monitor bird populations on DoD lands to the extent feasible to facilitate decisions about the need for, and effectiveness of, conservation efforts

5) In accordance with DoD *INRMP Implementation Manual* (DoDM 4715.03, 2013),work

cooperatively with FWS and state and fish and wildlife agencies to promote timely development, effective review, and revisions of INRMPs, including any potential revisions to promote the conservation of migratory birds.

6) Incorporate conservation measures addressed in regional or state bird conservation plans in the INRMP development process.

7) Consistent with safety and security requirements, allow the FWS and other partners reasonable access to military lands for conducting sampling or survey programs, including but not limited to MAPS, BBS, International Shorebird Survey, game-bird surveys, and breeding bird atlases.

8) Consistent with safety and security requirements and bird conservation responsibilities, support the economic and recreational benefits of bird-related activities by allowing public access to military lands for recreational uses, such as bird watching and other non-consumptive activities.

9) Develop policies and procedures for facilities design that will promote the conservation of migratory bird populations and habitat, including:

    a) Mitigating the negative impacts of reflective glass in building design by considering building location and orientation with respect to migratory bird areas, and use of other mitigation techniques, such as reducing the amount of reflective glass on buildings;

    b) Maximizing the use of native landscaping to promote migratory bird habitat, except in areas subject to BASH hazards.

    c) Turning off interior building lighting at night, especially lighting in offices with exterior windows that face outward to exterior building surfaces that may be visible to migratory or resident birds.

10) Prior to implementing any activity that has, or is likely to have, a measurable negative effect on migratory bird populations:

    a) Identify the migratory bird species likely to occur in the area of the proposed action, and determine if any species of concern could be affected by the activity;

    b) Assess and document, through the project planning process (e.g., NEPA), the potential effects of the proposed action on species of concern. Use best available demographic, population, or habitat-association data in the assessment of effects upon species of concern; and

    c) Engage in early planning and scoping with the FWS to proactively address migratory bird conservation, and to initiate appropriate actions to avoid or minimize the exposure of birds and their habitats to avian stressors that may result in the take of migratory birds.

11) Continue to promote the conservation of migratory birds on military lands, to the extent

permitted by law, subject to the availability of appropriations, within Administration budgetary limits, and where in harmony with DoD missions.

a) Fire and fuels-management practices. Fire plays an important role in shaping plant and animal communities, and is a valuable tool in restoring habitats altered by decades of fire suppression. Fire management may include fire suppression, fire prevention, fuels treatment, and prescribed burning. Prescribed burning is one of the most effective tools in managing grassland and longleaf pine/wiregrass ecosystems. Fire-management planning efforts will consider the effects of fire management strategies on the conservation of migratory bird populations, and should be combined with monitoring to properly assess fire management on relevant habitats and species.

b) Management practices for invasive and aquatic nuisance species. Invasive and aquatic nuisance species are a threat to native plants and wildlife throughout the United States, including on military lands. Efforts to prevent, control, and contain these species must take into account both the impacts from invasive species and the effects of the control efforts on migratory bird populations. Invasive species that can threaten migratory birds and their habitats include, but are not limited to, exotic grasses, trees and weeds, terrestrial and aquatic insects and organisms, non-native birds, and stray and feral cats.

c) Communications towers, utilities, and energy development. Increased communications demands, changes in technology, and the development of alternative energy sources have resulted in additional exposure of migratory birds and their resources to avian stressors. DoD will review best practices outlined in FWS Guidance, and consult with FWS as needed when considering the development of these technologies on military lands. Construction of new utility and energy systems and associated infrastructure should avoid or minimize the exposure of birds and their resources to avian stressors. Consideration also may be given to retrofitting existing utilities to reduce impacts. Available guidance includes (but is not limited to):

   i. Avian Power Line Interaction Committee - *Suggested Practices for Avian Protection on Power Lines* (2006)
   ii. Avian Power Line Interaction Committee - *Reducing Avian Collisions with Power Lines* (2012)
   iii. U.S. Fish and Wildlife Service *Land-based Wind Energy Guidelines* (2012)
   iv. U.S. Fish and Wildlife Service *Guidance on the Siting, Construction, Operation, and Decommissioning of Communication Towers* (2000) and FWS comments to the FCC on towers and lighting (2007)

12) To the extent reasonable and practicable, use a best-practices approach for routine maintenance, retrofitting, and management actions to the extent they do not diminish military readiness, including:

a) Turning out lights in buildings, especially multiple-story buildings, at night, except where needed for safety or security reasons;

b) Reducing or eliminating activities that can attract invasive species, including feeding or managing outdoor or feral cats;

c) Minimizing or eliminating the use of pesticides (e.g., insecticides, herbicides, rodenticides);

d) Covering open pipes in which birds may be able to enter but not escape (e.g., in-ground pipes, outhouses, roofs);

e) Minimizing exposure to hazardous chemicals, including covering or removing open pits containing oil or other chemicals; and

f) Minimizing vegetation removal and manipulation during the breeding season, as practicable and when not in conflict with airfield BASH management.

G. Responsibilities of the Fish and Wildlife Service

1) Work with DoD by providing recommendations to minimize the effects of avian stressors on migratory birds from DoD actions.

2) Through the Division of Migratory Bird Management, maintain a Web page of permits that provides links to all offices responsible for issuing migratory bird take permits and permit applications.

3) Provide essential background information to DoD, when requested, to ensure sound management decisions. This may include information on migratory bird distributions, status, key habitats, conservation guidelines, and risk factors within each BCR. FWS will regularly update its *Birds of Conservation Concern* publication so it can be reliably referenced.

4) Work to identify special migratory bird habitats (e.g., nesting, stopover, migration corridors), and the ecological conditions important in those habitats.

5) Using the Points of Contact list (Appendix A), the FWS will continue to provide general guidance and information regarding migratory birds and their habitats to DoD, upon request. This guidance includes technical assistance for avoiding or minimizing project-related impacts on migratory birds.

6) The Migratory Bird Program will develop and provide FWS guidance to the Ecological Services Field Offices to ensure consistency in the interpretation and implementation of the MBTA as it applies to all federal actions.

7) In accordance with FWS Guidelines for Coordination with DoD and Implementation of the 1997 Sikes Act, promote timely and effective review of INRMPs, including any potential recommendations and revisions related to the conservation of migratory birds.

8) Review and comment on NEPA and other planning documents forwarded by military

installations.

9) Notify installations of any proposed or current actions that may result in a significant take of migratory birds.

H. Dispute Resolution

Preventing potential conflicts or resolving disagreements between the Parties will be attempted first at staff levels and elevated through the respective organizational levels if necessary. If staff level resolution is not possible, the conflict will be addressed through Alternative Dispute Resolution processes.

I. Mutual Agreement

1) This MOU will not change or alter requirements associated with the MBTA, Eagle Act, ESA, NEPA, Sikes Act, or other statutes or legal authority. This MOU is intended to provide internal guidance to federal agency staff.

2) The discretionary responsibilities established by this MOU may be incorporated into planned DoD actions; however, DoD may not be able to implement these discretionary responsibilities until DoD has successfully included them in formal planning, programming, and budgeting processes. This MOU is intended to be implemented when new actions are initiated as well as when INRMPs, IPMPs, and BASH plans are initiated or revised, and if the MOU's discretionary responsibilities are successfully included in formal planning, programming, and budgeting processes.

3) This MOU in no way restricts either Party from participating in similar activities with other public or private agencies, governments, organizations, or individuals.

4) This MOU is neither a fiscal nor a funds-obligation document. Any endeavor involving reimbursement, contribution of funds, or transfer of anything of value between the Parties will be handled in accordance with applicable laws, regulations, and procedures, including those for government procurement and printing. Such endeavors will be outlined in separate agreements that shall be made in writing by representatives of the Parties, and shall be independently authorized by appropriate statutory authority.

5) The Parties shall schedule periodic meetings to review progress and identify opportunities for advancing the principles of this MOU.

6) This MOU is intended to improve the internal management of the executive branch, and does not create any right or benefit, substantive or procedural, separately enforceable as law or equity by a party against the United States, its agencies or instrumentalities, its officers or employees, or any other person.

7) Modifications to the MOU's scope shall be made by the Parties' mutual consent, through issuance of a written modification, signed and dated by the Parties, prior to any changes.

8) Either Party may terminate this MOU, in whole or in part, at any time before the

expiration date by providing the other Party with a written statement to that effect.

F. Definitions

Action – a program, activity, project, official policy, rule, regulation, or formal plan directly carried out by one of the Parties.

Airfield Environment – UFC 3-260-01 defines what an airfield is and all of its component parts, and defines clearance criteria. DoDI 4165.57 AICUZ describes the acceptable land uses for component parts of the airfield. The Airfield's BASH Program is responsible for maintaining hazard-free airfields.

Avian Knowledge Network – an international organization of government and non-government institutions focused on understanding the patterns and dynamics of bird populations across the Western Hemisphere (www.avianknowledge.net).

Avian Stressor – any alteration of or addition to the environment that affects birds or their resources.

Bird/Wildlife Aircraft Strike Hazard (BASH) – an actual or potential collision between wildlife (i.e., a bird, mammal, or reptile) and an aircraft (e.g., plane or helicopter).

Breeding Bird Survey (BBS) – a standardized international survey that provides information on population trends of breeding birds, through volunteer observations located along randomly selected roadside routes in the United States, Canada and Mexico (www.mbr-pwrc.usgs.gov/bbs/bbs.html).

Bird Conservation Region (BCR) – a geographic unit used to facilitate bird conservation actions under the North American Bird Conservation Initiative (www.nabci-us.org/bcrs.htm).

Birds of Conservation Concern – a list that is published and periodically updated by the FWS Division of Migratory Bird Management intended to identify the migratory and non-migratory bird species that-- in addition to species already listed under the ESA, proposed or candidate-- represent the FWS's highest conservation priorities, including ESA candidate species. The most current version of the list, Birds of Conservation Concern 2008, is available at www.fws.gov/migratorybirds/CurrentBirdIssues/Management/BCC.html.

Cantonment Area – the principal built-up area of a DoD installation, typically containing housing, barracks, military organizational areas, and community support infrastructure.

Comprehensive Planning Efforts for Migratory Birds – includes Partners in Flight, North American Waterfowl Management Plan, U.S. Shorebird Conservation Plan, Western Hemisphere Shorebird Reserve Network, North American Waterbird Conservation Plan, and other partnership planning efforts integrated through the North American Bird Conservation Initiative.

Conservation Measure – any action undertaken to address project-related stressors/impacts that ultimately improve the conservation status of one or more migratory bird species. Conservation measures split into two categories: Ecological/Habitat measures (driven by EO 13186) and Avian

Mortality measures (driven by MBTA). Conservation measures work to avoid or minimize an impact, reduce the impact over time, or rectify or compensate for the impact. Conservation Measures are also referred to as Mitigation, Best Practices, and Best Management Practices.

Conservation Planning – strategic and tactical planning of agency activities for the long-term conservation of migratory birds and their habitats.

Council for the Conservation of Migratory Birds – an interagency council established by the Secretary of the Interior to oversee the implementation of Executive Order 13186.

Ecological Condition – the composition, structure, and processes of ecosystems over time and space. This includes the diversity of plant and animal communities, the productive capacity of ecological systems and species diversity, ecosystem diversity, disturbance processes, soil productivity, water quality and quantity, and air quality. Often referred to in terms of ecosystem health, which is the degree to which ecological factors and their interactions are reasonably complete and functioning for continued resilience, productivity, and renewal of the ecosystem.

Effect (adverse or beneficial) – the biological consequences of an impact or the implementation of a conservation measure. Effects can be adverse (habitat avoidance) or beneficial (improved habitat quality). The effect is determined by the exposure of the bird or resource to the stressor/impact and the response to the impact. Effects may be direct, indirect, or cumulative, and refer to effects from actions or categories of actions on migratory birds, their populations, habitats, ecological conditions, and significant bird conservation sites.

Impact – the combined result of an action/project, all of its associated activities and components, and the stressors (see below) produced by those actions.

Integrated Natural Resources Management Plan (INRMP) – an integrated plan based, to the maximum extent practicable, on ecosystem management that shows the interrelationships of individual components of natural resources management (e.g., fish and wildlife, forestry, land management, outdoor recreation) to military mission requirements and other land use activities affecting an installation's natural resources. INRMPs are required for all DoD installations with significant natural resources, pursuant to the Sikes Act.

International Shorebird Survey – a monitoring program started in 1974 to survey shorebirds (sandpipers, plovers, etc.) across the Western Hemisphere (www.pwrc.usgs.gov/iss/iss.html).

International Migratory Bird Day (IMBD) – IMBD celebrates, brings attention to, and educates people about the migration of nearly 350 species of migratory birds that nest and breed throughout the Western Hemisphere. IMBD is celebrated in Canada, the United States, Mexico, Central and South America, and the Caribbean (http://birdday.org/birdday).

Management Action – an activity by a government agency that could cause a positive or negative impact to migratory bird populations or habitats. Conservation measures to mitigate potential activity-related stressors may be required.

Migratory Bird – an individual of any species protected by the Migratory Bird Treaty Act (MBTA) as listed in 50 CFR § 10.13.

Military Readiness Activity – all Armed Forces training and operations that relate to combat, including but not limited to the adequate and realistic testing of military equipment, vehicles, flight operations, weapons, and sensors for proper operation and suitability for use in combat.

Monitoring Avian Productivity and Survivorship (MAPS) – a program that uses the banding of birds during the breeding season to track the changes and patterns in the number of young produced, and the survivorship of adults and young (www.birdpop.org/maps.htm).

National Environmental Policy Act (NEPA) – a federal statute that requires federal agencies to prepare a detailed analysis of the environmental impacts of a proposed action and alternatives, and to include public involvement in the decision making process for major federal actions significantly affecting the quality of the human environment 42 U.S.C. 4321, et seq.

North American Bird Conservation Initiative (NABCI) – a partnership to align the avian conservation community to implement bird conservation through regionally-based, biologically driven, landscape-oriented partnerships across the North American continent. NABCI includes federal agencies of Canada, Mexico and the United States, as well as most landbird, shorebird, waterbird, and waterfowl conservation initiatives (www.nabci-us.org).

North American Waterbird Conservation Plan – a partnership of federal and state government agencies, non-governmental organizations, and private interests focusing on the conservation of waterbirds, primarily including marshbirds and inland, coastal, and pelagic colonial waterbirds (www.waterbirdconservation.org/plans.html). The partnership's vision is that the distribution, diversity, and abundance of breeding, migratory, and nonbreeding waterbirds are sustained throughout the lands and waters of North America, Central America, and the Caribbean.

North American Waterfowl Management Plan – a partnership of federal and state agencies, non-governmental organizations, and private interests focusing on the restoration of waterfowl populations through habitat restoration, protection, and enhancement (http://birdhabitat.fws.gov/NAWMP/nawmphp.htm).

Partners in Flight (PIF) – a cooperative partnership of more than 300 partners including federal and state government agencies, non-governmental organizations, conservation groups, foundations, universities, and industry focusing on the conservation of landbirds. DoD was an original signatory to the 1991 PIF Federal Agencies' MOA (www.partnersinflight.org).

Ranges & Training Areas (RTAs) – as defined within each installation's INRMP.

Species of Concern – refers to several categories of birds including: 1) species listed in the periodic report, *Birds of Conservation Concern*, published by the FWS Division of Migratory Bird Management (www.fws.gov/migratorybirds); 2) priority migratory bird species documented in the comprehensive bird conservation plans (North American Waterbird Conservation Plan, United States Shorebird Conservation Plan, Partners in Flight Bird Conservation Plans); 3) species or populations of waterfowl identified as high, or moderately high, continental priority in the North American Waterfowl Management Plan; 4) listed threatened and endangered bird species in 50 CFR § 17.11; and 5) MBTA-listed gamebirds of management concern, as listed in the *Birds of Management Concern* list (www.fws.gov/migratorybirds/CurrentBirdIssues/Management/BMC.html).

Take – to pursue, hunt, shoot, wound, kill, trap, capture or collect or attempt to pursue, hunt, wound, kill, trap, capture or collect (50 CFR § 10.12). The Executive Order 13186 further defines "take" to include intentional take, meaning take that take is the purpose of the activity in question, and unintentional (incidental) take, meaning take that results from, but is not the purpose of, the activity in question. Both intentional and unintentional take constitute take as defined by the MBTA. The regulations implementing the Eagle Act define take to mean pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, destroy, molest, or disturb bald and golden eagles (50 CFR § 22.3).

U.S. Shorebird Conservation Plan – a partnership of federal and state government agencies, non-governmental organizations, and private interests focusing on restoring and protecting stable and self-sustaining populations of all shorebird species (www.shorebirdplan.org).

K. Agreement Contacts and Execution

The principal contacts for this instrument are as follows:

Brad Bortner, Chief Division of Migratory Bird Management US Fish and Wildlife Service	L. Peter Boice, Deputy Director Natural Resources Program Office of the Secretary of Defense

This MOU is executed as of the last date signed below and expires no later than five (5) years thereafter, at which time it is subject to review and renewal, or expiration.

The Parties hereto have executed this agreement as of the date shown below:

Dan Ashe Director US Fish and Wildlife Service	John Conger Acting, Deputy Under Secretary of Defense (Installations & Environment) US Department of Defense
9.5.2014	7/10/2014
Signature Date	Signature Date

Appendix A: FWS Points of Contact list

Contact Information for Headquarters and Regional U.S. Fish and Wildlife Service Migratory Bird and Ecological Services Offices. For a complete listing of field offices see http://www.fws.gov/offices/.

FWS Region	States Covered	Migratory Bird Office	Migratory Bird Permits	Endangered Species
Headquarters		703-358-1714	703-358-1825	703-358-2171
Region 1	Hawaii, Idaho, Oregon, Washington	503-231-6164	503-872-2715	503-231-6151
Region 2	Arizona, New Mexico, Oklahoma Texas	505-248-6875	505-248-7882	505-248-6920
Region 3	Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio Wisconsin	612-713-5473	612-713-5436	612-713-5350
Region 4	Alabama, Arkansas Florida, Georgia Kentucky, Louisiana Mississippi, North Carolina, South Carolina, Tennessee	404-679-7070	404-679-7070	404-679-7140
Region 5	Connecticut, Delaware, Maine Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania Rhode Island, Vermont, Virginia West Virginia	413-253-8643	413-253-8643	413-253-8304
Region 6	Colorado, Kansas Montana, Nebraska North Dakota, South Dakota, Utah Wyoming	303-236-4409	303-236-8171	303-236-4252
Region 7	Alaska	800-368-8890	907-786-3693	907-786-3856
Region 8	California, Nevada	916-414-6464	916-414-6464	916-414-6464

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Prepared in cooperation with the DoD Natural Resources Program, Arlington, Virginia; Great Basin Bird Observatory, Reno, Nevada; U.S. Army Engineer Research and Development Center, Environmental Laboratory, Vicksburg, Mississippi; DoD Partners in Flight, Warrenton, Virginia

Coordinated Bird Monitoring: Technical Recommendations for Military Lands

Open-File Report 2010–1078

U.S. Department of the Interior
U.S. Geological Survey

Coordinated Bird Monitoring: Technical Recommendations for Military Lands

By Jonathan Bart and Ann Manning, U.S. Geological Survey; Leah Dunn, Great Basin Bird Observatory; Richard Fischer and Chris Eberly, Department of Defense Partners in Flight

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A Report Prepared for the Department of Defense Legacy Resource Management Program
Legacy Project # 05-246, 06-246, 07-246

Open-File Report 2010–1078

U.S. Department of the Interior
U.S. Geological Survey

U.S. Department of the Interior
KEN SALAZAR, Secretary

U.S. Geological Survey
Marcia K. McNutt, Director

U.S. Geological Survey, Reston, Virginia: 2012

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The DoD Legacy Resource Management Program funded this project. For more information, visit *https://www.dodlegacy.org*

For more information on the DoD Natural Resources Conservation Program, visit http://www.dodnaturalresources.net. For more information on the DoD Partners in Flight Program, visit http://www.dodpif.orgSuggested citation:
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Conversion Factors

Multiply	By	To obtain
	Mass	
gram (g)	0.03527	ounce, avoirdupois (oz)
	Length	
centimeter (cm)	0.3937	inch (in.)
millimeter (mm)	0.03937	inch (in.)
meter (m)	3.281	foot (ft)
kilometer (km)	0.6214	mile (mi)
kilometer (km)	0.5400	mile, nautical (nmi)
meter (m)	1.094	yard (yd)

Abbreviations and Acronyms

AAL	above antenna level
ABC	American Bird Conservancy
APA	Administrative Procedures Act
AKN	Avian Knowledge Network
ARU	autonomous recording units
BASH	Bird/Animal Aircraft Strike Hazard
BBIRD	Breeding Bird Research and Monitoring Database
BBS	North American Breeding Bird Survey
BMDE	Bird Monitoring Data Exchange
CBC	Christmas Bird Count
CBM	Coordinated Bird Monitoring
CBMD	Coordinated Bird Monitoring Database
CI	confidence interval
CV	coefficient of variation
DoD	Department of Defense
DoD PIF	DoD Partners in Flight
FOIA	Freedom of Information Act
FRESC	Forest and Rangeland Ecosystems Science Center
GBIF	Global Biodiversity Information Facility
GPS	Global Positioning System
IBP	The Institute for Bird Populations
INRMP	Integrated Natural Resources Management Plan
Legacy	DoD Legacy Resource Management Program

Abbreviations and Acronyms—Continued

MAPS	Monitoring Avian Productivity and Survivorship
MAWS	Monitoring Avian Winter Survival
MBTA	Migratory Bird Treaty Act
MoSI	Monitoreo de Sobrevivencia Invernal
MOU	Memorandum of Understanding
NABCI	North American Bird Conservation Initiative
NBII	USGS National Biological Information Infrastructure program
NE CBM Plan	Northeast Coordinated Bird Monitoring Plan
NEPA	National Environmental Policy Act
NEXRAD	NEXt generation RADar
NOAA	National Oceanic and Atmospheric Administration
NRMP	Natural Resources Monitoring Partnership
NWS	National Weather Service
PIF	Partners in Flight
PRISM	Program for Regional and International Shorebird Monitoring
RF	radio frequency
SE	standard error
SERDP	Strategic Environmental Research and Development Program
SOC	species of concern
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WSR-88D	Weather Surveillance Radar, 1988-Doppler

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Coordinated Bird Monitoring: Technical Recommendations for Military Lands

By Jonathan Bart and Ann Manning, U.S. Geological Survey; Leah Dunn, Great Basin Bird Observatory; Richard Fischer and Chris Eberly, Department of Defense Partners in Flight

Executive Summary

The Department of Defense (DoD) is subject to several rules and regulations establishing responsibilities for monitoring migratory birds. The Sikes Act requires all military installations with significant natural resources to prepare and implement Integrated Natural Resources Management Plans (INRMPs). These plans guide the conservation and long-term management of natural resources on military lands in a manner that is compatible with and sustains the military mission. An INRMP also supports compliance with all legal requirements and guides the military in fulfilling its obligation to be a good steward of public land.

The management and conservation of migratory birds is addressed in installation INRMPs. The National Environmental Policy Act (NEPA) requires federal agencies to evaluate and disclose the potential environmental impacts of their proposed actions. More recently, DoD signed an MOU (*http://www.dodpif.org/downloads/EO13186_MOU-DoD.pdf*) for migratory birds, under Executive Order 13186, with the US Fish and Wildlife Service (USFWS) in July 2006 and a Migratory Bird Rule (*http://www.dodpif.org/downloads/MigBirdFINALRule_FRFeb2007.pdf*) was passed by Congress in February 2007. The Migratory Bird Rule addresses the potential impacts of military readiness activities on populations of migratory birds and establishes a process to implement conservation measures if and when a military readiness activity is expected to have a significant adverse impact on a population of migratory bird species (as determined through the NEPA process). The MOU states that for non-military readiness activities, prior to initiating any activity likely to affect populations of migratory birds DoD shall (1) identify the migratory bird species likely to occur in the area of the proposed action and determine if any species of concern could be affected by the activity, and (2) assess and document, using NEPA when applicable, the effect of the proposed action on species of concern. By following these procedures, DoD will minimize the possibility for a proposed action to unintentionally take migratory birds at a level that would violate any of the migratory bird treaties and potentially impact mission activities. In addition, implementing conservation and monitoring programs for migratory birds supports the ecosystem integrity necessary to sustain DoD's natural resources for the military mission.

Non-compliance with the procedural requirements of the MBTA could result in a private party lawsuit under the Administrative Procedures Act (APA). A lawsuit filed under APA involving a Navy bombing range is the basis for a court ruling that unintentional take of migratory birds applies to federal actions. Ensuring the necessary data is available to adequately assess impacts of a proposed action will help avoid lawsuits or help ensure such lawsuits have no grounds. The data gathered in a bird monitoring program will provide the best scientific data available to assess the expected impacts of a proposed action on migratory bird species through the NEPA process.

This report presents recommendations developed by the U.S. Geological Survey (USGS) for the Department of Defense (DoD) on establishing a "Coordinated Bird Monitoring (CBM) Plan." The CBM Plan is intended to ensure that DoD meets its conservation and regulatory responsibilities for monitoring birds (Chapter 1). The report relies heavily on recommendations in the report, "Opportunities for improving avian monitoring" (*http://www.nabci-us.org/aboutnabci/monitoringreportfinal0307.pdf*), by the U.S. North American Bird Conservation Initiative (U.S. NABCI Monitoring Subcommittee, 2007) and on a review of 358 current DoD bird monitoring programs carried out as part of this project (Chapter 2).

This report contains 12 recommendations which, if followed, would result in a comprehensive, efficient, and useful approach to bird monitoring. The recommendations are based on the entire report but are presented together at the end of Chapter 1. DoD has agreed to consider implementing these recommendations; however, final decisions will be based upon such factors as the availability of resources and military mission considerations. These recommendations from USGS can be summarized into 6 major themes:

1. A major report on monitoring was released in 2007 by the U.S. North American Bird Conservation Initiative (*http://www.nabci-us.org/main2.html*). DoD can be consistent with this report by establishing policy that monitoring will be explicitly acknowledged as an integral element of bird management and conservation (Recommendation 1).
2. The design of monitoring and assessment programs for birds should include the following steps:
   a. Preparation of a document describing the program's goals, objectives, and methods similar to a format we provide (Recommendation 2, Chapter 4).
   b. Selection of field methods using an "expert system" developed in this project (Recommendation 3, Chapter 5) or another well-documented system.
   c. Preparation and storage of metadata describing the monitoring program in the Natural Resources Monitoring Partnership (NRMP), and other appropriate databases (Recommendation 4, Chapter 6).
   d. Entry of the survey data using eBird (*http://ebird.org/content/dod*) or the Coordinated Bird Monitoring Database (CBMD) and long-term storage of the data in the CBMD and the Avian Knowledge Network (AKN; Recommendation 5, Chapter 6; *http://www.avianknowledge.net/*).
   e. Submission of major results from the monitoring program for publication in a peer-reviewed journal (Recommendation 6).
3. The DoD Legacy Resource Management Program (Legacy; *https://www.dodlegacy.org*), Environmental Security Technology Certification Program (ESTCP; *http://www.serdp.org/*), and Strategic Environmental Research and Development Program (SERDP; *http://www.serdp.org/*) should be encouraged to continue their significant contributions to the foundations of bird monitoring (Recommendation 7, Chapters 1 and 3).

4. Appropriate monitoring should be conducted to identify species of concern on installations. A year-round, one-time survey of birds on installations with habitat for migratory birds would provide the most information to assist compliance with the MOU, the Final Rule, and the NEPA analyses of proposed actions. However, less intensive survey efforts can still be conducted to yield useful information. We describe how various levels of survey effort might be organized and conducted. In addition, continuing surveys, as feasible, would further assist in documenting effects of military readiness and non-readiness activities on species of concern (SOC) (Recommendation 8, Chapter 7).
5. Participation in well-designed, large-scale surveys [(e.g., North American Breeding Bird Survey (BBS; *http://www.pwrc.usgs.gov/bbs/*), Monitoring Avian Productivity and Survivorship (MAPS; *http://www.birdpop.org/maps.htm*)] on land that DoD manages or on lands where the results will be of high interest to DoD, will provide DoD and other NABCI members with information important to bird conservation (Recommendation 9, Chapter 8).
6. Review and implementation of the CBM Plan should involve both higher level management and installation-level natural resources managers (Recommendation 11), be implemented through cooperative partnerships (Recommendation 12), and be followed on U.S territory lands and Army Corps of Engineers projects (Recommendation 10).

Additional recommendations that pertain to implementing the DoD CBM Plan are discussed in Chapter 9.

Chapter 1: Project Summary

This document is the final report under a contract between the Department of Defense (DoD) and the U.S. Geological Survey (USGS). The report describes an approach for bird monitoring, termed the DoD Coordinated Bird Monitoring (CBM) Plan that is intended to ensure that DoD meets its legal requirements for monitoring birds in the most efficient manner possible. The motivation for the report was a determination within DoD that their monitoring programs could be made more efficient and effective through improved coordination, better specification of goals, advice on selection of field and analytic methods, and improved methods for storing and managing the data. Our review showed that the goals and objectives of many DoD monitoring programs are unclear or at least not specified in writing, little rationale is provided for field or analytic methods, and data are usually not contributed to a central repository. In addition, there has heretofore been no agreement on the role of DoD in large-scale, well-designed monitoring programs, nor has there been any specific guidance on how natural resources managers can fulfill DoD's responsibilities under the 2006 Memorandum of Understanding (MOU) with the U.S. Fish and Wildlife Service (USFWS; as required under Executive Order 13186) or the Final Rule regarding migratory birds. The DoD CBM Plan is intended to help DoD address these problems.

Major findings and recommendations are presented in this Chapter. The document then presents a review of current bird monitoring on DoD installations (Chapter 2) and of emerging technologies useful in bird monitoring that DoD has helped support (Chapter 3). These chapters describe the current state of bird monitoring and research on bird monitoring in DoD. The next three chapters are intended for those who conduct or directly supervise bird monitoring programs. They include suggestions for designing short-term monitoring or assessment programs (Chapter 4), selection of field methods (Chapter 5), and storage of monitoring data in long-term repositories (Chapter 6). The final three chapters are intended for policy makers who must make decisions about the general approach DoD will take in bird monitoring. They include a discussion of appropriate monitoring programs for species of concern (Chapter 7), DoD's participation in large-scale bird monitoring programs (Chapter 8), and suggestions for how to implement the CBM Plan throughout DoD (Chapter 9). In the next section below, we describe several recent developments with major implications for how DoD conducts bird monitoring programs.

The U.S. NABCI Report on Bird Monitoring

In February 2007, the Monitoring Subcommittee of the U.S. North American Bird Conservation Initiative (NABCI) released its report "Opportunities for improving avian monitoring" (U.S. NABCI Monitoring Subcommittee, 2007). The report, which was prepared by a distinguished panel of 16 experts in bird monitoring, emphasized the importance of clearly understanding the management questions that monitoring can address before initiating new surveys. The report established four goals and contained four recommendations to achieve these goals (table 1). It also presented a series of action items by which the recommendations and goals could be achieved. DoD, along with the other members of the U.S. NABCI Committee, signed an MOU (U.S. NABCI Committee, 2007) to adopt the goals, recommendations, and action items in the 2007 NABCI Monitoring Subcommittee report that, among other things, states that signatories will "use their best efforts to":

> *Support and promote broad scale bird monitoring programs such as the USGS Breeding Bird Survey (BBS), Monitoring Avian Productivity and Survivorship (MAPS), the Program for Regional and International Shorebird Monitoring (PRISM), and others.*

Table 1. Goals and recommendations in the U.S. NABCI report, “Opportunities for improving avian monitoring.”

[U.S. NABCI Monitoring Subcommittee, 2007]

Goal 1. Fully integrate monitoring into bird management and conservation practices and ensure that monitoring is aligned with management and conservation priorities.
Recommendation 1. Establish a policy level expectation that monitoring will be explicitly acknowledged as an integral element of bird management and conservation.
Goal 2. Coordinate monitoring programs among organizations and integrate them across spatial scales to solve conservation or management problems effectively.
Recommendation 2. Take specific steps to increase the appropriate coordination of monitoring programs.
Goal 3. Increase the value of monitoring information by improving statistical design.
Recommendation 3. Every monitoring program should be designed and periodically reviewed in consultation with administrators, managers, and statisticians familiar with bird conservation and survey design.
Goal 4. Maintain bird population monitoring data in modern data management systems. Recognizing legal, institutional, proprietary, and other constraints provide greater availability of raw data, associated metadata, and summary data from bird monitoring programs.
Recommendation 4. Develop a comprehensive plan for integrating and managing bird population monitoring data.

Making DoD monitoring activities consistent with recommendations in the report will ensure that DoD complies with the MOU and follows the best available science. Two other notable recent events in bird monitoring were the signing of an MOU between DoD and the USFWS “to promote the conservation of migratory birds” and the adoption of a Final Rule pertaining to “take of migratory birds by the Armed Forces.” The MOU became effective on August 30, 2006; the final rule became effective on March 30, 2007. Both measures include compelling language on the importance of monitoring bird populations. Such monitoring will be critical in assessing the overall impacts of proposed actions on populations of migratory birds, as required per the MBTA (Migratory Bird Treaty Act) /DoD Final Rule and NEPA.

Under the 2006 MOU (table 2), DoD agrees to collaborate with the USFWS and other groups involved in bird monitoring efforts to:

- assess the status and trends of bird populations and habitats,
- use national standards and protocols to the extent appropriate,
- deposit monitoring and inventory data it collects in national repositories, and
- promote participation in national inventory and monitoring programs, such as the BBS.

DoD also agrees that prior to starting any activity that is likely to affect populations of migratory birds it will identify species likely to occur in the area and determine whether any species of concern “could be affected by the activity.” Furthermore, DoD agrees to “evaluate the effectiveness of conservation measures to minimize or mitigate take of migratory birds” and to review Integrated Natural Resources Management Plans (INRMPs) to determine whether updates or revisions are needed “to avoid or minimize take of migratory birds.”

Table 2. Selected passages from the MOU between DoD and the U.S. Fish and Wildlife Service to promote the conservation of migratory birds.

[Department of Defense, 2006]

D. Responsibilities

1. Each Party shall:

   d. Promote collaborative projects such as:

   (1) Developing or using existing inventory and monitoring programs, at appropriate scales, with national or regional standardized protocols, to assess the status and trends of bird populations and habitats, including migrating, breeding, and wintering birds;

   (2) Designing management studies and research projects using national or regional standardized protocols and programs, such as MAPS, to identify the habitat conditions needed by applicable species of concern, to understand interrelationships of co-existing species, and to evaluate the effects of management activities on habitat and populations of migratory birds;

   (3) Sharing inventory, monitoring, research, and study data for breeding, migrating, and wintering bird populations and habitats in a timely fashion with national data repositories such as Breeding Bird Research and Monitoring Database (BBIRD), National Point Count Database, National Biological Information Infrastructure, and MAPS;

   [(4) Intentionally excluded]

   (5) Participating in or promoting the implementation of existing regional or national inventory and monitoring programs such Breeding Bird Survey (BBS), BBIRD, Christmas Counts, bird atlas projects, or game bird surveys (e.g., mid-winter waterfowl surveys) on DoD lands where practical and feasible.

   (6) Using existing partnerships and exploring opportunities for expanding and creating new partnerships to facilitate combined funding for inventory, monitoring, management studies, and research.

2. The Department of Defense shall:

   d. Consistent with imperatives of safety and security, allow the USFWS and other partners reasonable access to military lands for conducting sampling or survey programs such as MAPS, BBS, BBIRD, International Shorebird Survey, and breeding bird atlases.

   e. Prior to starting any activity that is likely to affect populations of migratory birds:

   (1) Identify the migratory bird species likely to occur in the area of the proposed action and determine if any species of concern could be affected by the activity;

   (2) Assess and document, using NEPA when applicable, the effect of the proposed action on species of concern.

   g. Develop and implement new and/or existing inventory and monitoring programs, at appropriate scales, using national standardized protocols, to evaluate the effectiveness of conservation measures to minimize or mitigate take of migratory birds, with emphasis on those actions that have the potential to significantly impact species of concern.

   i. In accordance with DoD INRMP guidance, promote timely and effective review of INRMPs with respect to migratory bird issues with the USFWS and respective state agencies. During The INRMP review process, evaluate and coordinate with USFWS on any potential revisions to migratory bird conservation measures taken to avoid or minimize take of migratory birds.

Under the Final Rule (table 3), DoD may take migratory birds during military readiness activities, but if DoD concludes that the take may result in a "significant adverse effect on a population" then it must confer with the USFWS "to develop and implement appropriate conservation measures to minimize or mitigate" the effects. If the actions taken include monitoring, then the data collected must be retained for 5 years. If monitoring mutually agreed to by the parties is not implemented, then the Secretary of the Interior can withdraw the take authorization, which would arguably make the military readiness activity in violation of the MBTA when a migratory bird is incidentally taken by the activity.

Table 3. Selected passages from the Final Rule by the USFWS pertaining to "take of migratory birds by the Armed Forces."

[U.S. Fish and Wildlife Service, 2007]

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§ 21.15 Authorization of take incidental to military readiness activities.

(a) Take authorization and monitoring

(1) …the Armed Forces may take migratory birds incidental to military readiness activities provided that, for those ongoing or proposed activities that the Armed Forces determine may result in a significant adverse effect on a population of a migratory species, the Armed Forces must confer and cooperate with the Service to develop and implement appropriate conservation measures to minimize or mitigate such significant adverse effects.

(2) When conservation measures implemented under paragraph (a)(1) of this section {§21.15} require monitoring, the Armed Forces must retain records of any monitoring data for five years from the date the Armed Forces commence their action.

(b) Suspension or withdrawal of take authorization

(2) The Secretary may … withdraw …authorization for take… if the Secretary determines that a proposed military readiness activity is likely to result in a significant adverse effect on the population of a migratory bird species and one or more of the following circumstances exists:

(ii) The Armed Forces fail to conduct mutually agreed upon monitoring to determine the effects of a military readiness activity on migratory bird species and/or the efficacy of the conservation measures implemented by the Armed Forces.

From the discussion in the NEPA portion of the Required Determinations section of the rule (Federal Register, p. 8949):

Furthermore, we [USFWS] expect that military readiness activities will rarely, if ever, have the broad impact that would lead to a significant adverse effect on a population of a migratory bird species, even absent the conservation measures that the Armed Forces undertake voluntarily or pursuant to another statue.

The implementation of DoD monitoring programs will provide essential information needed for assessing the impacts of proposed military actions on migratory birds, as required per NEPA. The information obtained would help guide DoD towards more effective and efficient management and conservation of migratory birds, which would reduce the potential for USFWS invoking their prosecutorial discretion in seeking a MBTA violation and protect from possible third party litigation. In support of this effort, DoD has agreed to participate appropriately in regional and national monitoring programs, to assess effects of military readiness activities on bird populations and, if those effects are significant, to undertake various actions including monitoring. When required by the Final Rule, failure to carry out appropriate monitoring could result in suspension of authorization to take migratory birds. In the rest of this report, we make frequent reference to the MOU and Rule and propose numerous measures to ensure that DoD meets its obligations under them.

CBM Plan for the Northeastern United States

The Northeast Coordinated Bird Monitoring (NE CBM; *http://www.nebirdmonitor.org/*) Partnership recently released their "Northeast Bird Monitoring Handbook" (Lambert and others, 2009; *http://www.nebirdmonitor.org/handbook*) featuring "Ten steps to successful bird conservation through improved monitoring" (table 4). Their steps are consistent with the recommendations in this report. For example, steps 1 through 6 are similar to the recommendations in Chapters 4 and 5 of this report, although they contain a number of useful new ideas, such as their emphasis on how the target population relates to "other ecosystem elements, processes, and stressors." Step 7, on data management, contains material similar to the recommendations in Chapter 6. Their steps 8-10 focus on implementation that we cover only briefly (Chapter 9). Overall, the NE CBM Plan provides an excellent companion document to this one. Both can be used at all installations involved in bird monitoring.

Table 4. Ten steps to successful bird conservation through improved monitoring.

[From Lambert and others, 2009]

Step 1:	Establish a clear purpose.
Step 2:	Determine whether an existing program or protocol meets your needs.
Step 3:	Assemble a team of collaborators with complementary interests and skills.
Step 4:	Summarize the relationship of target populations to other ecosystem elements, process, and stressors.
Step 5:	Develop a sound approach to sampling and data analysis.
Step 6:	Design standardized protocols that minimize error and bias.
Step 7:	Identify or develop a data management system.
Step 8:	Implement the monitoring program.
Step 9:	Report results in a format that supports conservation decisions.
Step 10:	Use results to make better and more cost-effective management and conservation decisions.

Major Findings of this Study

This section briefly reviews the major findings of this study. More detailed accounts of each part of the study are contained in the remaining Chapters. The review of current monitoring programs (Chapter 2) was conducted by contacting 405 DoD military installations using telephone and email throughout the United States (but not in territories or other countries) and obtaining standardized descriptions of bird monitoring programs that were active during 2002–2004. Descriptions were obtained of 358 monitoring programs from 134 installations. The descriptions were deposited in repositories maintained by Bird Studies Canada, the Laboratory of Ornithology at Cornell University, and the USGS. Many surveys were undertaken as part of the Monitoring Avian Productivity and Survivorship program (MAPS; 29 surveys), the Bird/Animal Aircraft Strike Hazard program (BASH; 25 surveys), the Christmas Bird Count (CBC; 22 surveys), or the Breeding Bird Survey (BBS; 9 surveys). Landbirds were the most common species studied (74 surveys), although waterbirds (22 surveys) and raptors (25) also were often studied. Major conclusions from this project were that documentation of DoD efforts in bird monitoring is poor at present but can readily be improved by requiring that a description of each survey be deposited in the Natural Resources Monitoring Partnership (NRMP; see Recommendation 4 below for description) and by following additional recommendations below. Detailed results from this survey are presented in Chapter 2.

DoD has been a leader in supporting research on bird monitoring and this support has helped not only DoD but many other agencies and organizations carry out effective and efficient monitoring. A brief review of emerging technologies that will lead to additional improvements is provided in Chapter 3.

Guidelines for designing bird monitoring surveys (Chapter 4) included three separate products: a manuscript describing how projects should be planned, guidelines for selecting field methods, and a new USGS database to be used for data management. The manuscript was based on current views of how monitoring should be designed (e.g., Oakley and others, 2003; U.S. NABCI Monitoring Subcommittee, 2007) and stressed explicit identification of goals, objectives, and methods. The guidelines have been published (Bart, 2005) but a slightly modified version stressing DoD applications is presented in Chapter 4.

The guidelines for designing bird monitoring surveys (Chapter 4) and those for selecting survey methods (Chapter 5) were developed to provide DoD natural resources managers and biologists (both employees and contractors) with a single authoritative source that can easily be adapted to their needs and updated as new methods are introduced.

The CBM database (Chapter 6) was created because all existing databases that accept data from throughout the country require that users accept a standardized list of variables; none of them permit the managers of the survey to define their own variables. By contrast, the new “Coordinated Bird Monitoring Database” (CBMD) does permit the managers of each program to define their own variables. The CBMD is maintained by the USGS. The CBMD is meant to be used in combination with the eBird program (for entering fairly simple observations) and the AKN (for storing a reduced set of variables).

An extensive review of existing information on ranges of species of concern (SOC), specifically from the American Bird Conservancy (ABC)/ National Audubon Society (Audubon) Watch List (*http://www.abcbirds.org/abcprograms/science/watchlist/index.html*), was undertaken to identify installations that are used or may be used by these species, especially during the breeding season, or that are major concentration areas for groups of species during the non-breeding seasons (Chapter 7). The review identified 293 installations that probably are used by >70 SOC. We identified 35 installations that probably do not support SOC. This review did not include contacting installation biologists, many of whom undoubtedly know what SOC occur on their installations. The review does show, however, that no comprehensive analysis exists of which installations are important for which SOC. This information is needed for compliance with the MOU and Migratory Bird Rule and other rules and regulations (e.g., NEPA compliance). We provide recommendations for how to carry out brief surveys, partly by using the eBird program, to obtain the needed information.

The following criteria can be used to determine the level of DoD participation in large-scale surveys (Chapter 8): (1) if the lands to be surveyed are under DoD management and are very important to the focal species, then greater participation by DoD will have greater benefits for both the resource and to DoD; (2) if the lands to be surveyed are not under DoD management, but are still very important to the focal species (e.g., on migration or wintering areas), then greater participation by DoD also will have greater benefits for both the resource and DoD.

Recommendations

This section summarizes our recommendations and provides brief explanations and justifications for them. The section is meant to serve as a short, stand-alone summary of the study that provides more detail than is in the Executive Summary.

1. The recent recommendation by the U.S. NABCI Committee (U.S. NABCI Monitoring Subcommittee, 2007) to “establish a policy level expectation that monitoring will be explicitly acknowledged as an integral element of bird management and conservation” offers a useful policy commitment to achieve scientifically based management throughout DoD.

   Although many federal and non-federal programs that influence birds do include monitoring efforts, the NABCI Subcommittee’s review indicates that many other programs do not. The recommendations in this report will help ensure that monitoring is appropriately incorporated into all DoD activities. An MOU endorsing the NABCI report was signed by members of the U.S. NABCI Committee, including DoD. Formal DoD policy endorsing the NABCI Subcommittee recommendation and this Plan would be appropriate and beneficial in implementing the goals of this Plan.

2. DoD monitoring programs will maximize scientific validity and success by following the ‘Guidelines’ presented in Chapter 4.

   A detailed description of what management issue the monitoring program will address, what quantities (e.g., individuals, breeding males, nests) need to be estimated, and what methods will be used — including the sampling plan, data management strategy, and reporting, as well as field methods — is now viewed as an essential component of planning any monitoring program (U.S. NABCI Monitoring Subcommittee, 2007). Following the Guidelines described in this report will ensure that all these topics are adequately addressed.

3. We recommend that DoD natural resources managers consider using the guidelines presented in this report for selecting field methods and contribute to improving them as needed.

   Using of the key presented in Chapter 5, and continually improving it, will ensure that state-of-the-art field methods are selected in DoD bird monitoring programs. This will both ensure that data collection is efficient and will provide a measure of assurance that others cannot successfully challenge the program's results on the basis that the methods used were inappropriate.

4. Preparation of metadata for all DoD monitoring programs and entry into permanent repositories, such as the NRMP database maintained by the USGS Status and Trends Program, will enhance the value and utility of the information collected.

   Metadata is a standardized format for describing datasets including who collected the data and how, what information the dataset contains, and numerous details about the data. The NRMP was developed through collaboration by numerous organizations involved in ecological monitoring and is now recognized as the primary repository for descriptions of monitoring programs and metadata. Entering the description of a program requires only a few minutes by someone familiar with the monitoring program. The information provided makes it possible to quickly and easily retrieve all programs within the database related to a given issue, area, or set of species. DoD participation in the NRMP would be consistent with the MOU and Migratory Bird Rule.

5. Using eBird or the CBMD for data entry and the CBMD and the AKN for permanent data storage will maximize efficiency of processing and guarantee future access to the information collected (see fig. 2 in Chapter 6).

   The eBird program, managed by the Cornell Laboratory of Ornithology, provides a convenient Internet-based method for recording observations made by birders, and steps are being taken to ensure that eBird is available to all DoD personnel. [For more information on eBird, see page 39]. For more complex surveys, we recommend use of the CBMD, which was developed during this project. Virtually any information collected on a "counts survey" (times and places were selected and something was counted) can be stored in the CBMD. The CBMD is a permanent USGS repository so information stored in it will not be lost. The data can be made available by password only (because it would be subject to a Freedom of Information Act (FOIA) request, highly sensitive data should not be stored in the CBMD). If the data owner chooses, core variables will be uploaded from the CBMD to the AKN at Cornell University on a regular basis. The Cornell Laboratory of Ornithology also has offered to make digital or paper copies of all DoD survey datasets and to store them until they are entered into eBird, the CBMD, or the AKN. Accepting this offer from the Cornell Lab would ensure that datasets are not lost. Chapter 6 provides details on how data entry can be accomplished efficiently.

   Having detailed data from DoD installations is important for assessing the population status of migratory birds and will permit assessment of the impacts of proposed military (both readiness and non-readiness) activities on migratory birds, especially at the population level, as required per the MBTA/DoD rule. An accurate assessment will reduce the installation's vulnerability to lawsuits filed under the Administrative Procedures Act (APA).

6. Publishing the results from major monitoring efforts in the peer-reviewed literature will enhance their credibility.

   When awarding contracts or making other arrangements for monitoring projects, DoD may choose to encourage publication of major results. This will help establish their reliability and will help discourage challenges to decisions based on the results.

7. Continuation by DoD of its SERDP and Legacy programs will accomplish a wide variety of avian conservation efforts.

   The Legacy and SERDP programs are widely recognized as making important contributions to bird conservation and bird monitoring in particular. For example, funds from these programs were used by USGS to develop the CBMD and by Cornell University to develop new monitoring techniques based on sophisticated sound recording systems. DoD, as well as the general research and management communities, should consider Legacy and SERDP as important programs that can provide funds to answer DoD-specific questions about bird conservation, and these programs should be considered an essential component of the overall DoD CBM Plan. An increase in Legacy funding to cover unfunded monitoring and other bird-related needs would provide significant benefit to DoD in sustaining its training mission.

8. Appropriate monitoring should be conducted to identify species of concern on installations. A year-round, one-time survey of birds on installations with habitat for migratory birds would provide the most information to assist compliance with the MOU, the Final Rule, and NEPA analyses of proposed actions. However, less intensive survey efforts can still be conducted to yield useful information. In addition, continuing surveys, as feasible, would further assist in documenting effects of military readiness and non-readiness activities on species of concern.

   The Final Rule makes it clear that DoD must determine the impact of military readiness training on migratory birds. This seems to require documentation of what birds are present, in what areas, and at what times of year. Without such information, collected using appropriate methods and archived in a permanent database, DoD cannot show that it has met this requirement, nor can it accurately assess the level of impacts that proposed actions may have on migratory birds. These datasets also will provide the appropriate basis for developing continuing programs to monitor migratory birds that are considered to be at risk from military readiness activities. Installations that have already completed surveys within an appropriate timeframe, and with a standardized sampling methodology, may not need to repeat this. We currently are assessing what is considered “an appropriate timeframe” and the CBM Implementation Plan will provide more guidelines for this topic. Chapter 7 provides suggestions for how to obtain the needed information with different protocols for different levels of available support and existing information on species of concern.

9. Participation in well-designed, large-scale surveys (e.g., BBS, MAPS) on land that DoD manages or on lands where the results will be of high interest to DoD, will provide DoD and other NABCI members with information important to bird conservation (Chapter 8).

   DoD may choose to participate in well-designed, extensive surveys by carrying out the recommended surveys on its own land. However, it might not choose to survey other lands, to participate in poorly designed surveys, or to take the lead in establishing surveys except when it has responsibility for a substantial fraction of the bird populations in question (e.g., some endangered species). For example, DoD might participate in the Intermountain West Aquatic Bird Survey and in the east coast surveys of migrating shorebirds because these are both well-designed, widely endorsed surveys and DoD manages some important wetlands in both of these areas. But DoD should not be expected to take the lead in extending these surveys to other areas. Other agencies (e.g., the USFWS) probably would take the lead in such efforts. It also is becoming increasingly clear that many bird populations are limited by events occurring outside of the breeding season and outside of the United States and that only by studying birds at these times can effective conservation plans be designed. It thus may be cost effective to study species of concern during migration and at wintering areas, as well as outside the U.S., especially in the neotropics. DoD support for such work has been critical in the past. Recommendations on DoD's participation in specific large-scale surveys are discussed in Chapter 8.

10. Implementing the CBM Plan on U.S. territories and other units within DoD may be useful.

    Installations on U.S. territories may benefit by following the DoD CBM Plan. In addition, the U.S. Army Corps of Engineers, which administers approximately 12 million acres of land and water, has done relatively little inventory or monitoring to develop even baseline bird lists (except for some isolated projects that have trained personnel). The U.S. Army Engineer Research and Development Center, Environmental Laboratory, has taken steps (see Guilfoyle and Fischer, 2007) to improve that coordination, but more work in the monitoring arena would be useful.

11. Review of the recommendations in the DoD CBM Plan by upper level management in DoD would be useful with subsequent implementation, as appropriate, on DoD lands.

    At present, most decisions about when, where, and how to carry out bird monitoring activities are made at the installation level. This complicates coordination of bird monitoring activities as required by the MOU and Final Rule. For example, many months were required in this project to conduct the inventory of current bird monitoring and assessment activities whereas it could have been done in a few minutes if descriptions of these programs had been in the NRMP database. Many decisions about when, where, and how to conduct monitoring will remain at the installation level, but decisions about how to design the programs and store the data and decisions about surveying species of concern and participating in large-scale surveys could be made at a higher level (Chapter 9).

12. Following review and revision of these recommendations, as appropriate, the installation-level recommendations could be implemented through a cooperative partnership among DoD and other agencies (e.g., USGS) and non-governmental organizations.

    The recommendations include new procedures for designing short-term surveys, selecting field methods, and storing data in long-term repositories. These recommendations need to be presented, reviewed, and revised as appropriate through a series of consultations at individual installations and at regional meetings for DoD personnel. More detail about how these activities might be carried out is contained in Chapter 9.

Chapter 2: Review of DoD's Existing Bird Monitoring Programs

Many DoD installations across the country have current or recently completed bird monitoring studies. These studies originate from a variety of sources including INRMP documents, BASH programs, requirements under NEPA, state and federal requirements for threatened and endangered species monitoring, and agreements with university research programs. At the start of this project, no comprehensive survey of DoD's bird monitoring programs was available and, as a result, it was difficult to determine how many monitoring programs occur on DoD land, what their objectives are, whether they use appropriate methods, and where the data are stored. We were therefore asked to make a detailed inventory of DoD monitoring programs and to make recommendations for improving the overall value of these efforts. We also were asked to prepare metadata records for the programs, when feasible as recommended by the NBII.

Methods

Chris Eberly, the DoD Partners In Flight (DoD PIF) Program Coordinator, provided a list of installations and contacts from the National Military Fish and Wildlife Association Fish and Wildlife News subscribers list. We modified the list with updated and additional contacts, although there is a considerable amount of turnover and many contacts may no longer be accurate. Attempts to contact all installations were made by phone, email, or both. The following information was requested for each study project: study name, author/originator, brief abstract, purpose of study, years, brief methods, point of contact (name, mailing address, phone, and email). Initially, David Kirk (a contractor for the USGS) gathered similar information by phone and email and entered the results (not including contact information) into the Bird Studies Canada North American Bird Monitoring Projects Database. Later, it was decided to store the information in the NBII Clearinghouse Gateway and still later that the metadata should be stored in the newly created Natural Resources Monitoring Partnership (NRMP) database also maintained by NBII. Metadata records were created using Metavist 2005 version 1.3 obtained from the United States Department of Agriculture (USDA) Forest Service Research & Development. Contact information for each installation will not be included in these publicly accessible records. Instead, the DoD PIF Program Coordinator will be listed as the point of contact and will maintain and distribute more detailed contact information as appropriate.

Results and Discussion

Contact was made with 207 of the 405 installations. Respondents provided information on 358 bird monitoring and/or assessment projects, both long-term and short-term, on 181 installations. We tried to find additional names or phone numbers for installations that did not respond to our request for information by using the Internet but this approach was not productive. We categorized studies into groups and found that most bird monitoring efforts focused on species of concern (SOC; table 5). Detailed data about each program are presented in appendix A.

The information obtained in the metadata records will be useful in many instances including the search for datasets to use in large-scale analyses, finding studies and methods that may be valuable to duplicate in other locations, and increasing interest and participation in future bird monitoring efforts across DoD lands. Considerable time and effort was expended in collecting the necessary information to create metadata records for this project, but it would be very easy for natural resources managers to enter and maintain bird monitoring records for their installation through the NRMP website. Such a database also could be used to answer many of the data calls that at present must be addressed at the installation level. This may provide impetus for managers to keep good records of work planned and completed with the associated datasets, making the data useful beyond the immediate needs of the study project.

Through many of the phone conversations with natural resources personnel, we learned of a widespread interest in having this database available for managers to see what kinds of monitoring other installations were conducting and how they might model their own studies after successful programs. Most data are stored at the point of collection and much is on paper in a file. Many of the biologists we interviewed also commented that they would like a place to store their data (which the NRMP does not do) and that they would like advice on design, selection of field methods, and analysis of data. These issues are addressed in Chapters 4–6.

Table 5. Types of bird monitoring and assessment projects on DoD lands, including projects completed during the last 10 years.

Number of installations	Category
25	Bird/Wildlife Aircraft Strike Hazard (BASH)
29	Monitoring Avian Productivity and Survivorship (MAPS)
9	Breeding Bird Survey (BBS)
22	Audubon Christmas Bird Count (CBC)
1	Breeding Bird Census (BBC)
4	Hawk Watch
29	Nest box monitoring
122	Species of Concern
20	Single species of interest
74	Landbird focus
22	Waterbird focus
25	Raptor focus
30	Other

Chapter 3. Emerging Technologies for Monitoring

As mentioned in Chapter 1, DoD has been a leader in supporting research on bird monitoring, primarily through the DoD Strategic Environmental Research and Development Program (SERDP) and Environmental Security Technology Certification Program (ESTCP), and applied management through the DoD Legacy Resource Management Program . Many of these projects have led to the development of methods useful to DoD as well to the larger conservation community. Here, we highlight a few areas and some of the possibilities for further progress. The few topics discussed are by no means the only areas in which substantial progress is likely to occur soon, but they illustrate the breadth of work now being done to make monitoring more effective. It also should be noted that these sections are intended only to identify some exciting potential methods, not to provide a complete discussion of advantages and disadvantages (which in general are not yet well known) or of all cases in which the methods will or will not be suitable.

Acoustics

Acoustical methods have a prominent role in avian monitoring efforts because many birds can be heard more reliably and at much greater distances than they can be seen. Autonomous data collection using recording devices and automatic data processing and analysis using specially designed software have both revolutionized and expanded the capabilities and application of acoustic technology for monitoring birds. However, several factors impede translation of bird sound detections by humans into reliable estimates of abundance. Human listeners differ significantly in hearing thresholds and psychoacoustic acuity and in their ability to identify sounds, in coping with dense choruses, and in judging distances to bird sounds. Moreover, patterns of bird sound production are not well quantified.

These limitations apply to all acoustic monitoring methodologies, whether ground-based monitoring of diurnal birds or monitoring the flight vocalizations of vast numbers of nocturnal migrants. The best uses of acoustic technologies to address these limitations and to enhance biological and conservation understanding could perhaps best be summarized as the following opportunities:

- to monitor species acoustically that vocalize infrequently,
- to improve accuracy of existing census methods,
- to produce acoustic datasets for training purposes, and
- to monitor flight-calls of migrant birds for predicting migration and stopover use on DoD installations.

Autonomous data collection is critical for any remote or extensive acoustic survey, and digital autonomous recording units (ARUs) can record time-stamped files for months-long periods or longer. These units provide a fundamental and valuable extension to traditional acoustical studies because (1) they can easily detect species that are not efficiently censused by point-count methods because they vocalize infrequently, and (2) ARUs can be deployed in advance at many sites for long durations and programmed to record simultaneously. These devices improve our knowledge of the limiting factors of observers monitoring birds acoustically and of protocols for monitoring birds that may be missed by traditional observation methods. ARUs were used extensively at Fort Hood to monitor endangered Golden-cheeked Warblers (*Dendroica chrysoparia*) and Black-capped Vireos (*Vireo actricapillus*), under SERDP CS-1185, and at DoD facilities nationwide to monitor the species composition and migration phenology of nocturnally migrating birds under Legacy 05-245, 06-245, and 07-245.

Additionally, such devices played a prominent and critical role in the recent search for several rare species (including Ivory-billed Woodpecker, *Campephilus principalis*). Other work by the University of Puerto Rico (Legacy 07-345 and 08-345) is investigating wireless remote automated digital recording systems and community-level identification of species.

Advances during the past decade in processing and analysis methodology include increased computer processor speed, automated detection software, increased data storage capacities, and a comprehensive identification guide. For processing and analyzing audio data containing flight calls, these advances permit recording of the vocalizations of passing migrants over entire nights across seasons, thus yielding data on species composition, migration timing and routing, and the magnitude of migration traffic. Because many North American species of birds give distinctive flight calls during nocturnal migration (likely close to 450–500 species), monitoring flight calls of nocturnally migrating birds is critical for studying the timing and magnitude of migration, as well as for confirming the presence of individual species. A citizen-based project running from 1999 to 2001 used pre-amplified microphones and a Java application that enabled volunteers to automatically detect nocturnal flight calls using the sound card inputs on their personal computers. Nocturnal flight calls were uploaded over the Internet each morning, and logged in a database that hosted graphical tools for reviewing and labeling the sounds. Numbers of migrants detected at night were then compared directly with ground-based censuses from nearby sites to relate the composition of species that passed overhead with those that stopped to use habitats on the ground. These numbers also were compared with WSR-88D (Weather Surveillance Radar, 1988-Doppler; also known as NEXt generation RADar, or NEXRAD) radar imagery, providing information on the species composition of radar-detected migration events. Several recent studies also have used these methods to compare nocturnal flight calls and bird density as quantified by WSR-88D imagery (e.g., Farnsworth and others, 2004). However, numerous challenges still remain to be addressed, including: quantification of birds using acoustic data; relationships between acoustic and radar data; source levels on bird vocalizations; and localization of birds in an acoustic array.

DoD applications. DoD installations require accurate measurements of migratory landbird migration patterns and population sizes. Yet, at most DoD locations, complete year-round migratory bird community inventories have not been completed. ARUs provide solutions and sample data that enhance DoD's capacity to monitor avian resources on and around DoD lands and to analyze and summarize these data. This approach to monitoring provides numerous cost efficiencies for surveys across large, inaccessible or difficult-to-survey areas. The innovative acoustic monitoring network under evaluation in current SERDP and Legacy projects provides tools to monitor migratory activity by species, contribute towards more accurate population estimates for these species, and provide information for more accurate environmental risk assessments (for the MBTA, ESA, and NEPA). In addition to monitoring avian use of DoD lands, acoustic techniques allow monitoring of bird use of airspace at night over and around DoD installations. A network of acoustic monitoring sites documents migratory phenomena that are unobservable by other means, and enable studies that extend beyond the boundaries of DoD installations. These approaches address four challenges confronting DoD:

1. acquiring detailed information to help reduce bird-aircraft strike hazards,
2. supporting the military mission while meeting environmental stewardship and regulatory obligations,
3. engaging broader societal support and solutions for environmental problems, and
4. ensuring mission sustainability by avoiding mission restrictions, delays, and impacts.

Radar

Since the discovery 60 years ago that birds were responsible for some of the puzzling radar echoes dubbed “angels” by the British, radar has proven to be a useful tool for the detection, monitoring, and quantification of the movements of organisms in the atmosphere. Radar can be used to study the movements of birds in the atmosphere during the day and at night at very small spatial scales (1–10 km of a tracking or marine radar), at intermediate spatial scales (10–200 km or the surveillance area of a single weather radar), and at large spatial scales (continent-wide radar network surveillance). Although some new technology exists and is being field tested, most available radars cannot be used to identify birds to species. However, radar can provide information on flight speeds, and this can be used to discriminate different types of birds based on their airspeeds relative to wind speed and direction (e.g., waterfowl and shorebirds, songbirds).

Radar displays show echoes of targets in the radar beam, and a single echo may be produced by a single target or two or more targets in close proximity. Radar has been valuable not only for descriptive studies of daily and seasonal patterns of bird migration and the roosting behavior of birds, but the technique also has been used to answer important questions related to orientation, aerodynamics, and habitat selection of migrants. Within the last two decades, radar has been used increasingly in risk assessment studies related to projects that could potentially impact species that are migratory, endangered, threatened, or of special concern. Most studies have used high-resolution, short-range marine radar and long-range weather surveillance radar.

Marine Radar

Configurations of Small Mobile Radars. Most of the small, mobile radar units used in studies to date have been 5 kW to 60 kW incoherent pulse marine surveillance radars of 3- or 10-cm wave length (X-band or 9410 MHz ±30 MHz and S-band or 3050 MHz ±30 MHz, respectively). Many of the units are used without modification, and the open array antenna that comes with the unit when purchased projects a beam that is narrow (1.0–2.3°) in the horizontal dimension and wider (20–25°) in the vertical dimension. The exact beam dimensions depend on the length of the open array antenna. Because the open array antenna samples a range of altitudes when the radar is operated in a horizontal surveillance mode, the altitude of individual targets cannot be determined. Several approaches have been used to get around this limitation. One involves placing the transmitter/ receiver with the open array antenna on its side and rotating the antenna vertically instead of horizontally. In this configuration, accurate altitudes of targets can be measured, but target track information is limited to targets moving along the axis of the antenna sweep. In some cases, two units are used—one devoted to horizontal surveillance and the other to vertical altitudinal scans. It also is possible to replace the open array antenna with a rotating, parabolic antenna that projects a narrow (2.5–4°) conical beam. When the conical beam is elevated in the horizontal surveillance mode, the altitude of an echo is a trigonometric function of the range of the echo and the angle of antenna tilt. In other cases, a non-rotating parabolic dish can be mounted on top of the transmitter/receiver unit and directed to any elevation angle between horizontal and vertical to measure the altitude of targets.

Each of the above configurations has its advantages and shortcomings. The open array antenna samples a greater air space, but the range of detection is reduced and the altitude of a target in the vertical scan cannot be linked to the track of a target in the horizontal scan. The parabolic antenna samples a smaller volume of atmosphere but has a greater detection range and three-dimensional information on each target can be measured.

Innovations in Small High-Resolution Radars. In the last decade, capture of raw radar data from marine radar and subsequent digital processing enabled automatic tracking of targets detected by the radar while reducing echo return from ground clutter. This innovation has eliminated the time-consuming manual plotting of radar echoes on the radar display, and provides information on target strength, speed of target, direction of flight, and altitude if a parabolic reflector is used. Track histories of individual targets can be stored for additional analysis. However, small targets flying over strong ground clutter are rarely detected because of the clutter suppression.

The latest developments in marine radar represent a radical and innovative departure from current marine radar technology. The new units are monostatic pulse radars that use the Doppler effect to determine target velocities. This is achieved by resolving targets within particular velocity bands by processing received echoes in a bank of narrowband coherently integrating filters. Consequently, the new radar is able to separate targets of interest from clutter because of the targets' different radial velocities. Thus, small targets in clutter can be detected, quantified, and tracked. Although these units have not been evaluated for bird movement studies, this will occur soon as more and more units are produced.

DoD Applications. Small mobile radars are valuable technological tools for the DoD. They can be used to detect dangerous concentrations of birds in the atmosphere on and near military air fields and this information can be used to inform flight operations that serious BASH conditions exist. When this information is gathered over time, it can be used in the development of a BASH plan for the airfield and greatly improve flight safety.

These radars also can be used to assess the best habitats on military installation for migrant birds. Because most birds initiate migratory flights shortly after dark, the radars can provide information on the relative density of migrants departing from different types of habitat. This information combined with on the ground bird census data can be extremely valuable to natural resources managers interested in the conservation of migratory birds.

Weather Surveillance Radar

Doppler Weather Surveillance Radar. The WSR-88D (Weather Surveillance Radar-1988, Doppler)—also referred to as Next Generation Radar (NEXRAD) during the planning and development stages—is the backbone of the national network of weather radars in the United States operated by the National Weather Service (NWS) in the National Oceanic and Atmospheric Administration (NOAA) of the Department of Commerce, DoD (units at military bases), and non-CONUS Department of Transportation sites. There are 155 WSR-88D radars in the nation, including the U.S. Territory of Guam and the Commonwealth of Puerto Rico.

Biological targets in the atmosphere are readily detected by the WSR-88D, and several investigators have detailed its use for studying bird migration, bird roosts, bat colonies, and concentrations of insects aloft. The WSR-88D can be used to quantify the amount of bird migration aloft and has been applied to studies of regional patterns of migration (e.g., Great Lake Region, Northern Coast of the Gulf of Mexico).

The WSR-88D can be used to delimit important migration stopover areas within 60 km of the radar by measuring the density of birds in the beam as they begin a migratory movement (exodus). Within minutes of the onset of nocturnal migration, the distribution and density of echoes in the radar beam can provide information on geographical ground sources of the migrants (migration stopover areas), and satellite imagery can be used to identify the topography and habitat type that characterizes these areas. At a larger spatial scale (that of the surveillance area of a single Doppler weather radar—out to 240 km range), this approach also can be used to delimit locations of post-breeding, nocturnal roost sites of birds, such as Purple Martins (*Progne subis*) and other species. Martins flying toward the roost late in the day generally do so at low altitudes and often fly under radar coverage, however, when they depart the roost near dawn they climb high into the sky and can be easily detected by Doppler.

At a continental scale, the national network of WSR-88D radars can be used to monitor bird migration over the United States on an hourly basis at different altitudes dependent on distance from the radar. The latter achievement is significant because it provides a means of monitoring the season-to-season and year-to-year variation in the patterns of migration at different altitudes for different geographical regions and the nation as a whole.

Because the radar pulse volumes of the WSR-88D are large (1º × 1 km for reflectivity and 1º × 250 m for velocity), a given pulse volume often contains birds, bats and insects, and one must use the mean air speeds of targets to discriminate between slow flying insects and foraging bats and faster-flying migrating birds and bats. The lowest tilt of the WSR-88D antenna averages 0.5º above the horizontal, and over most of the surveillance the base of the beam is too high to detect low flying birds. The beam width of the WSR-88D is 1º, and at a distance of 30 km, the base of the beam is 78 m above antenna level (AAL), the center of the beam is 321 m above AAL, and the top of the beam is 564 m AAL. At that distance, the beam width is 486 m wide. This eliminates the possibility of precise altitudinal measurements of targets.

Innovations to the WSR-88D. Beginning in 2008, WSR-88D technology was significantly upgraded. The radar will undergo a series of modifications that will greatly enhance the radar's capability to provide useful information for biologists who choose to study the distribution and abundance of organisms in the aerosphere. The azimuthal resolution of all three moments of data (reflectivity, radial velocity, and spectrum width) will change from 1° to 0.5°, and the range resolution of reflectivity will change from 1 to 0.25 km and match the existing resolution of radial velocity. Doppler data range will increase from 230 to 300 km, and the amount of data collected and transmitted during a volume scan will increase by a factor of about 2.3. In addition to the move toward super-resolution data, the radar will be upgraded to have a dual polarization capability. The latter upgrade provides additional information that can be used to discriminate between return from birds and return from insects.

DoD Applications. The WSR-88D is a valuable technological tool for the DoD. The radar can be used to detect dangerous concentrations of birds in the atmosphere over large geographical areas. This information is extremely valuable for alerting military flight operations of hazardous concentrations of birds along low-level training routes and near military air fields. Information on bird migration gathered with the WSR-88D is being used to develop migration forecast models that can be used to predict when hazardous concentrations of birds aloft will occur. This will allow flight operations at an airfield to schedule training flights when conditions are not favorable for bird migration.

The WSR-88D can be used to determine the locations of important migration stopover areas on or near military bases, and SERDP has funded a project that uses information from the WSR-88D to map important migration stopover areas on and near 50 military installations in the United States. The radar also can be used to determine when migrants are likely to be present on base so that natural resource personnel can census them in different habitats. The density of migration aloft at 10 p.m. local time measured with the WSR-88D correlates significantly with the number of migrant birds captured the next day at a banding station.

Telemetry

Telemetry devices, such as satellite and radio-frequency (RF) tags, play an increasingly important role in understanding bird movements across a spectrum of temporal and spatial scales. No other method for tracking birds can provide the detailed, individual information offered by these transmitters and data loggers. This technology addresses several fundamental questions about bird movements, such as the relationships between movements and energy budgets of individual birds, or understanding the exact location and condition of birds in multiple dimensions (e.g., time, space, biotelemetry). However, numerous challenges remain for implementing satellite and RF tag methods, including reducing tag size and mass, improving coverage for satellite and cellular providers, and increasing battery life. These issues aside, telemetry can be a powerful means of gathering specific and highly detailed information on birds on and away from DoD lands.

The array of different telemetry devices is growing, but the list is best summarized as: satellite-based systems, cellular tracking systems, direction finders, and data loggers. Previous DoD-supported research using some of these technologies includes Legacy projects 95-50100 (American White Pelican, *Pelecanus erythrorhynchos*; Peregrine Falcon, *Falco peregrinus*; Golden Eagle. *Aquila chrysaetos;* Swainson's Hawk, *Buteo swainsoni*; and Ferruginous Hawk, *Buteo regalis*), 95-10049 (Peregrine Falcon), 99-1874 (Broad-winged Hawk, *Buteo platypterus;* White-faced Ibis, *Plegadis chihi*), 00-1874 (Broad-winged Hawk), 03-1875 (White-faced Ibis), 06-292 and 07-292 (Osprey, *Pandion haliaetus*), and 05-243 and 06-243 (Burrowing Owl, *Athene cunicularia*) among others. In addition, SERDP funded research to develop Global Positioning System (GPS) satellite transmitters that were used in many of the Legacy-funded satellite projects.

Satellite-based tracking offers global coverage and rapid data availability, two significant improvements over previous technologies for studying animal behavior. The GPS (receiver) and Argos (transmitter) systems have been operational for over two decades and provide worldwide coverage. The high complexity and relatively rapid power consumption (i.e., a large battery typically is required) of these systems have led to relatively large tag masses (10 g range is the lowest presently available).

An alternative option for individual tracking is to use the global cellular network, also an attractive means to telemeter tag data. Their relatively high data rates enable RF tags to stream many types of data, including live GPS, audio, and video. Biotelemetry sensors even collect information about an animal's pulse, respiration, and wing beat. At least one manufacturer is developing a cellular tag based on commercially available radio components, and academic researchers are attempting to miniaturize such tags. Progress is impeded by the closed cellular system in North America, proprietary standards, and reluctant cellular providers. However, the potential is great: small size and low weight are necessary for deploying on animals too small for currently available satellite-based transmitters. This technology could be invaluable to DoD planners who need detailed information about the location and movements of species of interest. Application would benefit the military mission in numerous cases, particularly for understanding at what altitude and in what locations birds pass through flight training areas.

Traditional radio tracking with directional antennas and hand-held receivers is labor intensive. Automatic direction finding and automatic location finding receiver systems attempt to automate the process. Recent advances in digital signal processing technology have enabled application of sophisticated signal processing algorithms. Automatic tracking would remove the subjectivity of determining signal direction and reduce the amount of intensive field work inherent to radio tracking. Additionally, a new generation of tags, based on 802.15.4 and other low-power physical layer standards, is becoming available. These tags exploit generic capabilities of modern ultra-low power microcontrollers and store data from a wide variety of onboard sensors. A tag can schedule transmission to a fixed base station once it receives that station's interrogating signal, and then rapidly offload its data to the base station when other tags are not transmitting. This system enables data recovery from animals that are difficult or impossible to recapture.

Because of the quality and quantity of information that can be gained and the potential for significant savings of time and effort, development and implementation of these tags warrants additional funding and research by the avian scientific community. A light-level sensor that, when coupled with an accurate clock, yields a system capable of geolocation, may be of particular interest. This approach, which uses the time of local noon and the day length to determine position, yields coarse position estimates, with typical accuracies of ±300 km. Despite its low accuracy, this information can be invaluable in determining the routes and schedules of small long-distance migrants, as there currently are no other means to obtain this information. A very simplified sensor tag with only onboard storage and light sensing could weigh as little as 0.5 g, a mass that would allow this approach to be used on 90 percent of terrestrial bird species and virtually all aquatic birds. This technology has several benefits both to the bird (a low mass transmitter is easier to carry, thus reducing the bias of the data collected) and to the DoD (low cost relative to quantity and quality of information obtained).

DoD applications. Land managers at DoD installations require spatially accurate data on avian habitat use and movement. Wildlife telemetry techniques provide high quality data about bird movements and their energetic condition, numerous cost efficiencies for surveys across large, inaccessible or difficult to survey areas, and, similar to acoustical methods, information for more accurate environmental risk assessments (for the MBTA, NEPA, and ESA) and INRMPs. Benefits to mission sustainability and readiness include:

- identifying movements of migrant and resident birds in time and space in order to reduce bird-aircraft strike hazards,
- meeting environmental stewardship obligations by identifying specific areas and types of habitat use, and
- engaging broader societal support and solutions for environmental problems.

Stable Isotopes

Recent technological advances in the use of stable isotopic signatures make it possible to determine the geographic origins and population connectivity of breeding and wintering populations of migratory birds. Stable isotopes are naturally occurring elements that vary in their atomic weights, and previous studies have shown that animal tissues reflect the isotopic composition of their supporting environment. For example, hydrogen isotope (δD) ratios correlate with the δD of local precipitation patterns. In birds, these δD signatures are incorporated into feathers on the breeding grounds when birds molt in their new plumage prior to migration. Because δD isotopes in bird feathers are metabolically inert after growth, individuals can be sampled during the winter to determine their breeding origin. Combining δD with other isotopes that vary over large geographic distances, such as carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$), can provide an accurate method to track migratory birds year-round. Researchers at the Smithsonian Migratory Bird Center [Kirtland's Warbler (*Dendroica kirtlandii)* and other warblers] and USGS (Legacy project 05-241 focusing on shrubland birds) have worked with all of these isotopes previously and have published multiple papers regarding their utility and importance for understanding the ecology of migratory birds.

DoD applications. Department of Defense lands account for nearly 5 percent of Federal lands within the U.S. Managing and protecting populations of species, such as migratory birds, on these lands is challenging because such species spend different parts of the year in geographically disparate localities. Land-use patterns and anthropogenic factors, such as hunting and chemical use at non-breeding grounds (non-DoD lands) and along migratory routes, can have important and profound effects on the year-round condition and survival of birds that breed on DoD lands. Yet, for many migratory birds, we do not know basic information such as the location of their non-breeding grounds or their migratory route. Essential to protecting and understanding fluctuations in the abundance of Neotropical migratory birds breeding on military lands is documenting where these birds spend the non-breeding season and identifying threats to these birds on their non-breeding grounds as well as along the length of their migratory routes. Closing the loop on conservation can help with the protection and sustainment of viable bird populations, thus reducing the potential for listing under the ESA and for military activities to have significant impacts on bird populations. In essence, the more secure bird populations are, the better DoD can avoid potential impacts on mission activities.

Capture-Recapture Modeling

Since 1992, the DoD has played a key role in the development of, and contribution of data to, the largest standardized avian capture-recapture dataset in North America—the MAPS program. Initial goals of MAPS were focused on two demographic parameters, productivity, as indexed from constant-effort capture data, and adult apparent survival rate (survival), as estimated from capture-recapture models. In the early days of MAPS, however, options for capture-recapture modeling were limited, and estimating survival required acceptance of unrealistic assumptions about homogeneity of capture probability and survival among individuals. Few methods existed for estimating population parameters other than survival, and there were no formal methods available for modeling relationships among population parameters or linking population parameters to environmental drivers.

Advances in capture-recapture modeling over the past two decades now make it possible to provide realistic inferences about various population parameters (including, but not limited to, productivity and survival) and links between these population parameters and the environment. These advances have increased the value and scope of the MAPS program for avian monitoring and conservation. Methods for accounting for 'transients' in capture-recapture data, developed in part through funding from DoD's Legacy program, allow estimation of survival that is much closer to actual survival rates of resident birds. Reverse-time capture-recapture models allow estimation of recruitment and population growth rates. Robust-design models allow estimation of population size (which can be age-specific), as well as, temporary emigration and immigration rates.

Capture-recapture modeling continues to be one of the most rapidly evolving fields of statistical ecology. Bayesian hierarchical models that use Markov chain Monte Carlo parameter estimation show particular promise. These new methods make efficient use of sparse data and can be used to address various problems that were difficult or impossible to address using classical techniques. For example, hierarchical models can be used to model relationships between demographic parameters (for example, recruitment and survival), allow for incorporation of spatial or temporal effects, easily handle missing data, and allow inclusion of covariates or random (heterogeneity) effects at various levels. Continued development and application of hierarchical models to avian monitoring data, such as MAPS, should lend new insights into causes of population changes on DoD installations.

DoD Applications. MAPS data and analyses have been used on many installations to develop and refine management strategies for birds. The new methods, however, are providing much greater ability to tailor the findings to specific installations and management issues.

Chapter 4: Guidelines for Designing Short-Term Bird Monitoring Programs

Short-term monitoring, as used in this report, includes both one-time surveys designed to collect information on species composition, timing of use, and relative or absolute density, and monitoring designed to estimate a treatment effect such as the impact of training or habitat alteration on a species of concern. More specifically, short-term monitoring programs may be defined as any survey with a termination date (in contrast to surveys like the BBS that are intended to continue indefinitely). DoD conducts dozens to hundreds of short-term monitoring programs each year so their design must be addressed in any comprehensive approach to bird monitoring.

The guidelines in this Chapter are based on recent literature (Oakley and others, 2003; U.S. NABCI, 2007) that stresses the value of clearly identifying goals, objectives, and methods before field work begins. Some of the material in this chapter is technical. It is intended for specialists carrying out, or responsible for, program design and implementation. Guidelines for preparing each component of the project description (table 6) are described below. The identified elements are intended as suggestions only. Real examples, as indicated later in this report, usually differ somewhat in content and sequence. An example of the steps outlined below is provided at the end of this Chapter.

Table 6. Outline used to describe short-term bird monitoring projects.

A. Description of the Management Issue
B. Survey Objectives
1. Biological population
2. Information needed
3. Quantitative objectives
C. Methods
1. Brief description
2. Statistical population
3. Sampling plan
4. Training and field methods
5. Sample size requirements
6. Analytic methods
7. Data management
8. Reports
D. Roles and Responsibilities

Components of a Successful Short-term Bird Monitoring Program

Description of Management Issue

If this section is clear, and especially if only one or a few management decisions are the focus, then the rest of the survey description is relatively easy to complete. If the management issue is not clear, then the rest of the survey description is difficult to conceptualize and complete.

To begin, describe the management issue to be addressed or, preferably, the management decision that the monitoring will help managers make. Examples include what habitat management treatment to apply, minimizing bird-aircraft strikes, specific habitat restoration goals, and whether to grant a species increased or decreased protection. Next, explain the spatial and administrative level at which the project is being organized and why this is the right level. This information is important because it has a substantial impact on survey costs. Conclude with a clear, albeit qualitative, description of the product needed to address the management issue.

Survey Objectives

1. Biological population

   Describe the species to be studied (e.g., migrating shorebirds, breeding waterfowl). Specify which individuals are included (e.g., all birds, only breeders, only residents).

2. Information needed

   Provide as much detail as possible about the information to be obtained in the survey. Species, cohorts, times of year, and habitats of greatest interest should be identified, as should auxiliary information, such as level of disturbance, evidence of breeding, and habitat relationships. Identify the parameters to be estimated in precise, quantitative terms (e.g., density of pairs, trend in abundance, or habitat relationships expressed as regression coefficients).

3. Quantitative objectives

   Specify the accuracy target, expressed as power or as precision [for example, standard errors (SEs), confidence intervals (CIs), and coefficients of variation (CVs)] for each parameter, and discuss how it was chosen. This is frequently a difficult section to write, especially in the early phase of a project, and the target may change as work progresses. Having an accuracy target is important, however, because it provides the basis for calculating sample sizes and, in some projects, for choice of field methods. In some studies, resources are fixed so the objective is simply to maximize precision given the available resources. In such cases, simply acknowledge that this is the situation.

Survey Methods

1. Brief description

   Provide one or two sentences summarizing the survey methods.

2. Statistical population

   Identify the population unit and the statistical population. Population units are usually either individuals (e.g., birds), capture devices exposed for a given amount of time (e.g., a "mist net-hour"), or, most common of all, a location for a specified period (e.g., as in a 3-minute point count or a 30-minute area search). The statistical population is the set of population units about which we choose to make inferences (the population of interest), or from which we sample (the sampled population); these two should be distinguished if they are different. For example, in a point count project, the spatial dimension of the statistical population might be all forested locations on an installation, and the temporal dimension might be mornings without high winds or heavy rain. The population of interest probably would be all possible location-times in the population, but the spatial dimension in the sampled population might be locations along roads and trails.

3. Sampling plan

   Define the sampling plan using standard survey sampling terminology, as in the following example: "Two-stage sampling will be used, with stage one preceded by stratification by habitat. Three strata (probably woodlands, fields, other) will be delineated. Primary units will be locations (i.e., the set of possible survey times at a location), and secondary units will be survey times (at a given location). We anticipate that primary and secondary units will both be selected systematically." Assistance from a statistician familiar with survey sampling may be needed in this phase. (Arrangements are being made for USGS to provide this assistance to DoD personnel.)

4. Training and field methods

   Provide a detailed description of training and field methods. Try to foresee practical problems, how they can be addressed, and how seriously the sampling plan or data collection might be compromised by the problems.

5. Sample size requirements

   Use formulas for sample size estimation and allocation of effort, with multi-stage designs, to estimate the sample size needed to achieve the accuracy target for each parameter. Because minimum sample sizes will differ between parameters (e.g., number of pairs of a species), the final study design will usually be a compromise between costs and meeting most of the accuracy targets.

6. Analytic methods

   Describe the methods to be used identifying issues that may be especially difficult and how they are being addressed in the project design. Extremely detailed accounts are not needed, but demonstrate that careful thought has been given to where the analyses may lead and insuring, insofar as possible, that the data collection will support the most useful analyses.

7. Data management

   Describe how the data will be entered, organized, stored and retrieved. State if the data will be contributed to regional, national, or continental repositories (and if not, why not).

8. Reports

   Describe when reports will be prepared, what they will contain, to whom they will be provided, and by whom they will be reviewed.

Roles and Responsibilities

Describe who will have responsibility for detailed design, field work, data management, analysis, and communication. Also describe who will support/accomplish the project and how (e.g., contracts, in-house support).

Detailed Example of a Successful Program

Description of Management Issue

Recent surveys on barrier islands along the Florida Gulf Coast have revealed that some species of shorebirds are seldom found where beach nourishment projects have been carried out. This finding is a concern because many shorebirds are thought to be declining. Furthermore, the species using these beaches include a federally-listed species (Piping Plover, *Charadrius melodus*), a state-listed species (Snowy Plover, C. *alexandrinus*), and a subspecies of the Red Knot (*Calidris canutus*) determined to warrant federal listing as Threatened.

Due to these concerns, DoD, specifically the Army Corps of Engineers, consults with the USFWS on potential barrier beach projects in Florida to determine whether the project will affect shorebirds adversely and, if so, what might be done to reduce or mitigate the effects. In these discussions, estimates are needed of the number of shorebirds using the project's impact area. In this project, several contractors will use the protocol described below to estimate shorebird numbers in project areas. They also will provide information on behavior and habitat use of the focal species. This information will be useful in estimating impacts and discussing ways to reduce them. After experience is gained with the protocol it will be reviewed and revised as necessary. If appropriate, the revised protocol will be adopted as a standard approach for assessing shorebird numbers in project areas on Florida's barrier beaches. The goal of the project is thus:

> Provide scientifically-sound information on whether proposed beach nourishment projects on barrier islands in Florida will have adverse effects on shorebirds and, if so, how to avoid, minimize, or mitigate the effects.

Objective

Obtain estimates of the mean number of shorebirds present in proposed beach nourishment project areas. Collect data on habitat use and behavior of birds (e.g., roosting, foraging).

Selecting the needed number of surveys requires that we specify a quantitative objective for the estimate of mean numbers present. Because shorebird use differs substantially throughout the year, we suggest the surveys be designed to achieve the accuracy target during each of four seasons: winter, spring migration, breeding, fall migration. The coefficient of variation [CV, i.e., the standard error (SE) of the estimate divided by the estimate], is a reasonable metric (accuracy target) for this purpose.

Although no “standard values” for target CVs are available, we believe in this case that obtaining essentially unbiased estimates with CVs of no more than 0.20 is both desirable and feasible. If the CV for an estimate was 0.20 then the 95-percent confidence interval would be approximately the point estimator ±40 percent. For example, if the estimated mean number of birds present was 20 and the CV was 0.20, then the 95-percent confidence interval for the estimate would be approximately 12 to 28. The methods below are designed to produce essentially unbiased estimates of the mean number of birds present during one season with CVs <0.20. Other parameters will doubtless also be of interest, and many of them can be estimated from the survey data. To keep the sample size analysis from becoming too complex, however, the calculations below are based solely on achieving a CV of the estimated mean for one season <0.20.

Methods

Statistical Population

The statistical population includes the area within which shorebirds are likely to be affected by the proposed project at all times when surveys might be conducted. Potential survey times will be limited by darkness and practical factors. The survey times might thus be defined as weekdays between 9:00 a.m. and 5:00 p.m. throughout the season. This definition assumes the difference between the mean number present during these times and during all times of interest (which, e.g., might include weekends and nights) can be ignored. This assumption should be carefully evaluated. In the example given, excluding weekends might be questioned on the basis that human disturbance levels then might be higher, and the number of birds lower, than on weekdays. In other cases, the reverse might be true due to higher disturbance levels at other publicly accessible sites.

Sampling Plan

We assume that on any survey, the entire project area will be searched. The response variable is the number of birds “present” which we suggest defining as the number present at the start of the survey (i.e., birds that arrive during the survey should be excluded, perhaps by giving them a certain code and excluding them during the analysis). We assume that virtually all birds present will be detected and recorded so there is no need to estimate the detection ratio. Under this assumption, and assuming further that the specified sampling plan is followed, the estimate of mean number present is essentially unbiased using all common sampling plans and analytic methods.

Either systematic sampling or stratified random sampling could be used for selecting survey times. Stratified random sampling is appealing because conditions under which about the same number of birds would be present (e.g., low tide versus high tide) probably could be defined as strata. This would substantially reduce the unexplained variation and would result in smaller SEs compared to a systematic sample of the same size. On the other hand, assuming that covariates (e.g., tide height) are recorded, many of the same advantages could probably be obtained by using a model-based approach for the analysis. In the example given, tide height would be incorporated as a covariable that would help reduce residual variation in the model. The emergence during the past decade of “mixed models” offers an opportunity to gain advantages from both stratified sampling. By using mixed models, surveys can be concentrated in periods of highest use and additional covariables can be incorporated into statistical models. Both stratified sampling and use of mixed models in the analysis, however, require a greater degree of sophistication than employing systematic sampling to select times and treating the results as a simple random sample (the usual approach with systematic samples). The lead investigator, perhaps with consultation from a statistician, should choose the sampling plan and analytic methods, with the requirement that a well-defined sampling plan be used and that the general analytic approach be identified before collecting the data.

Field Methods

As noted above, we assume that a simple area search will suffice to find all birds present. Consequently, no special methods are needed to estimate detection rates. It will be useful to collect habitat and behavior information during the surveys. To do this, the survey area should be partitioned into habitat compartments. We recommend classifying compartments by “landform” and “substrate.” Review of the landform types will be needed and can vary if necessary between survey sites (although this will reduce ability to compare results across sites, and such comparisons are recommended).

A preliminary list of landforms is:

1. ocean beach
2. bay beach
3. inlet shorelines
4. spits
5. ebb shoals
6. flood shoals

A preliminary list of substrates is:

1. intertidal
2. mud and sand
3. dry beaches
4. fresh wrack
5. old wrack
6. ephemeral pools

Because some of these compartments will change with tide levels or other factors, maps will need to be updated periodically or separate maps will need to be prepared for each condition that affects locations of the compartments. During surveys, the compartment that each bird is in will be recorded along with its behavior. Preliminary behavior codes are roosting and non-roosting. Immediately after the survey, the surveyor will record disturbances during a specified period (e.g., 1 hour). A list of events that constitute a “disturbance” will be continuously developed along with a list of birds’ responses to disturbances. The number of disturbances and responses, by type, will be recorded during the observation period.

Analytic Methods

As noted above, two general approaches for the analysis are available: "design-based" and "model-based" methods. The design-based methods require few assumptions and are straightforward applications of survey sampling theory. For example, if stratified sampling is used to select survey times then the estimate of the mean number present is:

$$\overline{y} = \sum_{h=1}^{L} w_h \overline{y}_h \ , \qquad (1)$$

where $\overline{y}_h$ is the simple mean of the surveys in stratum h, w_h is the proportion of all times (not surveys) in stratum h, and L is the number of strata. The standard error of the estimate is:

$$SE(\overline{y}) = \left(\sum_{h=1}^{L} w_h^2 s^2(y_{hi}) / n_h \right)^{0.5} , \qquad (2)$$

where y_{hi} is the number of birds recorded on the ith survey in stratum h, $s^2(y_{hi})$ is the sample variance of the y_{hi}, and n_h is the number of surveys in the hth stratum. Degrees of freedom (*df*) may calculated using Satterthwaite's method (Cochran, 1977). The 95-percent confidence interval is: $\overline{y} \pm t_{df,0.05} se(\overline{y})$.

Numerous model-based methods could be devised. The most obvious is to construct a multiple (mixed) linear regression model that predicts number present as a function of such factors as date, time of day, tide height, and perhaps other factors (e.g., disturbance, weather). The model would then be used to predict number present under average conditions or under a representative sample of conditions (and the outputs would be averaged).

Sample Size Requirements

Sample size requirements will be much easier to estimate after a few years of data have been collected. Estimates made now should be viewed as preliminary. These cautions notwithstanding, an effort was made to predict needed sample size using data collected in the International Shorebird Survey (ISS) in Florida. We assumed that simple random sampling was used. For this method,

$$CV(\overline{y}) = \frac{SD(y_i)}{\overline{y}\sqrt{n}} \qquad (3)$$

Setting the CV equal to 0.2 and solving for n yields

$$n = \frac{1}{0.04} \left(\frac{SD(y_i)}{\overline{y}} \right)^2 \qquad (4)$$

We used the ISS data to estimate the quantity $SD(y_i) / \overline{y}$ and then calculated the needed number of surveys using expression (4). The results were expressed as a function of mean number present. We used all species, years, and sites surveyed in Florida, and we analyzed four periods separately (November–March, April–May, June–July, August–October). Estimates of $SD(y_i) / \overline{y}$ were only calculated when at least six surveys had been conducted and the mean number present was >0.5 birds.

Results were analyzed by season and species. A typical result is shown in figure 1. It can be seen that the needed number of surveys increases rapidly as the mean number present drops below about three.

Figure 1 should be viewed with caution because the surveys probably were not made according to a well-defined sampling plan and it is difficult to assess how this affected $SD(y_i)/\bar{y}$. If there was little affect on $SD(y_i)/\bar{y}$, then figure 1 probably over-estimates sample size requirements both because stratified sampling probably will be more efficient than simple random sampling (as explained above) and/or because a model-based approach for estimating $\bar{y}$ will be more efficient than a design-based approach. Given these facts, and based on examining other graphs like figure 1, we suggest that 20 surveys probably will be sufficient to achieve the accuracy target in most cases and that 10 surveys per period might be sufficient. If very few birds are present, then more surveys (either more locations or more surveys/location) may be needed to achieve the accuracy target although it also might be argued that the target should be relaxed if hardly any birds are present (i.e., there is less "resource" at risk).

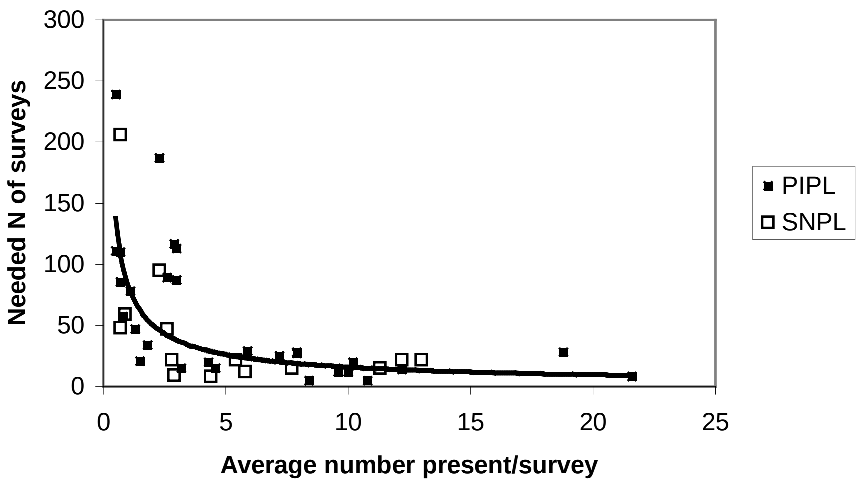

Figure 1. Estimates of the number of surveys needed for CV=0.2 based on surveys of piping plovers (PIPL, *Charadrius melodus*) and snowy plovers (SNPL, *C. alexandrinus*) in Florida during October–March.

Data Management

It is recommended that copies of the data be deposited in a permanent repository, such as the CBMD. This database offers password protection, if desired, query and analytic tools, and optional periodic uploading of core variables to the AKN.

Reports

We recommend brief, quarterly reports for project sponsors that state how many surveys were conducted and that the data have been deposited in a permanent repository, and that discuss preliminary findings as appropriate.

Roles and Responsibilities

The contractor will bear all responsibilities for the bird surveys. Oversight will be provided by DoD.

Concluding Comments

We believe that many project managers would have difficulty completing an example in the detail above. For this reason, a short-term, follow-up Legacy project has been initiated to investigate how best to implement the DoD CBM Plan. It involves providing free technical assistance to help project managers design their monitoring studies following the guidance above. Anyone interested in these services may contact the senior author at *jon_bart@usgs.gov* or (208) 426-5216. Following completion of the Legacy project, a decision will be made about whether to (1) continue the service on a DoD-wide basis (not using funds from Legacy),(2) maintain the service but have individual bases support it as needed, or (3) terminate the assistance program.

Chapter 5: Selecting a Survey Method

This Chapter describes a general approach for selecting field methods. Often, military natural resources managers contract out avian monitoring work and rely solely on the contractor to determine the appropriate type and level of sampling effort. It would be prudent to use this CBM plan as a tool to guide development of management objectives and sampling method and the terms of the contract specifying work to be accomplished.

We believe three objectives (i.e., reasons for conducting surveys) are especially common in DoD surveys: (1) preparing a bird checklist, (2) estimating the number of birds at colonies, and (3) estimating density or abundance of non-colonial birds. The user considers a series of questions until a reasonable method has been identified. The type of data needed depends entirely on the management issues being addressed. Identification of what parameter to estimate is covered in Chapter 4. Here, we assume this decision has already been made and that the answer is one of the three objectives above.

Readers will note that we do not include "estimate change in density (or abundance)" as a goal. Consistent with much of the current literature on bird monitoring (Northeast Coordinated Bird Monitoring Partnership, 2007), detection rates should be estimated as part of bird surveys rather than using index methods. Thus, estimating change in density (e.g., before and after a treatment) involves two efforts to estimate density and does not need to be identified as a separate parameter.

We have prepared these guidelines for wildlife biologists, particularly those in the Department of Defense, who are not specialists in bird monitoring methods. When a large or long-term project is being planned, we recommend consulting a specialist in bird monitoring. Many projects are small and short-term, however, and budget restrictions may hinder finding expert assistance. We hope the guidance in this chapter will be useful in these cases.

The questions below resemble a dichotomous key but there are a few differences in the numbering system. "Checklist" means a list of birds with indications of general abundance at each time of year. Checklists are often developed just with input from experienced birders rather than formal surveys.

1. Select Objective

    Prepare a bird checklist..2
    Estimate number of birds at a colony 3
    Estimate density or abundance other than at a colony.....4

2. Prepare a bird checklist

    Based solely on birders' input 2.1
    Surveys..2.2
    Birders input and surveys ....2.1 & 2.2

2.1 Prepare checklist based on birders' input

Good birders, knowledgeable about the area can be located through the American Birding Association (*http://www.americanbirding.org/*) or a local bird club or Audubon chapter.

2.2 Prepare checklist based on surveys

Area search surveys should be conducted in all parts of the area to which the checklist applies and at all times of year. Records should be kept of each area surveyed and results should be summarized by calculating the number of individuals recorded per unit time (e.g., 1 day = 8 hours) in appropriate habitat. Such data provide a good basis for defining the abundance categories and assigning birds to them in each season. These records also provide a good basis for describing habitat associations.

3. Estimate number of birds at a colony

Counts of nests are feasible 3.1
Counts of nest are not feasible...3.2

3.1 Colony surveys where counting nests is feasible

Nesting is synchronous or is asynchronous but re-nesting is rare

- In this case making the count at a single time should give an essentially unbiased estimate with suitable precision, assuming resources are available to count the entire colony or a large enough sample from it. If a complete count is possible, then we recommend this approach. If detecting nests is relatively easy but the colony is too large to count completely, then a line transect approach with distance-sampling may be the method of choice. This method assumes that all nests on the transect line are detected; if the assumption is not valid, then it may be preferable to subdivide the colony into plots and count nests in randomly selected plots. These plots should then be searched thoroughly. If not all nests are detected in the random plots, then a method to estimate the detection rate of nests (e.g., double sampling) should be employed.

Nesting is asynchronous but re-nesting is common

- Accurate estimates of the number of nesting birds in the colony can only be made through repeated surveys and by marking some birds to estimate how many nests they initiate.

3.2 Colony surveys where counting nests is not feasible

Birds can best be counted when they leave the colony.

- Use “flightline counts” to obtain an index to colony size.

Birds can best be counted while they are at the colony.

- Count birds when they are at the colony.

4. Estimate density or abundance of non-colonial birds.

One of the methods in table 7 is suitable.........................Use that method
None of the methods in table 7 is suitable ....See notes below

When no method in table 7 is suitable, then a form of double-sampling may be useful. In this approach, a rapid method is used to survey a large sample of locations and intensive methods are used on a subsample of the locations to obtain actual numbers present. The ratio of the estimate to the true number present, based on the subsample of locations, is then used as the detection rate on the rapid surveys. Advice from a specialist will normally be needed to design a double-sampling survey.

Table 7. Survey methods and required assumptions.

1. Area search

Plots are searched at least once. Surveyors are not constrained to survey pre-determined points or transect, but must search the entire plot. This method assumes all birds are detected or that the same fraction of birds present is detected in groups of plots being compared.

2. Fixed radius point counts

Points are randomly selected and surveyors spend a pre-determined amount of time at each point. Birds judged to be within a fixed distance (e.g., 50 m, 100 m) are recorded. The main assumptions are that (1) the points can be accessed, (2) birds are correctly classified as inside or outside the threshold distance, and (3) all birds within the threshold distance are recorded.

3. Distance

Randomly selected points or lines are selected and surveyed following a protocol that specifies time per point or speed in moving along the transect. For distance-based points counts (point-transects), record the difference from the observer to the detected bird(s). If using distance-based transects, perpendicular distances from the transect to detected birds are recorded, or are calculated using (1) the distance from the observer to the birds and (2) the angle between the compass bearing of the transect and the compass bearing to the bird(s). The main assumptions are that (1) points or transects can be accessed, (2) at least 75 detections will be made of each species, (3) all birds at the survey points or on the transects are detected (or that an unbiased estimate of the proportion of them detected can be obtained), (4) birds do not move prior to detection in response to the surveyors, and (5) distances and angles are accurately estimated. The last assumption means that birds or their locations must be seen by the surveyors.

4. Double observer

Surveyors work in pairs either independently or with detections made by one surveyor being revealed to the other surveyor. The main assumptions are that (1) points can be accessed, (2) any reduction in sample size due to surveyors working in pairs is acceptable, and (3) birds have the same detection probabilities (within surveyors). The last assumption is violated if some birds are quite obvious (e.g., due to persistent vocalizing or proximity to the surveyors) whereas others are hard to detect.

5. Removal methods

The survey period is divided into sub-periods and surveyors record which sub-period each bird is first recorded in. The main assumptions are that (1) points can be accessed and (2) detection events are independent in different sub-periods. The last assumption is often difficult to meet. It means, for example, that birds detected by ear do not sing in bouts.

6. Methods based on capture-recapture theory

The method is similar to the removal methods except that surveyors record every sub-period within which each bird is detected. The main assumptions are that (1) points can be accessed, (2) recording every bird detected in every sub-period is feasible, and (3) detection events for birds assigned to the same “cohort” are independent in different sub-periods. Approximately the same independence assumption is required (e.g., if many birds are detected by their vocalizations then birds must not sing in bouts).

Chapter 6: Data Management

As emphasized recently by the U.S. NABCI Committee and most specialists in avian monitoring, a critical need exists to ensure that monitoring datasets are collected and preserved in long-term repositories to prevent data loss. At a meeting to discuss the DoD CBM plan in Denver in early March 2008, a general approach was defined for insuring that DoD monitoring data are preserved and made available when appropriate (table 8). Table 8 presents a capsule summary of the process but more detail is provided in the section titled “Coordinated Bird Monitoring Database.”

eBird

What is eBird?

A real-time, online checklist program, eBird has revolutionized the way that the birding community reports and accesses information about birds. Launched in 2002 by the Cornell Laboratory of Ornithology and National Audubon Society, eBird provides rich data sources for basic information on bird abundance and distribution at various spatial and temporal scales. eBird's goal is to maximize the utility and accessibility of the vast numbers of bird observations made each year by recreational and professional bird watchers. It is amassing one of the largest and fastest growing biodiversity data resources in existence. For example, in 2006, participants reported more than 4.3 million bird observations across North America. The observations of each participant are combined with those of others in an international network of eBird users. eBird then shares these observations with a global community of educators, land managers, ornithologists, and conservation biologists. In time, these data will become the foundation for a better understanding of bird distribution across the western hemisphere and beyond.

How Does it Work?

eBird documents the presence or absence of species, as well as bird abundance through checklist data. A simple and intuitive web-interface engages tens of thousands of participants to submit their observations or view results through interactive queries into the eBird database. eBird encourages users to participate by providing Internet tools that maintain their personal bird records and enable them to visualize data with interactive maps, graphs, and bar charts. All these features are available in English, Spanish, and French.

A birder simply enters when, where, and how they went birding, then fills out a checklist of all the birds seen and heard during the outing. eBird provides various options for data gathering including point counts, transects, and area searches and bulk upload of large datasets. Automated data quality filters developed by regional bird experts review all submissions before they enter the database. Local experts review unusual records that are flagged by the filters. Installation bird checklists could be generated by doing year long surveys using point or area counts and entering data into eBird and generating a species frequency list.

Table 8. Recommendations to the Department of Defense (DoD) for management of historic records, inventory, and new monitoring projects.

[Data curation levels indicate a hierarchy of security, which increases as the level number increases]

---

1. **Data Curation**
   a. Level 1
      i. Identify and gather all existing DoD datasets (see following section for whom to contact regarding collection of data).
      ii. Archive the datasets (i.e., in their original format) at Cornell Lab of Ornithology.
      iii. Complete metadata descriptions of the Level 1 datasets
      iv. Enter metadata into NRMP (for many projects this is complete).
   b. Level 2
      i. Organize all existing DoD datasets into a single standardized data structure. Most of the existing datasets are stored in disparate data structures. Using the AKN Bird Monitoring Data Exchange (BMDE) all existing datasets will be brought into a single data framework.
      ii. A complete metadata description will be made available to the AKN.
      iii. Access to data will be restricted. Backups of the warehouse are made using persistent data archive techniques. AKN data managers will use all data backup options consistent with the goal of no data loss. Backups will undergo periodic data integrity testing. For each data set, a “data owner” will be established within DoD. No applications will access DoD data without specific consent from the data owner.
   c. Level 3
      i. With consent from DoD, Level 2 data will be made available for specific analyses.
      ii. The primary data warehouse serves as the Level 2 data archive, and no applications connect directly to the warehouse. Instead, with prior DoD approval, DoD data will be transferred to separate data views created specifically to optimize the performance of an application that connects to it.

2. **DoD Coordinated Bird Monitoring Database**
   a. Ongoing and new monitoring projects will use the DoD CBM data gathering applications and database.
   b. The DoD CBM database will provide a complete archive consistent with the goal of no data loss.
   c. Complete all metadata descriptions of the Level 1 datasets.
   d. Metadata will be entered into NRMP (for many projects this is complete).
   e. All DoD CBM data sets will be translated to BMDE format and added to the AKN primary data warehouse.

3. **DoD eBird**
   a. Bird inventory data will be collected through DoD eBird when appropriate
   b. The DoD eBird will be archived with the goal of no data loss.
   c. Complete all metadata descriptions of the Level 1 datasets.
   d. Metadata will be entered into NRMP (for many projects this is complete)
   e. All DoD eBird will be translated to BMDE format and added to the AKN primary data warehouse.

4. **DoD MAPS**
   a. Avian demographic data will be collected through DoD MAPS when appropriate
   b. The DoD MAPS will be archived with the goal of no data loss.
   c. Complete all metadata descriptions of the Level 1 datasets (recommendation is for Federal Geospatial Data Committee (FGDC) Biologic Data Profiler).
   d. Metadata will be entered into NRMP (for many projects this is complete)
   e. All DoD CBM MAPS will be translated to BMDE format and added to the AKN primary data warehouse.

Data Integration

eBird collects observations from birders through portals managed and maintained by local partner conservation organizations. In this way, eBird targets specific audiences with the highest level of local expertise, promotion, and project ownership. Portals may have a regional focus (aVerAves, eBird Puerto Rico) or they may have more specific goals and/or specific methodologies (Louisiana Winter Bird Atlas, Bird Conservation Network eBird). A DoD eBird portal is under development. Each eBird portal is fully integrated within the eBird database and application infrastructure so that data can be analyzed across political and geographic boundaries. For example, observers entering observations of Cape May Warbler (*Dendroica tigrina)* from Puerto Rico can view those data separately, or with the entire Cape May Warbler dataset gathered by eBird across the western hemisphere.

Data Accessibility

eBird data are stored in a secure facility and archived daily, and are accessible to anyone through the eBird web site and other applications developed by the global biodiversity information community. For example, eBird data are part of the AKN, which integrates observational data on bird populations across the western hemisphere. In turn, the AKN provides eBird data to international biodiversity data systems, such as the Global Biodiversity Information Facility (GBIF). In this way, any contribution made to eBird increases our understanding of the distribution and abundance of birds.

The Coordinated Bird Monitoring Database (CBMD)

The CBMD is a general “counts database” intended to hold data from a wide variety of surveys in which places and times were selected and then something was counted (fig. 2). The basic format involves a “surveys” table (description of the times and places), a “records” table (description of the things counted) and a “pedigree” table (optional description of the sampling plan). Core variables are defined, and their format is standardized (although the variables are optional). Each dataset has a “data owner.” This person defines as many variables additional to the core variables as they choose and decides whether restrictions will be placed on distribution. The CBMD uses the same five levels of access as used by Cornell Laboratory of Ornithology for eBird.

The CBMD is maintained by the USGS Forest and Rangeland Ecosystem Science Center (FRESC) in Boise, Idaho, and made available to all interested parties free of charge. When someone is interested in using the database, they contact the CBMD whose staff then works with them to define their program-specific variables and their sampling plan (if any). If requested, CBMD staff also can produce a Microsoft© Excel spreadsheet for data entry. It usually resembles the field survey forms and contains all variables entered on the form. The spreadsheet has all error-checking rules built into it and programs to reformat the data into the tables ready for upload into the CBMD. The user enters data and then clicks a “Submit” button, which activates the error checking routine. If no errors are found, the data are re-arranged into a format suitable for inclusion in the “surveys,” “records,” and “pedigree” tables mentioned above and appended to these tables. Periodically, for example at the end of each field season, the spreadsheet is emailed to the CBMD staff who uploads the data into the CBMD.

People can access the data through the Internet. They sign on; choose their program, and enter a password if needed. The variables in the program are then displayed and the user can define a query by selecting any values on any subset of the variables. The user also can query for either a bulk download of all records meeting their query or can query for estimated densities and population sizes for any “level” in the sampling plan. For example, if a user signed on to the Intermountain West Aquatic Bird

Survey, they could query for estimated means and totals (for any subset of records) for each State, each BCR, each “Bird Conservation Subregion” (polygons formed by intersecting a BCR and States/Provinces layers), or each site. They also could query for estimates at the next level below the Site but this would be most useful if they had one or two sites in mind and therefore knew what were the next levels down. This ability to aggregate results in a statistically rigorous fashion, even though many different sampling plans were followed at different sites is, to the best of our knowledge, unique among databases.

The CBMD is a node of the AKN and uploads core variables to it periodically (if the data owner requests this free service). CBMD staff prepare metadata (using both the full FGDC standards and the reduced NRMP set of variables) and submit them to the appropriate permanent repositories maintained by the government and by the Cornell Laboratory of Ornithology. All services related to the CBMD are free. For more information, visit the CBMD web site, *http://cbmdms.dev4.fsr.com/Default.aspx*.

Data from designed DoD monitoring and assessment programs will be entered in the CBMD. Variables suitable for eBird and for the AKN will then be uploaded to these programs. Similar uploads can be made to other repositories if DoD chooses. Birders collecting data on DoD land are encouraged to submit their observations directly to eBird (see *http://ebird.org/content/dod*). Existing datasets should be archived to ensure they are not lost. The Cornell Laboratory of Ornithology has offered to perform this service.

A final comment is that all of these services require access to the eBird, AKN, and CBMD web sites. In addition, DoD pays for access to Birds of North America Online, which resides on the same system as eBird and AKN, for every installation with an INRMP. It is our understanding that some installations are blocked from being able to access these capabilities. Relaxing such restrictions would be helpful to the purposes to which this report is directed.

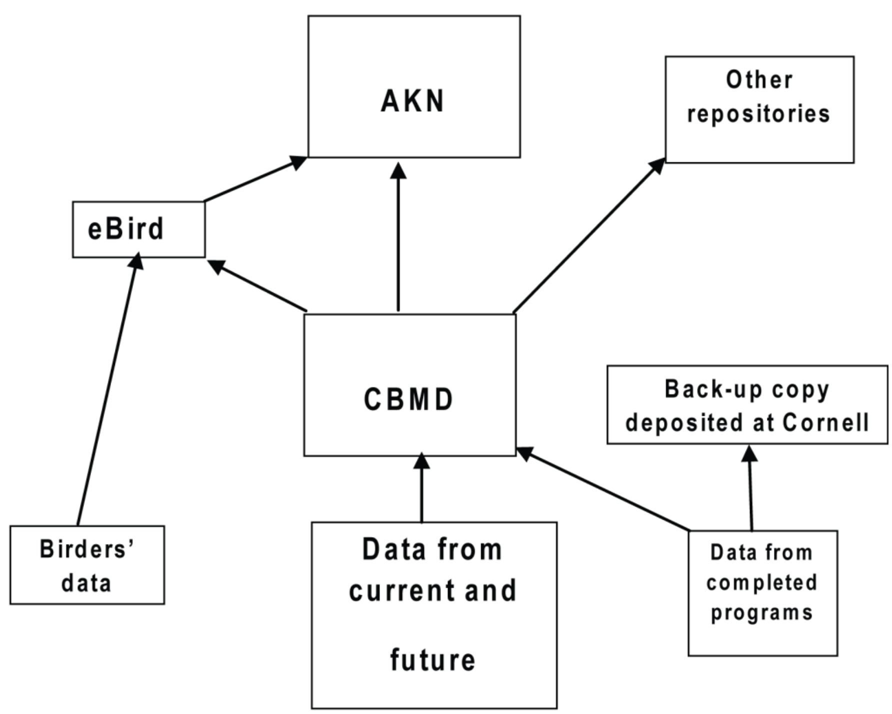

Figure 2. Data management in the DoD CBM program.

Chapter 7: Recommendations for Surveying Species of Concern

The third deliverable to be produced in this report was “a plan for monitoring bird Species of Concern on DoD land.” We prepared this plan by identifying DoD installations that have—or may have—Species of Concern in substantial numbers for at least a part of the year. We then developed guidelines for deciding which of these locations should be surveyed and how these surveys might best be conducted.

Methods

For purposes of generating an initial list of focal species, we identified SOC using the ABC and Audubon Watch List (American Bird Conservancy and National Audubon Society, 2007) except that exceedingly rare species were excluded. We included DoD installations in the United States and its’ territories and protectorates (e.g., Northern Mariana Islands).

The WatchList is representative of the SOC database on the DoD Partners in Flight web site (*http://www.dodpif.org/*), which was undergoing revisions due to changing assessments in several of the initiative or FWS lists. Regardless of the method used, this SOC identified in table 9 is only a subset of what occurs on DoD installations. In some cases, baseline surveys have not yet been completed, or baseline surveys that have been completed are filed away and not accessible for analysis or review. DoD can greatly advance its monitoring of bird species of concern by completing baseline surveys for all installations, and more importantly, by entering all survey, inventory, and monitoring data into an electronic repository so the data are accessible for such analyses. An initial estimate of the species occurring on each installation in the 50 U.S. States was made by intersecting maps of these installations with maps of each species’ range as depicted by Ridgely and others (2007). We then revised these lists using the SOC database from the DoD Partners in Flight website, factsheets describing Important Bird Areas, bird checklists provided by the USGS (Igl, 1996), and important shorebird sites identified by the Western Hemisphere Shorebird Reserve Network (*http://www.whsrn.org/*).

SOC on installations in Hawaii were identified using a combination of bird checklists from the USGS (Igl, 1996), digitized range maps of forest, sea and Nene habitat maps obtained from the State of Hawaii (*http://hawaii.gov/)* and the Rim of the Pacific Programmatic Environmental Assessment of 2002 (*http://www.dtic.mil)*. Species of Concern on installations in Guam, Tinian, and Farallon de Medinilla were identified using the Final Environmental Impact Statement for Military Training in the Marianas Volumes One and Two (*http://www.dtic.mil*) and confirmed on guampedia (*http://www.guampedia.com)*. Data for one Puerto Rico base, U.S. Naval Security Group Activity Sabana Seca, were obtained from an environmental assessment (*http://www.dtic.mil*).

The draft species lists were sent to editors in the eBird Program for review and revision. We also asked them to identify concentration sites for groups of species during the non-breeding periods. The result was a comprehensive list of installations with species and groups of species that may occur on each.

Table 9. Number of DoD properties with significant concentrations of migratory birds for at least a part of the year and numbers of properties known to contain at least one Species of Concern (SOC).

DoD Entity	Number of Properties	Waterfowl	Shorebirds	Raptors	Herons, etc.	Landbirds	SOC
Air Force	71	22	30	18	8	9	49
Army	39	11	12	5	4	10	30
Army Corps[2]	48	29	19	21	20	26	39
ARNG	30	6	8	6	5	9	25
Joint Reserve Base	1	1	1	1	1	1	1
Marine Corps	17	7	5	0	0	0	13
Navy	87	51	48	1	19	14	53
Total[1]	293	127	123	52	57	69	210

[1]These data are not comprehensive since installation managers were not contacted directly. Many more SOC occur on installations than indicated in this table—this only serves as a cursory guide and suggests much more comprehensive work is necessary to complete this particular table.

[2]Army Corps of Engineers properties are shown to illustrate their potential contribution to bird monitoring efforts within DoD.

Results

We identified 245 military installations and 48 Army Corps civil works sites with suspected or known SOC or significant concentrations of birds of any species (table 9). We included concentrations at all times of year because the new MOU and Migratory Bird rule do not restrict consideration to any portion of the year. We determined that SOC probably do not occur on 35 installations. More than 70 species (or in a few cases other taxa) of special concern are known to occur on the 293 facilities we surveyed.

Discussion

We were unable to obtain completely reliable lists of the SOC and concentrations of migratory birds on each installation. Despite these uncertainties, however, the analysis showed that a great many DoD installations, probably >300, are used by SOC or significant concentrations of migratory birds. It appears that these installations are used by >70 SOC.

As discussed in Chapter 1 of this report, the MOU for migratory birds between DoD and the USFWS includes the following provision (see table 2).

> *Prior to starting any activity that is likely to affect populations of migratory birds [the Department of Defense shall]: (1) Identify the migratory bird species likely to occur in the area of the proposed action and determine if any species of concern could be affected by the activity; and (2) Assess and document, using NEPA when applicable, the effect of the proposed action on species of concern.*

Thus DoD is required to determine effects of its activities on SOC.

This requirement implies that DoD must identify installations (a) that may be used by SOC and (b) on which activities may occur that are likely to affect these species. The only credible way to determine if activities do affect particular species is to have information about their status prior to the activity deemed likely to affect them. This, in turn, requires surveys to identify what species are present and to gather at least basic information on their abundance prior to carrying out the activities that may affect them. Two sorts of surveys (whose results could be combined) probably would be most efficient: initial surveys to determine what SOC, if any, are present on each installation and then follow-up surveys to determine the status of SOC.

It is our recommendation that initial surveys should be approached based on the ability of an installation to obtain funding and/or personnel to complete surveys. A description of survey efforts are described below in hierarchical order based on funding and other capabilities of individual installations.

1. **Year-Round Monthly Surveys**. The preferred method would be to conduct surveys throughout the year. This approach can be very rapid if conducted by an experienced bird surveyor. Although we have not conducted statistical power analyses, based on extensive experience with this sort of survey, we believe that about 12 surveys should suffice with increased intensity during periods when the birds are present or their behaviors are changing rapidly. One reasonable design under this first option would be 4 surveys during the breeding season; 3 surveys during the fall migration; 2 winter surveys (early and late-winter), and 3 surveys during the spring migration. Small installations should be covered completely because doing so will be relatively easy and inexpensive, but on larger installations stratification by habitat and perhaps accessibility will be needed. A few person-days per survey should suffice for small to medium-sized installations, although more effort may be needed on larger installations especially where SOC are known or suspected to be present. If surveys have already been conducted, then additional ones may not be needed. We recommend a simple area-search method, in which observers record estimated numbers of each species encountered. This method is easier for many surveyors than point counts and easier to fit into habitat-based sampling plans. Point counts, however, also could be used. On small to medium-sized installations design of the survey should be simple but on larger ones some detailed planning may be needed to ensure efficiency and that extrapolation to the entire installation is feasible.
2. **Four-season Surveys**. The next preferred level of effort would include a 4-season survey, with surveyors conducting point counts or area searches, as described above, once each during spring, summer, fall, and winter seasons. Point count surveys that are distributed throughout small to medium-sized installations, and stratified by habitat on larger installations, also are an effective method at least during the breeding season. This approach will give a relatively good indication of seasonal abundance and distribution of birds on the installation, but not as complete a picture as the effort described in (1) above.
3. **Two-season Surveys**. If 4-season surveys are not possible, efforts should be focused on the breeding and wintering seasons, with techniques similar to that described in (2) above. This will provide the best possible coverage for SOC on installations during times where bird communities are seasonally established and do not include transient migrants.
4. **Breeding-season Surveys**. If only a one-season survey is possible, that effort should typically be focused during the breeding season, with surveys conducted as widely as possible throughout the installation. Breeding birds will be vocal and will have established territories. Area searches or, perhaps, point-counts (similar to 2 above) are best suited to identify SOC and other species during this season.

If Species of Concern are detected during the baseline survey, installations may choose to develop specific monitoring programs for them. Since bird populations are changing constantly, DoD may also wish to repeat the entire baseline survey every 5-10 years. These additional surveys will also assist in supporting an installations INRMP.

Where SOC or significant concentrations of migratory birds are found a decision will have to be made about whether the numbers are large enough, and the likelihood of effects due to military activities is likely enough, that monitoring is warranted under the Migratory Bird MOU. This analysis will provide much of the information needed to decide what level of accuracy is needed in the monitoring and how to design the surveys to achieve the target accuracy. A few brief guidelines for design of these surveys can be offered, however.

If military activities are deemed unlikely to affect the species, but sufficient doubt remains to trigger the "may effect" clause in the MOU, then monitoring probably can be infrequent and rapid methods probably can be used. For example, if a landbird SOC breeds in a training area where few impacts on the bird are expected, but a decision is made to monitor its populations, then a few quick surveys while birds are establishing territories (and are easy to survey) and perhaps an assessment of reproductive success (e.g., nest-monitoring, late season mist-netting) may be appropriate. If direct, substantial effects are likely to occur, then more intensive methods may be needed. This was the case on Farallon de Medinilla (FDM), an island located approximately 150 miles north of Guam in the Pacific Ocean. FDM is an important island for both military training and nesting seabirds. The DoD has used FDM target ranges since 1976, and the island is an important nesting site for more than a dozen species of migratory seabirds. Conservationists expressed concern about effects of the training on the seabirds. A protracted legal battle followed. Monthly aerial surveys were initiated in 1997 and continue to the present time. They show that, since 1997, there have been no clear changes in the numbers of most species, and one species has increased (Vogt, unpub. data, 2008). This example clearly shows the value of obtaining monitoring data when military activities may affect species of concern.

On installations or parts of installations that are accessible to the public, one or both of the initial surveys described above might be augmented, or even replaced, by encouraging participation in the eBird program. This program permits easy recording of birds detected using various survey methods and the data, if collected by members of the public, would not cost DoD anything to obtain. Tens of thousands of observations from throughout the U.S. and beyond are recorded monthly through the eBird program. Recording data from installations in eBird has the advantage that assessing status near to—as well as on—the installations may be possible.

Given large sample sizes, it has proven possible to detect large changes in abundance across space or time with eBird (although the program is too new to have undergone formal, independent review in the refereed literature). Records entered in eBird usually are not selected randomly under a well-defined sampling plan so estimating density or population size is usually not possible, but trends in density may be more important to estimate. A particularly powerful approach would be to use eBird for initial identification of SOC and then to use designed surveys to monitor their status. The data collected from designed surveys, however, also should be entered in eBird both to support that program and to facilitate comparisons of populations on and off the installation. For more information on eBird, visit *www.ebird.org*.

Chapter 8: Recommendations for Participation in Large-Scale Surveys

As noted throughout this report, DoD has been a major supporter of avian monitoring, especially through its Legacy and SERDP programs. In the past, however, there was not a DoD-wide policy statement about the extent and kind of participation by DoD in regional and larger-scale monitoring programs. The bird monitoring MOU signed by NABCI members (table 1), the MOU with the USFWS (table 2), and the Migratory Bird Rule (table 3), all make it clear that DoD is a significant partner in and contributor to large-scale bird monitoring programs. Furthermore, the value of such programs is clear. Most management issues, in fact, are regional in scope and thus require regional-level data. This Chapter suggests ways for DoD to participate in regional and larger scale programs.

The following criteria can be used to determine the level of DoD participation in large-scale surveys: (1) if the lands to be surveyed are under DoD management and are very important to the focal species, then greater participation by DoD will have a greater benefits for both the resource and to DoD; (2) if the lands to be surveyed are not under DoD management, but are still very important to the focal species (e.g., on migration or wintering areas), then greater participation by DoD also will have greater benefits for both the resource and DoD. These guidelines are illustrated below by discussing appropriate DoD participation in the BBS and the MAPS program.

Breeding Bird Survey

The BBS is a well-established, widely-endorsed, long-term survey that provides some of the best evidence on the status of birds in North America (Sauer and others, 1997). Many BBS routes on DoD installations are surveyed by volunteers. DoD could help the survey the most—and could serve its own interests best—by encouraging coverage of routes that are on or near to its installations with installation personnel and partnerships with volunteers. Many such routes exist (table 10). For example, 30 routes that cross at least one DoD installation were surveyed on fewer than half of the years between 1995 and 2004 and the same was true of 109 routes that were within 10 km of one or more installations. The BBS office has indicated (Keith Pardieck, personal communications, February 2010) that they would be pleased to work with DoD on a plan for identifying those routes that are not surveyed regularly.

Table 10. Number of Breeding Bird Survey (BBS) routes classified by distance to a DoD installation and recent survey frequency.

Minimum distance (km) between installation and BBS route	Number of routes surveyed 1995–2004 during	
	0–4 years	5–10 years
0	30	150
5	82	568
10	109	854
25	210	1,718

Monitoring Avian Productivity and Survival (MAPS)

The MAPS monitoring protocol is a standardized breeding season mist-netting and banding protocol that is currently used by more than 450 monitoring stations continent-wide. The MAPS program (DeSante, 1999; DeSante and others, 2005a; Saracco and others, 2008) is more complex, and perhaps less well known, than the BBS so it is described in some detail below. Following the description, we suggest how the criteria above might be used to determine DoD's participation in this survey. Readers interested in learning more about the MAPS Program should contact The Institute for Bird Populations (IBP).

Since 1994, DoD has supported the operation of 135 MAPS landbird demographic monitoring stations on military lands (for one or more years) and the development of landbird management guidelines and management decision support tools. Overall, 99 stations were operated by IBP in one or more years. By 2007, a network of 58 long-term MAPS stations existed on 11 installations, strategically placed to monitor the demographics of landbird populations in the context of military mission-oriented land management.

Since 1994, the DoD Legacy Resource Management Program, Army Corps of Engineers, and Naval Facilities Engineering Command have provided logistical support and annual funding for:

a. The operation of MAPS stations on (or associated with) 22 military installations, of which 78 operated in any year between 1994 and 2002. Since 2003, 48 of those 78 stations were operated annually plus another 10 stations that were added to the network. This has resulted in more than 104,500 bird captures of 77,500 individual birds and 168 species, of which 23 species were captured >1,200 times.

b. Reorganization of the original monitoring network (78 stations) to better focus on species of conservation concern (since 2002). By 2007, 58 stations were active on 11 installations organized to monitor the management of species of conservation concern in response to land-management activities associated with Readiness and Range Sustainment (Nott and others, 2007, table 11). Clusters of stations were located in several Bird Conservation Regions: Central Hardwoods (24), Texas Oaks and Prairies (12), Edwards Plateau (6), Southeastern Coastal Plain (6), Appalachian Mountains (4), and Atlantic Northern Forest (6).

c. Calculation of landbird demographic variables (e.g., survival, productivity, population trend, body condition) from proofed and verified banding data (1994–2007).

d. Reporting of the results of demographic analyses to individual installations (or groups of installations) and the DoD Legacy Resource Management Program.

e. Construction of landscape-scale ecological models in which demographic variables for 10 species of conservation concern were used as response variables to landscape metrics derived from the National Land Cover Dataset (Nott and others, 2003).

f. Development of measures of population health or performance using a suite of demographic (and landscape) "performance measures" that allow managers to compare the within-installation demographic status of landbird populations with the status of populations in the surrounding region (Nott and others, 2007).

g. The formulation of species management guidelines and development of decision-support tools that help land managers predict the impact of alternate management scenarios on the demographic performance of multiple species of concern.

h. Analyses that have identified important relationships between avian demographics and a suite of spatio-temporal climate and weather variables. This is critical information to managers because the effects of weather and climate on environmental conditions, and in turn, on bird populations, must be accounted for when assessing the efficacy of management on landbird population demographics.

In addition, 38 MAPS stations operated independently of IBP on 23 DoD installations. However, only 20 of these stations were still operational in 2007. Data collected from these independent stations were analyzed to determine their efficacy in monitoring species of conservation concern (Nott and others, 2005). All publications relating to MAPS monitoring of landbird populations on military lands can be accessed through IBP's website.

Two additional programs from IBP contribute valuable demographic data during the non-breeding season to DoD managers. These winter monitoring projects include the MoSI (Monitoreo de Sobrevivencia Invernal) program across the northern Neotropics and the MAWS (Monitoring Avian Winter Survival) program in temperate North America. MoSI is designed to address monitoring, research, and management goals. The monitoring goal of MoSI is to provide estimates of monthly, overwintering, and annual survival rates and indices of late winter physical condition for a suite of 25 landbird species for various habitats and geographic regions.

Research goals of MoSI include:

- the statistical modeling of survival and physical condition as functions of age, sex, habitat, geographic location, and weather,
- linking winter population parameters with breeding season vital rates and population trends, and
- the development of predictive population models.

Management goals of MoSI are to

- use research results to develop strategies for reversing population declines and maintaining healthy populations, and
- evaluate management actions through an adaptive management framework.

Like MAPS, MoSI relies on the establishment of a geographically extensive network of mist-netting and banding stations to meet program goals. MoSI cooperators also contribute feather samples to the Center for Tropical Ecology at UCLA for molecular analyses aimed at linking breeding and wintering populations. The MAWS program was initiated in 2003 as a 4-year pilot project on four southeastern U.S. military installations. MAWS shares goals and protocols with MoSI but targets short-distance migrants and species that are year-round residents of temperate North America. In addition to the MAWS stations operated on military installations, several independent MAWS station operators have contributed data to the MAWS program.

As the material above indicates, MAPS is a well-established, widely endorsed large-scale survey. It has been specifically mentioned in various documents (see tables 1–3) as one of the surveys that DoD should support. MAPS stations are not located using a random sampling plan so an analysis, based on proximity of MAPS stations to DoD installation, like that carried out above for the BBS routes, could not be undertaken. DoD's participation in MAPS should be determined primarily by the extent to which the areas surveyed by MAPS stations will provide important information about the *populations* of concern, regardless of whether they are on DoD land. DoD thus may choose to participate in MAPS programs where their support will do the most good, even if this is far from DoD installations. Indeed, monitoring efforts on DoD installations may be most

Table 11. Current DoD-MAPS monitoring objectives relating to Readiness and Range Sustainment identifying DoD locations (number of MAPS stations) and target species (including two USFWS Focal Species—Wood Thrush and Painted Bunting).

[This work was funded by the DoD Legacy Resource Management Program (Project Number 00103). Scientific bird names in alphabetical order by common name: Acadian Flycatcher (*Empidonax virescens*), Blue-winged Warbler (*Vermivora pinus*), Cerulean Warbler (*Dendroica cerulean*), Field Sparrow (*Spizella pusilla*), Kentucky Warbler (*Oporornis formosus*), Louisiana Waterthrush (*Seiurus motacilla*), Painted Bunting (*Passerina ciris*), Prairie Warbler (*Dendroica discolor*), Red-cockaded Woodpecker (*Picoides borealis*), Wood Thrush (*Hylocichla mustelina*), Worm-eating Warbler (*Helmitheros vermivorum*)]

Installation	State	Monitoring objectives and target species
Fort Bragg (6)	NC	Effects of fire regimes intended to prevent wildfire and manage for Red-cockaded Woodpecker (USFWS Endangered Species status) on Prairie Warbler populations.
Jefferson Proving Ground (6)	IN	Effects of fire regimes and buffer forest thinning on populations of four forest species (Acadian Flycatcher, Wood Thrush, Worm-eating Warbler, Kentucky Warbler) and three successional species (Blue-winged Warbler, Prairie Warbler, and Field Sparrow).
Fort Knox (6)	KY	All monitored species in decline (including Wood Thrush). Effectiveness monitoring of powerline corridor management targeting Blue-winged Warbler
NWSC Crane (6)	IN	Effects of forest management relating to weapons storage on five forest species (Acadian Flycatcher, Wood Thrush, Worm-eating Warbler, Louisiana Waterthrush, and Kentucky Warbler) and three successional species(Blue-winged Warbler, Prairie Warbler, and Field Sparrow).
Fort Leonard Wood (6)	MO	Effects of forest management and fire regimes intended to reduce fuel loads and create fire breaks on five forest species and three successional species (same species as NWSC Crane). Also conduct annual Cerulean Warbler surveys.
Fort Hood (6)	TX	Monitoring of three successional species (including Painted Bunting) with intent to manage oak-prairie habitats for military drop zone using prescribed fire regimes.
Camp Bowie (6)	TX	Monitoring of three successional species (including Painted Bunting) under installation-wide restoration efforts including fire and cessation of cattle grazing (2007) intended to open TXARNG training areas.
Camp Swift (6)	TX	Effects of fire and habitat alteration used to manage military drop zone activities on performance measures of Painted Bunting populations.

effective if coupled with comparable monitoring efforts outside of installations (e.g., MAPS stations in the landscapes surrounding installations), or even during migration or on the Neotropical wintering grounds of SOC to DoD (e.g., as in the Monitoreo de Sobrevivencia Invernal [MoSI] program; DeSante and others, 2005b).

Chapter 9: Implementation

Implementation needs to be guided by DoD personnel. The NABCI Opportunities for Improving Avian Monitoring report (U.S. NABCI Monitoring Subcommittee, 2007), the Northeast Bird Monitoring Handbook (Lambert and others, 2009), this CBM Plan, and the subsequent implementation strategy provide guidance that DoD personnel may find helpful in implementing successful monitoring programs. Substantial work also will be needed to explain and refine the procedures for designing short-term projects (Chapter 4), selecting field methods (Chapter 5), and placing the data in appropriate repositories (Chapter 6). A proposal to do this work has been submitted to the DoD Legacy Program and was funded in 2009 and 2010. It includes the following description of the approach to be used:

> *The CBM Plan provides comprehensive guidance on how to design, conduct, and document bird monitoring programs and store the resulting data in national and international, password-protected, databases. Implementation of the CBM Plan will help insure that DoD carries out its responsibilities for bird monitoring under various federal rules and agreements, and that monitoring is conducted as efficiently as possible (e.g., that avian monitoring projects have a well-defined management focus and limited monitoring funds are placed where they will have most benefit to DoD). Although these changes are needed and will help DoD discharge its obligations to migratory birds, while at the same time saving money, implementation will not necessarily occur quickly or easily. In particular, DoD biologists will need assistance and encouragement in (a) design of monitoring programs including documentation, (b) selection of specific field methods to be used, (c) analysis of results, (d) preparation of metadata, and (e) submission of the data collected to data repositories. This project to help DoD implement the CBM Plan will provide extensive technical assistance on tasks (a)-(e) above.*
>
> *A Team consisting of both USGS and DoD personnel will identify installations considering or already carrying out bird monitoring programs and will work with natural resources managers to implement the CBM Plan, especially steps (a)-(e) above. We expect to work with approximately 15-20 installations per year and that assistance will average about one person-week per installation, though the time needed will likely vary considerably depending on the scope and complexity of the project(s) on which our assistance is needed. DoD personnel (especially Rich Fischer and Chris Eberly with whom we have been working closely on the CBM Plan) have agreed to provide the initial contacts and will explain the procedures in the CBM Plan to installation biologists. USGS staff to be hired for this project, along with the PI, Jonathan Bart (whose salary is covered as a contribution from USGS), will provide advice as needed especially about design, choice of field methods, and analysis. The USGS personnel will take the lead in helping installation biologists prepare metadata and format the data they collect for entry into the Coordinated Bird Monitoring Database at the USGS offices in Boise, Idaho. Annual reports will be submitted each year summarizing the assistance provided and discussing how DoD biologists are assuming responsibility for the planning of future monitoring efforts. Based on this work revisions will be made to the CBM Plan as needed. For example, our intention is to add the most comprehensive and relevant monitoring program descriptions to the Plan as examples for other natural resources managers to follow. American Bird Conservancy will also be engaged in assisting with the completion of a comprehensive implementation plan document.*

In addition, carrying out the implementation strategy described above will ensure that the DoD CBM Plan is reviewed and revised where necessary and that it is implemented throughout DoD.

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Appendix A. List of Avian Studies at DoD Installations

Bird monitoring and assessment that we were able to learn about are listed on the following pages. We know, as several reviewers pointed out, that many other programs exist, but we could only include the ones that the official contacts at each installation identified for us.

State	Service	Installation Name	Study
AK	AF	Fort Yukon LRRS (611 CES)	None
AK	AF	Murphy Dome LRRS (611 CES)	None
AK	AF	Indian Mountain LRRS (611 CES)	None
AK	AF	Tatalina LRRS (611 CES)	BBS
AK	AF	Sparrevohn LRRS (611 CES)	None
AK	AF	Tin City LRRS (611 CES)	Kittlitz's Murrelet study Sandhill Crane migration/windpower
AK	AF	Cape Lisburne LRRS (611 CES)	Eider study Kittlitz's Murrelet study
AK	AF	Kotzebue LRRS (611 CES)	Eider study
AK	AF	Point Barrow LRRS (611 CES)	Eider study Eider migration Raven nest chronology Breeding biology of Steller's eiders nesting near Barrow, AK
AK	AF	Oliktok LRRS (611 CES)	Eider study Brant study
AK	AF	Barter Island LRRS (Kaktovik) (611 CES)	Eider study
AK	AF	Cape Romanzof LRRS (611 CES)	Kittlitz's Murrelet study BASH survey Nesting biology and population ecology of yellow wagtails Avifaunal inventory
AK	AF	Cape Newenham LRRS (611 CES)	Kittlitz's Murrelet study Periodic Wildlife Surveys
AK	AF	Cold Bay LRRS (611 CES)	Included in USFWS BBS route
AK	AF	Bullen Point SRRS (611 CES)	Eider study
AK	AF	Wainwright SRRS (611 CES)	Eider study
AK	AF	Point Lay former LRRS (611 CES)	Eider study
AK	AF	Point Lonely former SRRS (611 CES)	Eider study
AK	AF	Clear Air Force Station	
AK	AF	Eareckson Air Station	Winter wildlife surveys Harlequin Duck diet contamination study Point count monitoring BASH surveys Spring & Fall Wildlife Surveys CBC Goose Forage Study
AK	AF	Eielson Air Force Base	Waterfowl brood and geese surveys BASH monitoring

Appendix A. List of Avian Studies at DoD Installations.—Continued

State	Service	Installation Name	Study
AK	AF	Elmendorf Air Force Base	Monitoring Bird Migrations and Movements with Radar and Landsat Imagery-II Bohemian waxwing monitoring Alaska Loon Watch Owl monitoring Point count monitoring Raptor nesting habitat
AK	Army	Black Rapids Training Area	None
AK	Army	Donnelly Training Area	Alaska Landbird Monitoring Survey Cavity nesting ducks box project Sharp-tailed grouse lek surveys Whimbrel nest site survey Ruffed grouse survey
AK	Army	Fort Greely	None
AK	Army	Fort Richardson	INRMP Avian Projects BBS CBC
AK	Army	Fort Wainwright	Boreal owl nest box project
AK	Army	Gerstle River Training Area	None
AK	Army	Tanana Flats Training Area	Owl monitoring Swan nesting and brood survey
AK	Army	Yukon Training Area	Alaska Landbird Monitoring Survey Cavity nesting duck box project Ruffed grouse survey Owl monitoring
AK	Army/NG	Stewart River Training Area - National Guard	Breeding bird survey (different from national program)
AL	AF	Maxwell Air Force Base	
AL	Army	Anniston Army Depot	Survey of Breeding Birds
AL	Army	Fort Rucker	None
AL	Army	Redstone Arsenal	None (breeding bird study planned for 2007)
AL	Army/NG	Fort McClellan - National Guard	Point count survey
AL	Navy	OLFs - Whiting Field	
AR	AF	Little Rock Air Force Base	4-season point count landbird surveys
AR	Army	Pine Bluff Arsenal	
AR	Army/NG	Camp J.T. Robinson - National Guard	Nearctic-Neotropical Migrants pt cts (years) Bachman's Sparrow survey Loggerhead Shrike Survey Brown-headed Cowbird Survey Northern Bobwhite Survey Cerulean Warbler Survey
AR	Army/NG	Fort Chaffee - National Guard	Annual Bird Count MAPS / MAWS Greater Prairie Chicken search
AZ	AF	Davis-Monthan Air Force Base	Migratory linkages of Burrowing Owls Dispersal Patterns of Burrowing Owls on Davis-Monthan AFB
AZ	AF	Luke Air Force Base	

Appendix A. List of Avian Studies at DoD Installations.—Continued

State	Service	Installation Name	Study
AZ	AF/MC	Barry M. Goldwater Range	Migratory linkages of Burrowing Owls
AZ	Army	Fort Huachuca	Grassland Bird Transect Monitoring Hummingbird Monitoring Mexican Spotted Owl Monitoring Southwestern Willow Flycatcher and Yellow-billed Cuckoo Surveys Wintering Ecology of Shrubland Birds
AZ	Army	Yuma Proving Ground	Migratory linkages of Burrowing Owls Wintering Ecology of Shrubland Birds Use of wildlife water developments by birds during migration
AZ	Army/NG	Camp Navajo - National Guard	Songbird monitoring
AZ	Army/NG	Florence Military Reservation - National Guard	
AZ	MC	MCAS Yuma	Migratory linkages of Burrowing Owls Wintering Ecology of Shrubland Birds
AZ	Navy	Flagstaff, NAVOBSY	None
CA	AF	Beale Air Force Base	Waterfowl Use of Wetland and Upland Nesting Habitats Surveys for Special-Status Aquatic Invertebrate, Botanical, and Wildlife Resources Hunting and Nesting Success of the Northern Harrier in Yellow Star-thistle Utility Pole Use and Electrocutions of Raptors Breeding bird point count survey (2005)
CA	AF	Edwards Air Force Base	Migratory linkages of Burrowing Owls Bird study at Edwards AFB Wintering Ecology of Shrubland Birds
CA	AF	March Joint Air Reserve Base	Migratory linkages of Burrowing Owls Burrowing Owl Monitoring at March Reserve Base
CA	AF	McClellan Air Force Base	
CA	AF	Travis Air Force Base	None
CA	AF	Vandenberg Air Force Base	SW Willow Flycatcher Study
CA	Army	Camp Parks (Reserve Forces Training Area)	
CA	Army	Fort Hunter Liggett	
CA	Army	Fort Irwin	Migratory linkages of Burrowing Owls Wintering Ecology of Shrubland Birds
CA	Army	Presidio of Monterey	None
CA	Army	Sierra Army Depot	None (several in past)
CA	Army/NG	Camp Roberts - National Guard	Bald eagle monitoring on the Nacimiento River MAPS
CA	Army/NG	Camp San Luis Obispo - National Guard	CBC
CA	Army/NG	Van Vleck Training Area - National Guard	

Appendix A. List of Avian Studies at DoD Installations.—Continued

State	Service	Installation Name	Study
CA	MC	Marine Corps MWTC Bridgeport	Riparian Bird Monitoring and Habitat Assessment in the Upper East and West Walker River Watersheds
CA	MC	MCAGCC Twentynine Palms	Burrowing Owls
CA	MC	MCAS Miramar	California Gnatcatcher Surveys Southwestern willow flycatcher and least Bell's vireo surveys MAPS
CA	MC	MCB Camp Pendleton	Migratory linkages of Burrowing Owls
CA	MC	MCLB Barstow	Riparian Bird Survey on the Mojave River
CA	MC	MCRD San Diego	
CA	Navy	China Lake, NAWS	Migratory linkages of Burrowing Owls Wintering Ecology of Shrubland Birds BASH Bird use survey
CA	Navy	Chocolate Mountains Gunnery Range	
CA	Navy	Concord Detachment, NWS Seal Beach	
CA	Navy	Coronado, NAB	Migratory linkages of Burrowing Owls NAS North Island and Naval Outlying Field Imperial Beach BASH Project, Bird Survey and Data Collection CA Least Tern and Snowy Plover Monitoring Burrowing Owl Monitoring San Diego Bay Waterbird Surveys
CA	Navy	Dixon Navy Radio Transmitter Facility	
CA	Navy	El Centro, NAF and Ranges	Migratory linkages of Burrowing Owls
CA	Navy	Fallbrook Detachment, NWS Seal Beach	Migratory linkages of Burrowing Owls
CA	Navy	Imperial Beach, NOLF (inset)	
CA	Navy	Lemoore, NAS	Migratory linkages of Burrowing Owls An Adaptive Management Plan for the Burrowing Owls at NAS Lemoore
CA	Navy	Monterey, NPS	
CA	Navy	Mountain Warfare Training Ctr, La Posta	
CA	Navy	Naval Radio Receiving Facility Imperial Beach (inset)	
CA	Navy	North Island, NAS (inset)	CBC
CA	Navy	Point Loma, Naval Base (inset)	
CA	Navy	Point Mugu, NAS	T & E surveys Monthly surveys for shorebirds, waders, raptors and some passerines
CA	Navy	Port Hueneme, CBC	Brown pelican count
CA	Navy	San Clemente Island, NALF	San Clemente Island Loggerhead Shrike
CA	Navy	San Diego, NAVSTA (inset)	
CA	Navy	San Nicolas Island, NOLF	

Appendix A. List of Avian Studies at DoD Installations.—Continued

State	Service	Installation Name	Study
CA	Navy	Seal Beach, NWS	Migratory linkages of Burrowing Owls
CA	Navy	Warner Springs, SERE Camp	
CO	AF	Buckley Air Force Base	Migratory linkages of Burrowing Owls Burrowing Owl surveys
CO	AF	Peterson Air Force Base	none
CO	AF	Schriever Air Force Base	Migratory linkages of Burrowing Owls
CO	AF	US Air Force Academy	Breeding Bird Census
CO	Army	Fort Carson	Migratory linkages of Burrowing Owls
CO	Army	Piñon Canyon Maneuver Site	Migratory linkages of Burrowing Owls
CO	Army	Pueblo Chemical Depot	Monitoring Colorado's Birds
CO	Army/FWS	Rocky Mountain Arsenal National Wildlife Refuge	Migratory linkages of Burrowing Owls
CO	Navy	Navy Oil Shale Reserve	
CT	Army/NG	Nehantic Training Site	
CT	Navy	New London, NSB	
CU	Navy	Naval Base Guantanamo Bay	
DE	AF	Dover Air Force Base	Migratory Bird Monitoring using Automated Acoustic and Internet Technologies
FL	AF	Avon Park AFR	Species at risk monitoring Bald eagle nest survey
FL	AF	Cape Canaveral Air Force Station	Seasonal bird surveys via installation-wide point counts Florida Scrub-Jay monitoring (yearly) Shorebird survey BASH point counts
FL	AF	Eglin Air Force Base	Red-cockaded woodpecker Shorebird surveys and nest monitoring Bald eagle monitoring Southeastern American Kestrel nesting Cavity nester community with RCW Longleaf pine restoration monitoring Habitat use by neotropical migrants Fall migration monitoring via radar/ground-based transects
FL	AF	Homestead Joint Air Reserve Base	
FL	AF	MacDill Air Force Base	None
FL	AF	Patrick Air Force Base	Seasonal bird surveys via installation-wide point counts Least Tern nesting surveys Shorebird survey BASH point counts
FL	AF	Tyndall Air Force Base	International Piping Plover Census
FL	Army	Malabar Transmitter Annex	Seasonal bird surveys via installation-wide point counts
FL	Army/NG	Camp Blanding - National Guard	Red-cockaded woodpecker Wild turkey Bald eagle
FL	Navy	Jacksonville, NAS	Neotropical migratory bird study

Appendix A. List of Avian Studies at DoD Installations.—Continued

State	Service	Installation Name	Study
FL	Navy	Key West, NAS	Least tem nest monitoring Bald eagle nest monitoring
FL	Navy	Mayport, NAVSTA	Neotropical Migrant checklist survey International Shorebird Survey
FL	Navy	Navy Coastal Systems Station (Panama City)	
FL	Navy	NOLF Whitehouse	Neotropical migratory bird study
FL	Navy	OLFs - Whiting Field	Neotropical migratory bird study
FL	Navy	Pensacola, NAS	
FL	Navy	Pinecastle Impact Range	
FL	Navy	Rodman Bomb Target	
FL	Navy	Stevens Lake Bombing Range	
FL	Navy	Whiting Field, NAS	
GA	AF	Dobbins Joint Air Reserve Base	
GA	AF	Moody AFB + Grand Bay Range	BASH point counts
GA	AF	Robins Air Force Base	
GA	Army	Fort Benning	RCW monitoring MAWS LCTA survey
GA	Army	Fort Gillem	
GA	Army	Fort Gordon	
GA	Army	Fort McPherson	
GA	Army	Fort Stewart	Wood duck nest box monitoring Bobwhite quail cock count Swallow-tailed kite monitoring Red-cockaded woodpecker conservation and recovery
GA	Army	Hunter Army Airfield	
GA	Army/NG	Catoosa Range Training Site	
GA	MC	MCLB Albany	
GA	MC	Townsend Range	
GA	Navy	Kings Bay, NSB	
HI	AF	Bellows Air Force Station	
HI	AF	Hickam Air Force Base	
HI	Army	Kahuku Training Area/ Army Training Range	
HI	Army	Pohakuloa Training Area	
HI	Army	Schofield Barracks Military Reservation	
HI	MC	Marine Corps Base Hawaii, Kaneohe Bay	
HI	Navy	Barking Sands, PMRF	Laysan Albatross Egg Relocation Project Wedge-tailed Shearwater Monitoring Shorebird surveys
HI	Navy	Kaula Rock	
HI	Navy	Lualualei, NAVMAG	Point counts for endangered species Point counts for all species Elepaio playback surveys Endangered waterbird survey at Niuli’I Ponds

Appendix A. List of Avian Studies at DoD Installations.—Continued

State	Service	Installation Name	Study
HI	Navy	NCTAMS Pacific Wahiawa	Flora and fauna survey
HI	Navy	Pearl Harbor, NAVSTA	
IA	Army	Iowa Army Ammunition Plant	
IA	Army/NG	Camp Dodge - National Guard	Avian species catalogue Avian and predator habitat use profiles in an agricultural matrix Avian communities on two prairie pothole wetlands Borrow area wetland mitigation monitoring
ID	AF	Juniper Butte Range	Raptor nest searching
ID	AF	Mountain Home AFB	Area search all species Sage grouse lek surveys Hummingbird banding
ID	AF	Saylor Creek Air Force Range	
ID	Army/NG	Kimama Training Area - National Guard	
ID	Army/NG	Orchard Training Area - (Idaho) National Guard	
ID	Navy	Bayview Det., Carderock NSWC	
IL	AF	Scott Air Force Base	Breeding bird survey via pt cts Spring migration survey Winter birds survey (all done in 2001)
IL	Army	Joliet Training Area	Long-term ecological study
IL	Army	Rock Island Arsenal	None
IL	Army/FWS	Lost Mound NWR (Savanna Army Depot)	
IL	Army/FWS	Midewin National Tallgrass Prairie (Joliet Arsenal)	
IL	Army/NG	Marseilles Training Area - National Guard	
IL	Navy	Great Lakes, NTC	
IN	AF	Grissom Joint Air Reserve Base	
IN	Army	Indiana Army Ammunition Plant	
IN	Army	Kingsbury Training Area	
IN	Army	Newport Chemical Depot	
IN	Army/FWS	Big Oaks NWR (Jefferson Proving Ground)	
IN	Army/NG	Camp Atterbury - National Guard	Surveys of State listed species CBC
IN	Navy	Crane, NSA	Indiana Breeding Bird Atlas MAPS in past T& E survey 2005
KS	AF	Forbes Field	
KS	AF	McConnell Air Force Base	
KS	AF	Smoky Hill Air Force Range	BBS Effects of management regimes on breeding bird densities
KS	Army	Fort Leavenworth	CBC MAPS in past

Appendix A. List of Avian Studies at DoD Installations.—Continued

State	Service	Installation Name	Study
KS	Army	Fort Riley	Auditory Quail Survey Bald Eagle Diurnal Habitat Utilization Henslow's Sparrow Line Transects and Point Counts Bald Eagle Nocturnal Roost Utilization Prairie-Chicken Lek Survey Ring-necked Pheasant Survey Kansas Shorebird Surveys Winter Raptor Survey
KS	Army	Kansas Army Ammunition Plant (Parsons)	BBS Riparian species nest success and diversity
KY	Army	Blue Grass Army Depot (North and South polygons)	
KY	Army	Fort Campbell	
KY	Army	Fort Knox	PIF Point Counts (summer and winter 2005- installation wide surveys)
KY	Army/NG	Artemus Training Site - National Guard	
KY	Army/NG	Wendell Ford Regional Training Center - Nat. Guard	
LA	AF	Barksdale Air Force Base	Observational Wild Turkey Survey
LA	Army	Fort Polk	MAPS Winter abundance of and habitat use by Henslow's Sparrows Spring and fall migration monitoring via radar/ground-based transects (2005-06) CBC Raptor migration study Eastern bluebird monitoring Point count monitoring of residents and neotropical migrants Kestrel nest box study
LA	Army/NG	Camp Beauregard -National Guard	
LA	Army/NG	Camp Minden - National Guard	
LA	Army/NG	Camp Villere - National Guard	
LA	Navy	New Orleans, NAS JRB	
MA	AF	Hanscom Air Force Base	
MA	AF	Westover Air Reserve Base	
MA	AF/Army/NG	Massachusetts Mil. Res. (Otis ANGB/Camp Edwards)	
MA	Army	Fort Devens (Reserve Forces Training Area)	
MD	AF	Andrews Air Force Base	None
MD	Army	Aberdeen Proving Ground	Maryland Breeding Bird Atlas Bald eagle investigations
MD	Army	Fort Detrick	
MD	Army	Fort George G. Meade	
MD	Army	Fort Ritchie	

Appendix A. List of Avian Studies at DoD Installations.—Continued

State	Service	Installation Name	Study
MD	Army/NG	Baker Training Site (Lil Aaron Strauss) - Nat. Guard	
MD	Navy	Annapolis USNA	
MD	Navy	Bloodsworth Island	
MD	Navy	Carderock, NSWC	None
MD	Navy	Indian Head, NSWC	Bald eagle monitoring
MD	Navy	Patuxent River, NAS	MAPS Nest box monitoring Migratory Bird Monitoring using Automated Acoustic and Internet Technologies
ME	AF/FWS	Aroostook NWR (Loring AFB)	
ME	Army/NG	Bog Brook/Riley Training Site - National Guard	
ME	Army/NG	Caswell Training Site - National Guard	
ME	Army/NG	Deepwoods Training Site - National Guard	
ME	Navy	Brunswick, NAS	
ME	Navy	Navy SERE Facility (Rangeley, Redington)	
ME	Navy	NCTAMS Cutler	
MI	AF	Selfridge Air Guard Base	
MI	Army/NG	Camp Grayling - National Guard	
MI	Army/NG	Fort Custer Training Center - National Guard	Raptor inventory Edge effects on avian nest predator Reproductive success, brood parasitism, and nest predation of forest-nesting neotropical migrants
MN	Army/NG	Arden Hills Training Site	
MN	Army/NG	Camp Ripley - National Guard	Bald eagle monitoring Ruffed grouse and wild turkey survey Red-shouldered hawk survey Bluebird nest box monitoring CBC Owl survey Annual songbird surveys Yellow rail monitoring
MO	AF	Whiteman Air Force Base	Point counts
MO	Army	Fort Leonard Wood	Spring migrant survey Great Blue Heron colony survey MAPS
MO	Army	Lake City Army Ammunition Plant	
MO	Army/NG	Camp Clark - National Guard	
MO	Army/NG	Camp Crowder Training Site - National Guard	
MO	Army/NG	Macon Training Site - National Guard	

Appendix A. List of Avian Studies at DoD Installations.—Continued

State	Service	Installation Name	Study
MO	Army/NG	Wappapello Training Site - National Guard	Bald eagle nest survey CBC Bluebird and wood duck nest box monitoring
MO	Army/NG	Weldon Spring Training Site - National Guard	
MS	AF	Columbus Air Force Base	Wildlife hazard assessment Endangered and threatened species survey
MS	AF	Keesler Air Force Base	
MS	Army	Mississippi Army Ammo Plant	
MS	Army/NG	Camp McCain - National Guard	
MS	Army/NG	Camp Shelby - National Guard	
MS	Navy	Gulfport, NCBC	
MS	Navy	Meridian, NAS	None
MS	Navy	Multi-Purpose Target Range	None
MS	Navy	NOLF Joe Williams	None
MS	Navy	Pascagoula, NAVSTA	
MS	Navy	Searay Target Range	None
MT	AF	Malmstrom Air Force Base	None
MT	Army/NG	Bearmouth Training Area - National Guard	
MT	Army/NG	Fort William H. Harrison - National Guard	
MT	Army/NG	Limestone Hills Training Center - National Guard	
NC	AF	Dare County Range	
NC	AF	Pope Air Force Base	
NC	AF	Seymour Johnson Air Force Base	BASH point counts
NC	Army	Camp Mackall	Red-cockaded woodpecker monitoring
NC	Army	Fort Bragg	Investigation of the American Kestrel MAPS, MAWS (MoSI) Red-cockaded woodpecker monitoring Grassland Bird Surveys (2000)
NC	Army	Military Ocean Terminal Sunny Point	Red-cockaded woodpecker monitoring CBC
NC	Army/NG	Camp Butner - National Guard	
NC	MC	Atlantic Outlying Field	
NC	MC	Bogue Field	
NC	MC	MCAS Cherry Point	Point count monitoring Effects of aircraft activities on waterfowl at Piney Island RCW baseline survey
NC	MC	MCAS New River	
NC	MC	MCB Camp Lejeune	Red-cockaded woodpecker (many studies) International Piping Plover Census State aerial waterfowl survey In past – Painted bunting study Other shorebird monitoring?

Appendix A. List of Avian Studies at DoD Installations.—Continued

State	Service	Installation Name	Study
NC	MC	Piney Island (Point of Marsh Target)	
NC	Navy	Harvey Point, DTA	
NC	Navy	Oak Grove Holt Navy Airfield	
ND	AF	Grand Forks Air Force Base	Seasonal bird surveys via pt cts installation-wide (2001 and 2004) Migration monitoring via radar
ND	AF	Minot Air Force Base	
ND	Army/NG	Camp Grafton - National Guard	
ND	Army/NG	Camp Grafton South - National Guard	
ND	Army/NG	Garrison Training Area - National Guard	
NE	AF	Offutt Air Force Base	
NE	Army/NG	Camp Ashland - National Guard	
NE	Army/NG	Cushing Training Site - National Guard	
NE	Army/NG	Greenlief Training Site (Hastings) - National Guard	
NE	Army/NG	Mead Training Area - National Guard	
NE	Army/NG	Stanton Training Site - National Guard	
NH	AF	New Boston Air Force Station	Birds in forested landscapes Whippoorwill monitoring
NJ	AF	McGuire Air Force Base	None
NJ	AF	Warren Grove Gunnery Range	Point counts
NJ	Army	Fort Dix	Bald eagle nest and foraging survey NJ winter bald eagle surveys Grasshopper sparrow nesting Raptor surveys Spring bird counts
NJ	Army	Fort Monmouth	None
NJ	Army	Picatinny Arsenal	Hawk Watch Bluebird nest box monitoring Passerine anecdotal info recorded Migratory Bird Monitoring using Automated Acoustic and Internet Technologies
NJ	Navy	Earle, NWS	Wetland Mitigation Area Monitoring Report 2005
NJ	Navy	Lakehurst, NAES	Grassland Bird Survey Migratory Bird Monitoring using Automated Acoustic and Internet Technologies Forest Bird Survey Nest box and platform monitoring
NM	AF	Cannon Air Force Base	Migratory linkages of Burrowing Owls Endangered, Threatened, Candidate and Sensitive Bird Species

Appendix A. List of Avian Studies at DoD Installations.—Continued

State	Service	Installation Name	Study
NM	AF	Holloman Air Force Base	Migratory linkages of Burrowing Owls Boles Wells Water System Annex Bird Surveys Wetland bird nesting and aquatic invertebrate occurrence
NM	AF	Kirtland Air Force Base	Migratory linkages of Burrowing Owls Population Status, Reproductive Success, Prey Availability, Site Fidelity and Migration of Western Burrowing Owls Grey vireo monitoring Loggerhead shrike monitoring MAPS starting 07 Long-term songbird monitoring 07
NM	AF	Melrose Air Force Range	Endangered, Threatened, Candidate and Sensitive Bird Species and Birds of Conservation Concern
NM	Army	Fort Bliss McGregor Range	Wintering Ecology of Shrubland Birds
NM	Army	Fort Wingate Depot Activity	
NM	Army	White Sands Missile Range	Wintering Ecology of Shrubland Birds Migratory linkages of Burrowing Owls Mexican Spotted Owl habitat evaluation Pinyon Jay monitoring Delineation of southwestern willow flycatcher and yellow-billed cuckoo habitat Seasonal landbird surveys in riparian/wetlands (1997-98)
NM	Army/NG	Black Mountain Training Site (Deming) - Nat. Guard	
NM	Army/NG	Camel Tracks Training Site - National Guard	
NM	Army/NG	Farmington Training Site - National Guard	
NM	Army/NG	Happy Valley Training Site (Carlsbad) - Nat. Guard	Threatened and Endangered Species Survey
NM	Army/NG	Roswell Training Site - National Guard	
NV	AF	Creech Air Force Base	
NV	AF	Nellis Air Force Base	Migratory linkages of Burrowing Owls
NV	AF	Nellis Air Force Range	
NV	Army	Hawthorne Army Depot	
NV	Army/NG	Henderson Training Site - National Guard	
NV	Army/NG	Stead Training Site - National Guard	
NV	Navy	Fallon Training Range Complex	None

Appendix A. List of Avian Studies at DoD Installations.—Continued

State	Service	Installation Name	Study
NV	Navy	Fallon, NAS	Nevada Breeding Bird Atlas Aquatic Bird Survey Monthly point counts CBC BASH Spring Wings
NY	Army	Fort Drum	Migratory Bird Monitoring using Automated Acoustic and Internet Technologies
NY	Army	West Point Military Reservation	Migratory Bird Monitoring using Automated Acoustic and Internet Technologies Spatial Distribution and Habitat Associations of Cerulean Warblers
OH	AF	Wright-Patterson Air Force Base	
OH	Army/NG	Newton Falls Training Site (NG)	
OK	AF	Altus Air Force Base	None
OK	AF	Tinker Air Force Base	Bird Inventory and Migration Trends
OK	AF	Vance Air Force Base / Kegelman Auxiliary Airfield	
OK	Army	Fort Sill	MAPS Black-capped Vireo Study
OK	Army	Lexington Army Aviation Facility	
OK	Army	McAlester Army Ammunition Plant	None
OK	Army/NG	Camp Gruber - National Guard	
OR	AF	West Coast Over the Horizon Backscatter Radar Sys.	
OR	Army	Umatilla Chemical Depot	
OR	Army/NG	Biak Training Center - National Guard	
OR	Army/NG	Camp Adair - National Guard	
OR	Army/NG	Camp Rilea - National Guard	
OR	Army/NG	Camp Withycombe - National Guard	
OR	Navy	Boardman, NWSTF	Migratory linkages of Burrowing Owls
PA	Army	Carlisle Barracks	
PA	Army	Letterkenny Army Depot	
PA	Army	New Cumberland Army Depot	
PA	Army	Tobyhanna Army Depot	
PA	Army/NG	Beaver Dam Training Site - National Guard	
PA	Army/NG	Fort Indiantown Gap - National Guard	Raptor Population Index Project Nest Box Monitoring Abundance and Diversity of Breeding Birds 2nd PA Breeding Bird Atlas Summer / winter owls and northern goshawk surveys eBird, opportunistic bird surveys Waterbird monitoring

Appendix A. List of Avian Studies at DoD Installations.—Continued

State	Service	Installation Name	Study
PA	Army/NG	Marshburg Training Area - National Guard	
PA	Navy	Willow Grove, NAS JRB	
SC	AF	Charleston Air Force Base	
SC	AF	Poinsett Range (Shaw AFB)	RCW monitoring MAPS Raptor survey Northern bobwhite survey
SC	AF	Shaw Air Force Base	Least Tern monitoring BASH
SC	Army	Fort Jackson	MAPS Red-cockaded woodpecker monitoring Southeastern American Kestrel and Wood Duck nest box monitoring
SC	Army/NG	Leesburg Training Site (McCrady TC) -National Guard	
SC	MC	MCAS Beaufort	Migratory bird monitoring
SC	MC	MCRD Parris Island	
SC	Navy	Charleston, NWS	Point counts
SD	AF	Ellsworth Air Force Base	Burrowing owl use of prairie dog towns
TN	AF	Arnold Air Force Base	Bald Eagle Status and Distribution Heron Monitoring MAPS Henslow's Sparrow Monitoring Nightjar Monitoring
TN	Army	Holston Army Ammunition Plant	Bird checklist
TN	Army	Milan Army Ammunition Plant	BBS
TN	Army/NG	Volunteer Training Site-Milan - National Guard	
TN	Army/NG	Volunteer Training Site-Smyrna - National Guard	
TN	Army/NG	Volunteer Training Site-Tullahoma - National Guard	
TN	Navy	Mid-South, Naval Support Activity (Memphis)	
TX	AF	Brooks City-Base	None
TX	AF	Dyess Air Force Base	Spring point counts Bluebird nest box monitoring CBC Riparian restoration area- long-term monitoring of avian response
TX	AF	Goodfellow Air Force Base	
TX	AF	Kelly Annex (Lackland AFB)	
TX	AF	Lackland Air Force Base	
TX	AF	Laughlin Air Force Base	
TX	AF	Randolf Air Force Base	Golden-cheeked warbler habitat
TX	AF	Sheppard Air Force Base	Migratory bird surveys
TX	Army	Camp Bullis	Endangered species survey (long-term monitoring of GCWA and BCVI) All bird checklist
TX	Army	Fort Bliss	Migratory linkages of Burrowing Owls

Appendix A. List of Avian Studies at DoD Installations.—Continued

State	Service	Installation Name	Study
TX	Army	Fort Hood	Endangered species monitoring Genetic Differentiation in the Endangered Black-Capped Vireo MAPS
TX	Army	Fort Sam Houston	
TX	Army	Lonestar Army Ammo Plant	
TX	Army	Longhorn Army Ammo Plant	
TX	Army	Red River Army Depot	
TX	Army/NG	Camp Bowie - National Guard	MAPS Black-capped vireo habitat survey Annual black-capped vireo survey
TX	Army/NG	Camp Maxey- National Guard	Baseline survey of birds
TX	Army/NG	Camp Mabry – National Guard	Bird species diversity & abundance Plant species on bird transects
TX	Army/NG	Camp Swift - National Guard	MAPS Avian richness and abundance Vegetation survey at bird sample points
TX	Army/NG	Fort Wolters - National Guard	Inventory of birds
TX	Navy	Corpus Christi, NAS	BASH International Piping Plover Grassland Bird Survey USGS
TX	Navy	Escondido Ranch (McMullen Range, Dixie Target)	Grassland Bird Survey USGS
TX	Navy	Ft Worth, NAS JRB	
TX	Navy	Ingleside, NAVSTA	
TX	Navy	Kingsville, NAS	BASH Grassland Bird Survey USGS
TX	Navy	NALF Orange Grove	BASH Grassland Bird Survey USGS
UT	AF	Hill Air Force Base	Bird Risk Assessment Population, Distribution and Habitat Study for Threatened, Endangered and Sensitive Species
UT	AF	Hill Air Force Range (Utah Test & Training Range)	Population Monitoring of Neotropical Migratory Birds BBS
UT	AF	Wendover Air Force Auxillary Field	
UT	AF	Wendover Range	
UT	Army	Deseret Test Center	BASH Nest boxes
UT	Army	Dugway Proving Ground	Raptor banding Eagle monitoring MAPS Nest boxes Hawkwatch
UT	Army	Tooele Army Depot (2 polygons)	None
UT	Army/NG	Camp Williams - National Guard	
VA	AF	Langley Air Force Base (inset)	
VA	Army	Craney Island Disposal Area (inset)	

Appendix A. List of Avian Studies at DoD Installations.—Continued

State	Service	Installation Name	Study
VA	Army	Fort AP Hill	MAPS Nest box monitoring
VA	Army	Fort Belvoir	Multi-season avian surveys via installation-wide point counts BASH point counts CBC BBS Bluebird nest box Shorebird survey Chimney swift roost survey Waterfowl survey Bald Eagle nest surveys Wild Turkey roost and winter track counts
VA	Army	Fort Eustis (inset)	Breeding Bird Survey (1999) Spring Migration Survey (2000)
VA	Army	Fort Lee	Breeding Bird point counts Biological Surveys and Inventories Nest box program CBC Wading bird surveys
VA	Army	Fort Monroe (inset)	
VA	Army	Fort Story (inset)	Breeding Bird Survey (1999) Spring Migration Survey (2000)
VA	Army	Radford Army Ammunition Plant	CBC Sporadic surveys
VA	Army/NG	Camp Pendleton State Mil. Res. - Nat. Guard (inset)	
VA	Army/NG	Fort Pickett - National Guard	
VA	MC	Marine Corps Base Quantico	MAPS
VA	Navy	Camp Peary	
VA	Navy	Craney Island Fuel Depot (inset)	
VA	Navy	Dahlgren, NSF	Bluebird Nest Boxes Eagle nest surveys In past – MAPS and point counts
VA	Navy	Dam Neck Annex (inset)	
VA	Navy	Fentress, NALF	MAPS (in past) BASH
VA	Navy	Little Creek, NAB (inset)	MAPS (in past)
VA	Navy	Norfolk, Naval Base (inset)	MAPS (in past) BASH
VA	Navy	Norfolk, Naval Shipyard (inset)	
VA	Navy	Norfolk-Northwest Annex, NSA	MAPS (in past)
VA	Navy	Oceana, NAS (inset)	MAPS (in past) BASH
VA	Navy	St. Julian Creek Annex (inset)	
VA	Navy	Yorktown, NWS	Northern bobwhite count Mute swan and Canada goose counts
VT	Army/NG	Camp Johnson - National Guard	
VT	Army/NG	Ethan Allen Firing Range - National Guard	

Appendix A. List of Avian Studies at DoD Installations.—Continued

State	Service	Installation Name	Study
WA	AF	Fairchild Air Force Base	Survey of birds and mammals RTHA survey planned
WA	AF	McChord Air Force Base	Range-wide Streaked Horned Lark Assessment MAPS, Nest box monitoring
WA	AF	McChord Training Annex	
WA	AF/USFS	Cusick Survival Training Site	
WA	Army	Fort Lewis	Range-wide Streaked Horned Lark Assessment MAPS Nest box and cavity monitoring RTLA bird surveys
WA	Army	Yakima Training Center	Sage grouse lek surveys
WA	Army/NG	Camp Bonneville	
WA	Army/NG	Camp Murray	None
WA	Army/USFS	Mount Baker Helicopter Training Area (3 polygons)	
WA	Army/USFS	Nap of the Earth Helicopter Training Area	
WA	Navy	Everett, NAVSTA	
WA	Navy	Indian Island, NAVMAG	
WA	Navy	Jim Creek, NAVRADSTA (T)	
WA	Navy	Kitsap, Naval Base	CBC
WA	Navy	Puget Sound, Naval Shipyard	
WA	Navy	Whidbey Island, NAS	NOHA and BAEG surveys
WA	Navy	NSB Bangor	CBC
WI	AF	Hardwood Range (Volk Field)	
WI	AF	Volk Field (ANGB)	
WI	Army	Badger Army Ammunition Plant	
WI	Army	Fort McCoy	Eagle and osprey monitoring Distribution, abundance and productivity of grassland birds Winter finch banding Ruffed grouse drumming survey
WI	Army/NG	Camp Wismer - National Guard	
WV	Army/NG	Camp Dawson - National Guard	
WV	Navy	Sugar Grove, NIOC	MAPS
WY	AF	F.E. Warren Air Force Base	Survey for breeding birds on Crow Creek (pt cts) Mountain Plover surveys Mountain Plover habitat
WY	Army/NG	Camp Guernsey - National Guard	
WY	Army/NG	Lander Training Area - National Guard	
WY	Army/NG	Lovell Training Area - National Guard	
WY	Army/NG	Sheridan Training Area - National Guard	
WY	Navy	Navy Petroleum Reserve	

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Bart and others—**Coordinated Bird Monitoring: Technical Recommendations for Military Lands**—Open-File Report 2010–1078

APPENDIX H: FISH

LIST OF FISH FOUND ON ARNG-MTC FORT PICKETT BLACKSTONE, VIRGINIA

Common name	Scientific name
American eel	*Anguilla rostrata*
Black jumprock	*Scartomyzon cervinus*
Bluegill	*Lepomis macrochirus*
Bluehead chub	*Nocomis leptocephalus*
Brook lamprey	*Lampetra appendix*
Bull chub	*Nocomis raneyi*
Creek chub	*Semotilus atromaculatus*
Eastern mosquitofish	*Gambusia holbrooki*
Glassy darter	*Etheostoma vitreum*
Green sunfish	*Lepomis cyanellus*
Margined madtom	*Noturus insignis*
Northern hogsucker	*Hypentelium nigricans*
Pirate perch	*Aphredoderus sayanus*
Redbreast sunfish	*Lepomis auritus*
Roanoke darter	*Percina roanoka*
Roanoke logperch	*Percina rex*
Rosefin shiner	*Lythrurus ardens*
Satinfin shiner	*Cyprinella analostana*
Shield darter	*Percina peltata*
Silver redhorse	*Moxostoma collapsum*
Swallowtail shiner	*Notropis procne*
Tesselated darter	*Etheostoma olmstedi*
Torrent sucker	*Thoburnia rhothoeca*
White shiner	*Luxilus albeolus*

*Based on Fish Survey of the Nottoway River for Fort Pickett Maneuver Training Center, Blackstone, Virginia. CMI-MLD R-50. Wolf, Eric D., and Michael B. Duncan. 2006.

APPENDIX I: INVERTEBRATES

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LIST OF INVERTEBRATES FOUND ON ARNG-MTC FORT PICKETT BLACKSTONE, VIRGINIA

Mussels	
Common Name	Scientific Name
Triangle floater	*Alasmidonta undulata*
Giant floater	*Pyganodon grandis*
Eastern elliptio complex	*Elliptio complanata/congerea*
Atlantic pigtoe	*Fusconaia masoni*
Eastern floater	*Pygangadon cataracta*
Creeper	*Strophitus undulatus*
Notched rainbow	*Villosa constricta*
Paper pondshell	*Utterbackis imbecillis*
Carolina slabshell	*Elliptio congarea*
Yellow lance	*Elliptio lanceolata*
Eastern lampmussel	*Lampsilis radiata*
Odonates	
Common Name	Scientific Name
Suborder: Anisoptera	
Fawn Darner	*Boyeria vinosa*
Green Darner	*Anax junius*
Comet Darner	*Anax longipes*
Swamp Darner	*Epiaeschna heros*
Twin-spotted spiketail	*Cordulegaster masculata*
Common baskettail	*Epitheca cynosura*
Prince baskettail	*Epitheca princeps*
Unicorn clubtail	*Arigomphus villosipes*
Black-shouldered spinyleg	*Dromogomphus spinosus*
Lancet clubtail	*Gomphus exilis*
Ashy clubtail	*Gomphus lividus*
Black clubtail	*Hagenius brevistylus*
Common sanddragon	*Progomphus obscurus*
Calico pennant	*Celithemis elisa*
Halloween pennant	*Celithemis eponia*
Banded pennant	*Celithemis fasciata*
Eastern pondhawk	*Erythemis simplicicollis*
Spangled skimmer	*Libeilula cyanea*
Blue corporal	*Ladona deplanata*
Slaty skimmer	*Libellula incesta*
Widow skimmer	*Libellula luctuosa*
Common whitetail	*Libellula lydia*
Painted skimmer	*Libellula semifasciata*
Blue skimmer	*Libellula vibrans*
Blue dasher	*Pachydiplax longipennis*

Eastern Amberwing	*Perithemis tenera*
Blue-faced meadowhawk	*Sympetrum ambiguum*
Autumn Meadowhawk	*Sympetrum vicinum*
Mississippi stream cruiser	*Didymops transversa*
Swift river cruiser	*Macromia illinoiensis*
Royal river cruiser	*Macromia taeniolata*
Gray petaltail	*Tachopteryx thoreyi*
Suborder: Zygoptera	
Sparkling jewelwing	*Calopteryx dimidiate*
Ebony jewelwing	*Calopteryx maculate*
Smoky rubyspot	*Hataerina titia*
Blue-fronted dancer	*Argia apicalis*
Variable dancer	*Argiafumipennis violacea*
Powdered dancer	*Argia moesta*
Blue-ridged dancer	*Argia Sedula*
Blue-tipped dancer	*Argia tibialis*
Azure bluet	*Enallagma aspersum*
Double-striped bluet	*Enallagma basidens*
Familiar bluet	*Enallagma civile*
Attenuated bluet	*Enallagma daeckii*
Turquoise bluet	*Enallagma divagans*
Stream bluet	*Enallagma exsulans*
Skimming bluet	*Enallagma geminatum*
Orange bluet	*Enallagma signatum*
Vesper bluet	*Enallagma vesperum*
Blackwater bluet	*Enallagma weewa*
Citrine forktail	*Ischnura hastate*
Fragile forktail	*Ischnura posita*
Southern sprite	*Nehalennia integricollis*
Southern spreadwing	*Lestes australis*
Elegant spreadwing	*Lestes inaequalis*
Slender spreadwing	*Lestes rectangularis*
Swamp spreadwing	*Lestes vigilax*
Butterflies and skippers	
Common Name	Scientific Name
Suborder:Hesperiidae	
Hoary edge	*Achalarus lyciades*
Least skipperling	*Ancyloxypha numitor*
Sachem	*Atalopedes campestris*
Silver spotted skipper	*Epargyreus clarus*
Wild indigo duskywing	*Erynnis baptisiae*
Horace's duskywing	*Erynnis horatius*
Juvenal's duskywing	*Erynnis juvenalis*

Dun skipper	*Euphyes vestris*
Sedge skipper	*Euphyres dion*
Swarthy skipper	*Nastra lherminier*
Zabulon skipper	*Poanes zabulon*
Tawny-edged skipper	*Polites themistocles*
Little glassywing	*Pompeius verna*
Southern cloudywing	*Thorybes bathyllus*
Northern cloudywing	*Thorybes pylades*
Suborder: Lycaenidae	
Olive hairstreak	*Callophrys gryneus*
Red-banded hairstreak	*Calycopis cecrops*
Spring azure	*Celastrina argiolus*
Eastern tailed blue	*Everes comyntas*
Harvester	*Feniseca tarquinius*
Suborder: Nymphalidae	
Hackberry butterfly	*Asterocampa ceitis*
Tawny emperor	*Asterocampa clyton*
Large wood nymph	*Cercyonis pegala*
Silvery crescentspot	*Chlosyne nycteis*
Gemmed satyr	*Cyllopsis gemma*
Monarch	*Danaus piexippus*
Variegated fritillary	*Euptoieta Claudia*
Carolina satyr	*Hermeuptychia sosybius*
Buckeye	*Junonia coenia*
Snout butterfly	*Libytheana carinenta*
Viceroy	*Limenitis archippus*
Red spotted purple	*Limenitis astyanax*
Little wood satyr	*Megisto cymela*
Southern pearly crescentspot	*Phyciodes tharos*
Comma	*Polygonia comma*
Question mark	*Polygonia interrogationis*
Appalachian brown	*Satyrodes appalachia*
Great spangled fritillary	*Speyeria cybele*
Red admiral	*Vanessa atalanta*
Painted lady	*Vanessa cardui*
American painted lady	*Vanessa virginiensis*
Suborder: Papilionidae	
Pipevine swallowtail	*Battus philenor*
Zebra swallowtail	*Eurytides marcelius*
Tiger swallowtail	*Papilio glaucus*
Black swallowtail	*Papilo polyxenes*
Spicebush swallowtail	*Papilio Troilus*
Suborder: Pieridae	
Falcate orangetip	*Anthocharis midea*

Orange sulphur	*Colias eurytheme*
Little yellow	*Eurema lisa*
Sleepy orange	*Eurema nicippe*
Cloudless giant sulphur	*Phoebis sennae*
European cabbage white	*Pieris rapae*
Moths	
Common Name	Scientific Name
Suborder: Apatelodidae	
Spotted apatelode	*Apatelodes torrefacta*
Suborder: Arctiidae	
Carlotta's tiger moth	*Apantesis carlotta*
Harnessed tiger moth	*Apantesis phalerata*
Yellow-collared scape moth	*Cisseps fulvicoliis*
Packard's lichen moth	*Cisthene packardii*
Lead-colored lichen moth	*Cisthene plumbea*
Little white lichen moth	*Ciemensia albata*
Dark grey lichen moth	*Crambidia lithosioides*
Uniform lichen moth	*Crambidia uniformis*
Oregon cycnia	*Cycnia oregonensis*
Delicate cycnia	*Cycnia tenera*
Salt marsh moth	*Estigmene acrea*
Arge moth	*Grammia arge*
Figured tiger moth	*Grammia figurata*
Phyllira tiger moth	*Grammia phyllira*
Virgin tiger moth	*Grammia virgo*
Banded tussock moth	*Halysidota tessellaris*
Clymene moth	*Haploa clymene*
Leconte's Haploa	*Haploa lecontei*
Virbia aurantiaca	*Holomelina aurantiaca*
Virbia opella	*Holomelina opelia*
Black and yellow lichen moth	*Hypoprepia cunea*
Painted lichen moth	*Hypoprepia fucosa*
Scarlet-winged lichen moth	*Hypoprepia miniata*
Long-streaked tussock moth	*Leucanopsis longa*
Mouse-colored lichen moth	*Pagara simplex*
Isabella tiger moth	*Pyrrharctia Isabella*
Agreeable tiger moth	*Spilosoma congrua*
Virginian tiger moth	*Spilosoma virginica*
Suborder: Drepanidae	
Arched hooktip	*Drepana arcuata*
Rose hooktip	*Oreta rosea*
Suborder: Geometridae	
	Anacamptodes humaria

Common gray moth	*Anavitrinelia pampinaria*
Oak besma	*Besma quercivoraria*
Dark scallop moth	*Cepphis decoloraria*
Angle-winged emerald moth	*Chloropteryx tepperaria*
Bent-line carpet hodge	*Costaconvexa centrostrigaria*
Packard's wave	*Cyclophora Packardi*
Showy emerald moth	*Dischorda iridaria*
Small engrailed moth	*Ectropis crepuscularia*
Tulip-tree beauty	*Epimecis hortaria*
The beggar	*Eubaphe mendica*
Deep yellow euchlaena	*Euchiaena amoenaria*
Least-marked euchlaena	*Euchiaena irraria*
Johnson's euchlaena moth	*Euchiaena johnsonaria*
Obtuse euchlaena	*Euchiaena obtusaria*
Forked Euchlaena moth	*Euchiaena pectinaria*
Lesser grapevine moth	*Eulithis diversilineata*
Brown-bordered geometer	*Eumacaria latiferrugata*
Common eupithecia	*Eupithecia miserulata*
Confused eusarca	*Eusarca confusaria*
Curve-toothed geometer	*Eutrapela clemataria*
Fine-lined gray moth	*Exelis pyrolaria*
Dotted gray moth	*Glena cribrataria*
Plumose gray	*Glena plumosaria*
Texas gray moth	*Gienoides texanaria*
Three-spotted fillip	*Heterophieps triguttaria*
Brown bark carpet moth	*Horisme intestinata*
Esther moth	*Hypagyrtis esther*
One-spotted variant	*Hypagyrtis unipunctata*
Hypomecis gnopharia	*Hypomecis gnopharia*
Umber moth	*Hypomecis umbrosaria*
Red-bordered wave moth	*Idaea demissaria*
Rrippled wave	*Idaea obfusaria*
Curve-lined loopper	*Lambdina athasaria*
Dark-ribboned wave moth	*Leptostales rubromarginaria*
Common lytrosis	*Lytrrosis unitaria*
Canadian melanolophia	*Melanolophia canadaria*
Orange wig moth	*Meliilla xanthomata*
Angled metarranthis moth	*Metarranthis angularia*
Metarranthis moth	*Metarrranthis hypocharia*
Red-bordered emerald	*Nemoria lixaria*
Red-fronted emerald	*Nemorria rubrifrontaria*
Nemproa saturiba	*Nemproa saturiba*
The gem	*Orthonama obstipata*
Patalene olyzonaria	*Patalene olyzonaria*

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Hubner's pero	*Pero hubneraria*
American barred umber moth	*Plagodis pulveraria*
Common tan wave	*Pleuroprucha insuisaria*
Alien probole	*Probole alienaria*
Friendly problole	*Probole amicaria*
Large maple spanworm	*Prochoerodes transversata*
Porcelain gray moth	*Protoboarmia porcelaria*
Soft-lined wave	*Scopula inductata*
Common angle moth	*Semiothisa aemulataria*
Bicolored angle moth	*Semiothisa bicolorata*
Red-headed inchworm moth	*Semiothisa bisignata*
Curved-line angle moth	*Semiothisa continuata*
Semiothisa gnophosaria	*Semiothisa gnophosaria*
Minor angle moth	*Semiothisa minorata*
Many-lined angle moth	*Semiothisa multilineata*
Promiscuous angle moth	*Semiothisa promiscuata*
Blurry chocolate angle moth	*Semiothisa transitaria*
	Tomos scholopacinarius
Toothed brown carpet	*Xanthorhoe lacustrata*
Crocus geometer moth	*Xanthotype sospeta*
False crocus geometer	*Xanthotype uticaria*
Suborder: Lasiocampidae	
Dot-lined white	*Artace cribraria*
Eastern tent caterpillar	*Malacosoma americanum*
Forest tent caterpillar	*Malacosoma disstria*
Small tolype	*Tolype notialis*
Suborder: Lymantriidae	
Dasychira atrivenosa	*Dasychira atrivenosa*
Yellow-based tussock	*Dasychira baswava*
Sharp-lined tussock	*Dasychira dorsipennata*
Manto tussock moth	*Dasychira manto*
Southern tussock moth	*Dasychira meridionalis*
Streaked tussock moth	*Dasychira obliquata*
Dasychira tephra	*Dasychira tephra*
White-marked tussock moth	*Orgyia leucostigma*
Suborder: Mimallonidae	
Scalloped sack-bearer	*Lacosoma chiridota*
Suborder: Noctuidae	
Greater red dart moth	*Abagrrotis alternata*
One-dotted dart	*Abagrotis magnicupida*
American dagger moth	*Acronicta americana*
Birch dagger moth	*Acronicta betulae*
Cherry dagger moth	*Acronicta hasta*
Unclear dagger moth	*Acronicta inclara*

Pleasant dagger moth	*Acronicta laetifica*
Streaked dagger moth	*Acronicta lithospila*
Long-winged dagger moth	*Acronicta longa*
Medium dagger moth	*Acronicta modica*
Orche dagger moth	*Acronicta morula*
Night-wandering dagger moth	*Acronicta noctivaga*
Smeared dagger moth	*Acronicta oblinita*
Ovate dagger moth	*Acronicta ovata*
Retarded dagger moth	*Acronicta retardata*
Triton dagger moth	*Acronicta tritona*
Delightful dagger moth	*Acronicta vinnula*
Bolle's Dart	*Agnorisma bollii*
Green marvel moth	*Agriopodes fallax*
Swordman dart moth	*Agrotis gladiaria*
Dark sword-grass moth	*Agrotis ipsilon*
Venerable dart moth	*Agrotis venerabilis*
	Ailagraphea aerea
False underwing moth	*Allotria elonympha*
Feeble grass moth	*Amolita fessa*
Copper underwing	*Amphipyra pyramidoides*
Celery looper moth	*Anagrapha falcifera*
Green cutworm moth	*Anicla infecta*
Slowpoke moth	*Anorthodes tarda*
Short-lined chocolate moth	*Argyrostrotis anilis*
	Arugisa latorelia
Common looper moth	*Autographa precationis*
Small baileya moth	*Baileya australis*
Sleeping baileya moth	*Baileya dormitans*
Doubleday's baileya	*Baileya doubledayi*
Kentucky moth	*Baiieya ophthaimica*
Gold moth	*Basilodes pepita*
White-tailed diver moth	*Beliura gortynoides*
Bent-winged owlet	*Bleptina caradrinalis*
	Caenurgia chioropha
Clover looper	*Caenurgina crassiuscula*
Forage looper moth	*Caenurgina erechtea*
Mourning underwing moth	*Catocala flebilis*
Graceful underwing	*Catocala gracilis*
Linella underwing	*Catocala lineella*
The bride	*Catocala neogama*
Penitent underwing	*Catocala piatrix*
Ultronia underwing	*Catocala ultronia*
Widow underwing	*Catocala vidua*
Black bit moth	*Celiptera frustulum*

The laugher	*Charadra deridens*
Bent-line dart	*Choephora fungorum*
Morbid owlet	*Chytolita petrealis*
Blueberry leaftier	*Chytolita palliatricula*
Tickseed moth	*Cirrhophanus triangulifer*
Yellow-lined owlet	*Colobochyla interpuncta*
Yellowhorn	*Colocasia flavicornis*
White dotted groundling	*Condica videns*
Sharp stigma looper	*Ctenoplusia oxygramma*
Spot-edged dyspyralis	*Dyspyralis nigella*
Grateful midget moth	*Elaphria grata*
Elaphria cornutinus	*Elaphria cornutinis*
Variegated midget	*Elaphria versicolor*
Snowy dart moth	*Euagrotis illapsa*
Toothed somberwing moth	*Euclidia cuspidea*
Beautiful wood-nymph	*Eudryas grata*
Fleece-winged dart	*Euxoa velleripennis*
Master's dart	*Feltia herilis*
Gabara subnivosella	*Gabara subnivosella*
Wedgling moth	*Galgula partita*
Harris's Tree spot	*Harrisimemna trisignata*
Corn earworm	*Helicoverpa zea*
Variable tropic moth	*Hemeroplanis scopulepes*
Black-wedge spot	*Homophoberia apicosa*
Waterlily moth	*Homophoberia cristata*
Hormorthodes lindseyi	*Hormorthodes lindseyi*
Baltimore bomolocha moth	*Hypena baitimoralis*
Flowing-line hypena	*Hypena manalis*
Green cloverworm	*Hypena scabra*
Small necklace moth	*Hypsoropha hormos*
Common idia	*Idia aemula*
American idia	*Idia americalis*
Orange spotted-idia	*Idia diminuendis*
Glossy black idia	*Idia lubricalis*
Chocolate idia	*Idia rotundalis*
Smokey idia	*Idia scobialis*
White-eyed borer moth	*Lodopepla album*
Thin-lined owlet	*Isogona tenuis*
Explicit arches moth	*Lacinipolia explicata*
Implicit arches moth	*Lacinipolia implicata*
Bristly cutworm moth	*Lacinipolia renigera*
Lacinipolia teligera	*Lacinipolia teligera*
Lost owlet	*Ladaea perditalis*
Detracted owlet moth	*Lesmone detrahens*

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Adjutant wainscot moth	*Leucania adjuta*
Unarmed wainscot	*Leucania inermis*
Linda wainscot moth	*Leucanis linda*
Green owlet	*Leuconycta diphteroides*
Small mossy lithacodia	*Lithacodia musta*
Red-footed Hypena	*Lomanaltes eductalis*
Marathyssa inficta	*Marathyssa inficta*
Richard's fungus moth	*Metalectra richardsi*
Texas mocis	*Mocis texana*
Fluid arches	*Morrisonia latex*
Gray half-spot	*Nedra ramosula*
Bronzed cutworm moth	*Nephelodes minians*
Large yellow underwing	*Noctua pronuba*
Common pinkband moth	*Ogdoctona cinereola*
Rustic quaker	*Orthodes crenulata*
Small mottled gray-brown moth	*Orthodes detracta*
Goodell's Arches Moth	*Orthodes goodelli*
Large paectes moth	*Paectes abrostoloides*
Pygmy paectes moth	*Paectes pygmaea*
Imperial moth	*Paithis imperpialis*
Decorated owlet moth	*Pangrapta decoralis*
Panopoda cameicosta	*Panopoda cameicosta*
Red-lined panopoda	*Panopoda rufimargo*
Northern Burdock Borer	*Papiapema arctivorens*
Indigo stem borer	*Papiapema baptisiae*
Umbellifer borer moth	*Papiapema birdi*
Black-red borer moth	*Papiapema marginidens*
Maple looper moth	*Parallelia bistriaris*
Buffalo moth	*Parapamea buffaloensis*
Red grounding moth	*Perigea xanthioides*
Brown angle shades	*Phlogophora periculosa*
Spotted phosphila moth	*Phosphila miselioides*
Curve-lined owlet moth	*Phyprosopus callitrichoides*
Pink-bordered moth	*Phytometra rhodarialis*
Hebrew moth	*Polygrammate hebraeicum*
Large mossy lithacodia	*Protodeltote muscosula*
Brown-collared dart moth	*Protolampra brunneicollis*
Miranda moth	*Proxenus miranda*
Armyworm	*Pseudaletia unipuncta*
Small brown quaker	*Pseudorthodes vecors*
Common ptichodis moth	*Ptichodis herbarum*
Discolored renia	*Renia discoloralis*
Sober renia moth	*Renia sobrialis*
Arcigera flower moth	*Schinia arcigera*

Ragweed flower moth	*Schinia rivulosa*
Three-lined flower moth	*Schinia trifascia*
Dead-wood borer moth	*Scolecocampa libuma*
Six-spotted gray	*Spargaloma sexpunctata*
Tiger moth	*Spiloloma unilinea*
Fail armyworm	*Spodoptera frugiperda*
Yellowstriped armyworm	*Spodoptera ornithogalli*
Southern spragueia	*Spragueia dama*
Common spragueia	*Spragueia leo*
Obtuse yellow moth	*Stiriodes obtuse*
Bicolored sallow moth	*Sunira bicolorago*
Olive-shaded Bird-dropping Moth	*Tarachidia candefacta*
Olive-shaded bird-dropping moth	*Tarachidia erastrioides*
Yellow-cloaked midget	*Tarachidia semiflava*
Florida tetanolita moth	*Tenanolita floridana*
Smoky tetanolita	*Tetanolita mynesalis*
Black-bordered lemon moth	*Thioptera nigrofimbria*
Signate quaker	*Tricholita signata*
Cabbage looper	*Trichoplusia ni*
Striped garden caterpillar moth	*Trichordestra legitima*
Knee-joint dart	*Trichosilia geniculata*
Dull reddish dart moth	*Xestia dilucida*
Greater black-letter dart moth	*Xestia dolosa*
Southern variable dart moth	*Xestia elimata*
Maple zale moth	*Zale galbanata*
Horrid zale	*Zale horrida*
Lunate zale	*Zale lunata*
Gray-banded zale	*Zale metata*
Colorful zale	*Zale minerea*
Oblique zale moth	*Zale oblique*
Early fan-foot	*Zanclognatha cruralis*
Variable zanclognatha moth	*Zanclognatha laevigata*
Lettered zanclognatha	*Zanclognatha lituralis*
Dark zanclognatha	*Zanclognatha obscuripennis*
Suborder: Notodontidae	
Poplar tentmaker	*Clostera inclusa*
Black-spotted prominent moth	*Dasylophia anguina*
Angus's datana moth	*Datana angusii*
Drexel's datana moth	*Datana drexelii*
Walnut caterpillar moth	*Datana integerrima*
Azakea caterpillar moth	*Datana major*
Yellow-necked caterpillar moth	*Datana ministra*
Spotted datana moth	*Datana perspicua*
Wavy-lined heterocampa moth	*Heterocampa biundata*

Saddled prominent	*Heterocampa guttivitta*
Oblique heterocampa moth	*Heterocampa obiiqua*
White-blotched heterocampa	*Heterocampa umbrata*
Pink prominent moth	*Hyparpax aurora*
Georgian prominent moth	*Hyperaeschra georgica*
Double-lined prominent moth	*Lochmaeus bilineata*
Variable oakleaf moth	*Lochmaeus manteo*
Mottled prominent	*Macrurocampa marthesia*
Drab prominent moth	*Misogada unicolor*
White-dotted prominent	*Nadata gibbosa*
White-streaked prominent	*Oligocentria lignicolor*
Red-washed prominent	*Oligocentria semirufescens*
Angulose prominent	*Peridea angulosa*
Oval-based prominent	*Peridea basitri*
Chocolate prominent	*Peridea ferruginia*
Chestnut schizura	*Schizura badia*
Morning glory prominent	*Schizura ipomoeae*
Unicorn caterpillar moth	*Schizura unicornis*
White-headed prominent	*Symmerista albifrons*
Suborder: Saturniidae	
Luna moth	*Actias luna*
Spiny oakworm moth	*Anisota stigma*
Polyphemus moth	*Antheraea polyphemus*
Lo moth	*Automeris io*
Tulip-tree silk moth	*Cailosamia angulifera*
Regal moth	*Citheronia regalis*
Pine devil moth	*Citheronia Sepuicralis*
Rosy maple moth	*Dryocampa rubicunda*
Elm sphinx	*Ceratomia amyntor*
Suborder: Sphingidae	
Catalpa sphinx	*Ceratomia catalpa*
Virginia creeper sphinx	*Daraosa Myron*
Lettered sphinx moth	*Deidamia inscripta*
Walnut sphinx	*Laothoe juglandis*
Southern pine sphinx	*Lapara coniferarum*
Five-spotted hawkmoth	*Manduca quinquemaculata*
Huckleberry sphinx	*Paonias astylus*
Blinded sphinx	*Paonias excaecatus*
Small-eyed sphinx	*Paonias myops*
Plebeian sphinx	*Paratrea plebeja*
Suborder: Thyatiridae	
Tuffed Thyatirid	*Pseudothyatira cymatophoroides*

Other	
Common Name	Scientific Name
Suborder: Coleoptera	
Punctured tiger beetle	*Cicindela punctulata*
Bronzed tiger beetle	*Cicindela repanda*
Eastern red-bellied tiger beetle	*Cicindela rufiventris*
Six-spotted Tiger beetle	*Cincindela sexguttata*
A burying beetle	*Nicrophorus orbicollis*
Diving beetles	*Dytiscidae*
Whirling beetles	*Gyrinidae*
Burrowing water beetles	*Noteridae*
Suborder: Hemiptera	
Wheel bug	*Arilus cristatus*
Toad bugs	*Gelastocondae*
Suborder: Plecoptera	
Stoneflies	*Pteronarcys*
Stoneflies	*Acroneuria*
Suborder: Ephemeroptera	
Mayflies	*Heptageniidae*
Mayflies	*Baetidae*
Suborder: Trichoptera	
	Ceraclea spongillovorax
Suborder: Crustacea	
Crayfish	*Orconectes*
Amphipods	*Gammarus*
Amphipods	*Crangonyx*
Suborder: Bivalvia	
Fingernail clams	*Bivalvia*
Suborder: Gastropoda	
Freshwater snail	*Gastrioida*
Suborder: Diptera	
Crane flies	*Tipulidae*
Suborder: Neuroptera	
Hellgramites (Dobsonfly larvae)	*Corydalidae*

List taken from: 1. Chazal, Anne C. and Katherine L. Derge. 2001. Rare fauna inventory at Fort Pickett-MTC. Natural Heritage Technical Report 01-12. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, Virginia. Unpublished report submitted to Fort Pickett-MTC. April 2001. 78 pp.; 2. Oliver S. Flint, Jr., Richard L. Hoffman, Charles R. Parker. 2008. An Annotated List of the Caddisflies (Trichoptera) of Virginia: Part II. Families of Integripalpia. Banisteria, Number 31, pages 3-23

APPENDIX J: VIRGINIA DEPARTMENT OF FORESTRY BEST MANAGEMENT PRACTICES FOR WATER QUALITY

Virginia's Forestry Best Management Practices for Water Quality

Technical Manual
2011

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Virginia's Forestry Best Management Practices for Water Quality
Technical Manual
Fifth Edition
March 2011

Virginia's Forestry
Best Management Practices
for Water Quality

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Contents

Tables

Foreword

The Virginia Department of Forestry – in cooperation with many of our associates with state and federal agencies, forest industry, forestry consultants and private non-profit groups – is pleased to present this Fifth Edition of our Forestry Best Management Practices for Water Quality Technical Manual. The original publication has served the forestry community well since 1978 and time has shown us more efficient and technically correct ways to install practices, as well as more instructive ways to present this information.

Continued effort by the forestry community is necessary to stay on top of Best Management Practices and water quality protection. The Virginia Department of Forestry remains committed to increased adoption of these practices by all who impact our forest resources. As the public becomes more aware of our collective practices on the land, we must be willing to instill the "Stewardship Ethic" and Sustainable Forestry Principles as we provide the raw material necessary for continued economic viability and the environmental amenities enjoyed by our citizens.

I trust this Fifth Edition is helpful and fosters the appropriate installation of Best Management Practices on Virginia's forestland.

Carl E. Garrison III

NOTES

CHAPTER 1

Introduction

Introduction

Commercial forests occupy more than 61 percent or 15.4 million acres of land in Virginia. Forest ownership is dominated by non-industrial private ownership at 77 percent; forest industry owns 10 percent, and the remaining 13 percent is held by public agencies.

Forestry annually contributes more than $27.5 billion to Virginia's economy. If Virginia is to thrive economically, the forests' ability to produce goods and services along with their harvestability must be sustained.

Forest management programs and operations should incorporate adequate measures to provide for proper soil and water conservation. Most streams originating in or flowing through our timberlands are sources for water supplies, recreation and a wealth of other uses.

Purpose

This manual is prepared to inform and educate forest landowners and the professional forest community on the proper Best Management Practices (BMP) use; its specific purpose, and technical specifications for installation. BMPs are proven methods used to protect water and site quality.

What is Nonpoint Source Pollution?

Nonpoint source pollution is generated from land runoff resulting from precipitation. As the runoff moves over the land surface, it picks up and carries away natural and man-made pollutants and deposits them into waterways, wetlands and ground water. Human activity can dramatically increase nonpoint source pollution potential.

There can be five types of water pollutants resulting from silvicultural activities. They are:

1. Sediment
2. Nutrients
3. Organics
4. Temperature
5. Chemicals

Silvicultural activities that have the greatest chance of causing nonpoint source pollution include:

1. Forest road construction, including stream crossings;
2. Forest harvesting activities, including skidding and processing timber;
3. Site preparation;
4. Pesticide application, and
5. Wildfire control lines and prescribed fire use.

Of all the listed silvicultural activities, road construction is generally considered to have the greatest potential to increase nonpoint source pollution and, subsequently, to degrade water quality. This potential impact is dependent on slope, soil type, area affected and intensity of activity.

Why is Nonpoint Source Pollution Important to Us?

Abundant clean water is important to all citizens of the Commonwealth. Excessive runoff can increase sedimentation to streams. Increased sedimentation raises filtering costs for drinking water; increases flood potential by filling up streambeds, and chokes irrigation systems. Fish habitats can be altered by improper management activities. Removing shade from critical riparian or streamside areas can increase water temperatures, thus affecting fish and other aquatic life. The entire food chain in and near streams can be affected and damaged by land management activity. Best Management Practices can reduce the impact from these management activities.

Best Management Practices – What are They and Why are They Important?

Best Management Practices are activities chosen to reduce soil erosion and prevent or control pollution resulting from forestry operations. BMPs have been in existence for many years in the areas of forestry, agriculture and urban development. Forestry BMPs are directed primarily at controlling erosion. Erosion can lead to sedimentation, which is the entry of soil into waterways. BMPs are proven methods to lessen the potential damage from land-disturbing activities.

Using this Manual

This technical manual is organized according to broad categories of forestry operations where the forest manager needs to recognize appropriate BMPs. The broad topics will describe useful BMPs and techniques to minimize pollution from the forestry operations. The back of the manual contains an appendix of standards and specifications for each BMP. The manual will not replace on-the-ground recommendations by a qualified professional forester or resource professional and should not be used as a substitute. Forest operators should always consult a professional for solutions to difficult on-the-ground problems. Alternative methods that achieve equal water quality protection are acceptable.

Appendices

Appendix A – BMP Specifications. Provides detailed information on each BMP, where it is to be used, design specifications and any planning considerations.

Appendix B – Planning Tools. Provides guidance on the use of various planning tools, such as slope determination; use of aerial photographs; use of soil maps; evaluation of topographic maps, and methods useful in determination of drainage areas.

Appendix C – Road Surface Area. Provides tables useful in determining road surface area; determining road surface material requirements, and the use of geotextile fabrics.

Appendix D – Revegetation of Disturbed Areas. Focuses on the stabilization of disturbed or bare soil areas following forestry operations.

Appendix E – Agency Listing. A listing of natural resources agencies that may provide technical assistance with any situations not provided for by this technical manual.

What Happens When Water Quality is Degraded?

If a silvicultural activity is negatively affecting water quality, the logger, landowner and timber buyer are all liable and each may be required to correct the problem. In July of 1993, the Virginia Department of Forestry was given the responsibility to inspect harvesting operations for water quality degradation. The Department, through this legislation, has the authority to do the following:

1. Recommend corrective action;
2. Stop harvesting, and
3. Initiate civil penalties.

Forest industry and forest consultants who monitor compliance with this legislation have adopted the Department's inspection program. Any questions regarding this law should be directed to your local Department of Forestry office.

Please see Chapter 10, Regulations and Legislation Pertaining to Water Quality and Forestry in Virginia. (See "CHAPTER 10" on page 85.)

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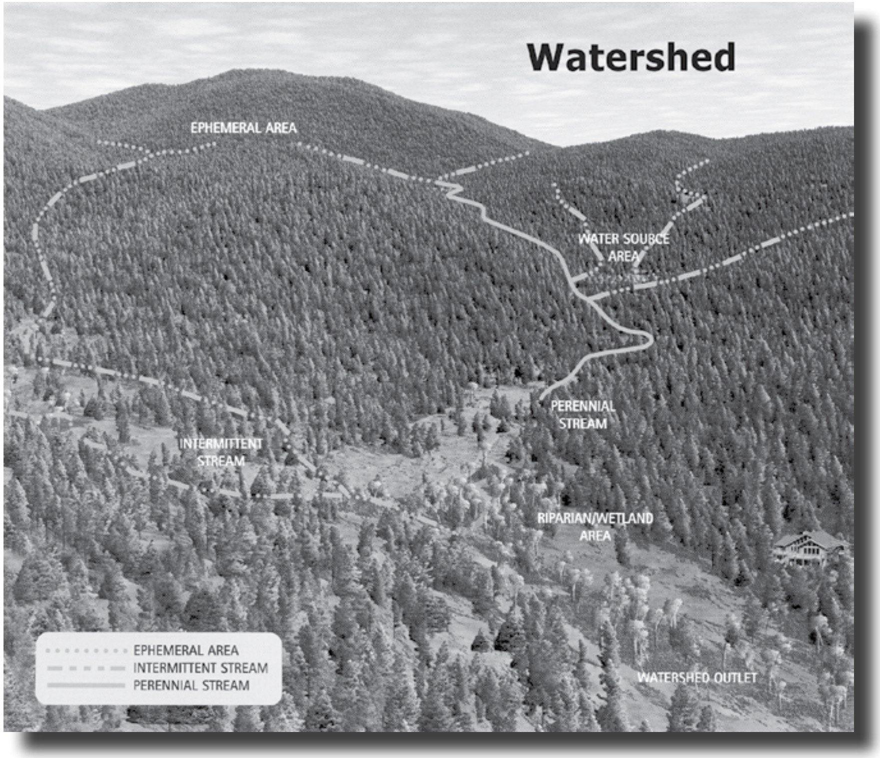
CHAPTER 2

WATERSHEDS

Watersheds

A watershed is a land area where precipitation collects and funnels to an outlet – usually a stream. The image below shows perennial streams, intermittent streams and wetland areas illustrated over a watershed.



An intermittent stream has water in it for only a portion of the year but has defined channels and banks, and evidence of scouring is apparent. A perennial stream has water in it all year and also has a well-defined channel and established banks. As the image depicts, most intermittent streams occur near the upper portion of the watershed while most perennial streams are near the lower portion of the watershed.

A comparison widely used is that of the roof on your home. Rain falls on the roof and moves by gravity toward the gutters, collecting debris and materials as it flows. The water eventually reaches the downspouts where it concentrates, picking up speed and additional debris. Different land uses affect watersheds differently. The effect of storms is dependent on slope, soil type and overall land use. For example, precipitation moves more slowly through a forested watershed than through an urban watershed because organic forest soils absorb the rainfall's energy more efficiently than rooftops and pavement in urban settings. Land-disturbing activities, such as road construction, timber skidding and site preparation, can greatly affect the movement of water and associated debris, including sediment, to a stream. One must be careful when conducting silvicultural operations so soil movement is minimized. Of particular importance are the intermittent streams that, despite not having water in them most of the year, can contribute to downstream water quality. The use of heavy equipment during timber harvesting can lead to altered and compacted soil causing downstream water quality problems if forest operators do not properly use BMPs.

Sensitive areas, such as wetlands, bogs, seeps and marshes, are found in all watersheds and should be treated with care and receive special protection. The Clean Water Act of 1972 (Public Law 92-500) and its amendments mandate water quality sufficient to provide “fishable” and “swimmable” waters. It requires that all “waters of the United States” will be protected from degradation. This includes, but is not limited to, headwater creeks, rich bottomland hardwood bogs, marshes and permanently flooded cypress-tupelo areas. The scope of the legal jurisdiction was expanded in 1977 by amendments redefining protection to include the “waters of the United States” and their “adjacent wetlands.” This protection, under Section 404, specifies that anyone engaging in activities impacting waters and wetlands is required to secure a permit before proceeding, unless exempted. In forested wetlands, the law provides an exemption from permitting under Section 404 for normal ongoing silvicultural operations provided that the “15 Federally-Mandated Best Management Practices” are followed. (See “CHAPTER 10” on page 85.)

NOTES

CHAPTER 3

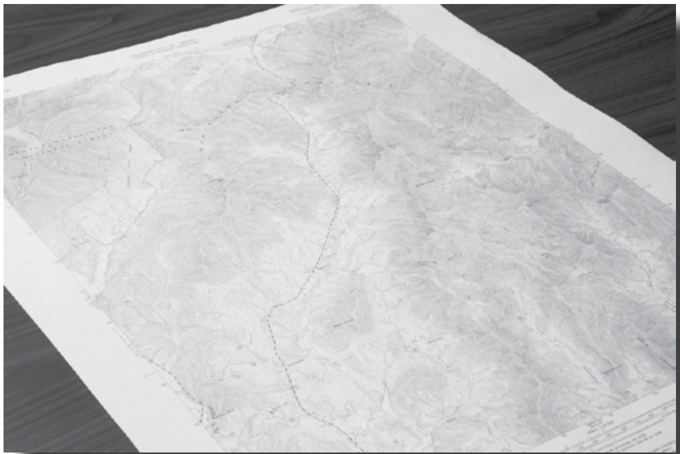
Planning for Forestry Operations

Planning for Forestry Operations

Any forest management activity, regardless of potential impact on water quality, should be thoroughly planned. Whether the activity involves timber harvesting, site preparation and reforestation, chemical treatments, timber stand improvement or fire management, the planning process should consider the objectives of the proposed activity and potential impacts of all actions that disturb the soil surface or impact water quality. Planning should help identify sensitive areas and applicable BMPs to be used during timber sales, forest management activities, road construction, stream crossings, harvesting, site preparation, reforestation, fire management and silvicultural chemical applications. Planning should also identify terms and conditions of a written contract for any forestry practice. While BMPs do not specifically require written plans, it is generally a sound practice to maintain written records of any forest management activity on the land.

Plans should consider:

1. History of the site, including previous land use;
2. Sensitive areas, such as perennial and intermittent streams, lakes, ponds, wetlands, sinkholes, steep slopes, highly-erosive or hydric soil types, and active gully systems;
3. Regulations and/or permitting requirements, and
4. Location, type, timing and logistics of each activity.



Useful resources for planning forestry operations include U.S. Geological Survey (USGS) topographic maps, Natural Resource Conservation Service (NRCS) county soil survey maps with interpretations, aerial photographs and county tax maps. Additional tools include an area stand map and tract boundary survey map that can reveal tract boundaries and sensitive areas. Because no map is 100 percent accurate, they should be used as a reference to identify potentially sensitive areas that must then be verified and plotted during field reconnaissance to minimize impacts before silvicultural operations begin. Most of these maps, along with aerial photographs, are accessible at Department of Forestry area offices. The NRCS maintains soil maps at local field offices where field personnel are available to assist with map and resource information interpretation.

Water quality protection begins with the ability to recognize watercourses and water bodies. According to the Federal Clean Water Act, "waters of the U.S." include lakes, rivers, perennial and intermittent streams, wetlands, sloughs or natural ponds. Identifying stream types (perennial or intermittent) is important in prescribing the level of protection through the implementation of BMPs listed in this manual. USGS topographic maps and NRCS county soil maps can be used as a reference to help identify stream types. Where available, they should be cross-referenced and field-verified.

Stream Types

Perennial streams flow in a well-defined channel throughout most of the year under normal climatic conditions. Some may dry up during drought periods or due to excessive upstream use. They are usually identified as solid blue lines on USGS topographic maps and as either solid black or black lines separated by one dot on NRCS soil maps. Aquatic organisms are normally present and easily found in these streams.

Intermittent streams flow in a well-defined channel during wet seasons of the year but not for the entire year. They generally exhibit signs of water velocity (scouring) sufficient to move soil material, litter and fine debris. They are usually identified as blue lines separated by three dots on USGS topographic maps and as black lines separated by two or more dots on NRCS soil maps. Aquatic organisms often are difficult to find or not present at all in these streams.

The landowner or manager may be familiar with a stream's flow characteristics and make the determination of stream type. In some cases, there may be uncertainty. In such situations, a qualified professional forester or other resource professional should be consulted.

Other Sensitive Areas

Some water bodies and upland areas have particular characteristics or regulatory requirements that require different management approaches. These include, but are not limited to, mountain trout streams, protected river corridors, water supply reservoirs/watersheds, cave entrances, ditches, canals, sloughs, wetlands, braided streams and gullied areas. In such situations, a qualified professional should be consulted. Forest health issues, such as fire management, integrated pest management and disease control, may also require a qualified professional to prescribe appropriate actions. Forest managers, landowners, foresters, timber buyers, logging contractors, site preparation contractors and reforestation contractors should clearly identify water bodies, sensitive areas and streamside management zones (SMZs) in the field and then decide which BMPs to apply and when and where to apply them to better design access roads, log decks and stream crossings. They should supervise these operations to ensure that BMPs are followed where necessary so that water quality is not compromised.

Benefits of Planning

The benefits of a well-written plan and/or written contract include better communications of expectations between the landowner and forestry professionals; maximum return from the harvest; potential long-term benefits in site productivity; better infrastructure; economic efficiency; minimal environmental impacts; compliance with federal, state and local laws; avoidance of fines or penalties, and enhancement of habitat for wildlife diversity. For information regarding sample contracts and management planning, contact the Virginia Department of Forestry. Planning for the protection of water quality just makes good sense.

Special Management Areas

Braided Streams – Streams that have multiple channels. Treat each channel individually, depending on whether the stream is perennial or intermittent. These unique and unstable streams require site-specific management planning and recommendations. Check with a qualified professional forester for management assistance.

Canals and Ditches – Provide minor drainage to **temporarily** lower the water level on a wetland site during road construction, timber harvesting and site preparation and is considered normal and exempt from Section 404 permitting if it does not result in the immediate or gradual conversion of a wetland to an upland or other land use. Minor drainage does not include the construction of a canal, dike or any other structure that continuously drains or significantly alters a wetland or other water body. If the ditches could potentially move sediment or other pollutants into the natural stream system and/or off-site, appropriate water protection techniques and devices should be used. Ditches should not empty directly into streams. New drainage ditches should not be located within the SMZ.

Gullies – Many old erosion gullies have healed and are not actively eroding. Care should be taken not to reactivate gully erosion. If the silvicultural activity leads to reactivation of flow, then the gullies may require stabilization.

Lakes, Ponds and Other Bodies of Flowing Water – Follow the BMPs recommended for perennial streams.

Seeps and Springs – Check with a local professional forester when seeps and springs are present to determine appropriate SMZ recommendations.

Sinkhole – A geologic feature typically found in karst geology, it usually provides a direct connection between land surface and groundwater. Cave entrances where active streams are present should be protected by an SMZ.

Slough – Sometimes referred to as an oxbow, treat as a perennial or intermittent stream if it could potentially move sediment or other pollutants off-site.

Water Supply Reservoir/Watershed – Requires wider buffer areas. Please refer to Table 1 for buffer width requirements.

Table 1 Streamside Management Zone (SMZ) Width			
Percent Slope of Adjacent Lands (%)	SMZ Width Per Side (ft.)		
	Warm Water Fisheries (all other waters including wetlands)	Cold Water Fisheries (Trout)	Municipal Water Supplies (Streams or Lakes)
0 - 10	50	66	100
11 - 20	50	75	150
21 - 45	50	100	150
46 +	50	125	200

Wetlands – For regulatory purposes, wetlands are defined by the presence or absence of specific plant communities, hydric soils and hydrologic conditions. Because of the generally wet soil conditions associated with forested wetlands, these areas are extremely sensitive to forestry activities. For example, bottomland hardwood sites and other swamps differ from upland forest types because their soils are wet most of the year. They are frequently connected directly to a larger aquatic system; often have overbank flow from nearby stream flooding, and may accumulate sediments and nutrients from upstream erosion and runoff.

To properly manage forested wetlands, plan for regeneration; consider the areas beyond the management boundary, and use special harvesting equipment and techniques to protect water quality. Any stream channels should be identified and protected by utilization of the appropriate SMZ.

For more information on harvesting and site preparation of wetlands, refer to Chapter 9 ("CHAPTER 9" on page 73).

Endangered Species

The Virginia Department of Game and Inland Fisheries, the Virginia Department of Conservation and Recreation – Division of Natural Heritage and the U.S. Fish and Wildlife Service have listings of endangered species and their known locations within Virginia. If you suspect the presence of an endangered species on the property where the silvicultural activity is to occur, consult one or more of these agencies for verification and management considerations. A listing of these agencies can be found in Appendix E ("APPENDIX E" on page 159).

NOTES

CHAPTER 4

Forest Roads

Forest Roads

Best Management Practices for forest roads are designed to provide greater opportunities for safe, efficient and profitable operations. A well-planned and properly-constructed forest road is necessary to effectively protect the forestland and water quality when removing forest products from the harvest site.

Studies have shown that most stream sedimentation that occurs during and after timber harvesting operations is the result of improperly constructed or maintained forest roads, skid trails or landings. Sediment may enter streams from these sources if BMPs are not properly installed to prevent soil erosion.

Well-drained and properly-surfaced forest roads not only prevent erosion but also allow better wet weather harvesting access. Properly constructed and maintained forest roads will save money in the long run by reducing down time and lowering equipment maintenance costs associated with wet weather operations.

Specifications

1. Roads should follow contour as much as possible with grades between two percent and 10 percent. Steep gradients that exceed these grades may be necessary when boundary lines or SMZs require such deviation. In these instances, additional BMP measures may be necessary to mitigate the disturbance. Vary road grades frequently to help reduce road surface erosion.

2. Forest roads should be out-sloped wherever road gradient and soil type will permit. Out-sloping allows surface water to drain off of the road quickly, reducing erosion potential.

3. Use in-sloping or ditch and culvert type of cross-section when constructing a road where road gradients are greater than 15 percent; toward sharp turns, or when constructed on clay and/or slippery soils. In such cases, the use of an under-road culvert positioned at a 30-degree angle to ensure proper inside road drainage is recommended (See Table 2 for spacing guidelines).

Table 2
Suggested Spacing for Cross-Drainage Culverts

Road Grade (%)	Spacing Distance (ft.)
0 - 2	500 - 250
3 - 5	250 - 167
6 - 10	167 - 140
11 - 15	140 - 126
16 - 20	126 - 100
21 +	100

4. Good road drainage can be ensured through the use of properly constructed and spaced water turnouts, such as broad-based dips, rolling dips, culverts and lead-off ditches.

   a. Use broad-based or rolling dips at appropriate intervals to channel water off the road (See Table 3 and 4 for spacing guidelines). The bottom of these structures should be out-sloped at approximately three percent to allow the removal of surface water. (See “APPENDIX A” on page 99.)

   b. Locate and install water turnouts a minimum of 25 feet before stream crossings to disperse runoff water through undisturbed areas of the SMZ.

   c. Use rip-rap or brush at the outlets of drainage structures to reduce water velocities and to avoid channelized flow as needed.

   d. Use water bars when retiring temporary access roads. Water bars should be constructed at an angle of 30 to 45 degrees downslope with open ends to allow the removal of surface water (See Table 5 for spacing guidelines). (See “7 – Water Bars” on page 108.)

5. To help ensure proper road surface drainage, construct roads on the sides of ridges. New roads should not be constructed on the top of ridges where water tends to collect, resulting in poor drainage.

6. Locate new roads above flood plains and out of the lowest part of the terrain where surface water drainage can be difficult, such as the center of dry drainages.

7. Intermittent and perennial streams should be crossed using properly designed and constructed structures installed at right angles to the road. Structures should not impede fish passage or stream flow. (See “Stream-Crossing Design and Construction” on page 39.)

8. Minimize the number of stream crossings and choose stable stream crossing sites.

9. Approaches to stream crossings should be stabilized with gravel, mulch or other suitable material for a minimum distance of 50 feet on each side of the crossing, or to the top of the grade that is contributing sediment to the stream crossing.

Table 3
Suggested Spacing for Rolling Dips

Road Grade (%)	Spacing Distance (ft.)
2 - 5	180
6 - 10	150
11 - 15	135
16 +	120

Table 4
Suggested Spacing for Broad-Based Dips

Road Grade (%)	Spacing Distance (ft.)
2	300
3	235
4	200
5	180
6	165
7	155
8	150
9	145
10	140
12	135

Table 5
Suggested Spacing for Water Bars

Road Grade (%)	Spacing Distance (ft.)
2	250
5	135
10	80
15	60
20	45
30	35

10. Locate access roads outside the SMZ unless no other alternative exists.

11. If access roads have to be located within the SMZ due to right-of-way, boundary line restrictions or other physical features, such as rock outcroppings, additional measures must be taken to prevent erosion and/or water quality degradation. Carefully examine pre-existing roads when they are to be used for timber harvesting as drainage may be difficult.

    a. Locate roads as far as practical from the stream channel and maintain an unbroken organic litter layer on the forest floor in the SMZ.

    b. Roads within the SMZ should be surfaced with gravel, mulch or other suitable material to provide a non-erodible running surface.

    c. Cut-banks and fill-slopes should be stabilized as soon as feasible to a non-erodible condition using vegetation, rock, geotextile material or other suitable material.

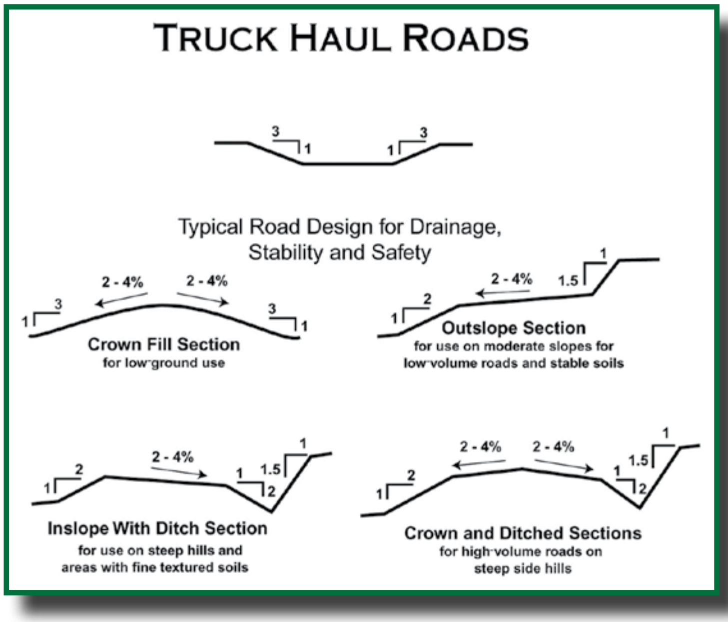
    d. Install a properly constructed silt fence, staked-in straw bales or brush barriers at outlets of drainage structures within the SMZ. (See "APPENDIX A" on page 99.)

12. Roads should be "day-lighted" (shade removed) to aid in drying of the road surface.

13. Make road wide enough to accommodate traffic safely.

14. Minimize cuts and fills as much as possible during design and construction. Properly stabilize slopes exposed by road construction to prevent problems with erosion and runoff. Tall cut-slopes may require back-sloping to achieve stability and successful revegetation. Do not side-cast fill material if there is a chance that it will enter a stream, or if side slope exceeds 60 percent. Full bench construction with end hauling material to a suitable location is recommended when side slopes exceed 60 percent.

15. Restrict traffic on access roads during unfavorable conditions, such as saturated soil. Gravel, wooden mats or a combination of geotextile and gravel may be used to help facilitate operations during wet periods.



16. Skimming or removal of saturated soils from access roads should be avoided.

17. When access roads intersect public highways, use gravel, wooden mats or a combination of geotextile and gravel (or other means) to help keep mud off highway entrances.

18. Maintain road so that water can flow freely from the road surface.

19. Use existing roads where practical unless use of such roads would cause or aggravate an existing erosion problem.

20. Avoid slide-prone areas, which are characterized by steep side slopes with unstable soil.

Maintenance

1. Control access by using a locked gate to prevent unnecessary damage to the road surface.

2. Keep drainage systems open and working during and after logging operations.

3. Inspect the road at regular intervals to detect and correct maintenance problems.

4. When the timber harvest is complete and the road has been stabilized, control of access and road maintenance will be the responsibility of the landowner.

NOTES

CHAPTER 5

Timber Harvesting

Timber Harvesting

Pre-Harvest Planning

Proper planning for timber harvesting is imperative to minimize the potential impact to soil and water quality. Incorporating BMPs into a logging operation while carrying out that operation in the most efficient manner requires planning.

There are two stages of harvest planning: preliminary pre-harvest planning and comprehensive harvest planning. A pre-harvest plan is a fairly simple plan commonly prepared for a forest landowner by a VDOF area forester, forestry consultant or procurement forester prior to conducting a timber sale. The plan will identify recommended streamside management zones as well as potential problem areas, such as fragile soils or steep slopes, that may require special treatment during the harvesting operation.

A comprehensive harvest plan is much more detailed. The plan is usually prepared by the logger or logging manager just prior to beginning the harvesting operation. The logging plan may include recommendations on logging roads, log decks, streamside management zones, stream crossings, skid trails and the schedule of activities. The logger must have the following information at his or her disposal:

1. **Type of cut** (clear-cut, row thinning, individual tree selection, etc.) – This could affect deck size and location, equipment restrictions or job layout.
2. **Terms of the timber sale contract** – For example, the length of time on the contract may dictate the time of year that the tract will be logged, which may impact the haul road construction standards.
3. **Tract topography** – In the mountains, topography will often limit the logger's options for road and deck location. In addition to slope, aspect and exposure should also be considered.
4. **Tract soil conditions** – Soils will affect road and deck location, especially in the Coastal Plain and Piedmont regions. Soils also impact equipment decisions and scheduling of activities.
5. **Tract hydrology** – Knowing how much water to expect in a stream after a big rain will dictate stream crossing structures.

6. **Tract boundaries, easements and rights-of-way** – This information is necessary to locate access points and haul roads and may be the limiting factors on accessibility for the site.

7. **Timber volume** – Timber volume to be removed by species and product, and the distribution of that volume across the tract. This information is vital for determining haul road standards, deck size, deck location and scheduling.

8. **Logging system and equipment spread** – The planner must be intimately familiar with the characteristics of the logging operation, including any equipment limitations or operating constraints. For example, the type of log truck (tandem or tractor/trailer) will impact the haul road layout, acceptable curve radius and landing size.

9. **Applicable laws and regulations** – Laws affecting logging, including but not limited to the current non-regulatory BMPs, Silvicultural Water Quality Law, Chesapeake Bay Preservation Act and Clean Water Act. These could affect all aspects of the harvest plan.

There are several tools available to the harvest planner. Topographic maps, available from the U.S. Geological Survey, are a must in the Piedmont or Mountain regions. Soil survey maps are most important in the coastal plain regions, where soils impact logging operations much more than topography. Soil maps for most counties can be obtained from the Natural Resources Conservation Service. A detailed timber stand map can be of great assistance in planning log deck location and scheduling operations. Many landowners have these on file for their property, prepared by a VDOF area forester, forestry consultant or forest industry representative.

An accurate estimate of slope is necessary to maintain acceptable road grade, determine spacing between required water bars and to comply with various BMP recommendations. Plastic flagging of various colors is an important tool for the logging planner. Boundaries, log deck locations, "back-lines" for skidding zones, streamside management zones and designated skid trails can all be effectively marked and distinguished by flagging or paint of different colors. Plastic flagging, paint and slope-determining instruments can be purchased from any forestry or engineering supply company.

Steps to Prepare a Harvest Plan

The following 14 steps provide a framework for a comprehensive harvest plan:

Step 1 Prior to but no later than three working days after commencement of an operation, the owner or operator shall notify VDOF by on-line website or by calling the toll-free number below.

This is a requirement of the law. Failure to notify can result in a Civil Penalty of $250.00 for a first offense and up to $1,000.00 for subsequent violations.

To notify of a timber harvest, you must obtain a notification identification number from VDOF. This is simply an assigned number that you will use to identify your company when you notify VDOF of timber harvests.

You will be asked for your phone number; when logging will begin; the county where it will occur; the location; the size of the operation, and contact information for the landowner. You will receive a confirmation number when you notify. Retain this confirmation number as proof of notification.

This information will be sent to the appropriate VDOF office.

The VDOF will assist with pre-harvest planning if requested. Pre-harvest planning guidance prior to moving equipment on the tract may lessen the chance of BMP or water quality problems later.

Step 2 Study applicable maps and conduct an on-the-ground reconnaissance of the area to be logged. Note the slope, aspect, soils, timber, streams, wetlands, access, boundaries, old logging roads and "indicator" plants. Document as you proceed. A good method is to carry a large-scale topographic map covered with a sheet of acetate or mylar on a clipboard. Mark important details and locations on the acetate "map." Become familiar with all of the tract characteristics that will impact logging.

Step 3 Identify and mark streamside management zones (SMZs). These are one of the most important and effective ways to reduce stream sedimentation in a harvested area, and should be implemented on all perennial and intermittent streams. (See "Streamside Management Zones" on page 35.)

Step 4 Locate and flag log decks. These are critical decisions that will directly affect production. Log deck location is a trade-off between skidding distance and haul road construction. A log deck should be on a slightly sloped area (to facilitate drainage) with stable soils that do not easily rut.

Step 5 Locate and mark logging road stream crossings. Generally the best rule regarding stream crossings is not to have any if at all possible. They can be expensive and a potential source of major environmental and water quality problems. However, if it is determined that a stream crossing is necessary, choosing the proper location is critical. Look at the stream width; water depth; stability of the stream bottom and banks; the approaching topography and soils, and the normal high-water mark. Choose a location that will minimize the chance of stream sedimentation arising from logging and hauling operations. As much as possible, locate log roads and skid trails outside the SMZ.

Step 6 Locate and mark logging road entrance points from public roads. The law requires that a truck driver pulling onto the highway from a temporary log road be able to see clearly in either direction for a minimum of 200 feet. Contact your local VDOT office for specific concerns regarding your tract and any entrance permit requirements

Step 7 Locate any other logging road "control" points. These are points or locations that the logging road must either connect or avoid. Entrance points, stream crossing locations and the log deck locations are all "positive" control points for the haul road network. Examples of "negative" control points are rock outcrops or gumbo clay flats – areas through which the haul road cannot pass.

Step 8 Locate and flag the logging road gradeline (in the mountains) or centerline (in the coastal plain). A good procedure is to first attempt to plot the gradeline on a topo map, connecting the positive control points while keeping the road at an acceptable grade (recommend maximum 15 percent grade for no more than 200 feet at a time). Ideally, the grade should be kept at 10 percent or less. Locating a centerline on relatively flat coastal plain terrain is usually somewhat easier. Soils are often the main consideration. Try to locate the haul road on well-drained, stable soils with good load-bearing capacity, such as clay or sandy clay loams with a solid base.

Step 9 Locate and flag designated skid trails, if necessary. In general, "bladed" designated skid trails should be avoided if at all possible as they greatly increase environmental impact through erosion and stream sedimentation.

Step 10 Specify logging road construction standards. There are generally three logging road standards:

1. The most common is a "branch" logging road. It is designed as a temporary road that will be "retired" immediately after logging is completed. A branch road is usually not much more than a 10- to 12-foot-wide trail where the surface organic material has been graded off. There is no surfacing, and drainage is handled through a few well-placed water turnouts or broad-based dips.

2. A "primary" logging or forest road is designed for permanent, all-weather use. It has a 20-foot-wide subsurface, permanent ditches, cross-culverts, stabilized banks and occasional crushed rock surfacing. A primary road is expensive and can be justified only on very large timber sales where the road will be used for several years.

3. A "secondary" logging road has a narrower subsurface than a primary road, with water control devices installed, but without surfacing. It is designed for all-weather use, and is a good choice for extended logging jobs that must operate year 'round.

Consider the use and availability of temporary road stabilizing or surfacing options, such as crushed rock, geotextiles or mats (wooden, metal or rubber). These are best applied at potential "trouble spots" **before** a problem occurs.

Step 11 Specify stream crossing structures. The common choices, from least to most expensive, are: a ford; a culvert with dirt fill; a "low-water" bridge, and an elevated timber bridge. The "best" choice depends upon the cost, the stream characteristics, the amount of use anticipated, the load-bearing requirements, the area of forestland drained by the stream, the previous "high-water" mark, the time of year the structure will be used and the environmental impact.

A proper stream crossing structure will minimize any disruption to the normal stream flow and pattern. Type and method of harvesting may influence culvert size. Refer to the section on stream crossings in this chapter for more details.

Step 12 Determine the schedule of operations and harvest patterns. The most efficient schedule of operations depends on tract topography, time of year, current and anticipated weather conditions, road construction requirements, cash flow and other outside factors. Equipment maintenance, safety meetings and planned holidays or mill shutdowns should be included in scheduling. Scheduling should be constantly refined and updated as the operation progresses.

Step 13 Specify tract "close-down" requirements. These primarily involve the implementation of BMPs that will minimize erosion and stream sedimentation on the tract in the period after harvesting has been completed. They include re-grading ruts; installing water bars on abandoned roads or designated skid trails; reseeding landings and roads; removing any temporary stream crossing structures; scattering brush; opening ditches or water turnouts, and any clean-up necessary to leave the tract in acceptable condition. Close and gate roads to unauthorized traffic.

Many of these operations can be scheduled during "slow" times as harvesting is completed on various parts of the tract, thereby avoiding a massive job at the end. It is important to make the landowner aware of his responsibility to maintain the tract in the environmentally-sound condition in which it is left after logging is completed and BMP compliance recorded.

Step 14 Determine if permits are required and obtain them. The Virginia Marine Resources Commission has regulatory control over most of the stream bottoms of Virginia. Through mutual agreement between the Virginia Marine Resources Commission and the Virginia Department of Forestry, any stream crossing that has more than a five-square-mile watershed drainage area above the crossing will require a permit from the Virginia Marine Resources Commission. The permit application can be obtained from the Virginia Marine Resources Commission. (See "APPENDIX E" on page 159.) Any crossing on streams below the five-square-mile watershed threshold will have to adhere to the Best Management Practices for stream crossings as outlined in this manual.

Logging Systems for Effective BMP Implementation

A logging system is the combination of equipment and personnel used to harvest timber. Logging systems can be described in detail by all of the functions used to develop the harvest (felling, yarding, processing and loading).

For this general discussion on BMP implementation, logging systems will refer only to the primary method used to move the tree from the stump to the landing.

Logging systems, or tools to harvest timber, have evolved to be responsive to different harvesting conditions. As harvesting conditions change, so have the tools to harvest timber. Today, this evolution in logging systems results in a wide variety of specialized harvesting tools, each designed to effectively harvest timber in particular conditions. As public acceptability of harvesting's adverse environmental impacts has decreased, logging systems have evolved to decrease these impacts.

As the utilization of the timber resource has pushed harvesting on increasingly difficult sites, logging systems have evolved to be effective in challenging timber and terrain. This evolution has resulted in a logging system toolbox, each tool being suited to a particular set of conditions. Proper application of logging systems means applying the tools to the set of conditions for which it was designed. Proper application of a logging system can result in both cost effectiveness and minimal adverse impact to the forest environment.

Improper application of a logging system usually results in increased harvesting costs and/or undesirable environmental impacts. Effective BMP implementation to mitigate harvesting impacts is dependent on the proper logging system application. The environmental impacts of improper logging system applications cannot usually be cost-effectively mitigated through BMP implementation, particularly on more challenging timber and terrain.

As a simple example, larger skidders were developed to skid larger timber. Small skidders and large skidders could represent two logging systems. When a large skidder is applied to a small timber tract, the result is increased costs as well as the potential for increased damage to the residual timber. Increased costs come through payloads lower than capacity (too many trees needed to get payload) and increased damage potential (choking stems) because of the reduced maneuverability of the larger skidder. Proper selection and application of a logging system, such as skidder size in this example, is key to minimizing harvesting costs as well as environmental impacts.

Logging System Descriptions

These are examples of some of the basic harvesting systems used today:

1. **Animal** – Horses or mules to pull logs or carts suspending logs. Animal weight, number of animals and species of animal vary to provide different skidding capacities.

2. **Tracks** – Use of track-laying tractors to pull logs or arches suspending logs. Tracks may be hard, as in dozers with rails, or soft, as in KMC skidders with torsion bar suspension. Tracked systems may have winches, grapples or swing-boom grapples. Track length, width and grouser patterns vary for differing weight and horsepower classes.

3. **Skidder** – Use of rubber-tired articulated tractors with integral arch to pull logs. Skidders may have winches, grapples, both or swing-boom grapples. Tire width and grouser pattern can vary for differing weight and horsepower classes.

4. **Shovel** – Use of hydraulic excavator-based loader/shovel to bail logs. Reach, track length, width and grouser patterns vary for differing weight and horsepower classes and may be combined with processing heads, grapples, grapple saws, felling heads, excavation buckets, live or dead heels and quick connections to transform into a multi-function machine.

5. **Forwarders** – Use of rubber-tired tractors equipped with log bunks and loader to transport logs free of the ground. The number of axles, tires, weight capacity and loader size vary for differing weight and horsepower classes.

6. **Cable** – Use of a cable yarder and carriage to yard logs, either with one end suspended or completely suspended by wire rope. A yarder is logging equipment combining winch drum and steel spars or towers. Cable yarders may be mounted on tracks, truck, trailer or sled. Tower height, number of winches, line size and line length vary by horsepower and weight class. A carriage is the device that moves in and out from the yarder to the timber and accommodates chokers or a grapple for hooking logs. Carriage characteristics are non-slack pulling or manual, mechanical, motorized slack pulling, radio, cycle or mechanically controlled, single or multiple span.

7. **Helicopter** – Use of helicopters to vertically lift timber from the stump and fly fully suspended to the landing. Helicopters used in logging have different lifting capacities.

Logging System Selection

The proper selection of a logging system involves consideration of many different conditions, such as slope, terrain shape, yarding distance, weather, soils, tree size, volume per acre, size of tract, cost of road construction, cost of logging and productivity goals. Table 6 lists the logging systems and the various characteristics of each system's niche. The niche, or place, for a logging system is the application where the harvesting costs and the environmental impacts are minimal when compared to other logging systems.

Table 6
Logging System Application

Logging System	Weather Sensitivity	Terrain Slope (%)	External Yarding Distance	Average Tree Size	Volume Per Acre	Volume Per Tract	Cost of Road	Terrain Shape & Length
Animal	Moderate	< 20	< 500 ft.	Small	Low	Small	Low	Flat Short
Tracks	Moderate	< 40	< 800 ft.	Large	Common	Small	Low	Moderate Short
Skidder	High	< 35	< 1,500 ft.	Medium	Common	Medium	Medium	Flat + Common
Shovel	Low	< 45	< 400 ft.	Medium	Common + Clear Cut	Small	Low	Moderate Broken
Forwarder	High	< 30	< 2,500 ft.	Medium	Low	Large	High	Gentle Long
Cable	Low	Any	< 1,500 ft.	Medium	Common +	Medium	High	Steep Concave Long
Helicopter	Low	Any	< 6,000 ft.	Large	High Sawtimber	Large	High	Any

Logging System Application

Animal – Using animals to skid timber is best applied in flat terrain, close to existing roads and in a publicly sensitive location. The sensitivity may be a recreation site, trail, road or residential viewshed. The system is limited by the weight of the animals and their ability to exert pull, and, in general, can be used in up to 20-inch timber on favorable slopes. Because of the low productivity and low move costs, small tracts can be harvested economically.

Tracks – Tracks are best used where short, steeper slopes prohibit overland rubber-tired skidding. Because of the slower travel speeds, yarding distance is limited and roads should be either existing or inexpensive to construct. Soft tracks, or high-speed torsion bar suspended tracks, can extend the efficient skidding distance and operate on somewhat steeper slopes than traditional hard tracks. Swing-boom grapple-tracked machines can be effective in larger timber on steeper slopes at short distances. These can be used on wetter sites or in moderately inclement weather.

Skidder – Rubber-tired skidders have application in the broadest range of logging conditions of any logging system. This is why skidders are the conventional logging system in Virginia. Skidders are a flat-ground system, but with winches can be effectively used on flat to moderate slopes. Skidding is the default logging system selection except when: 1) logging is necessary in inclement weather; 2) skidding distances are longer than 1,500 feet due to the cost of road construction, or 3) a dozed road is necessary for the skidder because slope is excessive. Under these conditions, other logging systems should be considered. Tire widths can be increased to operate over land on steeper slopes and on wetter sites.

Shovel – Shovel logging is limited to clear-cutting when it is necessary to pick up and swing the timber toward the road (bail). Shovels can work in adverse weather, in wet areas and on steeper slopes because they are not dependent on tractive effort to move the timber. Shovels are best applied in common + timber volumes clear-cut per acre; logging in adverse weather, or on steeper slopes where yarding distance is generally less than 400 feet and roads are either existing or inexpensive to build due to the shorter yarding distance.

Forwarder – Forwarders are best applied where longer yarding distances in fairly gentle terrain is needed to avoid expensive truck road construction, or where the volume to be harvested per acre is low and does not justify truck road construction. Scattered pieces can be picked up and forwarded. It is suited to larger tracts with existing trails that can be used as is without the need for truck road construction and for yard distances of 1,500 feet up to 2,500 feet.

Cable – Cable logging systems are best applied where, due to excessive slope, ground-based systems require excavated skid roads to operate; when harvesting in adverse weather is necessary, or where compaction due to ground-based systems is unacceptable. Logging uphill up to 1,500 feet is most efficient, however downhill and cross-canyon cable systems can also be used effectively. Terrain features control the landing, cable corridor pattern and the acres that can be harvested from a setting. Because there must be a sufficient volume of timber on each setting to make it economically efficient, higher-than-common timber volumes and value are generally needed.

Helicopter – Helicopter logging is best applied when road costs are high; large volumes must be moved in a short period (salvage or keep the mill running); sawtimber only is planned for harvest; harvest in adverse weather is needed, or when the landowner's objective is to minimize the environmental impacts of harvesting. This harvesting option, due to the expense, should be considered when other options are unsatisfactory. Maximum flight distances should be less than 6,000 feet to maintain an average of 2,500 feet or less per turn. Flight paths can be uphill or downhill but are limited by powerlines, roads, houses and other improvements. Maximum log size is limited by the lift capacity of the helicopter used. Helicopter logging will stop when visual contact between the pilot and ground crew cannot be maintained (fog); when the wind is >30 mph, or when icing conditions (jet intake 30°F to 34°F) are present. Due to the high productivity, 80 million to 100 million board feet per day, extensive landing and trucking support is required.

Swing System – Swing systems are combinations of logging systems to move the timber from stump to a full-service landing. They may or may not involve a swing landing, which is a concentration point between the logging systems employed. The combination of logging systems allows each system to operate in the terrain on which it is most efficient. For example, since tracks can operate on steeper slopes than skidders, yet are limited in the distance to which they can pull, combining tracks with grapple skidders allows for logging on steeper slopes at greater distance than either tracks or skidders alone. If the distance is even greater, combining tracks with a forwarder would be efficient. Another good option for steeper slopes at longer distances is a shovel-skidder swing; however, it is applicable only to clear-cutting operations.

Table 7
Swing System Application

Swing System	Application
Tracks to Skidder	Short, Steep Slopes to Flat Ridge or Flat Bottom
Shovel to Skidder	Short, Steeper Slopes to Flat Ridge or Flat Bottom
Skidder to Forwarder	Moderately Steep Slopes to Long Flat Ridge or Bottom
Skidder to Cable	Flat Slopes/Bottom to Steep Slopes (up a cliff, across a river)
Cable to Skidder	Steep Slope to Moderately Steep Ridge

Logging System Planning

The successful implementation of any specialized logging system is dependent upon successful planning. With a specialized logging system, it is possible to do a more efficient job under particular conditions. The key to logging planning is to keep the specialized logging system working in its particular niche. If the logging system is applied in conditions for which it is not suited, harvesting costs and adverse environmental impacts will likely be high. An example is the application of mechanical felling. It is well known that mechanical felling is safer, more productive and less expensive than manual felling; however, there are certain slope and tree size limitations to mechanical felling equipment. As an example: a logger buys a mechanized feller but can use it only 50 percent of the time because the tracts are too steep or the timber too large. The costs are effectively doubled because the risk of accident is high and productivity suffers when the machine is pushed on slopes beyond its effective working range to increase utilization. As a rule, mechanical felling is better than manual felling – in its niche.

Keeping the specialized tool in its niche is what logging planning is all about – knowing well ahead of the scheduled harvest what logging system is needed and if there is enough timber to keep it utilized. Logging plans are done at different scales, to serve different purposes, and are typically referred to as **strategic** and **tactical** logging plans.

Strategic Logging Plans – These involve large areas on numerous tracts and are based heavily on topographic maps with field work verifying only critical items. A paper logging plan is designed, showing landing locations, road locations, logging systems and yarding patterns. This paper plan is then reviewed in the woods to verify questionable locations, such as access points and major road locations, and is adjusted accordingly. In this fashion, different logging systems can be evaluated for their environmental impacts and cost of harvesting. An example of such evaluations is comparing the conventional cable skidder to cable logging on steep ground. The results of this comparison might reveal that the impacts and costs of building extensive skid road networks for the skidder would create more impacts and cost more than cable logging. Additionally, the capacity of the cable system would be identified, such as how much uphill, sidehill and downhill yarding is required. How far will the cable system need to yard? On what type carrier should the yarder be to negotiate the landing settings? What size lines should the yarder run, and how tall a tower is needed? Following strategic logging planning that represents the variety of timber and terrain being harvested, patterns develop and lead to logging system equipment selection.

Tactical Logging Plans – These involve specific tracts with specific logging systems and are field verified to the extent that the plan can be implemented as designed with acceptable environmental impacts, and within the harvesting cost budgeted for the tract. This is the plan that the selected logging contractor can take to the woods, with his or her particular equipment, and build the roads where shown and log with the patterns shown, at the cost that has been planned. Having an accurate logging plan enables the contractor to schedule the work efficiently and avoid unknown surprises. As logging system specialization occurs, tracts will need to be subdivided for the logging contractor who has the system to fit the timber and the terrain. This could mean, for example, reserving a strip of selective harvest along a residential development for a horse-logging contractor (or small selective-cut contractor), while the remainder of the tract is reserved for a fully mechanized, high-production, clear-cutting contractor. In the mountains, it will mean separating the tract between the specialized cable logger from a conventional skidder logger. **By tactically identifying each logging system's niche and planning to fit the specialized system to the timber and terrain, a reduction in both the harvesting costs and environmental impacts can be achieved.**

Conclusion

Effective BMP implementation for timber harvesting operations needs to consider appropriate logging systems selection and logging plans. The utilization of specialized logging systems can result in lower costs and lower environmental impacts when compared to a one-size-fits-all harvesting operation. Logging planning is essential to the successful implementation of specialized logging systems and the effective implementation of BMPs.

Streamside Management Zones

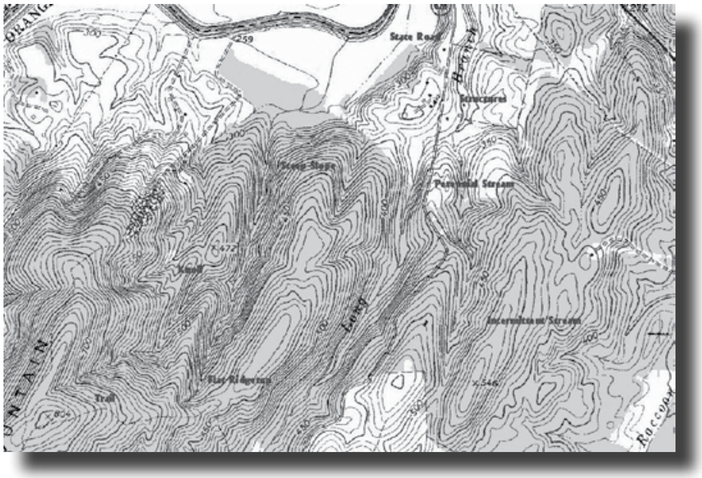
Streamside Management Zones (SMZs) are areas adjacent to streams that protect water quality. They may have other names, such as riparian areas or buffer strips. Whatever the name, these areas are extremely important to the protection of water quality. An effective SMZ will filter sediment and nutrients; maintain desirable water temperatures, and provide many of the essential requirements of forest stream ecosystems.

On all harvest operations that take place in Tidewater Virginia, all necessary forestry BMPs must be implemented properly according to the Chesapeake Bay Preservation Act. The SMZ is one such BMP and must be left according to the specifications in this section. If a proper SMZ is not left, it is considered a violation of the Chesapeake Bay Preservation Act. The enforcement procedure is outlined in Chapter 10.

The first step in delineating SMZs is to identify the perennial and intermittent streams on the property. Other significant waters, such as lakes, ponds, natural springs and municipal water supplies, will also merit an SMZ. A perennial stream is one that holds water throughout the year except during periods of extreme drought. An intermittent stream is one that holds water during seasonally wet times of the year.

A 1:24,000 USGS topographic map is a good starting point for identifying the major perennial and intermittent streams. Perennial streams are designated as a solid blue line. Intermittent streams are shown with a dotted blue line. It must be remembered that many intermittent streams that are not shown on the topographic map merit an SMZ. Identifying characteristics of an intermittent stream include a defined channel, evidence of streambed scouring and bare soil or rock showing on the streambed bottom.

It is recommended that all SMZs be a minimum of 50 feet in width, measured from the top of the stream bank. This 50-foot SMZ is a managed forest; within this managed area, up to 50 percent of the basal area or up to 50 percent of the forest canopy can be harvested.

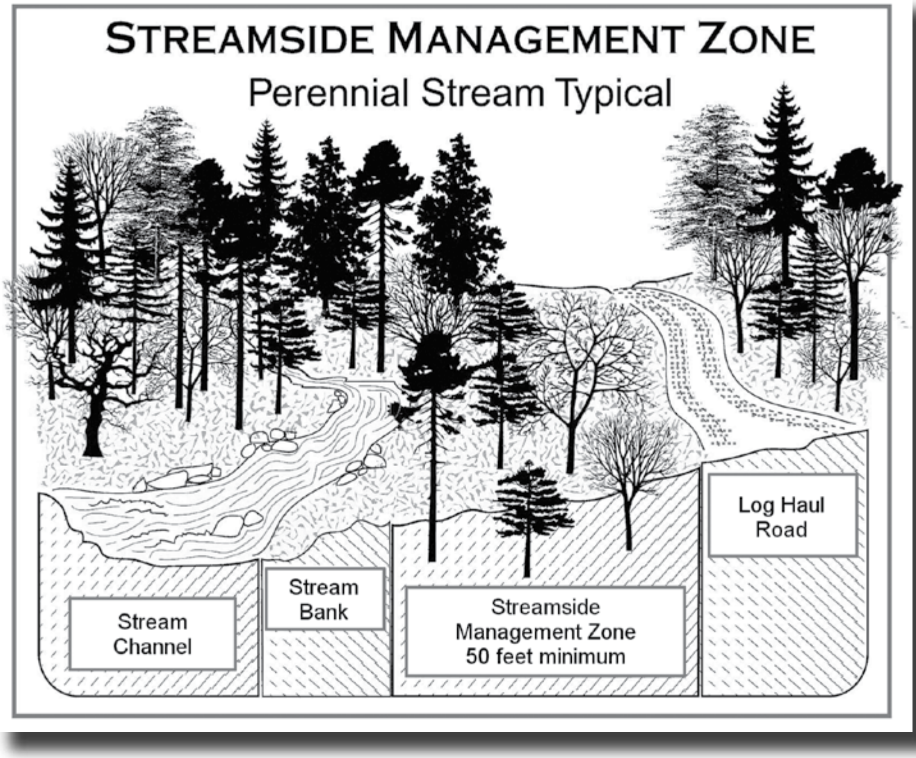


Tidal streams are unique in that they often encompass wide areas of adjacent grasslands. For the purposes of establishing SMZ width, measure from the edge of the grassland/woodland area.

Some streams in Virginia flow into caves in areas where karst geology exists. It is important to treat these cave entrances with an appropriate 50-foot SMZ.

The photo to the right shows a proper SMZ. Please notice the continuity of the SMZ up and down the stream channel. Partial clear-cutting of the SMZ should be avoided. It is not desirable to have large fluctuations in SMZ width in an attempt to reach the average of the desired width.

Harvesting within the SMZ should minimize disturbance. The forest floor should remain essentially undisturbed. Manual felling, directional felling and mechanized felling can be effectively used providing minimal disturbance of the forest floor results. Drainage structures, such as ditches, water bars, broad-based dips and culverts, should be used on skid trails and haul roads prior to entrance to the SMZ. Locate all decks and sawmill sites outside the SMZ. On tracts where this is not possible, additional practices may be necessary to protect water quality.



Steep slopes, cold-water fisheries and municipal water supplies all need wide SMZs to protect water quality. Table 8 lists the widths for streamside management zones for streams in conjunction with different stream types.

Table 8 Streamside Management Zones (SMZs)			
Percent Slope of Adjacent Lands (%)	SMZ Width (ft.)		
	Warm Water Fisheries (all other waters including wetlands)	Cold Water Fisheries (Trout)	Municipal Water Supplies (Streams or Lakes)
0 - 10	50	66	100
11 - 20	50	75	150
21 - 45	50	100	150
46 +	50	120	200

SMZs for Trout

It should be noted in the previous table that cold water fisheries (trout) require a wider SMZ than warm water fisheries. A wider SMZ is more effective at reducing sedimentation; maintaining lower water temperatures through shading, and introducing food, such as leaves and insects, into the food chain. Ninety percent of the food in forested streams comes from bordering vegetation.

Wild trout populations require cold, well-oxygenated water, a clean stream bottom and good fish cover. An overhead cover, such as undercut banks, large rocks or submerged logs, is required. When such cover is removed, the trout leave. Lack of suitable cover limits the number of large trout a stream can support. In Virginia, most trout habitat losses occur through increased stream temperature, siltation and stream channel alteration.

Water temperature may be the most critical factor facing Virginia's trout populations. Most shaded mountain streams do not exceed 70°F during the summer, which is suitable for trout. Aquatic habitat and suitable water temperature can be maintained even during logging operations when streamside vegetation is left intact. In most cases, maximum stream temperatures in the low 70s are within the tolerable range for trout, but such temperatures improve the habitat for other stream fishes against which trout cannot compete.

Silted stream bottoms decrease the stream's insect population, an important source of food for trout. Siltation also makes trout reproduction difficult. Trout lay eggs in stream gravel and clean gravel is necessary to ensure movement of oxygenated water over the eggs. As little as a quarter-inch of silt over trout eggs can result in 100 percent mortality.

The Department of Game and Inland Fisheries' trout stream inventory identifies more than 2,300 miles of wild trout streams in Virginia. Biologists are encouraged to find that brook trout – the only trout species native to Virginia – still account for 80 percent of the wild trout resource in the state.

Salvage and Sanitation in the SMZ

The necessity to remove and utilize forest products that have been damaged by insects, disease or other factors is important to the health of adjacent timberlands. Factors that need to be considered for salvage and sanitation within the SMZ are: 1) potential threat to neighboring forest resources, and 2) alternatives for insect and disease control strategies that may be more economical with less potential for site damage.

It is important to weigh all factors related to the salvage and sanitation operation and to minimize the potential impact to water quality when operating within the SMZ. This can be accomplished by:

1. Locating haul roads and skid trails outside the SMZ.
2. Harvesting of areas adjacent to the SMZ to remove potential brood trees, susceptible species, low-vigor trees and high-quality stems at or near maturity.
3. Removal of harvested timber in the SMZ should be done so that the forest floor remains virtually undisturbed. If disturbance does occur, a permanent vegetative cover should be established on exposed soil within the SMZ.
4. Equipment should not be operated in or adjacent to the SMZ for salvage and sanitation purposes when soils are saturated.
5. When more than 50 percent of the basal area is removed, evaluate the density of the understory and importance of stream temperature to determine the need for revegetation or reforestation.
6. Small spots of damage – less than one acre – may be completely harvested.

When a salvage/sanitation harvest within the SMZ occurs within an area of the state that falls within the guidance of The Chesapeake Bay Preservation Act (CBPA), notify the locality and the local contact for Virginia Department of Conservation and Recreation Division of Chesapeake Bay Local Assistance of the intent to harvest a portion of the SMZ. The reason should be documented as salvage/sanitation for forest health.

Debris in Streams

Significant logging debris should be kept out of streams. Logging debris can change the flow of water and cause stream bank erosion. A large amount of green logging debris in a stream can cause oxygen depletion and kill fish. Trash, logging debris, tree limbs or tops cannot block the passage of fish or boats. The Department of Forestry has been given the responsibility for enforcement of the Debris in Streams Law, Section 62.1-194.2, *Code of Virginia*. A copy of this regulation may be found in Chapter 10.

Stream-Crossing Design and Construction

Stream crossings are the point at which the haul road or skid trail intersects a stream channel. The manner and construction of a road or skid trail crossing a stream is extremely important and is where most logging water quality problems occur. Stream crossings have the potential to adversely affect water quality by exposing soil at or near a stream channel. Stream crossings should be avoided whenever possible through proper pre-harvest planning. Permits may be required from the Virginia Marine Resources Commission, local government and/or the Army Corps of Engineers for permanent culvert installations.

If a stream crossing is necessary through pre-harvest planning, one must consider three basic types of crossings: bridges, culverts and fords.

Temporary Bridges

Bridges are the preferred method of crossing streams because they require little or no in-stream work to install. They typically require less time to install and can be used many times, making them more cost-effective than culverts. Furthermore, bridges have less effect on fisheries than other stream-crossing methods. Pole bridges may also be used for temporary crossings under certain conditions. **Any bridge installed for use by the general public for public transport should be designed by a licensed civil engineer.**

Temporary Bridge Specifications

1. Temporary bridges should be installed at right angles to the stream.

2. Bridges should be of sufficient length to maintain at least five feet of bridge/ground contact on each side of the stream (this will vary depending on bridge design).

3. Mud sills consisting of rough sawn hardwood beams 16 inches wide, three inches thick and 16 feet long can be used to provide additional load-bearing capacity in soft soil conditions.

4. As with culverts, the approaches should be stable. Stabilize approaches with rock (in the case of haul roads), brush, corduroy with poles (in the case of skid trails) or other non-erodible surface extending at least 50 feet from both sides of the stream edge. Ideally, the non-erodible surface would extend to the top of the hill on each side of the stream approach.

5. Bridge approaches should be straight to limit safety hazards and prevent logs, soil and other debris from being deposited into the stream by the sliding movement of logs over the edge of the bridge. As with temporary culverts, remove temporary bridges when logging is completed. Stabilize approaches and stream edges by installing the appropriate number of water control structures, and establish vegetation to prevent soil delivery to stream. The use of tree tops, limbs and debris incorporated into the skid trail during use is an excellent soil stabilizer.

Prompt stabilization after removal of the bridge will be most critical to the protection of water quality.

Pole Bridges

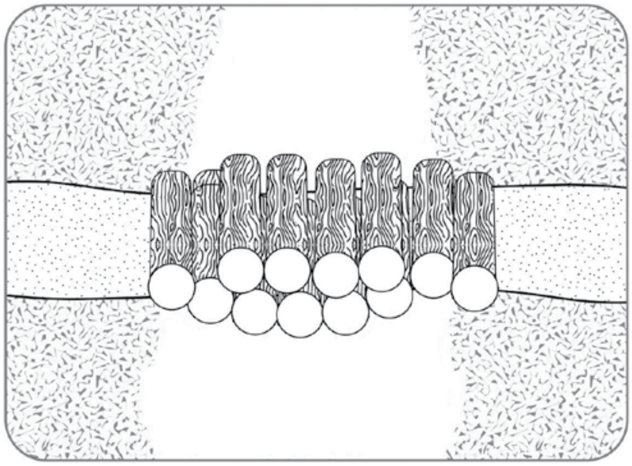
Pole bridges may be used when crossing a stream channel where no water is present. Pole bridges are wood logs of no less than 10 inches in diameter packed in a stream channel creating a solid foundation on which to skid. This structure may incorporate the use of heavy gauge steel pipe (no specific diameter requirement) with the logs to allow for short periods of flow should it rain. Pole bridges should not be used on channels greater in width or depth than the diameter of the skidder tire.

Pole bridges can be used in dry, intermittent stream channels for a short period of time. Pole bridges should be removed immediately following their use.

Pole Bridge Specifications

1. Pole bridges should be packed sufficiently so as not to allow the skidder to dip below the streambank edge and cause erosion.
2. A heavy-gauge steel pipe incorporated in the channel with the logs will help in the event an unforeseen rainfall event occurs while the structure is in place.
3. Pole bridges should not have any dirt or debris associated with the logs. Pole bridges must be removed following logging. As with temporary culverts, pole bridges are considered a water quality problem if not removed.
4. Stabilize the approaches to the pole bridge location following logging with the appropriate number and type of water control structures and establish rooted vegetation.

POLE BRIDGE



Culverts

Culverts may be either temporary or permanent installations. Temporary culverts are those that are installed and used for less than 30 consecutive months. Culvert sizing will increase if the culvert is considered a permanent installation. Permanent installations are those remaining following logging at the request of the timber buyer or landowner (proper permitting may be required). The purpose and duration of time for a culvert's use are determining factors in selection of culvert diameter. If circumstances dictate that a culvert sized with the intention of being temporary will in fact remain as a permanent structure, the culvert should be replaced with a culvert sized to permanent specifications. Since culvert replacement and size upgrade is expensive, it is important that the logger and landowner are clear on the long-term use of forest roads, stream crossings and culverts.

Most culvert installations for harvesting purposes are considered temporary and must be removed. A reduced-sized culvert is permitted for temporary culverts.

Temporary Culvert Specifications

Table 9 lists culvert diameters for temporary culvert sizes and is intended to be used as a guide. **No guarantees are given or implied by the use of this table. The Virginia Department of Forestry retains no liability for the failure of pipes.**

- Drainage basins larger than five square miles require a permit from the Virginia Marine Resources Commission.
- Based on N.R.C.S. TR-55 Method, modified for a two-year frequency storm event.
- Assumes B soils; a CN = 55, and sheet and shallow concentrated flows only for averages of four watersheds for each physiographic region of the state.
- Coastal Plain: Areas East of Interstate 95.
- Piedmont: Areas East of Route 29 and West of Interstate 95.
- Mountains: Areas West of Route 29.
- Calculations for specific situations will provide a more accurate culvert size.

Table 9
Temporary Culvert Sizing (2-Year Event)

Culvert Size (in.)	Watershed (acres)		
	Coastal	Piedmont	Mountains
15	Up to 65	Up to 35	Up to 15
18	65 - 90	35 - 65	15 - 25
24	90 - 200	65 - 110	25 - 40
30	200 - 400	110 - 210	40 - 60
36	400 - 700	210 - 420	60 - 135
42	–	–	135 - 230

- Culvert-crossing solutions for watersheds greater than 600 acres should be designed based on the specific situation, or other options considered.

Permanent Culvert Specifications

Table 10 lists culvert diameters for permanent culvert sizes. **This table is intended to be used as a guide. No guarantees are given or implied by the use of this table. The Virginia Department of Forestry retains no liability for the failure of pipes.**

- Drainage basins larger than five square miles require a permit from the Virginia Marine Resources Commission.
- Based on N.R.C.S. TR-55 Method, modified for a 10-year frequency storm event.
- Assumes B soils; a CN = 55, and sheet and shallow concentrated flows only for averages of four watersheds for each physiographic region of the state.
- Coastal Plain: Areas East of Interstate 95.
- Piedmont: Areas East of Route 29 and West of Interstate 95.
- Mountains: Areas West of Route 29.
- Calculations for specific situations will provide a more accurate culvert size.
- Culvert crossing solutions for watersheds greater than 600 acres should be designed based on the specific situation, or other options considered.

If it is preferable to place either two or three smaller culverts instead of one larger one, Table 11 shows the required diameters. For example, the 66-inch permanent culvert could be replaced with three 42-inch culverts installed side by side.

Table 10
Permanent Culvert Sizing (10-Year Event)

Culvert Size (in.)	Watershed (acres)		
	Coastal	Piedmont	Mountains
15	Up to 8	Up to 7	Up to 4
18	8 - 12	7 - 10	4 - 7
24	12 - 25	10 - 20	7 - 12
30	25 - 35	20 - 30	12 - 15
36	35 - 70	30 - 50	15 - 25
42	70 - 100	50 - 75	25 - 35
48	100 - 150	75 - 110	35 - 55
54	150 - 240	110 - 170	55 - 75
60	240 - 360	170 - 240	75 - 100
66	360 - 550	240 - 350	100 - 135
72	–	–	135 - 200

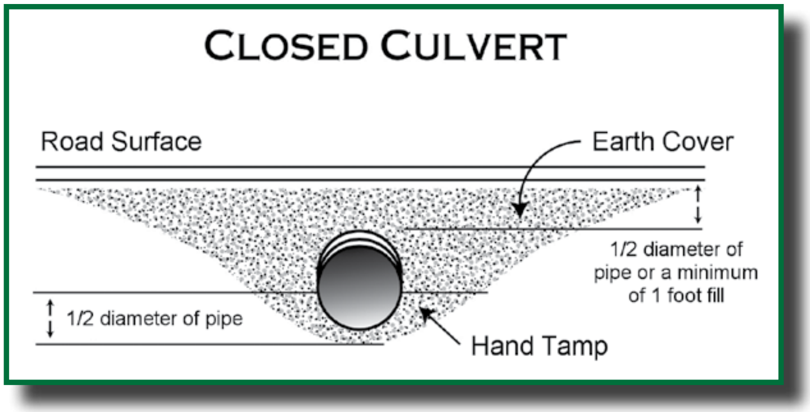
Table 11
Culvert Alternatives (diameter)

Required Culvert Diameter (in.)	2-Culvert Alternative (in.)	3-Culvert Alternative (in.)
15	–	–
18	15, 15	–
24	15, 18	15, 15, 15
30	18, 24	18, 18, 18
36	24, 30	18, 24, 24
42	30, 30	24, 24, 30
48	36, 36	30, 30, 30
54	36, 42	30, 36, 36
60	42, 48	36, 36, 42
66	42, 54	42, 42, 42
72	48, 60	48, 48, 48
84	60, 66	48, 54, 54

Culvert Installation

The pipe length will extend one foot beyond the edge of the fill material on each side of the culvert.

1. The culvert should be placed on the same grade as the natural stream bottom.
2. Crossings should be installed at as close to right angles to the stream as possible. Erosion protection measures will need to be used to minimize soil movement. Rip-rap; filter cloth; seeding and mulching, and non-erodible surfaces may be necessary in any culvert installation. This is important at both the inlet and outlet end of the pipe where scour can occur.
3. Culverts should be installed with 10 percent of its diameter below the streambed. This will minimize undercutting at the inlet or outlet. If the outlet is more than six inches above the natural stream channel, a non-erodible energy absorbing structure should be placed at the outlet.
4. Culverts require periodic maintenance and inspection to avoid plugging with leaves and debris.
5. If a culvert is to be installed in soft or sandy material, use of small crushed stone as a stable base under the pipe will cause minimal settling of the pipe. When the logging is completed and a temporary pipe will be removed, remove all material used during construction and any debris generated following construction from the stream channel and re-establish its natural dimension and profile. Earth cover over pipes should be half the culvert diameter but not less than one foot.
6. Culvert pipes less than 15 inches in diameter are not recommended for stream crossings.



Fords

Natural rock fords are an acceptable crossing method in portions of the Piedmont and Mountains areas. They may have some limited use in portions of the Coastal Plain as well. **In some cases, they may be the most acceptable of the stream crossing types because of the reduced amount of continued stream disturbance.** When fords are used, streambeds should have a firm rock base.

Any changes made to stream bottoms – including the addition of foreign material or unnatural material into a stream that has a drainage area in excess of five square miles – require a permit from the Virginia Marine Resources Commission. Any changes made to improve an existing ford or create a new ford on streams with less than a five-square-mile drainage area will have to adhere to forestry BMPs.

In some cases, the temporary use of wooden mats in a stream channel may be allowable to increase the carrying capacity of the ford. These mats must be removed following use. The addition of crushed limestone rock might be allowable in certain situations to level the stream bottom for truck traffic. Care should be taken to minimize the addition of stone for this purpose so as not to restrict the natural flow of the stream. Geo Web® material may be allowed to create a "hardened" stream bottom in certain situations. (See "20 – Geo Web® Improved Ford" on page 137.) Use of the ford should be temporary and be restricted to low-traffic volumes. The water depth should be no more than an average two feet deep for that section of stream being crossed. Crossing should be made at right angles to the stream. Locate fords where stream banks are low and with stable approaches. To avoid sediment delivery to the stream, stabilize approaches with rock a minimum of 50 feet from the water's edge on both sides of the stream and maintain a clean layer of rock at all times.

Installation of a Geo-Web® hardened ford.

Equipment crossing the stream should have no leaks of hydraulic oil, engine oil, fuel or any other foreign substance.

Rock approaches should be underlined with geotextile fabric where necessary.

Skid Trails

A skid trail by definition is an unsurfaced travelway, usually a single lane trail or narrow road typically narrower and sometimes steeper than a haul road. Skid trails are generally temporary pathways over forest soils where logs, trees or roundwood products are dragged, resulting in ground disturbance.

The skid trail is used to move logs, tree lengths or roundwood products from the stump to the log landing.

Skid Trail Specifications

Locate log landings first and lay out road approach with grades less than 15 percent. Major skid trails should have planned locations to minimize damage to the residual stand; reduce erosion and sedimentation, and provide the most economical method for skidding products. Planning is needed for efficient skid trail operation in the woods.

1. Bladed or dozed skid trail grades should not exceed 25 percent. However, steeper segments may be required to avoid boundary lines, sensitive areas or other areas not accessible using skid trails of lesser grades. Allowances for skid trail grades of up to 35 percent for short segments can be acceptable. If steeper grades are necessary, practices must be used to prevent concentrated water flow that causes gullying. Skid trails should not be constructed on sideslopes exceeding 60 percent. If it is impossible to limit exposure of mineral soil, alternate systems, such as extra cable length or cable yarding, should be considered.
2. Overland and dispersed skidding on steep slopes should not exceed 35 percent or when bare soil areas provide potential for channelized flow.
3. Skid trails should be located outside the SMZ.
4. Any skid trails that must cross a perennial stream, intermittent stream or drainage ditch should use a bridge or culvert of acceptable design. (See “Stream-Crossing Design and Construction” on page 39.)

   Logs shall not be dragged through an intermittent or perennial stream.

   Approaches to stream crossings should be as close to right angles to the stream direction as possible.
5. Install water turnouts 25 feet prior to a stream crossing to direct surface runoff into undisturbed areas of the SMZ.
6. A brush mat of logging slash can be used to stabilize skid trails on stream crossing approaches. This alleviates rutting and firms up the running surface.
7. Climb upslope on a slant or zigzag pattern to avoid long, continuous grades.

8. Skidding should be restrained when soils are saturated to prevent excessive soil compaction and channelized erosion. The skimming of saturated soils from skid trails should be avoided.

9. Rutting should be avoided whenever possible and especially where it causes channelized erosion. If rutting is unavoidable, concentrated skidding may be used to reduce the amount of disturbance, but in no instance may channelized erosion be allowed to direct sediment into a stream channel. Site preparation should be used to ameliorate excessively compacted or rutted sites.

10. Upon completion of skidding, water bars should be installed immediately in the areas subject to erosion. The primary need is drainage of surface water from the skid road and exposed soils by establishing water bars at the recommended intervals. (See "7 – Water Bars" on page 108.)

11. Water bars should be installed at a 30 to 45 degree angle downslope, with ends open to prevent water accumulation behind them. A permanent vegetative cover should be established upon exposed roads, trails and soils that are greater than or equal to five percent slope when subject to erosion. (See "APPENDIX D" on page 151.) Scattered logging slash or other ground cover on the trails or exposed soils may enhance soil stability but should not be substituted for appropriate water bars and seeding.

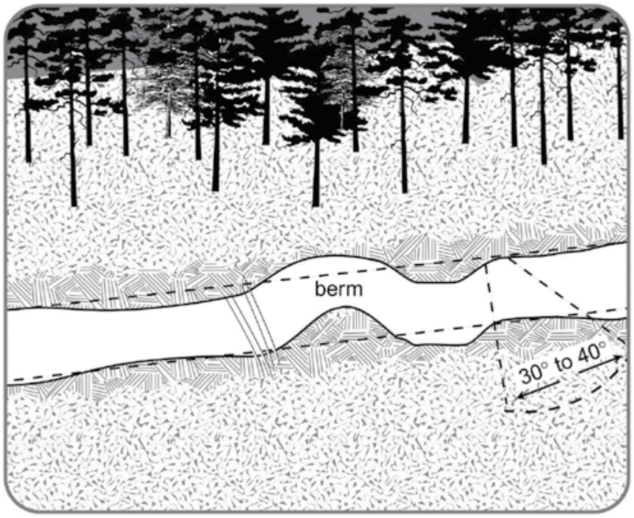
12. Water turnouts should be installed on main skid roads. Cross drainage should be installed immediately above extra steep pitches in skid roads and below bank seepage spots.

13. Identify bumper trees and/or install fender logs on the outside edge of skid roads on steep slopes and at turns and switchbacks to prevent logs from rolling off the skid road and to protect adjacent standing timber from damage.

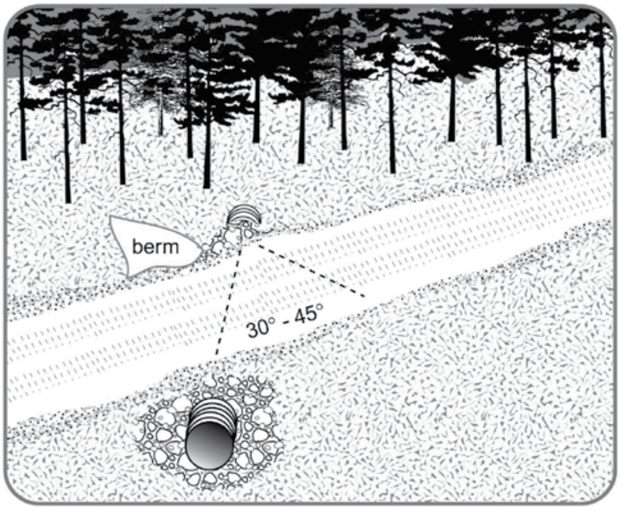
14. Maintenance of skid roads during periods of use is usually confined to keeping the surface water drained off.

15. Where skid roads cross streams or intermittent water courses, the stream beds should be cleaned of fill material and slash and be restored to their natural shape and grade provided the action taken does not cause greater likelihood of sedimentation and erosion.

WATER BAR



CROSS-DITCH CULVERT



16. Temporary closeout of skid trails should be considered if the skid trail becomes inactive for periods longer than seven days or if a storm event is anticipated.

Log Landings

Log landings are the areas where logs are concentrated, processed, sorted and loaded prior to shipping. Care should be taken to properly locate landings to minimize the chances of erosion or sedimentation. Like skid trails, landings are subject to severe compaction. Runoff from these sites must be addressed in the pre-harvest plan and on the ground both during and after the operation is completed. Soil compaction at landing sites may require extra effort to establish an adequate vegetative cover following harvest.

Properly located and constructed log landing sites are essential for profitable and environmentally friendly timber harvesting operations. Log landings that have been properly re-vegetated at the conclusion of a harvest can provide an excellent food source for wildlife.

Log Landing Specifications

1. Locate sites for log landings in advance of road construction. These sites should be located in areas that will help minimize skid trail and haul road distances.
2. Where possible, log landings should be constructed on well-drained, gently sloping sites of no more than five percent. On areas greater than five percent, additional soil protection measures may be necessary.
3. Haul roads and skid trails that terminate at the landing area should be properly drained to prevent run-off water from entering the landing.
4. Log landings should be located at least 50 feet from the SMZ. If closer placement is necessary, additional BMP measures should be considered.
5. A diversion ditch around the uphill side of landings can intercept the flow of water and direct it away from the landing.
6. Prevent stormwater runoff from landings from entering stream channels.
7. In areas where run-off water from the landing may reach a stream channel, install a silt fence, and stake in straw bales and/or brush and debris barriers to filter sediment. (See "APPENDIX A" on page 99.)
8. Construct log landing no larger than is necessary to handle loading and merchandizing activities.

9. Do not drain engine fluids onto the ground when servicing equipment. Maintain equipment to control leakage of hydraulic fluids, antifreeze and similar substances. Provide proper storage and removal for fuel and other used oils. A secondary containment structure, such as earthen berms or straw bales, should be placed around stationary fuel tanks.

10. Keep site clean and free of trash. Do not leave trash at the site following harvest completion.

11. Disturbed areas should be reshaped to provide adequate surface drainage. Revegetate landings following completion of harvesting operations using appropriate methods and materials. (See "APPENDIX D" on page 151.)

Biomass Harvesting

Whole-tree harvesting with careful logging practices is no more of an erosion risk than conventional logging systems (Martin and Hornbeck, 1994). In general, the research suggests that biomass harvesting will not contribute to or create additional physical impacts on soil productivity as compared to conventional harvesting as long as best management practices (BMPs) are followed and harvest rotations are not shortened.

Biomass Harvesting Considerations

- It is important that some ground cover be left on site to protect the soil from raindrop erosion and to lessen the possibility for increased soil displacement during rain events.
- It is critical that the forest floor, including leaf litter, pine straw, grasses, forbs, root mats and fine woody material, be retained as a well-distributed ground cover as much as possible.
- Sites that are harvested for biomass should be regenerated with planted or natural regeneration as quickly as possible. It may become necessary to forgo early weed control treatments to protect the soil resource.
- It may become important to find a way to retain some tree tops and limbs on site, regardless of biomass needs, to protect the integrity of the soil resource and ultimately to protect water quality from soil impact.
- Harvesting following leaf fall will help retain the forest floor and vital site nutrients necessary to promote revegetation of the site.

Equipment Maintenance and Litter

- Perform all maintenance away from riparian areas.
- Capture all coolants, oils, fuels, etc., and dispose of waste properly.
- Repair equipment leaks immediately.
- Properly dispose of all trash associated with harvesting. Do not burn or bury.
- Consider the use of biodegradable fluids, such as modified vegetable oil, as hydraulic fluid.

Harvest Closure

The "close-down" of the timber harvest operation is one of the most important considerations to the protection of water quality. The installation of the appropriate BMPs at this time will minimize erosion and stream sedimentation after harvesting is completed. If the harvest has been effectively planned, the requirements for "close-down" will be minimal. The necessary BMPs should be installed on the site as various portions of the site have had harvesting completed. These include: regrading of ruts to prevent channelized water flow; installation of water bars on abandoned roads and trails used for the harvest; revegetation of landings, roads and bare soil areas with greater than five percent slope; removal of any temporary stream-crossing structures, and the opening of any ditches or water turnouts.

The type of future access should be a consideration in the degree of closure that is desired. Is the road system going to be used for continuous or periodic access? Will haul roads and skid trails be abandoned until the next rotation of timber is ready to harvest? These are the type of decisions that need to be made in the harvest planning phase of the operation, as they will influence the design characteristics of the various roads and trails and reduce maintenance costs associated with retention of an access road.

Upon completion of the harvest operation:

1. All road surfaces should be crowned, outsloped, insloped or water-barred. Remove berms from the outside edge of the road or trail where water can be channeled. **This may not apply if the area is under a mining permit, or the timber sale contract specifies.**
2. Abandoned roads should be left in a condition that provides adequate drainage without further maintenance. These roads should be closed to traffic; scarified if required, and reseeded. The drainage system of closed roads needs careful thought and attention – water still runs on closed roads.
3. Do not allow closed roads to become stream channels. Outslope closed roads where possible, or divert channelized flow off the road surface.
4. Temporary bridges, abutments, culvert pipes or other crossing structures should be removed prior to road closure.
5. If the decision is to remove bridges and "pull" all culverts, it is also necessary to restore all drainage features to their natural condition. This includes reseeding road surfaces and all cut and fill slopes.
6. Cut and fill slopes should be reshaped to a stable gradient.

Traffic control on forest roads can be an effective way to reduce road maintenance costs and provide protection of other forest resources. Traffic control may include full road closure; temporary or seasonal closure, or require restrictions of light use only.

Any degree of control requires inspection for maintenance needs.

The unauthorized use of traffic-controlled roads is a problem for forest landowners. Damage to road surfaces can occur as easily by a pickup truck as by a logging truck. Any access that is granted voluntarily by the forest landowner or the timber operator must be done in a manner that does not compromise the stabilization effort.

In many cases, physically blocking the access to roads may be necessary. Gates are used because they can provide temporary closure along with quick access if needed. Alternatives to gates include large berms or trenches, logs, stumps or boulders. To prevent removal by vandals, gates and other barriers need to be well anchored. For safety reasons, it is advisable to provide good visibility and signage for road closure, and adequate space for turn-around.

NOTES

CHAPTER 6

Site Preparation and Reforestation

Site Preparation and Reforestation

General Definition and Purpose

Site preparation and reforestation refers to those methods used to prepare harvested areas for the establishment of desirable trees and to control undesirable vegetation.

The purpose of site preparation and reforestation work is to:

- Enhance forest establishment;
- Improve environmental protection of the woodlands, and
- Reduce the regeneration gap or the time to start a new forest.

Important concepts of site preparation are to:

- Enhance forest establishment;
- Occur only once in a forest rotation, and
- Ensure that the duration of risk of soil erosion lasts only until the site revegetates naturally, which is a short period of time in the forest life cycle.

General Conditions Where Practice Applies

These reforestation practices can be used where it is desirable to prepare areas for artificial or natural regeneration or to control undesirable vegetation.

Although soil erosion may result from site preparation, it typically presents a much smaller erosion problem than construction projects or the annual cultivation of agricultural crops. As with other practices, the guiding principle is to expose as little soil as possible to accomplish the intended purposes. The land manager should carefully analyze site conditions and prescribe the treatment or treatments that will adequately remove competing vegetation with a minimum of site disturbance. Some site conditions that can influence treatment selection are:

Topography – Slope should be a major consideration in determining treatment intensity. Some treatments acceptable to the Piedmont and Coastal Plain Regions may be unsuited to the Mountains.

Soil – Inherent soil erodibility characteristics should be evaluated. Upland soils showing evidence of accelerated erosion from past field cropping should receive special attention to avoid removing all litter from the forest floor.

Residual Vegetation – The species, size and amount of vegetation on the site will be a major determinant of treatment intensity. The greater the volume, the greater will be the need for intensive preparation with attendant risks of erosion. Every effort should be made to remove as much volume as possible through good utilization at the time of logging to avoid the need for extreme site preparation treatments.

Reforestation / Regeneration Plan

Purpose/Application

Pre-harvest planning often includes site preparation activities. If not, then a Regeneration Plan should be made prior to starting site preparation action. This plan should address the condition of the tract, adjacent property and environmental concerns, including water quality. Potential problems should be identified and mitigating measures noted to prevent water quality problems. The plan could indicate, for example, that in some situations a light burn through the SMZ would do less damage than constructing a fireline adjacent to the SMZ. The land manager should carefully analyze site conditions and prescribe the treatment or treatments that will adequately remove competing vegetation and prepare the site for planting with a minimum of site disturbance.

General Specifications

1. Site preparation intensity will be confined to the minimum soil disturbance required to achieve the planned results.

2. Chemicals, fire and hand-lopping – as opposed to the use of heavy machinery – will be favored on steep terrain and/or fragile soils.

3. Because it is less site disturbing, it is preferable to use a shear (KG) blade than to use a straight blade. Shearing and drum chopping are more preferable than disking. In general, disking should be avoided unless site conditions dictate no other management alternative.

4. An SMZ with undisturbed forest floor and ground cover of adequate width will be maintained adjacent to all intermittent and perennial streams. Soil disturbance along perennial and intermittent streams are subject to Virginia's Silvicultural Water Quality Law.

5. No debris or soil that might impede water flow or cause stream bank degradation will be placed in intermittent or perennial streams.

Individual Site Preparation Specifications

1. **Prescribed Burning** – Refer to Chapter 8, Fire Management, for specific BMPs for Prescribed Burning.

2. **Drum Chopping** – to knock down and crush residual trees, thereby providing available fuel for a prescribed burn. Limited mineral soil is exposed by drum chopping. On slopes in excess of 10 percent, the direction of travel should be based on safe equipment operations.

3. **Disking** – reduces unwanted vegetation by incorporating organic matter; reduces soil compaction, and improves the site for planting.

   a. Disk parallel to contour lines.

   b. Schedule operations during favorable soil moisture conditions. When soil moisture is favorable, a ball can be formed but will break apart readily when lightly squeezed between two fingers.

   c. Do not disk within SMZs or near streams.

4. **Bulldozing** – (straight, root rake and KG blade) to remove residual trees and pile debris.

   a. If an erosion potential exists – and whenever possible – topsoil, including root mat, should be left in place to preserve site quality and minimize water quality impact. Stumps should be left in place. Keep dozer blade a minimum of three inches above ground surface. Do not expose more than 50 percent of the mineral soil.

   b. Normally bulldozing must not be attempted on slopes greater than 45 percent due to operator safety, increased risk of erosion, inefficient equipment operation and greater clearing cost.

   c. Do not bulldoze the surface within SMZs or near streams.

   d. Windrow Construction

      1) Windrows should be constructed along contour lines, as free of soil and as narrow as possible. Windrows are effective sediment traps.

      2) All standing vegetation should be pushed or sheared prior to windrow construction. Standing live trees should not be left in windrows.

      3) Slope, soil type and the amount of vegetation to be sheared or pushed will determine the distance between windrows. As the slope increases, the distance between windrows (slope length) should decrease. Reducing the slope length by spacing windrows as shown on Table 12 will reduce the potential for sheet and rill erosion.

Table 12
Suggested Windrow Spacing

Slope (%)	Maximum Spacing Distance (ft.)
10	200
20	150
30	100
40	60

4) For the purpose of forest wildfire access and wildlife passage, windrows should have openings of at least 20 feet in width for each 600 feet of length. Windrows, regardless of length, shall have a minimum opening of at least 20 feet between each end of the windrow and the boundary lines or SMZ of the tract being sheared or pushed. On steep terrain, openings within windrows must be offset in down-slope alignment to reduce the potential for water and sediment to move straight down hill and form gullies.

5) Windrows can cross or occupy small gullies (less than three feet deep) where they will trap sediment. Larger gullies require surface water management to rehabilitate the eroded area.

e. Raking and Piling

1) Raking and piling in combination with shearing should be done very carefully when working on steep slope and fragile soil areas.

2) Toothed-type root rakes will be favored over straight and KG blades for raking and piling.

3) Care should be exercised in raking to avoid gouging and penetrating the soil with the blade.

4) When a sloping site is raked, the debris will be pushed into windrows placed on the contour to act as a trap or filter for any surface runoff. Where old gullies are present, debris (without soil attached) may be placed in the gullies to break the velocity of water flow during storm events.

5) The presence of considerable soil in the windrows is a sign of improper equipment operation when raking. Frequent checks are needed to prevent this from occurring.

5. **Bedding** – to mound soil in rows to overcome poor soil conditions for seedling establishment.

a. Bedding should be on the contour if slope is discernible.

b. Bedding rows should not be "tied in" to any drainage. Avoid channeling runoff and sediment into streams and ditches.

6. **Furrowing, Scalping and Ripping** – to create a shallow furrow, removing sod competition (and sometimes sub-soiling to improve water infiltration and root penetration) to improve the site for tree planting and seedling survival.

a. Furrowing and scalping work should be done as shallow as possible and should be less than 6 inches deep.

b. The furrowing and scalping rows should follow the contours. Where the equipment cannot follow the contours, the plow or blade shall be picked up periodically to leave undisturbed strips to check erosion.

c. Sub-soiling or ripping of at least 12 inches in depth should follow contours.

d. Furrowing, scalping and sub-soiling rows should not channel water into any drainage.

7. **Hand Tools and Equipment** – the use of hand tools or other small equipment to destroy or reduce competing vegetation for the purpose of site preparation or timber stand improvement. Hand tools and equipment should be favored on steep slopes, fragile soils and in sensitive areas, such as Streamside Management Zones.

8. **Machine Planting** – to establish tree seedlings and have the effect of sub-soiling to break up plow layers, hard pans or compacted soil.

    a. Machine planting and sub-soiling should be done along contour lines. Steep slopes should be hand planted.

    b. Site conditions must be suitable for machine planting operation.

9. **Pesticides/Herbicides** – Chemicals used in the forest consist almost entirely of herbicides used for the removal of unwanted vegetation and insecticides or fungicides used to control insects and diseases. Minor use is made of rodenticides and animal repellents for specialized purposes. For further information see Chapter 7 Silvicultural Chemical Treatment. ("CHAPTER 7" on page 61.)

Precautions

- Avoid excessive soil compaction.
- Soil disturbance should be kept to a practical minimum.
- Minimize disturbance on slopes with extremely erodible soils.
- Wherever possible, mechanical site preparation should follow the contour.
- Wherever possible, discharge water from site-prepared areas onto vegetated surfaces.
- Operations should be planned to minimize disturbance in filter strips.
- No chemical containers or equipment should be washed in any stream.

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CHAPTER 7

Silvicultural Chemical Treatment

Silvicultural Chemical Treatment

Fertilizer, Herbicides and Pesticides

Chemicals are used to control or prevent damage by insects, disease, unwanted vegetation, rodents or birds to a forest or to individual trees within a forest. The target pests to be controlled will vary with stand age, species, site conditions, stand density or market goals for the stand. The purpose for including a section on chemicals is to prevent the contamination of surface waters or ground water by pesticides that are used for forestry purposes.

General Conditions Where Practice Applies

Pesticides are used to protect the landowner's investment from loss due to pests. Herbicides are used to selectively remove certain plants from competition with those designated for the site.

The conditions for the appropriate handling of forest chemicals to protect water quality are the focal concerns of this chapter.

Pesticides/Herbicides may be used with different goals throughout the life of a stand. The following are possible applications of forest pesticides/herbicides:

1. The control of insects or grubs that will attack seedlings.
2. Pesticides may be applied to seeds used for direct seeding to repel insects, mammals and birds.
3. Seedlings may be dipped in pesticides to repel insects and herbivores that might attack the seedlings.
4. Sapling stands may be treated with pesticides when they are short-rotation, high-value stands, such as Christmas trees, or to control an infestation that is likely to spread.
5. Both immature and mature trees may be treated with pesticides to reduce the effects of outbreaks of insect damage beyond the levels normal to the forest. High-value trees may be individually treated to preserve their potential value.
6. Dead or dying trees may be treated with pesticides to stop the spread of the insect or disease.
7. Herbicides may be used when a change in the composition of the existing forest is desired and herbicides will be less expensive or easier to apply than other measures, and their use will safely achieve the desired results.

8. Herbicides can be used for site preparation with or without the use of fire and can duplicate or surpass mechanical site preparation results with less water quality impact. Soil is undisturbed so slope is not the limiting factor as it is with mechanical site preparation.

9. Herbicides may also be used to control unwanted vegetation in established stands.

Planning Considerations

Pesticides and herbicides can be liquid, granular or powder and can be applied aerially or by ground equipment. Water quality considerations include measures taken to keep pesticides and herbicides from reaching streams whether by direct application or through runoff of surface water. Applications must follow manufacturers' label instructions, EPA guidelines, regulations pursuant to the Virginia Pesticide Control Act and VDOF aerial spray guidelines (when spraying under a VDOF aerial spraying contract).

Pesticides and herbicides vary widely in toxicity and persistence. Caution in their use is always essential. Excessive applications and misuse are the most immediate problems. Expert advice is available from the Department of Forestry.

Pesticides and herbicides that have been designated “Restricted Use” by the Environmental Protection Agency require application by or under the supervision of applicators certified by the Virginia Department of Agriculture Pesticide Board. Information on the certification process is available from the Virginia Department of Agriculture and Consumer Services.

1. **Proper Application of Pesticides**

   Many pesticides and herbicides must be used by or under the direct supervision of a State Certified Pesticide Applicator.

   Potential for adverse water quality impact varies widely from one chemical to another and depends primarily on: 1) the chemical's mobility; 2) its persistence, and 3) the accuracy of its placement. Water quality can be protected by knowledge of the chemical being used and adherence to the manufacturer's specification and directions. The label contains information regarding the safety of the applicator; target species for which the chemical is registered; the pesticide/herbicide application rate or concentration; appropriate weather conditions during application; environmental impact, and proper container disposal. Material Safety Data Sheets provide toxicological data and are available from the chemical manufacturer.

   Each pesticide or herbicide application project will have its own unique considerations, but the following are general guidelines that should be followed:

   a. Pesticide and herbicide applications should be scheduled when atmospheric conditions will assure that the pesticide/herbicide reaches the target species. Application in advance of and during unstable and unpredictable changing weather patterns should be avoided.

   b. Aerial Applications will not be made when surface wind speeds exceed five miles per hour or when there is danger that the pesticide/herbicide will be displaced by wind. **In no case shall application be made under windy or gusty conditions.**

c. Filter and buffer strips must conform to federal and state regulations and any label requirements. The use of aerial or broadcast application of herbicides is not allowed in any SMZ adjacent to perennial streams. (See "Streamside Management Zones" on page 35.) Buffers and filter strips should be considered next to agricultural crops, farm animals, orchards, apiaries, horticultural crops, etc.

d. The use of persistent, bioaccumulating pesticides should be avoided as much as possible. Virginia Department of Forestry personnel can assist in determining the optimum chemical to use.

e. The use of granular pesticides and herbicides, preplant treatments and injection methods are preferred because of the reduced likelihood of water pollution. Pesticides and herbicides with low solubility in water are less likely to cause water pollution through drainage and runoff than pesticides/herbicides with high water solubility. Pesticides and herbicides with low solubility often adhere strongly to sediment particles, and the loss of these pesticides/herbicides can be greatly reduced by preventing erosion.

f. Pesticides and herbicides should not be mixed, and application equipment should not be filled, emptied or repaired where spilled chemicals can drain or be washed into streams, lakes or other bodies of water.

g. Equipment and techniques that are designed to assure maximum control of the spray swath with minimum drift will be used.

h. Under no circumstances will silvicultural pesticides, herbicides or fertilizers be applied to the surface of lakes, ponds or streams as part of a practice to establish stands of trees.

i. Transportation regulations for pesticides and herbicides must be followed. Accidents that result in spillage must be reported promptly to the proper authorities.

2. Proper Disposal of Pesticides and Herbicides

A careful evaluation of pesticide/herbicide needs should be made in advance and purchases limited to a one-year or one-season supply. This will reduce carryover, damaged containers and diminished effectiveness of the pesticide or herbicide. Another consideration should be to mix only the amount of pesticide/herbicide needed for the job at hand to end the application with an empty tank or hopper. Unwanted pesticides/herbicides should never be disposed of in a manner inconsistent with the product label.

3. Proper Disposal of Containers

No pesticide/herbicide container is ever truly empty – all contain residues. Disposal of pesticide and herbicide containers must be in accordance with label directions.

Containers should be allowed to drain in a vertical position for 30 seconds after normal emptying. The container should then be rinsed three times with water or other diluting material, allowing 30 seconds for draining after each rinse. A good rule of thumb is to refill the container 1/4 to 1/5 full for each rinse; e.g., use one quart of water or diluting material for each gallon container; one gallon for five-gallon containers, and five gallons for 30- or 55-gallon drums. Each rinse should be drained into the spray tank.

Pesticide and herbicide containers should not be reused even after the triple rinse procedure has been completed.

Any specific disposal directions or procedures on the product labels must be carefully followed. Disposal of containers should be supervised by someone qualified and licensed for the application and handling of pesticides/herbicides. The disposal of the containers is as much a part of proper handling as is the application of the chemical to the target area.

4. Forest Fertilization

The application of nitrogen, phosphorus or other elements by conventional ground equipment, helicopter or fixed wing aircraft is to enhance the growth of tree species. Ammonium nitrate is known to be toxic to fish and shellfish, and phosphorus is known to be responsible for the acceleration of the oxygen depletion process in water bodies.

a. Fertilizer may be broadcast no closer than 100 feet from open water or perennial streams.

b. Application of fertilizer mixtures should be at rates reflecting tree species and soil needs.

c. Application must be made according to the manufacturer's label instructions.

d. Loading and unloading operations should occur away from ditches and water bodies.

5. Sources of Advice

Landowners should consult the Virginia Department of Forestry. Technical advice on pesticide use is available from the Virginia Cooperative Extension Service, the Environmental Protection Agency (EPA) and the chemical manufacturer. Advice on the disposal of pesticides/herbicides and containers is available from the same sources and from the Virginia Department of Health and the Virginia Department of Agriculture and Consumer Services (VDACS). VDACS administers the examination and certification of applicators.

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CHAPTER 8

FIRE MANAGEMENT

Fire Management

Wildfire

The first and foremost concerns in wildfire control are the safety of personnel and the prevention of damage to property. During wildfire suppression, fireline BMPs that slow containment efforts must take a lower priority than fire suppression. Potential effects of firelines should be dealt with at a later time.

Stabilize all areas that have significantly increased erosion potential or drainage patterns altered by fire suppression activities.

Treatments for damage include, but are not limited to:

1. Installing water bars and other drainage diversions in fire roads, firelines and other clear areas.
2. Seeding, planting and fertilization to provide vegetative cover.
3. Spreading slash or mulch to protect bare soil.
4. Repairing damaged road-drainage structures.
5. Clearing stream channels of debris deposited by excessively burned soils.
6. Scarification may be necessary to encourage percolation on excessively burned soils.

Incident Command Areas and Staging Areas

1. Protect surface and subsurface water resources from nutrients, bacteria and chemicals associated with solid waste and sewage disposal.
2. Locate these sites away from active streams.
3. Garbage and other solid waste is also a concern, and these materials should be collected and disposed of at a properly designated, operated and permitted landfill.

Wildfire Rehabilitation Plan

Minimize soil and site productivity loss; threats to life and property, and deterioration of water quality both on and off the site by:

1. Seeding grasses or other vegetation to provide a protective cover as soon as possible on steeper grades;
2. Fertilizing;
3. Stabilizing actively eroding gullies, when possible;
4. Ensuring that all road surfaces are stabilized and protected;
5. Fencing, where necessary, to protect new vegetation, and
6. Clearing all debris from the wildfire from stream channels.

Prescribed Burning

Prescribed fire is an important and useful silvicultural tool. It can be used to prepare a site for planting by reducing logging debris or to prepare a seedbed for seed fall. Prescribed fire can also be used in established stands for silvicultural purposes, wildlife habitat improvement and hazard reduction. A concern in the use of fire for any of these management purposes is the effect of the prescribed fire on surface runoff and soil erosion.

Studies have shown that properly planned and conducted prescribed burning has a minimal impact on water quality in the South. Most problems associated with prescribed burning can be minimized with proper planning, awareness of changing weather conditions and by following the guidance of a certified prescribed burn manager who has been through the Virginia Department of Forestry's **Certified Burn Manager Program**.

BMPs for Prescribed Burning

1. Site preparation burns on steep slopes or highly erodible soils should be conducted only when they are absolutely necessary and should be of low intensity.
2. A significant amount of soil movement can occur when preparing for prescribed burns. Firebreaks should have water control structures to minimize erosion. Locate firelines on contours as much as possible. Water bars should be constructed in firelines at frequent intervals to slow surface runoff in areas subject to accelerated erosion, such as steep grades or highly erodible sloping firelines. (See “7 – Water Bars” on page 108.)
3. Site preparation burning creates the potential for soil movement. All efforts should be made to keep high-intensity site prep burns out of SMZs.
4. Use hand tools when necessary to connect firelines into stream channels.
5. Avoid burning when conditions will cause a fire to burn too hot and expose mineral soil to erosion.
6. Avoid allowing high-intensity fire to enter SMZs.
7. Avoid burning on severely eroded forest soils when the average duff layer is less than one-half inch.

Fireline Construction Methods

Fireline construction is an essential part of forest management and wildfire control. A number of erosion control practices can be implemented during fireline construction to prevent unnecessary erosion.

BMPs for Fireline Construction

1. Firelines should be constructed along the perimeter of the burn area and, when prescribed, along the boundary of the SMZ. The purpose of protecting the SMZ from fire is to safeguard the filtering effects of the leaf litter and organic material. If a fireline along the SMZ boundary is not prescribed, allowance should be made for a low-intensity backing fire within the SMZ.
2. Firelines should follow the guidelines established for skid trails with respect to water bars and wing ditches and should be only as wide and as deep as necessary to permit safe prescribed burns.
3. Firelines that approach a drainage should be turned parallel to the stream or include the construction of a wing ditch or other structure that diverts concentrated runoff into the woods prior to entry into the stream channel.
4. Firelines on highly-erodible sites should be inspected periodically to correct any developing erosion problems before they become too serious.
5. Avoid disturbing existing gullies where possible.
6. Avoid disturbing any more soil surface than necessary.
7. Avoid plowing straight up and down a slope, where possible.
8. Revegetate bare soil areas with slopes greater than five percent, where practical.

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CHAPTER 9

WETLANDS

Wetlands

The Army Corps of Engineers defines "wetlands" in their delineation manual as follows: Those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas.

Description of Forested Wetland Types

Red River Bottoms – These wetlands are usually located in the floodplain of major rivers with the headwaters originating in the Piedmont or Mountain regions. These areas are parallel and immediately adjacent to the drainage system, sloughs and oxbows. If large enough, they may be classified separately as muck swamps. This wetland type is characterized by turbid, sediment-bearing water flowing in well-defined channels and sloughs with overland flow during seasonal floods. Water tupelo, cypress, red maple, swamp black gum and others are found along these sloughs. Beyond the sloughs and oxbows are found first bottoms that flood periodically, however, drainage is fairly rapid because of higher elevation. Species include sweetgum, green ash, water oak, sycamore, red maple, river birch, elms and willow. At still higher elevations, second bottoms and terraces are found; flooding is infrequent and species found include cherrybark, swamp chesnut and white oaks, hickories, beech and yellow poplar.

Black River Bottoms – These wetlands are usually located in floodplains of major rivers with headwaters in the large swamps of the Lower Coastal Plain. The river banks and first terraces flood periodically during the wet season. The low sediment load of blackwater rivers allows less development of complex terrace systems than alluvial rivers. It is characterized by darkly colored and generally low-turbidity water flowing in well-defined channels. Species of trees found are similar to red river bottoms.

Branch Bottom Swamps – Relatively flat, alluvial land along minor drainage systems. They are dominated by constant seepage of spring-fed water with minor flooding during the wet season. On wetter portions with heavier soils, the predominant species are willow and water oaks, swamp black gum, sweetgum, red maple and ash. The lighter soils of the terrace support cherrybark, swamp chestnut and white oaks, sweetgum, hickory, yellow poplar and loblolly pine.

Cypress Strand – These elongated or linear sequences of depressions occur infrequently in the flatwoods. The waters are slowly draining through multiple braided channels or by sheetflow into blackwater rivers. The forest vegetation is dominated by bald cypress interspersed with sweetbay and redbay, swamp black gum and, sometimes, Atlantic white cedar.

Muck Swamp – This wetland type is characterized by slow moving to standing water during the dry seasons but more rapid sheetflow during annual flood stages. They are semi-permanently flooded during the growing season and are characterized by heavy accumulation of organic matter. Soils range from silt loam to clay. Water tupelo and bald cypress are common in deeply-flooded areas and swamp black gum predominates toward the fringes.

Wet Flat – Similar to peat swamps and pocosins, they lie in broad interstream areas where drainage systems are poorly developed. However, wet flats are better drained than their associates because of higher elevation. The non-alluvial soils may possess some accumulation of organic material, but fertility is superior to peat swamps and pocosins because of superior parent material. Species generally encountered are sweetgum, red maple, oaks, ashes, loblolly pine and elms.

Peat Swamp – These are located at the headwaters of most blackwater drainages. The areas consist of large concave depressions behind natural impounding levees or ridges. Peat swamps mainly impound rainwater and may recharge groundwater of the surrounding area when the water table is low during the dry season. The swamps are poorly drained with heavy accumulations of raw organic matter. Soils resemble those of muck swamps but in general are heavier and of better quality. Swamp black gum and red maple predominate with a mixture of many other hardwood species along with loblolly and pond pines and some Atlantic white cedar.

Cypress Pond – These occur infrequently and are irregular or circular swamps formed by depressions and sink holes and are often connected by cypress stands. They are characterized by standing or very slowly flowing water during the wet season if connected to a channel or outlet. Cypress ponds mainly impound rainwater and may recharge groundwater of the surrounding area when the water table is low during the dry season. The site is dominated by bald or pond cypress.

Jurisdictional Wetlands

Jurisdictional wetlands require three criteria:

1. **Hydrophytic vegetation** – plants that have the ability to grow, effectively compete, reproduce and/or persist in anaerobic soil conditions.
2. **Hydric soils** – soils that are saturated, flooded or ponded long enough during the growing season for anaerobic conditions to develop.
3. **Wetland hydrology** – inundated by water sufficient to support hydrophytic vegetation and develop hydric soils.

All three must be present under normal circumstances for an area to be identified as a jurisdictional wetland.

Many sites classified as bottomlands may be wetland-like, but are not necessarily "wetlands" in the strictest legal or jurisdictional sense. Jurisdictional wetlands are found throughout the state and are not limited to flooded or open marsh areas.

Maintaining ecological productivity for wetland and wetland-like sites often calls for the same management techniques. These wetland BMPs work well in both types of sensitive land types.

Although wetlands are federally regulated, normal forestry operations in wetlands – including but not limited to site preparation, harvesting and minor drainage – are exempt from permit requirements under Section 404 of the Clean Water Act Amendments of 1977, as long as the activity:

- Qualifies as normal silviculture;
- Is part of an established silvicultural operation;
- Does not support the purpose of converting a water of the United States to a use to which it was not previously subject;
- Follows the 15 mandatory BMPs for road construction, and the six mandatory BMPs for site preparation, and
- Contains no toxic pollutant listed under Section 307 of the Clean Water Act in discharge of dredge or fill materials into waters of the United States.

A forestry activity will require a Section 404 permit if it results in the conversion of a wetland to a non-wetland. Individuals who wish to change land use, or whose activity may change the land use, or who are uncertain about permit exemption status of a forestry activity, should contact the U.S. Army Corps of Engineers. If the activity is on a farmed wetland or on agricultural land, the Natural Resources Conservation Service is the appropriate initial contact.

Minor drainage refers to installation of ditches or other water control facilities for temporary de-watering of an area. Minor drainage is considered a normal silvicultural activity in wetlands to temporarily lower the water level and minimize adverse impacts on a wetland site during road construction, timber harvesting and reforestation activities. **Minor drainage does not include construction of a canal, dike or any other structure that continuously drains or significantly modifies a wetland or other aquatic area.**

Minor drainage is exempt from needing an individual 404 permit if it is part of an ongoing silvicultural operation and does not result in the immediate or gradual conversion of a wetland to an upland or other uses. Any artificial drainage on a site must be managed. Once the silvicultural activity has been completed, the hydrology that existed prior to the activity should be restored by closing drainage channels.

Normal silvicultural activities conducted as part of "established, ongoing" silvicultural operations are exempt from Section 404 Corps of Engineers permit requirements as long as the appropriate measures are implemented. Normal activities include but are not limited to road construction, timber harvesting, site preparation, reforestation, timber stand improvement and minor drainage. Best Management Practices listed in the Virginia Technical Guide are not necessary for exemption from Section 404 Corps of Engineers permit requirements, but they are strongly recommended to minimize nonpoint source pollution of waters of the Commonwealth and/or waters of the United States. Their utilization will also help prevent violations of the Virginia Silvicultural Water Quality Law.

Established silvicultural operations are included in a management system (not necessarily written) that is planned over conventional rotation cycles for a property or introduced as part of an established operation. An activity need not itself have been ongoing as long as it is introduced as part of an ongoing operation.

Evidence of use of the property may be used to determine whether an operation is ongoing. Examples of such evidence may include, but are not limited to:

- A history of harvesting with either natural or artificial regeneration;
- A history of fire, insect and disease control to protect maturing timber;
- The presence of stumps, logging roads, landings or other indications of established silvicultural operations that will continue on the site;
- Explicit treatment of the land as commercial timberlands by government agencies under zoning, tax, subsidy and regulatory programs;
- Certified plan under the National Tree Farm System, Stewardship Program or NRCS, or
- Ownership and management by a timber company or individual whose purpose is timber production.

For federal wetland BMPs required for exemption from Section 404 permit requirements, refer to Chapter 10, Federal Clean Water Act, Mandated Best Management Practices for Road Construction and Maintenance BMPs.

Site Preparation BMPs for Pine Plantation Management in Wetlands

1. **Minimize soil disturbance.** Position shear-blades or rakes at or near the soil surface and windrow or pile and otherwise move logs and logging debris by methods that minimize dragging or pushing through the soil to minimize soil disturbance associated with shearing, raking and moving trees, stumps, brush and other unwanted vegetation.
2. **Avoid soil compaction.** Conduct activities in a manner to avoid excessive soil compaction and maintain soil tilth.
3. **Limit erosion and runoff.** Arrange windrows in a manner to limit erosion, overland flow and runoff.
4. **Keep logging debris out of SMZs.** Prevent disposal or storage of logs or logging debris in streamside management zones to protect water quality.
5. **Maintain natural contour and drainage.** Maintain the natural contour of the site and ensure that activities do not immediately or gradually convert the wetland to a non-wetland.

6. **Exercise water management.** Conduct activities with appropriate water management mechanisms to minimize off-site water quality impacts.

When Using Chemicals in Wetlands

1. Follow **all** label instructions. Some chemicals are approved for wetlands; others are not.
2. Conduct applications by skilled and licensed applicators.
3. Identify and establish buffer areas for moving surface waters, especially for aerial applications.

Wetlands Best Management Practices (State)

Planning is a critical BMP when working in wetland areas. At all times, three primary considerations should be maintained:

1. Consider the relative importance of the wetland in relation to the total property to be managed. Perhaps the wetland should be left undisturbed.
2. Protect the environment. Do not alter the hydrology of the wetland by:
   - Restricting the inflow or outflow of surface, sub-surface or groundwater;
   - Reducing residence time of waters;
   - Introducing toxic substances, or
   - Changing the temperature regime.
3. Protect wildlife habitat.

Identify and comply with local, state and federal regulations.

Identify control points – those places within the areas to be managed that should be accessed; those that should be avoided, or those that need special consideration.

Identify and mark Streamside Management Zones.

Locate access system components, such as roads, landings, skid trails and maintenance areas, outside filter strips and streamside management zones.

Wetland Access Systems

Wetland Forest Roads

Roads provide access for timber removal, fire protection, routine forest management activities and other multiple-use objectives. When properly constructed and maintained, roads will have minimal impact on water quality, hydrology and other wetland functions.

Permanent roads are constructed to provide multiple-season access for silvicultural activities and are maintained regularly. Construction of permanent roads in wetlands and wetland-like areas should be minimized.

Road drainage designs in wetlands must provide cross drainage of the wetland during both flooded and low-water situations.

Methods of cross drainage in fills for wetlands:

1. Space 24-inch culverts at regular intervals along the fill throughout the wetland. These culverts should have one-half their diameter placed below ground level to handle sub-surface flow. The fills around all culverts should be stabilized.

2. Install a 12-inch-thick porous layer of material aligned in elevation with the porous surface soil layer. A layer of geotextile cloth should separate the layers of this type road.

Use drainage techniques, such as crowning, insloping, outsloping and two percent minimum grades, as well as surface gravel and maintenance, to ensure adequate drainage and discourage rutting and associated erosion and sedimentation.

All road outflows from road ditches should be discharged before entering wetlands and riparian areas to minimize the introduction of sediment and other pollutants. Road width should be kept to the minimum necessary to achieve silvicultural operational success. Typically, on straight road sections, the running surface should be no more than 12 feet wide. Curved road running surfaces should be no more than 16 feet wide.

Use geotextile fabric during construction to minimize disturbance, fill requirements and maintenance costs.

Ditches parallel to the road center line should be constructed along the toe of the fill to collect surface and subsurface water; carry it through the cross drainage structure, and redistribute the water on the other side of the road.

All fills in wetlands should consist of free-draining granular material.

Build roads in advance of harvesting to allow them to settle and harden.

Favor temporary roads that will be “closed” after the silvicultural operation is completed.

Wetland Skid Trails

Choose the best harvesting system to remove the timber. The choice should minimize equipment entry into the wetland areas.

Where equipment entry into wetlands is unavoidable, minimize the area disturbed and practice dispersed skidding.

Use specialized equipment that exerts very low ground pressure to traverse wetland areas. The use of such equipment on areas that are marginally operable with conventional equipment results in minimum impact.

Schedule the harvest during dry seasons of the year or during times when the ground is completely frozen.

Minimize the crossing of perennial or intermittent streams and waterways. Use portable bridges, pole bridges (in dry channels) and corduroy approaches to minimize bank disturbance and sedimentation.

Cross streams at right angles and use bumper trees to keep logs on the trail or bridge.

Do not skid through vernal ponds, spring seeps or stream channels.

Wetland skid trail

Wetland Log Landings (Decks)

Keep the number and size of landings to the minimum necessary to accomplish the operation.

Locate landings on well-drained areas that are not located near streams, seeps or other water-conveying channels.

Geotextile fabric is recommended in wetlands and on soils with low weight-bearing strength.

Shovel logging

BMPs for Wet Weather Operations in Wetlands

1. Avoid heavy equipment operations, especially skidding, during flooded or wet soil conditions.

2. Do not operate heavy equipment, especially skidders, in floodplains when they are flooded or during conditions of flowing or standing floodwater.

3. Minimize skidder and other heavy equipment operation during wet conditions to avoid widespread excessive soil rutting. Although some minor rutting may occur in a typical wetland harvesting operation, skidders and other heavy equipment operation should be planned for dry periods as much as possible.

Poor wetland logging practice

Wildlife Habitat

Wetlands provide habitat to many sensitive endangered or threatened species. Consult with VDOF, DGIF or other professionals if your tract could be home to threatened or endangered species.

When planning operations, be cognizant that these areas are very important for amphibians and other species. Be sure to incorporate elements of preserving critical habitat during the planning stage.

Wetland Streamside Management Zones

Wetland areas tend to have multiple stream channels, oxbow lakes, vernal pools, sloughs and other unique features that do not show on topographic maps. These areas deserve special protection, and a minimum buffer of 50 feet should be left around them. Like SMZs on streams, 50 percent of the basal area should be retained or up to 50 percent of the crown cover can be removed. Crossing these features should be avoided if possible. If they must be crossed, temporary bridges, roads or skid trails (e.g., corduroy roads) or alternate logging systems (e.g., helicopter logging) should be considered. These man-made features should be removed after the operation is completed.

Both fresh- and saltwater marshes require the SMZ to start at the boundary between the marsh and the woodland. Up to 50 percent of the crown cover or 50 percent of the basal area can be removed during harvesting, but the forest floor must remain undisturbed. Also, any debris from the harvesting operation must be removed from the marsh boundaries.

Legal Requirements

Federal requirements have been discussed earlier in this chapter. There are also several state laws that affect harvesting operations in wetlands.

Virginia Silvicultural Water Quality Law – states that it is illegal to conduct silvicultural operations in any manner that allows sediment or the likelihood for sediment to enter the waters of the Commonwealth.

Debris in Streams Law – states that it is illegal to impede the navigation of man or fish in any navigable stream with debris from a silvicultural operation.

Submerged Aquatic Lands Law – states that a permit is required from VMRC to cross any drainage channel that drains more than five square miles, as well as any crossing of a tidal stream or marsh.

There may be additional local ordinances governing operations in wetland areas. Check with local authorities before beginning any operation.

Where to Go for Wetlands Assistance

Contact the Department of Forestry for assistance in forest management on both uplands and wetlands. However, forest management activities on wetlands are subject to special regulations. (See "APPENDIX E" on page 159.)

The District Office of the U.S. Army Corps of Engineers has the authority to determine which lands are subject to wetland regulations.

NOTES

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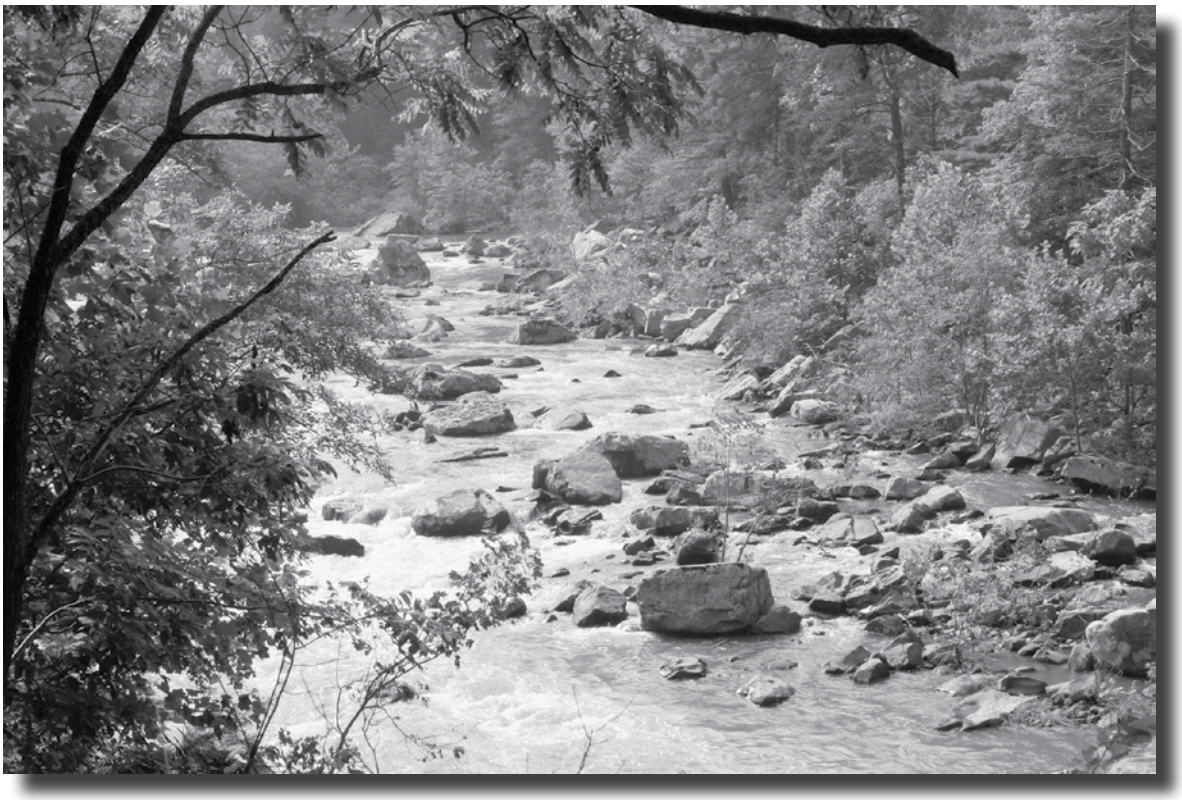
CHAPTER 10

Regulations and Legislation



Regulations and Legislation for Water Quality and Forestry in Virginia

Federal Clean Water Act-Mandated Best Management Practices

As published, Section 404(f) affords an exemption for normal and established silvicultural activities in wetlands. However, landowners should be aware that even though a state may have a nonregulatory BMP program for forestry, as is true for most Southern states, the 15 BMPs below for road construction and maintenance are mandatory in jurisdictional wetlands. These are enforceable by federal agencies and these agencies are increasingly penalizing those who fail to comply.

1. Roads and trails for forestry in U.S. waters must be minimal in number and area consistent with silvicultural operations and topographic and climate conditions.
2. All roads must be far enough from streams or water bodies (except those crossing these waterways) to minimize dredge/fill discharge in U.S. waters.
3. Road fill must be bridged, culverted or otherwise designed to prevent the restriction of expected high flows.
4. The fill must be properly stabilized and maintained during and following construction to prevent erosion.
5. Discharges of dredge/fill material into U.S. waters to construct road fill must be done so as to minimize the encroachment of trucks, tractors, bulldozers or other heavy equipment within (into) U.S. waters and wetlands that lie outside the lateral boundaries of the fill.
6. In designing, constructing and maintaining roads, negative disturbance in U.S. waters must be kept to a minimum.
7. The design, construction and maintenance of the road crossing must not disrupt the movements of aquatic species living in the water body.
8. Borrow material must be taken from upland sites when feasible.
9. Discharges must not take, jeopardize, adversely modify or destroy the critical habitat of threatened or endangered species as defined under the Endangered Species Act.
10. Discharges into wetlands and into breeding, nesting and spawning areas for waterfowl must be avoided if less harmful alternatives exist.
11. Discharges must not be located in the proximity of a public water supply intake.
12. Discharges must not occur in areas of concentrated shellfish production.
13. Discharges must not occur in part of the National Wild and Scenic Rivers System.

14. Discharges must not contain toxic pollutants in toxic amounts.

15. Temporary fills must be entirely removed and the area restored to its original elevation.

Silvicultural Operations in Chesapeake Bay Preservation Areas

Regulatory Requirements

The Chesapeake Bay Preservation Act, §10.1-2100 et seq., required "that all localities within Tidewater Virginia incorporate general water quality protection measures into their comprehensive plans, zoning ordinances and subdivision programs, in accordance with criteria established by the Commonwealth, that define and protect certain lands called Chesapeake Bay Preservation Areas."

Subsequently, the Chesapeake Bay Preservation Area Designation and Management Regulations, 9VAC10-20 et seq., charge the VDOF with the responsibility to oversee and document the installation of silvicultural best management practices. Section 9VAC10-20-120.10 states that:

> **Silvicultural activities in Chesapeake Bay Preservation Areas are exempt from [the] regulations provided that [the] silvicultural operations adhere to water quality protection procedures prescribed by the Department of Forestry in its 'Forestry Best Management Practices Handbook for Water Quality in Virginia.'**

In other words, silvicultural operations within Chesapeake Bay Preservation Areas must implement all necessary Forestry BMPs.

- Before beginning a silvicultural operation, the landowner or harvester should contact the local government to determine if the proposed timber harvest site is within a Chesapeake Bay Preservation Area.

- Pursuant to a Memorandum of Understanding between the Department of Forestry (VDOF) and DCR's Division of Chesapeake Bay Local Assistance, the VDOF will conduct harvest inspections on all known silvicultural activities within Chesapeake Bay Preservation Areas to determine impacts on water quality.

- The VDOF will notify the local government and DCR when it is determined that the Streamside Management Zone (SMZ) has not been maintained during the silvicultural activity, as recommended in this manual. Even if VDOF determines that an SMZ violation may not pose an immediate threat to water quality, the SMZ violation is still considered a violation of the Chesapeake Bay Preservation Act and requires an enforcement action by the local government.

- Failure to properly install or maintain any of the forestry BMPs within a CBPA would automatically eliminate the silvicultural exemption status under the Regulations. For example, clear-cutting or partially clear-cutting within an SMZ would constitute an illegal clearing of vegetation in the RPA and would be subject to local CBPA enforcement procedures. Landowners are legally and financially responsible for all such violations and any penalty or corrective measures required by the enforcement action.

- Please contact DCR's Division of Chesapeake Bay Local Assistance at (800) CHES-BAY for more information about the Chesapeake Bay Preservation Act and Regulations.

Silvicultural Water Quality Law

Title 10.1 – Conservation

Chapter 11 – Forest Resources and the Department of Forestry

Article 12 – Silvicultural Activities Affecting Water Quality

This section of the *Code of Virginia* (§10.1-1181.1 through 10.1-1181.7) refers to the Silvicultural Water Quality Law. This law gives the State Forester legal authority to protect water quality from excessive sedimentation originating from silvicultural operations on any stream in Virginia.

This law allows the State Forester to issue Special Orders or Emergency Special Orders that will require implementation of corrective measures, and to impose civil penalties of up to $5,000 per violation, with each day of a continuing violation being considered a separate violation. These orders and penalties involve all owners and operators involved in the silvicultural activity.

The law also requires that owners and operators notify the State Forester prior to the start of a silvicultural activity. Failure to do so will result in a civil penalty of $250 for a first offense and up to $1,000 for subsequent offenses.

Please refer to the *Code of Virginia* for specific language regarding this law, or contact your local Department of Forestry field office for specific information regarding this law.

Debris in Streams Law

§62.1-194.1. Obstructing or contaminating state waters.

Except as otherwise permitted by law, it shall be unlawful for any person to dump, place or put, or cause to be dumped, placed or put into, upon the banks of or into the channels of any state waters any object or substance, noxious or otherwise, which may reasonably be expected to endanger, obstruct, impede, contaminate or substantially impair the lawful use or enjoyment of such waters and their environs by others. Any person who violates any provision of this law shall be guilty of a misdemeanor and upon conviction be punished by a fine of not less than $100 nor more than $500 or by confinement in jail not more than 12 months or both such fine and imprisonment. Each day that any of said materials or substances so dumped, placed or put, or caused to be dumped, placed or put into, upon the banks of or into the channels of, said streams shall constitute a separate offense and be punished as such.

In addition to the foregoing penalties for violation of this law, the judge of the circuit court of the county or corporation court of the city wherein any such violation occurs, whether there be a criminal conviction therefore or not shall, upon a bill in equity, filed by the attorney for the Commonwealth of such county or by any person whose property is damaged or whose property is threatened with damage from any such violation, award an injunction enjoining any violation of this law by any person found by the court in such suit to have violated this law or causing the same to be violated, when made a party defendant to such suit.

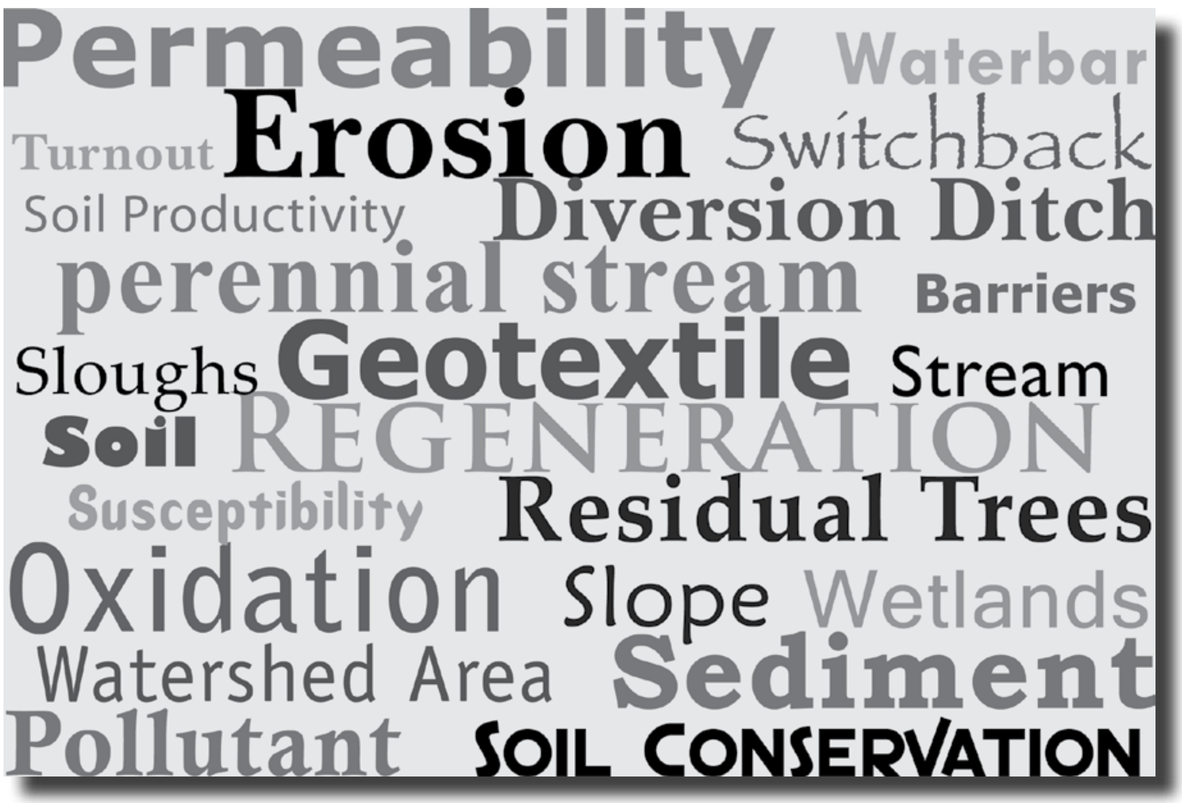
§62.1-194.2. Throwing trash, etc., into or obstructing river, creek, stream or swamp.

It shall be unlawful for any person to throw or otherwise dispose of trash, debris, tree laps, logs, or fell timber or make or cause to be made any obstruction which exists for more than a week (excepting a lawfully constructed dam) in, under, over or across any river, creek, stream, or swamp, so as to obstruct the free passage of boats, canoes, or other floating vessels, or fish in such waters. The provisions of this section shall be enforceable by duly authorized state and local law-enforcement officials and by conservation police officers whose general police power under §29.1-205 and forest wardens whose general police powers under §10.1-1135 shall be deemed to include enforcement of the provisions of this section. Violations of this section shall be punishable as a misdemeanor under §18.2-12; and each day for which any violation continues without removal of such obstruction, on and after the tenth day following service of process on the violator in accordance with §19.2-75, shall constitute a separate offense punishable as a misdemeanor under §18.2-12.

NOTES

CHAPTER 11

Glossary of Forestry Terms



Glossary of Forestry Terms

Access road – A temporary or permanent access route for vehicles into forestland.

Barriers – Obstructions to pedestrian, horse and/or vehicular traffic. They are intended to restrict such traffic to a specific location.

Bearing capacity – Maximum load that a material (soil) can support before failing.

Bedding – A site preparation method in which special equipment is used to concentrate surface soil and forest litter into a ridge six to 10 inches high on which forest seedlings are to be planted.

Bottom lands – A term often used to define lowlands adjacent to streams.

Broad-based dip – A surface drainage structure specifically designed to drain water from an access road while vehicles maintain normal travel speeds.

Brood trees – Trees that harbor reproducing insect pest populations. They often serve as sources of infection for neighboring trees.

Channel – A natural stream that conveys water. A ditch or channel excavated for the flow of water.

Check dam – A small dam constructed in a gully or other small water-course to decrease streamflow velocity, minimize channel scour and promote deposition of sediment.

Contamination – A general term signifying the introduction into water of micro-organisms, chemical, organic, inorganic wastes or sewage, which renders the water unfit for its intended use.

Contour – An imaginary line on the surface of the earth connecting points of the same elevation. A line drawn on a map connecting points of the same elevation.

Cultipacker – A cultipacker is a piece of agricultural equipment that crushes dirt clods, removes air pockets, and presses down small stones, forming a smooth, firm seedbed. Where seed has been broadcast, the roller gently firms the soil around the seeds, ensuring shallow seed placement and excellent seed-to-soil contact.

Culvert – A conduit through which surface water can flow under roads.

Cut – Portion of land surface or area from which earth has been removed or will be removed by excavation; the depth below original ground surface to excavated surface.

Cut-and-fill – Process of earth moving by excavating part of an area and using the excavated material for adjacent embankments or fill areas.

Dispersion, soil – The breaking down of soil aggregate into individual particles, resulting in single grain structure. Ease of dispersion is an important factor influencing the erodibility of soils. Generally speaking, the more easily dispersed the soil, the more erodible it is.

Diversion – A channel with a supporting ridge on the lower side constructed across or at the bottom of a slope for the purpose of intercepting surface runoff.

Diversion ditch – A drainage depression or ditch built across the top of a slope to divert surface water from that slope.

Erosion – The process by which soil particles are detached and transported by water, wind and gravity to some downslope or downstream point. The wearing away of the land surface by running water, wind, ice or other geological agents, including such processes as gravitational creep; detachment and movement of soil or rock fragment by water, wind ice or gravity.

Erosion classes (soil survey) – A grouping of erosion conditions based on the degree of erosion or on characteristic patterns. Applied to accelerated erosion, not to normal, natural or geological erosion. Four erosion classes are recognized for water erosion and three for wind erosion.

Fill slope – The surface area formed where earth is deposited to build a road or trail.

Firebreaks – Naturally occurring or man-made barriers to the spread of fire.

Fireline – A barrier used to stop the spread of fire constructed by removing fuel or rendering fuel nonflammable by use of water or fire retardants.

Ford – Submerged stream crossing where tread is reinforced to bear intended traffic. A place where a perennial stream may be crossed by vehicle.

Forest chemicals – Chemical substances or formulations that perform important functions in forest management. They include fertilizers, herbicide, repellents and other chemicals.

Forestland – Land bearing forest growth or land from which the forest has been removed but which shows evidence of past forest occupancy and which is not now in other use.

Forest landowner – An individual, combination of individuals, partnership, corporation, foundation, government agency, or association of whatever nature that holds an ownership interest in forestland.

Forest Practice – An activity relating to the growing, protecting, harvesting or processing of forest tree species on forestland and to other forest management aspects, such as wildlife, recreation, etc.

Grade – The slope of a road or trail expressed as a percent or change in elevation per unit of distance traveled.

Geotextile – A fabric underlainment for roads to increase bearing capacity.

Gully erosion – Erosion process whereby water accumulates in narrow channels and over short periods removes soil from this narrow area to considerable depths (one foot plus).

Harvesting – The felling, loading and transportation of forest products, roundwood or logs.

Herbicide – Any substance, or mixture of substances, intended to prevent the growth of or destroy any tree, bush, weed, algae and other aquatic weeds.

Herbicide mobility – The case with which the active ingredients can move away from the area of application. This movement can be by drift, evaporation, rain, runoff or through the soil.

Insecticide – A liquid or chemical compound used to kill insects.

Intermittent streams – A stream or portion of a stream with defined stream banks and scoured stream channel that flows during part of the year. Defined as a dotted blue line on the 1:24,000 USGS topographic maps.

Karst – A unique geological terrain formed in limestone and dolomite by the dissolving of bedrock, eroding of underground spaces and collapsing of the ground surface. Karst terrain is characterized by sinkholes, caves and underground drainage patterns.

Landing – A place where logs are gathered in or near the forest for further transport, sometimes called a “deck.”

Logging debris – That unwanted, unutilized and, generally, unmarketable accumulation of woody material in the forest, such as large limbs, tops, cull logs and stumps, that remain as forest residue after timber harvesting.

Mineral soil – Organic-free soil that contains rock less than two inches in size.

Mulch – A natural or artificial layer of plant residue or other materials covering the land surface that conserves moisture, holds soil in place, aids in establishing plant cover and minimizes temperature fluctuations.

Mulching – Covering forest soil with any loose cover of organic residues, such as grass, straw, bark or wood fibers, to check erosion and stabilize exposed soil.

Nonpoint source pollution – Pollution that enters a water body from a diffuse origin on the watershed and does not result from discernible, confined or discrete pathways.

Nutrients – Mineral elements in the forest ecosystem, such as nitrogen, phosphorus or potassium, that are naturally present or may be added to the forest environment by forest practices, such as fertilizer or fire retardant applications. Substances necessary for the growth and reproduction of organisms. In water, those substances that promote growth of algae and bacteria; chiefly nitrates and phosphates.

Organics – Particles of vegetation or other biologic material that can degrade water quality by decreasing dissolved oxygen and by releasing organic solutes during leaching.

Oxidization – The process of breaking down organics into their basic chemical constituents.

Perennial stream – A stream that maintains water in its channel throughout the year. Defined as a solid blue line on the 1:24,000 USGS topographic maps.

Permeability, soil – The quality of a soil horizon that enables water or air to move through it. The permeability of a soil may be limited by the presence of one nearly impermeable horizon even though the others are permeable.

Persistence – The relative ability of a pesticide to remain active over a period of time.

Pesticides – Chemical compounds used for the control of undesirable plants, animals or insects. The term includes insecticides, herbicides and rodenticides, but as used in this handbook does not include non-toxic repellents or other chemicals.

Pocosin – A rare natural community characterized by peaty soils and heath-like vegetation, tucked between coastal freshwater marshes and deepwater swamp forests of the Atlantic Coastal Plain. A high water table, an abundance of sphagnum moss and the slow decay of dead vegetation contribute to the deep peat and acidic soils of these areas. Pocosins are one of Virginia's rarest wetlands.

Pollutant – Dredged soil, solid wastes, incinerator residue, sewage, garbage, sewage sludge, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock sand, cellar dirt and industrial, municipal and agricultural waste discharged into water. (P.L. 92-500, Section 502(6)).

Pollution – The presence in a body of water (or soil or air) of substances of such character and in such quantities that the natural quality of the environment is impaired or rendered harmful to health and life or offensive to the senses.

Puncheon – A structure used to cross wet locations on a trail, constructed of logs and/or lumber.

Regeneration – The young tree crop replacing older trees removed by timber harvest or disaster; the process of replacing old trees with young ones.

Residual trees – Live trees left standing after the completion of timber harvesting.

Rill erosion – An erosion process in which numerous small channels only several inches deep are formed. Occurs mainly on disturbed and exposed soils.

Rip-rap – Aggregate placed on erodible sites to reduce the impact of rain or surface runoff on these areas.

Rolling dip – A shallow depression built diagonally across a light duty road or trail for the purpose of diverting surface water runoff from the road or trail.

Runoff – In forest areas, that portion of precipitation that flows from a drainage area on the land surface or in open channels.

Ruts – Gullies or channels created by logging.

Salvage harvest – Removal of trees that are dead or imminently threatened with death to utilize wood before it is rendered valueless by natural decay agents.

Sanitation harvest – Removal of trees that are under attack by or highly susceptible to insect and disease agents to stop or prevent the spread of such agents.

Sediment – Solid material that is in suspension, is being transported or has been moved from its site of origin.

Seedbed – The soil prepared by natural or artificial means to germination of seed and the growth of seedlings.

Sheet erosion – The removal of a fairly uniform layer of soil from the land surface by water runoff.

Silvicultural activities – All forest management activities, including logging, log transport and forest roads.

Site preparation – A forest activity to remove unwanted vegetation and other material and to cultivate or prepare the soil for reforestation.

Skid trails – A temporary pathway over forest soil to drag felled trees or logs to a landing.

Slope – Degree of deviation of a surface from the horizontal, measured as a numerical ratio, percent or in degrees. Expressed as a ratio, the first number is the horizontal distance (run) and the second is the vertical distance (rise) as 2-1. A 2:1 slope is a 50 percent slope. Expressed in degrees, the slope is the angle from the horizontal plane, with a 90 degree slope being vertical (maximum) and 45 degrees being a 1:1 slope.

Sloughs – Normally sections of old stream channel that have been abandoned by the normal reach and flow of the stream, but that still may carry or flow water to the main channel, especially during periods of moderate to high water.

Soil – The unconsolidated mineral and organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants.

Soil conservation – Using the soil within the limits of its physical characteristics and protecting it from unalterable limitations of climate and topography.

Soil productivity – The output or productive capability of a forest soil to grow timber crops.

Stream – A permanently or intermittently flowing body of water that follows a defined stream course with scoured channel bottom.

Streamside Management Zone (SMZ) – An area of reduced management activity on both sides of the banks of perennial and intermittent streams and bodies of open water where extra precaution is used in carrying out forest practices to protect bank edges and water quality.

Streambanks – The usual boundaries, not the flood boundaries, of a stream channel. Right and left banks are named facing downstream.

Susceptibility – The likelihood of attack or infection by a destructive insect or disease organism.

Susceptible species – A type of tree or plant that has a high probability to be attacked by a given insect or disease agent.

Switchback – A 180-degree direction change in a trail or road used to climb steep slopes.

Thermal pollution – A temperature rise in a body of water sufficient to be harmful to aquatic life in the water.

Toxicity – The characteristic of being poisonous or harmful to plant or animal life; the relative degree or severity of this characteristic.

Tread – Load bearing surface of a trail or road.

Turnout – a) A widened space in a road to allow vehicles to pass one another. b) A drainage ditch that drains water away from roads.

Vernal Pools – Vernal pools are seasonally flooded depressions found on ancient soils with an impermeable layer, such as hardpan, claypan or volcanic basalt. The impermeable layer allows the pools to retain water much longer than the surrounding uplands; nonetheless, the pools are shallow enough to dry up each season. Vernal pools normally hold water for a minimum of two continuous months during spring and/or summer and are free of adult fish populations. These pools are required habitat for numerous amphibian and invertebrate species that have evolved to take advantage of the relative safety of waters without predatory fish.

Waste – Materials and substances usually discarded as worthless to the user.

Water bar – A diversion ditch and/or hump across a trail or road tied into the uphill side for the purpose of carrying water runoff into the vegetation, duff, ditch or dispersion area so that it does not gain the volume and velocity that causes soil movement and erosion.

Water body – An area where water stands with relatively little or slow movement (ponds, lakes, bays).

Water course – A definite channel with bed and banks within which concentrated water flows continuously or intermittently.

Water pollution – Any introduction of foreign material into water or other impingement upon water that produces undesirable changes in the physical, biological or chemical characteristics of that water.

Water quality – A term used to describe the chemical, physical and biological characteristics of water, usually in respect to its suitability for a particular purpose.

Water quality standards – Minimum requirements of purity of water for various uses; for example, water for agricultural use in irrigation systems should not exceed specific levels of sodium bicarbonate, pH total dissolved salts, etc. In Virginia, the Department of Environmental Quality sets water quality standards.

Watershed area – All land and water within the confines of a drainage divide or a water problem area consisting in whole, or in part, of land needing drainage or irrigation.

Weir – A dam in a stream or river to raise the water level or divert its flow.

Wetlands – Geographic areas characteristically supporting hydrophytic vegetation, hydric soils and some saturation or flooding during the growing season.

Wildfire Control – Actions taken to contain and suppress uncontrolled fires.

Wildfires – Uncontrolled fires occurring in forestland, brushland and grassland.

NOTES

APPENDIX A

BMP Specifications

1 – Forest Roads

The following is a simple list of recommended specifications for forest roads.

- Roads should follow contour as much as possible with road grades between two percent and 10 percent. Steeper gradients for up to 15 percent are permissible for up to 200 feet. By breaking or changing grade frequently, fewer erosion problems will result.
- On highly erodible soils, grades should not exceed eight percent. Graveling the road surface can help maintain stability.
- Forest roads should be out-sloped whenever road gradient and soil type will permit. Out-sloping allows surface water to drain off the road quickly, reducing erosion potential.
- Use in-sloping when constructing a road where road gradients are greater than 10 percent, toward sharp curves or when constructed on clay and/or slippery soils. In such cases, the use of an under-road culvert positioned at a 30° angle to ensure proper inside road drainage is recommended. The use of broad-based and rolling dips is encouraged to provide adequate drainage of the road surface.
- Intermittent or perennial streams, as well as certain ephemeral drains, should be crossed using bridges, culverts or fords. Cross as close to a right angle as possible. Structures should be sized so as not to impede fish passage or stream flow. (See "Permanent Culvert Specifications" on page 43.)
- Install water turnouts prior to a stream crossing to direct road water runoff into undisturbed areas of the streamside management zone. Road gradients approaching water crossings should be changed to disperse surface runoff water at least 50 feet from the stream. With the exception of stream crossings, roads should be located a minimum of 50 feet from any flowing or identifiable stream. Distance is measured from the bank to the edge of soil disturbance or, in case of fills, from the bottom of the fill slope.
- Where a road must be constructed or used within 50 feet of the stream, locate road as far away from the active channel as possible and surface the road section within 50 feet of the stream with material to create a non-erodible running surface. Cut banks and fill should be stabilized immediately using vegetation, rock, erosion blankets, or other suitable material. Install silt fence barriers at outlets of any drainage structures that are constructed.
- Where haul roads intersect highways, use gravel, mats or other means to keep mud off the highway. (See "21 – Logging Entrance" on page 138.)
- Install rip rap or other devices at the outlets of culverts and dips to absorb and spread water if needed.
- Use brush barriers or check dams as needed along roads and sensitive areas to filter sediment.
- Control the flow of water on road surfaces by keeping drainage systems open and intact during logging operations.
- Inspect roads at regular intervals to detect and correct potential maintenance problems.

2 – Skid Trails

Definition

An unsurfaced trail, usually single lane and occurring on a gradient steeper than a truck road. A skid trail is generally temporary in nature and is used to move the log or tree by either dragging or carrying, thus creating ground disturbance.

Purpose

A trail used to move logs and trees from the stump to the landing or concentration area.

Recommended Specifications

- Bladed or dozed skid trail grades should not exceed 25 percent. However, steeper segments may be required to avoid boundary lines, sensitive areas or other areas not accessible using skid trails of lesser grades. Allowances for skid trail grades of up to 35 percent for short segments can be acceptable. If steeper grades are necessary, practices must be used to prevent concentrated water flow that causes gullying. Skid trails should not be constructed on sidesteps exceeding 60 percent. If it is impossible to limit exposure of mineral soil, alternate systems, such as extra cable length, cable yarding or others, should be considered.
- Overland and dispersed skidding on steep slopes should not exceed 35 percent or when bare soil areas provide potential for channelized flow.
- Avoid skidding in a streambed.
- Skid trails should be located outside the SMZ.
- Any skid trail that must cross a perennial or intermittent stream or drainage ditch should use a bridge or culvert of acceptable design. Logs shall not be dragged through a stream of any type.
- Skid trail crossings of any stream channel should be as close to a right angle as possible.
- Turn water out of skid trail at least 25 feet prior to stream crossing.
- Break grade frequently to avoid long, continuous stretches of the same grade.
- Rutting should be avoided whenever possible and especially where it causes channelized erosion. If rutting is unavoidable, concentrated skidding may be used to reduce the amount of disturbance. Site preparation should be used to ameliorate excessively compacted or rutted sites.
- Upon completion of skidding, areas subject to erosion should have water bars installed immediately. (See “7 – Water Bars” on page 108.)
- A permanent vegetative cover should be established upon exposed soils that are greater than or equal to five percent slope, or less if soil type is highly erodible. (See “APPENDIX D” on page 151.)

- Temporary closeout of skid trails should occur if the skid trail will be inactive for periods longer than seven days or if a severe storm event is anticipated.

3 – Wing (Lead Off) Ditches

Definition

A water turnout, or diversion ditch, constructed to move and disperse water away from the road and side ditches into adjacent undisturbed areas so that the volume and velocity of water is reduced on slopes.

Purpose

To collect and direct road surface runoff from one or both sides of the road away from the roadway and into undisturbed areas.

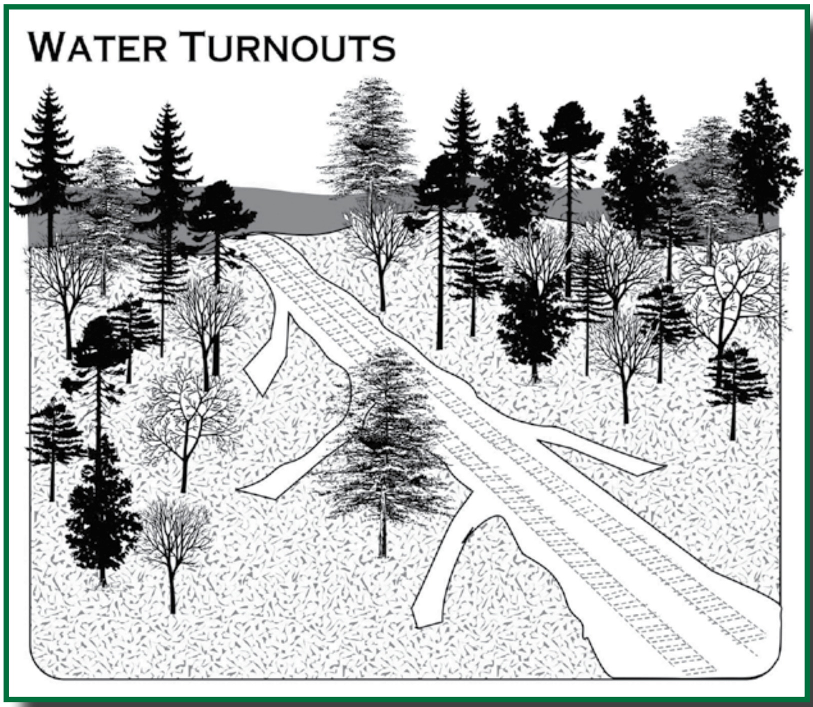
Conditions Where Practice Applies

- Any road or trail section where water could accumulate or accelerate. The water should be diverted onto undisturbed areas so the volume and velocity is reduced.

Recommended Specifications

Wing ditches should:

- Intersect the roadside ditch at the same depth and be outsloped to a maximum grade of two percent.
- Not feed directly into adjacent drainages, gullies or channels.
- Be installed or cut solidly into the soil and wide enough to allow maintenance with logging equipment, such as skidders.



On sloping roads, leave the road ditch line at a 30- to 45-degree angle to the roadbed and be downsloped less than two percent of the natural contour.

Wing ditches may be needed to provide outlets for other water control devices, such as water bars and dips, but additional turnouts may also be needed along stretches of road where water is expected to collect. Topography and relief of the area will determine the spacing of wing ditches. Soil texture should also be considered for wing ditch spacing. On highly erodible or sandy soils, wing ditches (turnouts) should be spaced closer together than on clay soils.

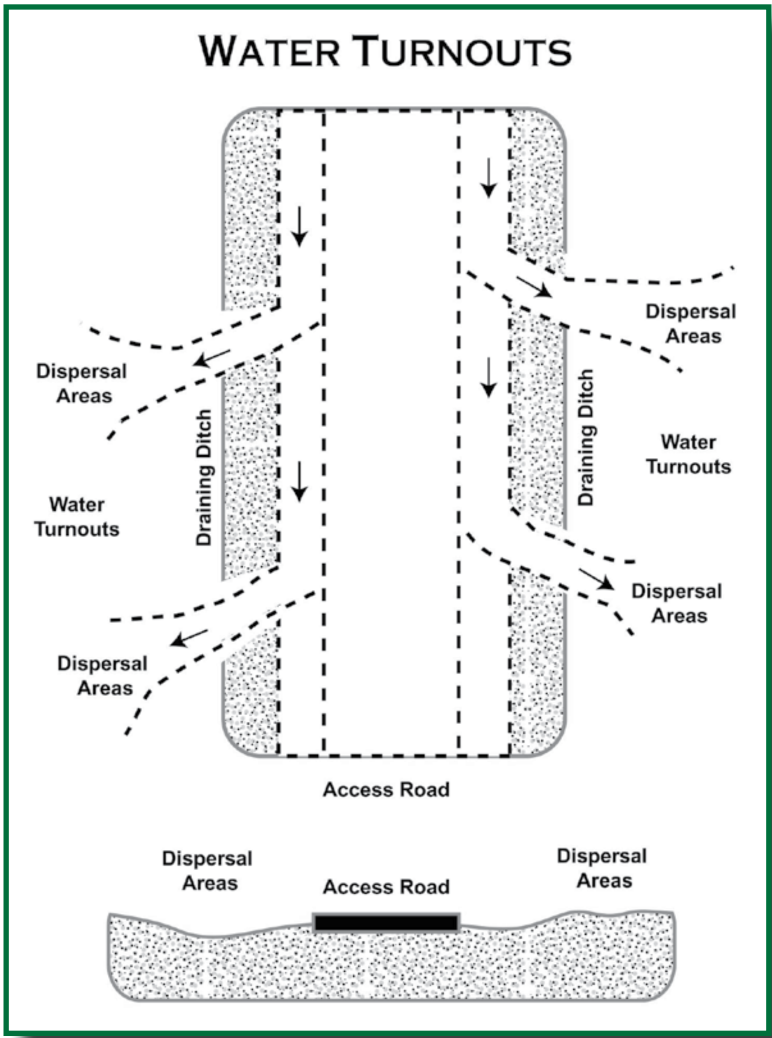


Table 13
Maximum Distance Between Wing Ditches/Turnouts

Topography	Slope (%)	Spacing Distance (ft.)
Flat	2	250
	3	220
	4	190
	5	160
Moderate	6	144
	7	128
	8	112
	9	96
Steep	10	80
	11	60

4 – Culvert Sizes for Cross-Drainage of Roads

Definition

Pipe made of metal, plastic or other suitable material installed under haul roads to transmit water from the roadside ditch, storm runoff, seeps and drains.

Purpose

To collect and transmit water safely from side ditches, seeps or natural drains under haul roads and skid trails without eroding the drainage system or road surface.

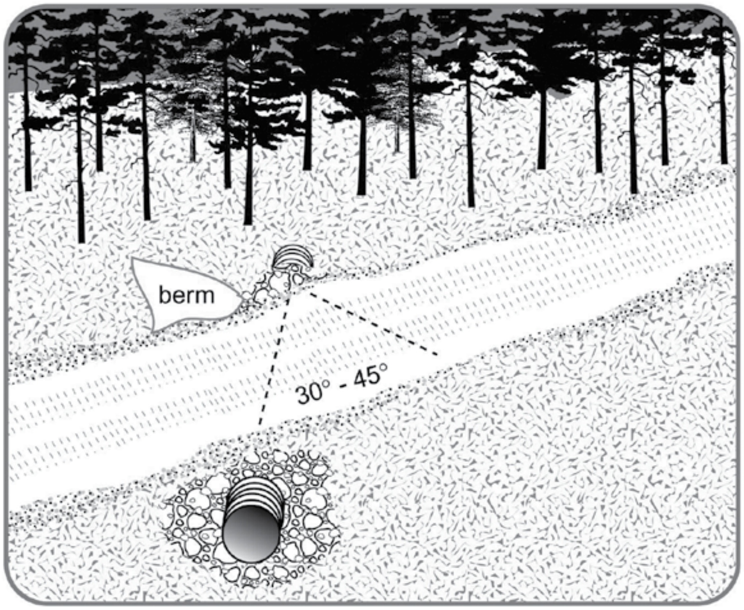
Conditions Where Practice Applies

- Culverts can be used for any operation where cross-drainage of water is needed. In some cases, a culvert is necessary for temporary drainage crossings. Permanent installation should be periodically inspected for obstructions.

Recommended Specifications

- Pipe length should be long enough so both ends extend at least one foot beyond the side slope of fill material.
- The culvert should be placed one percent to two percent downgrade to prevent clogging and be laid so the bottom of the culvert is as close as possible to the natural grade of the ground or drain.
- The culvert should be angled 30 degrees to 45 degrees across the direction of the road.

CROSS-DITCH CULVERT



Erosion protection should be provided for outflows of culverts to minimize erosion downslope or downstream of the outfall; it may also be needed on the upstream end of culverts on flowing streams. This protection can be in the form of headwalls, rip rap, geotextile filter cloth, large stone or prefabricated outflow and inflow devices.

Culverts should be firmly seated and earth compacted at least halfway up the side of the pipe. Cover equal to a minimum of half the culvert diameter (preferably 1 foot of fill per 1 foot of culvert diameter) should be placed above the culvert. Never use less than one foot of cover. The distance between pipes in a multiple culvert application should be a minimum of half the pipe diameter.

Table 14
Suggested Spacing for Cross-Drainage Culverts

Cross-Drainage Road Grade (%)	Culvert Spacing Distance (ft.)
0 - 2	500 - 250
3 - 5	250 - 167
6 - 10	167 - 140
11 - 15	140 - 126
16 - 20	126 - 100
21 +	100

Spacing should be determined by the following formula:

Spacing = 400 feet/slope + 100 feet

Also refer to Table 15 Suggested Spacing for Broad-Based Dips. (See “Table 15” on page 106.)

5 – Broad-Based Dip

Definition

A surface drainage structure specifically designed to drain water from an access road while allowing vehicles to maintain normal travel speeds.

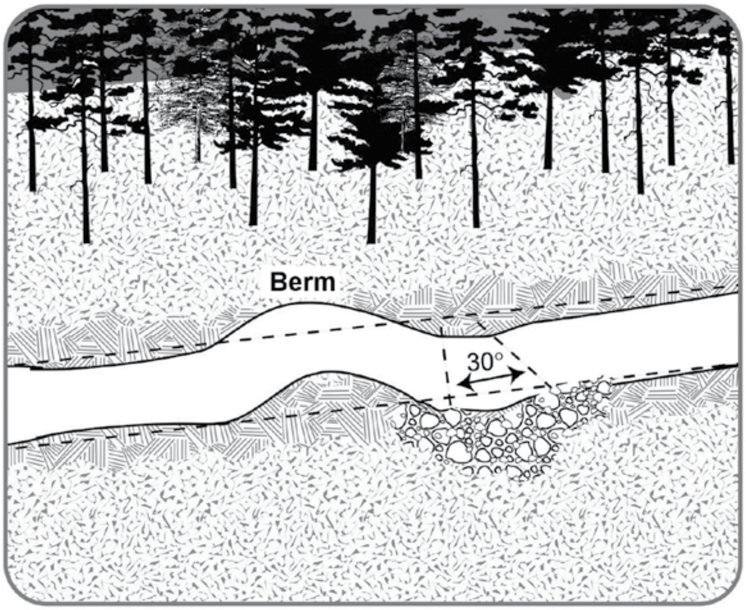
Purpose

To gather surface water and direct it off the road to prevent buildup of surface runoff and subsequent erosion while allowing the passage of traffic.

Conditions Where Practice Applies

- Used on truck haul roads and heavily-used skid trails generally having a gradient of eight percent or less. Should not be used for stream crossings.

BROAD-BASED DIP

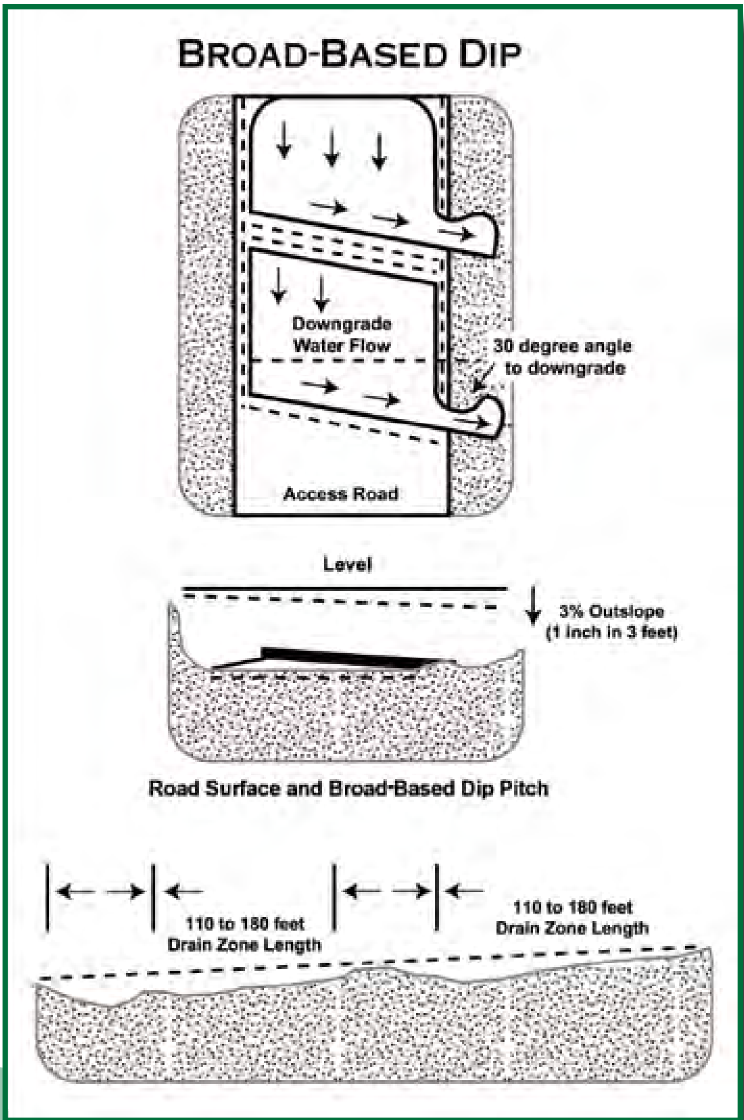


Recommended Specifications

- Installation should take place following basic clearing and grading for roadbed construction.
- A 20-foot, three percent reverse grade is constructed into the existing roadbed by cutting from upgrade of the dip location.
- The cross-drain outslope will be two percent to three percent maximum.
- An energy absorber, such as rip rap, and, in some cases, a level area where the water can spread, should be installed at the outfall of the dip to reduce water velocity, thus minimizing erosion.
- On some soils, the dip and reverse grade section may require bedding with three inches of crushed stone to avoid rutting the road surface.
- Broad-based dips are very effective in gathering surface water and directing it safely off the road. Dips should be placed across the road in the direction of water flow.

Table 15
Suggested Spacing for Broad-Based Dips

Road Grade (%)	Spacing Distance (ft.)
2	300
3	235
4	200
5	180
6	165
7	155
8	150
9	145
10	140
12	135



6 – Rolling Dips

Definition

Rolling dips are a cross between a water bar and a broad-based dip. Like broad-based dips, they have a reverse grade (although shorter) and direct water off the road. Like water bars, they may rely on a mound of soil at the downhill side. Rolling dips should be used on roads with a grade steeper than where a broad-based dip is used.

Purpose

To gather water and direct it safely off the road to prevent buildup of surface runoff and subsequent erosion, while allowing the passage of traffic.

Conditions Where Practice Applies

- Used on truck haul roads and heavily-used skid trails having a gradient of 15 percent or less. Should not be used for crossing streams, springs and seeps.

Recommended Specifications

- Installation follows basic clearing and grading for roadbed construction or on skid trails after logging is completed.
- A 10- to 15-foot-long, three percent to eight percent reverse grade is constructed into the roadbed by cutting upgrade to the dip location and then using cut material to build the mound for the reverse grade.
- In hills, rolling dips are located to fit the terrain as much as possible. They should be spaced according to the slope of the planned roadbed.

Table 16
Suggested Spacing for Rolling Dips

Road Grade (%)	Spacing Distance (ft.)
2 - 5	180
6 - 10	150
11 - 15	135
16 +	120

7 – Water Bars

Definition

A diversion dam constructed across a road or trail to remove and disperse surface runoff in a manner that adequately protects the soil resource and limits sediment transportation.

Purpose

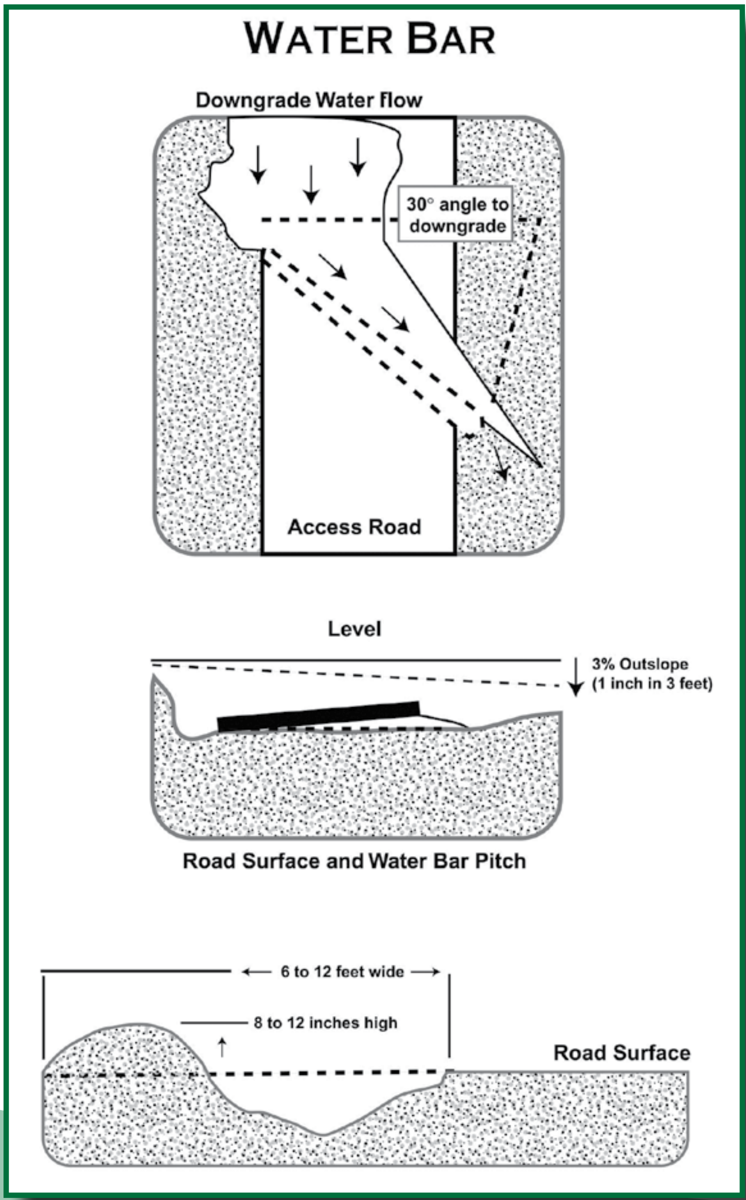
To gather and shed surface water off a road, firebreak, trail, etc.; prevent excessive erosion until natural or artificial revegetation can become established, and to divert water from an inside (uphill) ditch.

Conditions Where Practice Applies

- This is a practice that can be used on limited-use roads, trails and firebreaks. It is an excellent method of retiring roads and trails as well as abandoned roads where surface water runoff may cause erosion of exposed mineral soil.

Recommended Specifications

- Water bars should be placed at an angle of 30 degrees to 45 degrees to the road, firebreak or trail. Water bars are not dams. Water bars intercept and/or divert surface water runoff.
- The outflow end of the water bar should be fully open and extend far enough beyond the edge of the road or trail to safely disperse runoff water onto the undisturbed forest floor. The outlet should fall no more than two percent.



- The uphill end of the water bar should be tied into the cutbank of the road or trail, or into the upper bank of the road or trail.
- Specifications for water bar construction on forest roads, trails and firebreaks must be site specific and should be adapted to existing soil and slope conditions.

Table 17
Suggested Spacing for Water Bars

Road Grade (%)	Spacing Distance (ft.)
2	250
5	135
10	80
15	60
20	45
30	35

8 – Temporary Fill Diversion

Definition

A channel with a supporting ridge of soil on the lower side, constructed along the top of an active earth fill.


Photo courtesy of Missouri Department of Transportation

Purpose

To divert storm runoff away from the unprotected slope of the fill to a stabilized outlet or sediment-trapping condition, whether the sediment trapping is natural or man-made.

Conditions Where Practice Applies

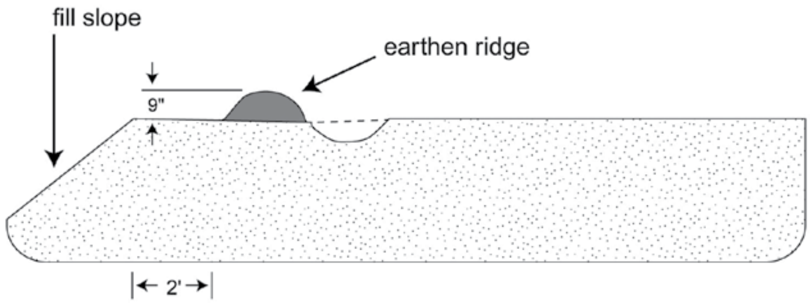
- Where the drainage area at the top of an active "earth fill" slopes toward the exposed slope and where other drainage structures cause the fill to erode during and after construction of haul roads, log decks, skid trails, etc. The temporary fill diversion is used where other diversions are not feasible during construction of haul roads, log decks, etc. This temporary structure should remain in place for the period of active harvesting.

Planning Considerations

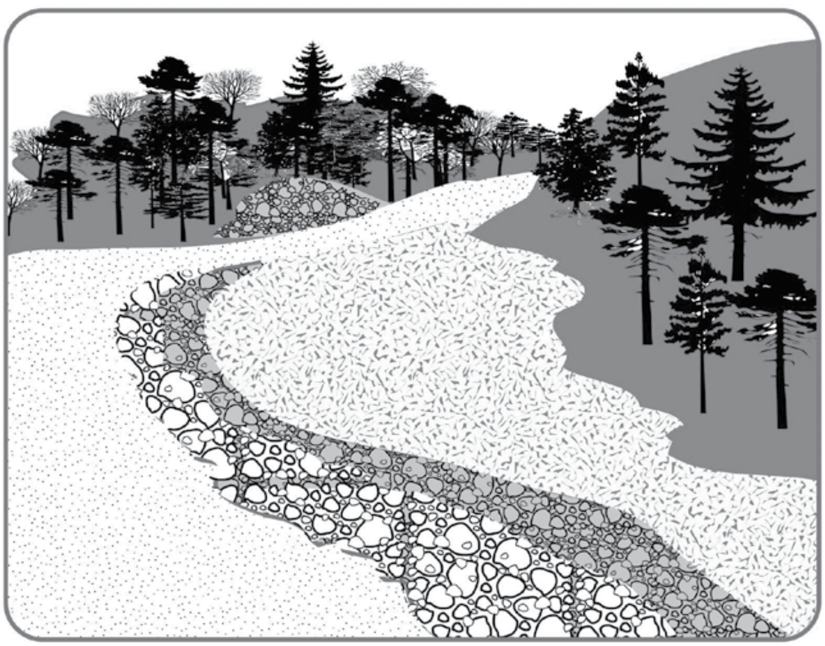
On rare occasions, a road, skid trail or log deck is installed on steep slopes where the construction of such roads and decks may take several days. This is not a good BMP and should be avoided when other alternatives are available. One important principle of the BMPs is to keep stormwater runoff away from exposed slopes. This can be accomplished by installing a dike, diversion, temporary slope drain or, if the road is to be permanently maintained after harvest, a vegetated or lined ditch may be appropriate to carry the runoff away from the slope to a stabilized outlet. In general, these measures may be installed after the final grade has been reached. On cuts, the measures may be installed at the beginning since the work proceeds from the top to the bottom of the slope, and the measures have little chance of being covered or damaged. On cuts, the work proceeds from the bottom to the top and the elevation changes daily until the final grade is reached (it is rare that a silvicultural operation will require such extreme excavation). It is, therefore, not feasible to construct a compacted dike or permanent diversion that may be covered by the next day's grading.

The temporary fill diversion is intended to provide some slope protection on a daily basis until final elevations are reached and a more permanent measure can be constructed. This practice can be constructed by the use of a motor grader or a small dozer. To shape the diversion, the piece of machinery used may run near the top edge of the fill with its blade tilted to form the channel. This work would be done at the end of the workday and provide a channel with a berm to protect the slope. Wherever possible, the temporary diversion should be sloped to direct water to a stabilized outlet. If the runoff is diverted over the fill itself, the practice may cause erosion by concentrating water at a single point.

TEMPORARY FILL DIVERSION



TEMPORARY FILL DIVERSION



9 – Temporary Slope Drain

Definition

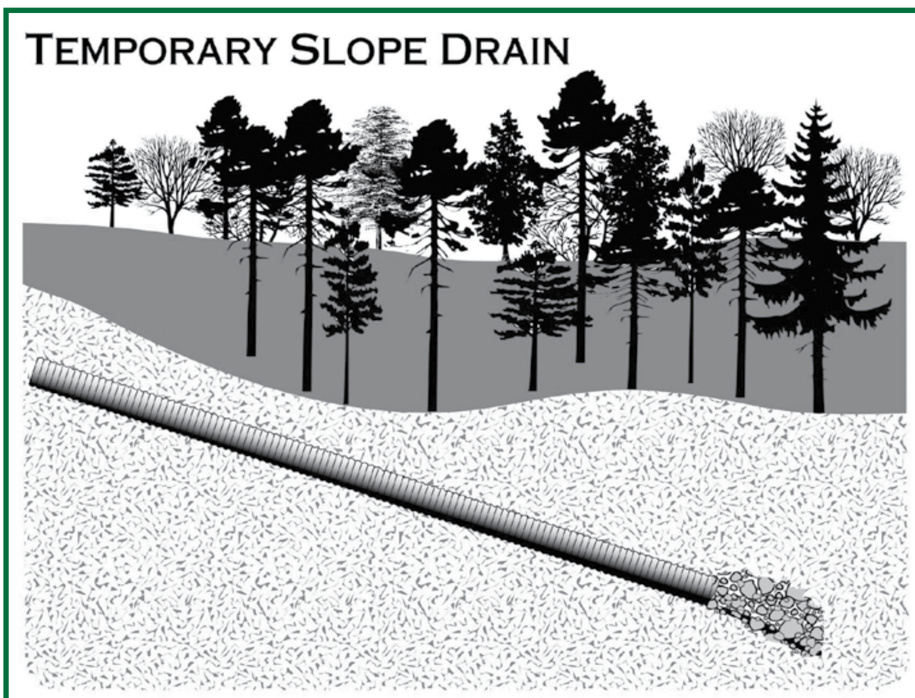
A flexible tubing or conduit extending from the top to the bottom of a cut or fill slope.

Purpose

To temporarily conduct concentrated stormwater runoff safely down the face of a cut or fill slope without causing erosion on or below the slope.

Conditions Where Practice Applies

- On cut or fill slopes where there is a potential for flows to move over the face of the slope causing erosion and preventing adequate stabilization.
- There is often a significant lag between the time a cut or fill slope is completed (on truck haul roads, log decks, skid trails, etc.) and the time a temporary or permanent drainage system can be installed or permanent vegetation established. During this period, the slope is usually not stabilized and is particularly vulnerable to erosion. This situation also occurs on slope construction that is temporarily delayed before final grade is reached. Temporary slope drains can provide valuable protection of exposed slopes until temporary or permanent drainage structures can be installed or vegetation can be established.



Temporary slope drains can be used in conjunction with diversion dikes to convey runoff from the entire drainage area above a slope to the base of the slope without erosion. It is very important that these temporary structures be installed properly as their failure will often result in severe gully erosion on the site and sedimentation below the slope. The entrance section must be securely entrenched, all connections should be watertight, and the conduit must be staked securely.

Drainage Area

The maximum recommended drainage area per slope drain is five acres.

Flexible Conduit

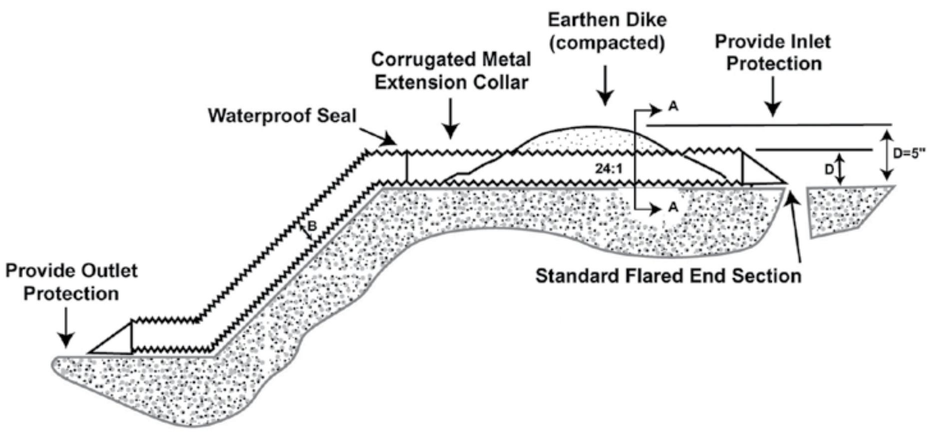
The slope drain should consist of heavy-duty, flexible material designed for this purpose. The diameter of the slope drain should be equal over its entire length. Reinforced hold-down grommets should be spaced at 10-foot (or less) intervals.

Recommended Construction Specifications

- The measure should be placed on undisturbed soil or well-compacted fill.
- The entrance section should slope toward the slope drain at the minimum rate of ½ inch per foot.
- The soil around and under the entrance section should be hand-tamped in eight-inch lifts to the top of the dike to prevent piping failure around the inlet.
- The slope drain should be securely staked to the slope at the grommets provided.
- The slope drain sections should be securely fastened together and have watertight fittings.
- Properly install culvert inlet protection and outlet protection.

The slope drain structure should be inspected weekly and after every storm, and repairs made if necessary. The logger should avoid the placement of any material on the slope drain, and prevent logging traffic (including skidding) across the slope drain.

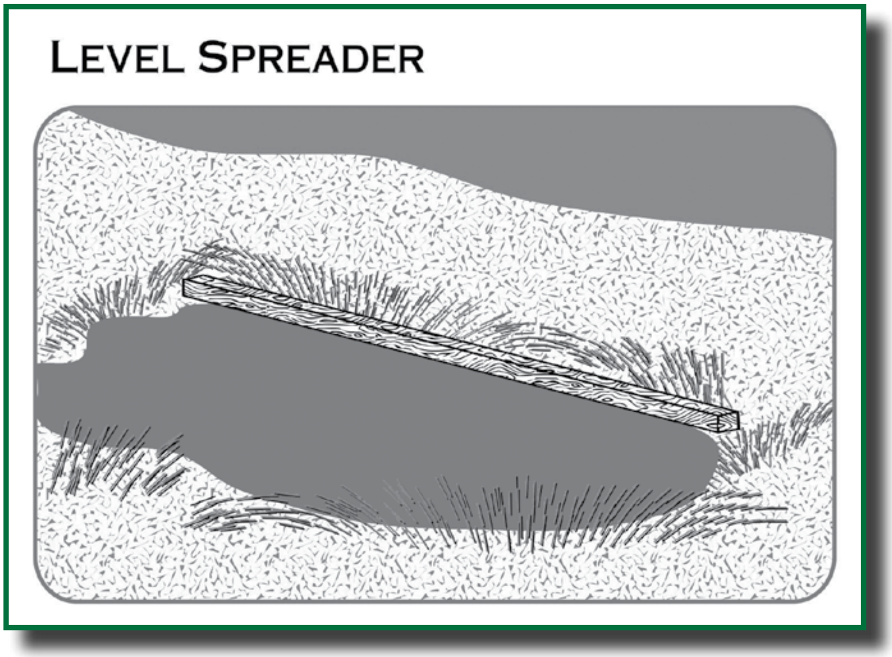
TEMPORARY SLOPE DRAIN



10 – Level Spreader

Definition

An outlet for drainage structures and diversions consisting of an excavated depression constructed at zero grade across a slope.



Purpose

To convert concentrated runoff to sheet flow and release it uniformly onto areas stabilized by existing vegetation.

Conditions Where Practice Applies

- Where there is a need to divert stormwater away from disturbed areas, such as log truck haul roads, log decks, skid trails, etc., to avoid overstressing erosion control measures, and where sediment-free storm runoff can be released in sheet flow down a stabilized slope without causing erosion.

This practice applies only in those situations where the spreader can be constructed on undisturbed soil and the area below the level lip is uniform with a slope of 10 percent or less and is stabilized by natural vegetation. The runoff water should not be allowed to re-concentrate after release.

Planning Considerations

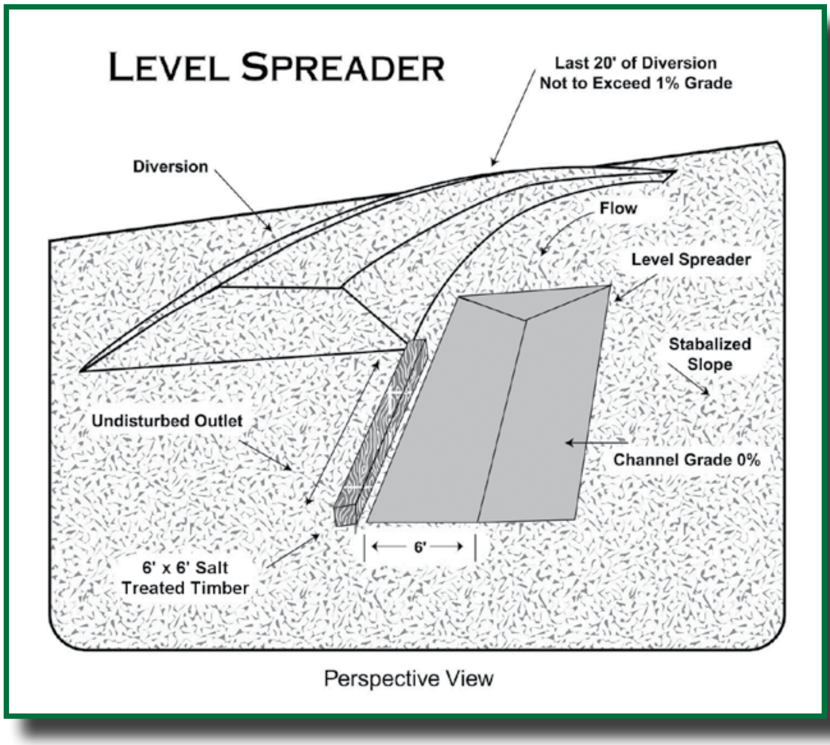
Diversions installed in haul roads and skid trails should have stable outlets for concentrated stormwater flows. The level spreader is a relatively low-cost structure designed to release small volumes of concentrated flow where site conditions are suitable and there is a need to spread the runoff to prevent channeling.

The outlet area must be uniform and well vegetated with slopes of 10 percent or less. Particular care must be taken to construct the outlet lip completely level in a stable, undisturbed soil. Any depressions in the lip will concentrate the flow, resulting in erosion.

Recommended Construction Specifications

- Level spreader should be constructed on undisturbed soil (not fill material).
- The entrance to the spreader should be shaped in such a manner as to ensure that runoff enters directly onto the zero percent channel.

- Construct a 20-foot transition section from the diversion channel to blend smoothly to the width and depth of the level spreader.
- The level lip should be constructed at zero percent grade to ensure uniform spreading of storm water runoff.
- Protective covering for vegetated lip should be a minimum of four feet wide and extending six inches deep in a vertical trench on the lower edge. The upper edge should butt against smoothly cut sod and be held securely in place with closely spaced heavy-duty wire staples.
- Rigid level lip should be entrenched at least two inches below existing ground and be securely anchored to prevent displacement. An apron of VDOT #1, #2 or #3 Coarse Aggregate should be placed on top of level lip and be extended down slope at least three feet. Place filter fabric under stone and use galvanized wire mesh to hold stone securely in place.



- The released runoff must outlet onto undisturbed stabilized areas with slope not exceeding 10 percent. Slope must be sufficiently smooth to preserve sheet flow and prevent flow from concentrating.
- Immediately after its construction, appropriately seed and mulch the entire disturbed area of the spreader.

Maintenance

The measure should be inspected after every rainfall and repairs made, if required. Level spreader lip must remain at zero percent slope to allow proper function of measure. The operator should avoid the placement of any material on the structure and prevent logging traffic across the structure. If the measure is damaged by logging traffic, it should be repaired immediately.

11 – Temporary Sediment Trap

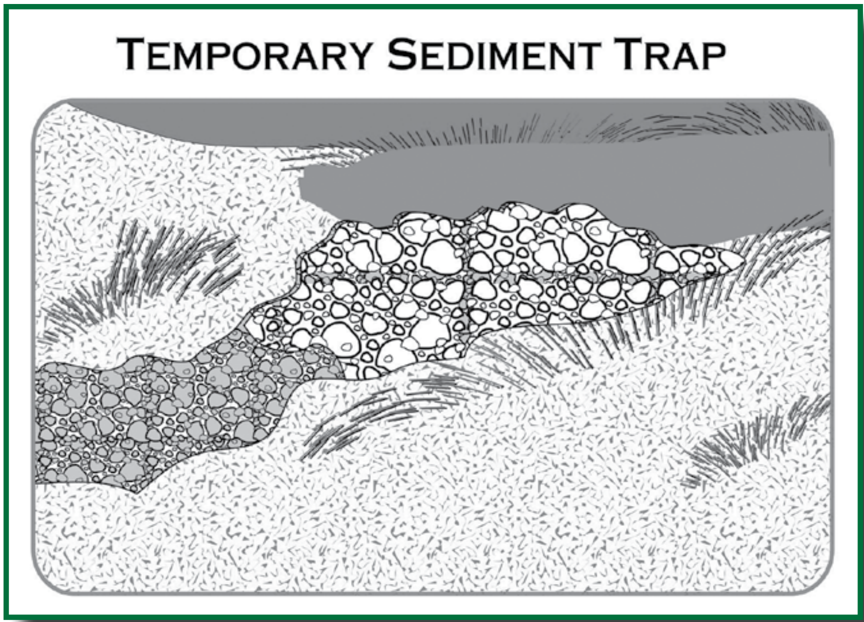
Definition

A temporary ponding area formed by constructing an earthen embankment with a stone outlet.

Purpose

To detain sediment-laden runoff from small disturbed areas long enough to allow the majority of the sediment to settle out.

Conditions Where Practice Applies



- Below disturbed areas where the total contributing drainage area is less than three acres.
- Where the sediment trap will be used not longer than 18 months (the maximum useful life is 18 months).
- The sediment trap may be constructed either independently or in conjunction with a temporary diversion dike.

Rarely is the Temporary Sediment Trap used or needed in silvicultural operations. Proper pre-harvest planning will, in most cases, eliminate the need for such structures. Changing land use from silvicultural to development, for example, may require installation of such control structures if grading or stumping is performed during harvest. A soil disturbance permit may be required and can be obtained from the county or city when certain soil-disturbing activities take place. It is most cost efficient and environmentally correct to plan temporary and permanent stabilization to suit the intended land use.

Sediment traps should be constructed as a first step in any land clearing activity expected to be 10,000 square feet contiguous or more (e.g., log decks, haul roads or skid trails that cannot be properly drained and filtered otherwise). Sediment traps should be made functional before upslope land disturbance takes place.

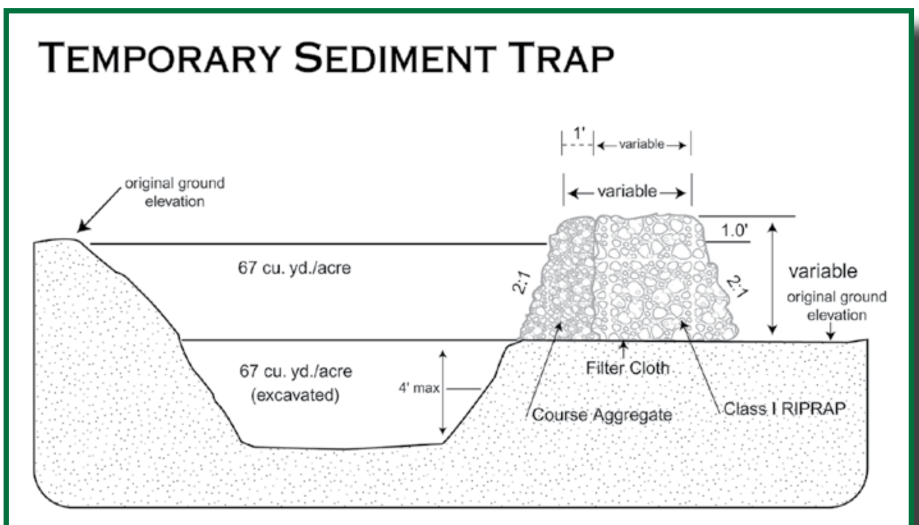
A properly constructed sediment trap will remove 60 percent or more of the sediment during large storm events. To achieve this rate, the sediment trap must have adequate storage volume. There are both a “wet” storage volume and a draw down or “dry” storage volume that help to enhance sediment fall-out and prevent excessive sediment losses during large storm events that occur during advanced stages of land disturbance.

In most cases, excavation will be required to attain the necessary storage volume. Sediment must be periodically removed from the trap to maintain the required volume. Plan to properly dispose of and stabilize excavated sediment.

There are a number of acceptable ways to design many of the BMP structures, and this is true in the case of the sediment trap. However, variations in design should be considered by an engineer to ensure that the minimum storage requirements and structural integrity noted in this specification are maintained.

Trap Capacity

The sediment trap must have an initial storage volume of 134 cubic yards per acre of drainage area, half of which should be in the form of a permanent pool or wet storage to provide a stable settling medium. The remaining half should be in the form of a draw down or dry storage that will provide extended settling time during less frequent, larger storm events. The volume of the wet storage should be measured from the low point of the excavated area to the base of the stone outlet structure. The volume of the dry storage should be measured from the base of the stone outlet to the crest of the stone outlet (overflow mechanism). Sediment should be removed from the basin when the volume of the wet storage is reduced by one-half. Calculation of the sediment trap should be done by a forest engineer or civil engineer.



12 – Rock Check Dams

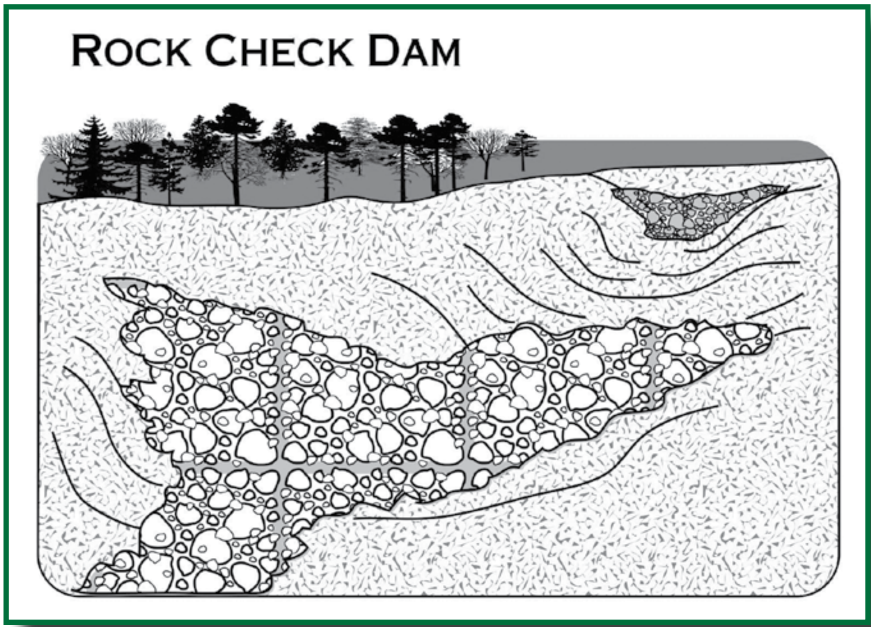
Photo courtesy of Missouri Department of Transportation

Definition

Small, temporary stone dams constructed across a swale or drainage ditch.

Purpose

To reduce the velocity of concentrated stormwater flows, thereby reducing erosion of the swale or ditch. This practice also traps sediment generated from adjacent areas or from the ditch itself, primarily by ponding of the stormwater runoff. Field experience has shown it to perform more effectively than silt fences or straw bales in the effort to stabilize "wet-weather" ditches.



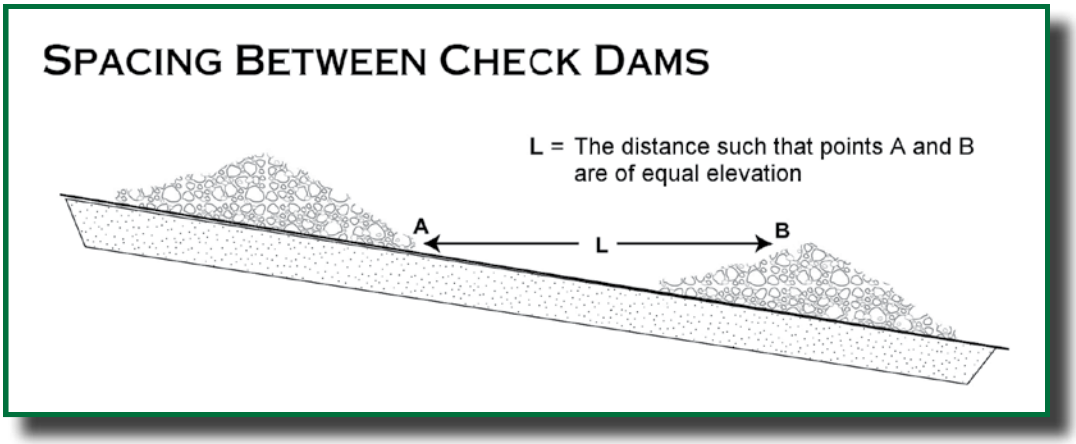
Conditions Where Practice Applies

- Alongside haul roads and other areas where ditches are the method of drainage, and in the bottom of hollows or swales where skidding has occurred (skidding is not recommended in these areas) and a temporary solution is needed until permanent vegetation can be established. This practice, using a combination of stone sizes, is limited to use in small open channels that drain 10 acres or less. It should not be used in a live stream as the objective should be to protect the live watercourse.
- Temporary ditches or swales that, because of their short length of service, cannot receive a non-erodible lining but still need protection to reduce erosion.
- Permanent ditches or swales that, for some reason, cannot receive a permanent non-erodible lining for an extended period of time.
- Either temporary or permanent ditches or swales that need protection during the establishment of vegetation.
- An aid in sediment trapping strategy for silvicultural operations.

Planning Considerations

Check dams are effective in reducing flow velocity and, thereby, the potential for channel erosion. It is preferable to establish a protective vegetative cover lining or to install a structural channel lining than to install check dams in log haul road ditches, swales, etc. However, under circumstances where this not feasible, checks dams are useful.

As previously mentioned, rock dams have been found to be an effective aid in trapping sediment particles by virtue of the ability to pond runoff. Other measures may be required in addition to rock dams to more completely filter sediment in ditches and swales.



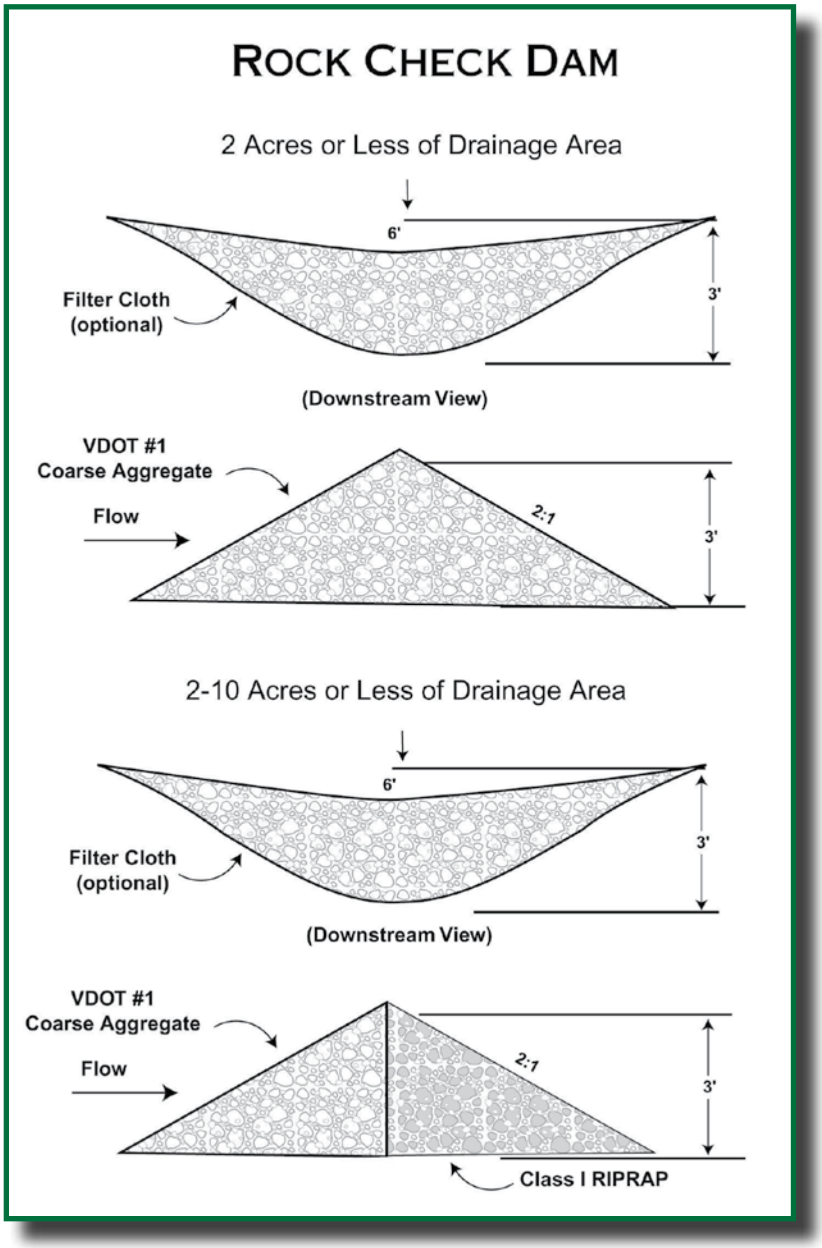
Recommended Specifications

- The drainage area of the ditch or swale being protected should not exceed two acres when VDOT #1 Coarse Aggregate is used alone and should not exceed 10 acres when a combination of Class I Rip-rap (added for stability) and VDOT #1 Coarse Aggregate is used. An effort should be made to extend the stone to the top of channels banks.
- The maximum height of the dam should not exceed three feet.
- The center of the dam should be at least six inches lower than the outer edges to promote a "weir" effect. If not constructed in such a manner, stormwater flows are then forced to the stone-soil interface, thereby promoting scour at that point and subsequent failure of the structure to perform its intended function.
- For added stability, the base of the check dam should be keyed into the soil approximately six inches.
- The maximum spacing between the dams should be such that the toe of the upstream dam is at the same elevation as the top of the downstream dam.

- Hand or mechanical placement will be necessary to achieve complete coverage of the ditch or swale and to ensure that the center of the dam is lower than the edges.
- Filter cloth may be placed under the stone to provide a stable foundation and to facilitate the removal of the stone.

Maintenance

Check dams should be inspected for sediment accumulation after each runoff-producing storm event. Sediment should be removed from behind the check dams when it has accumulated to one-half of the original height of the dam.



13 – Mulching

Definition

Application of plant residues or other suitable materials to the soil surface.

Purpose

To prevent erosion by protecting the soil surface from raindrop impact and reducing the velocity of overland flow.

To foster the growth of vegetation by increasing available moisture and providing insulation against extreme heat and cold.

Conditions Where Practice Applies

- Areas that have been permanently seeded may require mulching to enhance seedling germination.
- Areas that cannot be seeded because of the season may be mulched to provide some protection to the soil surface. An organic mulch should be used and the areas then seeded as soon as weather or seasonal conditions permit. In most cases, the area should be seeded immediately so that if desirable seasonal conditions occur, vegetation is established at the earliest date.
- Mulching may be used in conjunction with temporary seeding operations.

Planning Considerations

Mulches are applied to the soil surface to conserve a desirable soil property or to promote plant growth. A surface mulch is one of the most effective means of controlling runoff and erosion on disturbed land.

Mulches can increase the infiltration rate of the soil; reduce soil moisture loss by evaporation; prevent crusting and sealing of the soil surface; modify soil temperatures, and provide a suitable microclimate for seed germination.

Organic mulch materials, such as straw, wood chips, bark and fiber mulch, have been found to be the most effective.

Chemical soil stabilizers or soil binders should not be used alone for mulch. These materials are useful to bind organic mulches together to prevent displacement.

A variety of manufactured soil stabilization blankets and matting have been developed for erosion control. Some of these products can be used as mulches, particularly in critical areas, such as waterways. They may also be used to hold other mulches to the soil surface.

The choice of materials for mulching will be based on the type of soil to be protected, site conditions, the season and economics. It is especially important to mulch liberally in mid-summer and prior to winter, and on cut slopes and southern slope exposures.

Organic Mulches

Straw – The mulch most commonly used in conjunction with seeding. The straw may come from wheat, oats, barley, etc., and may be spread by hand or machine. Straw can be windblown and should be anchored down by lightly scattering brush over the straw, or by other acceptable methods.

Hay – May be used in lieu of straw and may be spread by hand or machine. Hay can be windblown and may need anchoring or tacking down.

Corn Stalks – These should be shredded into four- to six-inch lengths. Stalks decompose slowly and are resistant to displacement.

Wood Chips, Bark Chips, Shredded Bark chipping trash – Decompose slowly and do not require anchoring. Chips must be treated with 12 pounds of nitrogen per ton to prevent nutrient deficiency in plants and should not be used on stream banks where there is a chance woody debris and logging slash can enter the stream channel during storm events. Logging slash is better used as filters at outlets of drainage structures, brush barriers, etc. Green wood chips, bark, logging slash, etc., can be used in combination with straw or hay mulches, but used alone it is not the best mulch to promote perennial vegetation.

Fiber Mulch – Used in hydroseeding operations and applied as part of the slurry. It creates the best seed-soil contact when applied over (as a separate operation) newly seeded areas. This form of mulch does not provide sufficient protection to highly erodible soils. Fiber mulch is not considered adequate mulch when used during the dry summer months or when used for late fall mulch cover. Use straw or old hay mulch during these periods. Fiber mulch may be used to tack (anchor) straw or hay mulch. This treatment is well suited for steep slopes, critical areas and areas susceptible to displacement.

Chemical Mulches and Soil Binders

A wide range of synthetic, spray-on materials are marketed to stabilize and protect the soil surface. These are emulsions or dispersions of vinyl compounds, rubber or other substances that are mixed with water and applied to the soil. They may be used alone in some cases as a temporary stabilizer, or in conjunction with fiber mulches or straw.

When used alone, chemical mulches do not have the ability of organic mulches to insulate the soil or retain soil moisture. This soil protection is also easily damaged by traffic. Application of these mulches is usually more expensive than organic mulching and the mulches decompose in 60 to 90 days. A composted or air-dried organic mulch is preferred when available.

Blankets and Matting

Field experience has shown that plastic netting, when used alone, does not retain soil moisture or modify soil temperature. In some cases, it may stabilize the soil surface while grasses are being established, but is primarily used in waterways and on slopes to hold straw, hay or similar mulch in place.

Jute mesh and other soil stabilization blankets are good choices for mulching on difficult slopes and in minor drainage swales. Many of the soil stabilization matting (used to create a permanent matrix for root growth within the soil) must receive mulching to properly stabilize an area. Notably, permanent matting is available that includes self-contained, temporary mulching materials; however, these measures should meet the recommendations noted in Appendix A: Specification 14 Soil Stabilization Blankets and Matting, before being used on steep slopes and in channel flow situations. (See "14 – Soil Stabilization Blankets and Matting" on page 124.)

The most critical aspect of installing blankets and mats is to obtain firm, continuous contact between the material and the soil. Without such contact, the material may fail and thereby allow erosion to occur. It is important to use an adequate number of staples and make sure the material is installed properly to maximize soil protection. These are discussed in more detail in Appendix A: Specification 14 Soil Stabilization Blankets and Mats. (See "14 – Soil Stabilization Blankets and Matting" on page 124.)

Recommended Specifications

Organic mulches may be used in any area where mulch is required.

Materials – Select mulch material based on site requirements, availability of materials and availability of labor and equipment. Other materials, such as peanut hulls and cotton burs, may be used as a mulch. Many of the organic mulches may require the addition of Nitrogen (N) to replace Nitrogen removed from soils in the process of decomposition of the mulch, which is in addition to soil requirements before mulch is added. Mulches, such as bark mulch, may deter germination and growth of vegetation, which in extreme cases may require the removal of bark mulch to be replaced by a more compatible mulch.

Prior to Mulching – Complete required grading and install temporary erosion control structures and other BMPs as needed.

Lime and fertilizer should be incorporated and surface roughening accomplished as needed. Seed should be applied prior to mulching, except in the following cases:

- Where seed is to be applied as part of a hydroseeder slurry containing fiber mulch, or
- Where seed is to be applied following a straw mulch spread during winter months.

Application – Mulch materials should be spread uniformly, by hand or machine.

When spreading straw or hay mulch by hand, divide the area to be mulched into approximately 1,000 sq. ft. sections and place 100 to 200 lbs. (two to four bales) of straw or hay in each section to facilitate uniform distribution.

Mulch Anchoring – Straw and hay mulch may need anchoring immediately after spreading to prevent displacement. Hay is less likely to be displaced than straw. The following methods of anchoring straw or hay may be used:

1. **Brush** – Cut brush and, in some cases, hay mulch, may be scattered thinly over straw to prevent displacement. The brush should be single branched (butt of branch no larger than 1.5 inches) and only enough applied to hold mulch in place.
2. **Mulch Anchoring Tool** (often referred to as a Krimper or Krimper tool) – This is a tractor-drawn implement designed to punch mulch into the soil surface. This method provides good erosion control with straw. It is limited to use on slopes no steeper than 3:1, where equipment can operate safely. Machinery should be operated on the contour.
3. **Fiber Mulch** – A very common practice with widespread use. Apply fiber mulch by means of a hydroseeder at a rate of 500 lbs. to 750 lbs./acre on top of straw mulch or hay. It has an added benefit of providing additional mulch to the newly seeded area.
4. **Liquid Mulch Binders** – Application of liquid mulch binders and tackifiers should be heaviest at edges of areas and at crests of ridges and banks to prevent displacement. The remainder of the area should have binder applied uniformly. Binders may be applied after mulch is spread or may be sprayed into the mulch as it is being blown onto the soil. There are several suitable binders available. Seek recommendations from a forest engineer.
5. **Mulch Netting** – Lightweight plastic, cotton or paper nets may be stapled over the mulch according to manufacturer's recommendations.
6. **Peg and Twine** – Because it is labor-intensive, this method is feasible only in small areas where other methods cannot be used. Drive 8- to 10-inch wooden pegs to within three inches of the soil surface, every four feet in all directions. Stakes may be driven before or after straw is spread. Secure mulch by stretching twine between pegs in a criss-cross within a square pattern. Turn twine two or more times around each peg.

Maintenance

All mulches and soil coverings should be inspected periodically (particularly after rainstorms) to check for erosion. Where erosion is observed in mulched areas, additional mulch should be applied. Nets and mats should be inspected after rainstorms for dislocation or failure. If washouts or breakage occur, re-install netting or matting as necessary after repairing damage to the slope or ditch. Inspections should take place up until vegetation is firmly established.

14 – Soil Stabilization Blankets and Matting

Definition

The installation of a protective covering (blanket) or a soil stabilization mat on a prepared planting area of a steep slope or channel.

Purpose

To aid in controlling erosion on critical areas by providing a microclimate that protects young vegetation and promotes its establishment. Some types of soil stabilization mats are also used to raise the maximum permissible velocity of vegetated channels by reinforcing the vegetated channel to resist the forces of erosion during storm events.

Conditions Where Practice Applies

- On short, steep slopes, such as cut and fill slopes, and in side ditches on haul roads and skid trails, where erosion hazard is high and planting is likely to be slow in providing adequate protective cover.
- In vegetated channels where the velocity of flow exceeds recommended velocity for other applications.
- On streambanks or other areas where moving water is likely to wash out or destroy germinating and juvenile vegetation.
- In areas where wind may prevent standard mulching practices from remaining in place until vegetation becomes established.

Planning Considerations

Soil stabilization blankets and mats can be applied to problem areas to supplement nature's erosion control system (vegetation) in its initial establishment and in providing a safe and "natural" conveyance for high-velocity stormwater runoff.

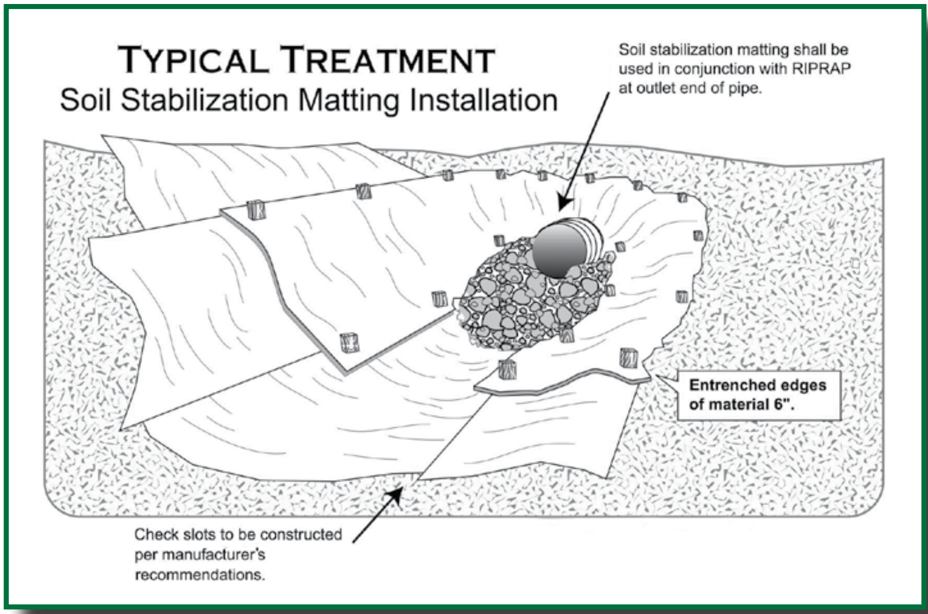
Installation Recommendations

Site Preparation – After site has been shaped and graded, prepare a friable seedbed relatively free of clods and rocks more than one inch in diameter and any foreign material that will prevent uniform contact of the protective covering with the soil surface. If necessary, redirect any runoff away from the ditch or slope during installation.

Seeding – Lime, fertilize and seed as appropriate for site conditions. When using jute mesh on a seeded area, apply approximately one-half the seed after laying the mat.

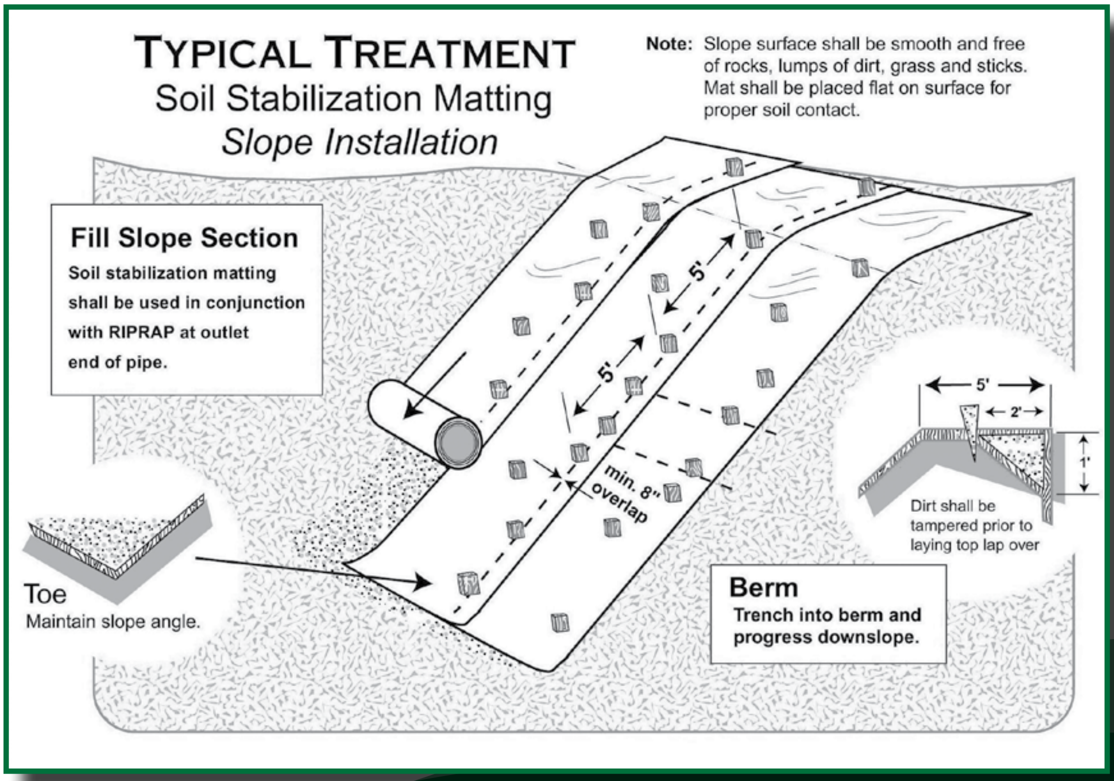
When open weave nets are used, lime, fertilizer, seed and mulch should be applied before laying the net. When using a combination blanket, such as an excelsior blanket, seed and soil amendments should be applied before the blanket is laid. In some treatments, mulching is applied after installation of treatment, depending on volume and velocity of flow expected in channel treated.

When installing blankets and mats, it is important to follow the manufacturer's recommendations for laying and anchoring, orientation on slope, overlap, etc. A forest engineer can assist with recommendations for the proper treatment, application and installation.



Maintenance

All soil stabilization blankets and matting should be inspected periodically following installation, particularly after rainstorms, to check for erosion and undermining. Any dislocation or failure should be repaired immediately. If washouts or breakage occurs, re-install the material after repairing damage to the slope or ditch. Continue to monitor these areas until they become permanently stabilized.



15 – Straw Bale Barrier

Definition

A temporary sediment barrier consisting of a row of entrenched and anchored straw bales.

Purposes

To intercept and detain small amounts of sediment from disturbed areas of limited extent to prevent sediment from leaving the logging site and/or entering stream channels.

To decrease the velocity of sheet flows.

Conditions Where Practice Applies

- Below disturbed areas subject to sheet and rill erosion, such as haul roads, log decks and skid trails.
- Where the size of the drainage area is no greater than one-fourth of an acre per 100 feet of barrier length; the maximum slope length behind the barrier is 100 feet, and the maximum slope gradient behind the barrier is 50 percent (2:1).
- Where effectiveness is required for less than three months.
- Straw bale barriers should not be constructed in live streams.
- This measure should not be used where water may concentrate in defined ditches.

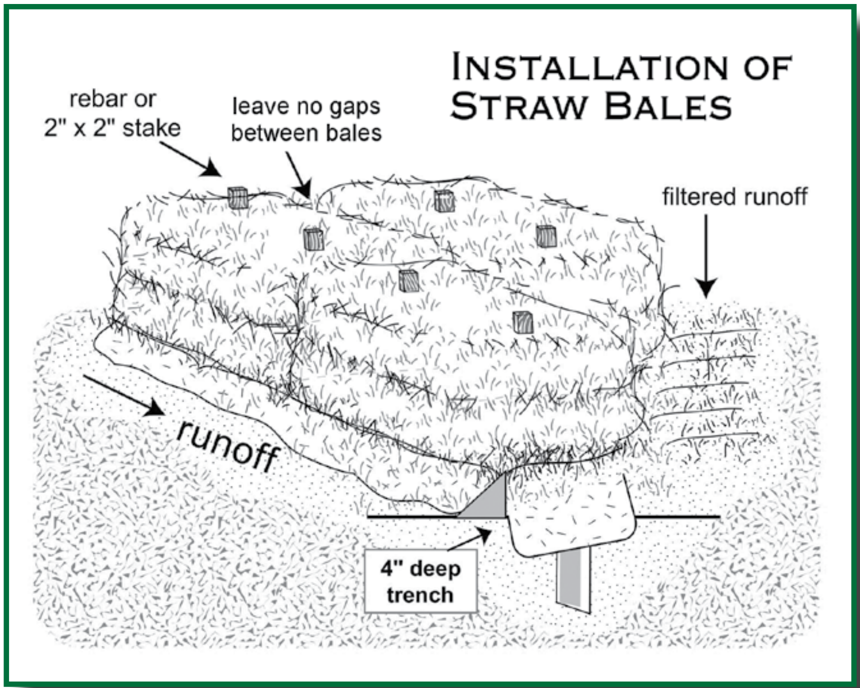
Straw bale barriers should *not* be used on areas where rock or another hard surface prevents the full and uniform anchoring of the barrier.

Straw bale barriers are poor filters of sediment if not properly installed and maintained. In cases where the barrier is not properly installed and maintained, the measure can create additional problems.

Locate the straw bale barrier at least five to seven feet from the base of disturbed slopes with grades greater than seven percent.

Recommended Installation

1. Bales should be placed in a single row, lengthwise on the contour, with ends of adjacent bales tightly abutting one another.
2. All bales should be wire-bound or string-tied. Straw bales should be installed so that bindings are oriented around the sides rather than along the tops and bottoms of the bales to prevent deterioration of the bindings.



3. The barrier should be entrenched and backfilled. A trench should be excavated the width of a bale and the length of the proposed barrier to a minimum depth of 4 inches. After the bales are staked and chinked (gaps filled by wedging), the excavated soil should be backfilled against the barrier. Backfill soil should conform to the ground level on the downhill side and should be built up to four inches against the uphill side of the barrier.

4. Each bale should be securely anchored by at least two stakes (minimum dimensions two inches x two inches x 36 inches) or standard "T" or "U" steel posts (minimum weight of 1.33 pounds per linear foot) driven through the bale. The first stake or steel post in each bale should be driven toward the previously laid bale to force the bales together. Stakes or steel pickets should be driven a minimum 18 inches into the ground to securely anchor the bales.

5. The gaps between bales should be chinked with straw to prevent water from escaping between the bales. Loose straw scattered over the area immediately uphill from a straw bale barrier tends to increase barrier efficiency. Inspection should be frequent, and repair or replacement should be made promptly as needed.

Straw bale barriers should be removed when they have served their usefulness, but not before the upslope areas have been permanently stabilized.

Straw bale barriers should be inspected immediately after each rainfall and at least daily during prolonged rainfall.

Close attention should be paid to the repair of damaged bales, end runs and undercutting beneath bales.

Sediment deposits must be removed when the level of deposition reaches approximately one-half the height of the barrier.

Any sediment deposits remaining in place after the straw bale barrier is no longer required should be dressed to conform to the existing grade, prepared and seeded.

16 – Silt Fence

Definition

A temporary sediment barrier consisting of a synthetic filter fabric stretched across and attached to supporting posts and entrenched.

Purposes

To intercept and detain small amounts of sediment from disturbed areas during logging operations to prevent sediment from leaving the site. To decrease the velocity of sheet flows and low-to-moderate level channel flows.

Conditions Where Practice Applies

- Below disturbed areas where erosion would occur in the form of sheet and rill erosion.
- Where the size of the drainage area is no more than one quarter acre per 100 feet of silt fence length; the maximum slope length behind the barrier is 100 feet, and the maximum gradient behind the barrier is 50 percent (2:1).
- In minor swales or ditch lines where maximum contributing drainage area is no greater than one acre and flow is no greater than one cubic foot per second.
- Silt fence should not be used in areas where rock or other hard surfaces prevent the full and uniform depth anchoring of the barrier.

Silt fence will trap a much higher percentage of suspended sediments than straw bales because the silt fence passes the sediment-laden water more slowly. Silt fences are preferable to straw barriers in many cases because of their durability and potential cost savings. While the failure rate of silt fences is lower than that of straw barriers, improperly installed silt fences invite failure and sediment loss. The installation methods outlined here can improve performance and reduce failures.

As noted, flow rate through silt fence is significantly lower than the flow rate for straw bale barriers. This creates more ponding and, therefore, more time for sediment to fall out. Both woven and non-woven synthetic fabrics are available commercially. The woven fabrics generally display higher strength than the non-woven fabrics and, in most cases, do not require any additional reinforcement. When tested under acid and alkaline water conditions, most of the woven fabrics increase in strength, while the reactions of non-woven fabrics to these conditions are variable. The same is true of testing under extensive ultraviolet radiation. Permeability rates vary regardless of fabric type. While all the fabrics demonstrate very high filtering efficiencies for sandy sediments, there is considerable variation among both woven and non-woven fabrics when filtering the finer silt and clay particles.

1. As with straw bale barriers, an effort should be made to locate silt fences at least five to seven feet beyond the base of disturbed slopes with grades greater than seven percent.

2. The use of silt fences, because they have such a low permeability, is limited to situations in which only sheet flow or overland flows are expected and where concentrated flows originate from drainage areas of one acre or less.

3. Field experience has demonstrated that silt fences are often installed too short (less than 16 inches above ground elevation). The short fences are subject to breaching during even small storm events and will require maintenance "clean outs" more often. Properly supported silt fences that stand 24 to 34 inches above the existing grade tend to promote more effective sediment control.

Materials

1. Synthetic filter fabric should be a pervious sheet of propylene, nylon, polyester or ethylene yarn and should be certified by the manufacturer or supplier.

2. Synthetic filter fabric should contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of zero degrees to 120°F.

3. If wooden stakes are used for silt fence construction, they should have a diameter of two inches when oak is used and four inches when pine is used. Wooden stakes should have a minimum length of five feet. Some silt fences come with preinstalled stakes that meet the manufacturer's standards; these are adequate for forestry uses.

If steel posts (standard "U" or "T" section) are used for silt fence construction, they must have a minimum weight of 1.33 pounds per linear foot and should have a minimum length of five feet.

Wire fence reinforcement for silt fences using standard-strength filter cloth should be a minimum of 14 gauge and should have a maximum mesh spacing of six inches.

The height of a silt fence should be a minimum of 16 inches above the original ground surface and should not exceed 34 inches above ground elevation. The filter fabric should be purchased in a continuous roll cut to the length of the barrier to avoid the use of joints. When joints are unavoidable, filter cloth should be spliced together only at a support post, with a minimum six-inch overlap, and be sealed securely.

A trench should be excavated approximately four inches wide and four inches deep on the upslope side of the proposed location of the silt fence.

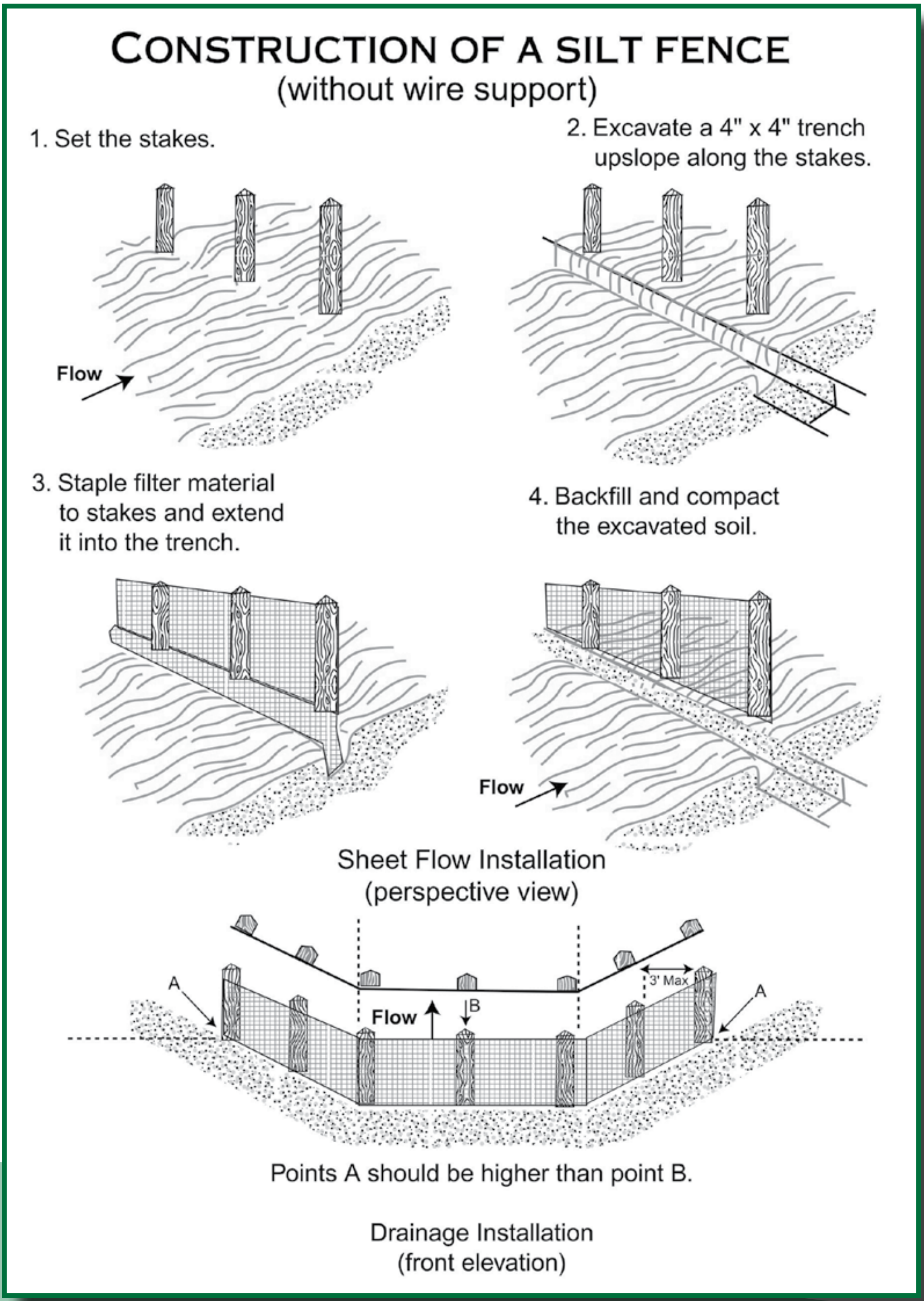
When wire support is used, standard-strength filter cloth may be used. Posts for this type of installation should be placed a maximum of 10 feet apart. The wire mesh fence should be fastened securely to the upslope side of the posts using heavy duty wire staples at least one inch long, tie wires or hog rings. The wire should extend into the trench a minimum of two inches and should not extend more than 34 inches above the original ground surface. The standard-strength fabric should be stapled or wired to the wire fence, and eight inches of the fabric should be extended into the trench. The fabric should not be stapled to existing trees.

When wire support is not used, extra-strength filter cloth should be used. Posts for this type of fabric should be placed a maximum of six feet apart. The filter fabric should be fastened securely to the upslope side of the posts using one-inch-long (minimum) heavy-duty wire staples or tie wires and eight inches of the fabric should be extended into the trench. The fabric should not be stapled to trees.

If a silt fence is to be constructed across a ditch line or swale, the measure should be of sufficient length to eliminate endflow, and the plan configuration should resemble an arc or horseshoe with the ends oriented upslope. Extra-strength filter fabric with a maximum three-foot spacing of posts should be used for this application.

The four-inch by four-inch trench should be backfilled and the soil compacted over the filter fabric.

Silt fences should be removed when they have served their useful purpose, but not before the upslope area has been permanently stabilized.



Silt fence should be inspected immediately after each rainfall and at least daily during prolonged rainfall. Any required repairs should be made immediately.

Close attention should be paid to the repair of silt fence damaged by end runs and undercutting.

Should the fabric on a silt fence decompose or become ineffective prior to the end or the expected usable life and the barrier still be necessary, the fabric should be replaced promptly.

Sediment deposits should be removed after each storm event. They should be removed when deposits reach approximately one-half the height of the barrier.

Any sediment deposits remaining in place after the silt fence is no longer required should be graded to conform with the existing road grade, prepared and seeded.

17 – Brush Barriers

Definition

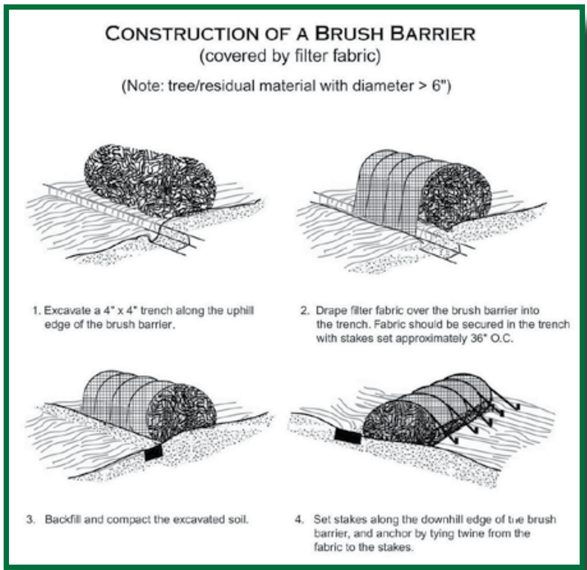
A temporary sediment barrier constructed at the perimeter of a disturbed area, such as log decks within the SMZ or skid trails in the bottoms of swales.

Purpose

To intercept and retain sediment from disturbed areas of limited extent, preventing sediment from leaving the site.

Conditions Where Practice Applies

- Below disturbed areas subject to sheet and rill erosion, where enough residue material is available for construction of such a barrier.
- Where the size of the drainage area is no greater than ¼ of an acre per 100 feet of barrier length; the maximum slope length behind the barrier is 100 feet, and the maximum slope gradient behind the barrier is 50 percent (2:1).



Planning Considerations

Slash from the logging operation and organic litter, spoil material and woody debris from clearing logging decks and haul roads are usually piled nearby. Much of this material can be used effectively on the site. During the logging operation, equipment can push and pile the mixture of limbs, small vegetation and root mat into windrows along the toe of a slope where erosion and accelerated runoff are expected. Because brush barriers are fairly stable and composed of natural materials, maintenance requirements are small. Field experience has shown, however, that many brush barrier installations are not effective when there are large voids created by the use of material that is too large to provide a compact, dense barrier. It is necessary to use residual material less than six inches in diameter that will create a more uniform barrier, or use a filter fabric overlay to promote enhanced filtration of sediment-laden runoff.

Recommended Construction Specifications

Without Filter Cloth

- The height of a brush barrier should be a minimum of three feet.
- The width of a brush barrier should be a minimum of five feet at its base. The sizes of brush barriers may vary considerably based upon the amount of material available and the judgment of the operator.
- The barrier should be constructed by piling brush, stone, root mat and other material from the logging process into a mounded row on the contour. Material larger than six inches in diameter should not be used to create the mound as the non-homogeneity of the mixture can lead to voids where sediment-laden flows can easily pass.

If a Filter is Used

- The filter fabric should be cut into lengths sufficient to lay across the barrier from its up-slope base to just beyond its peak. Where joints are necessary, the fabric should be spliced together with a minimum six-inch overlap and sealed securely.
- A trench six inches wide and four inches deep should be excavated along the length of the barrier and immediately uphill from the barrier.
- The lengths of filter fabric should be draped across the width of the barrier with the uphill edge placed in the trench and the edges of adjacent pieces overlapping each other.
- The filter fabric should be secured in the trench with stakes set approximately 36 inches on center.
- The trench should be backfilled and the soil compacted over the filter fabric.
- Set stakes into the ground along the uphill edge of the brush barrier, and anchor the fabric by tying twine from the fabric to the stakes.
- Brush barriers should be inspected after each rainfall and necessary repairs should be made promptly. Sediment deposits should be removed when they reach approximately one-half the height of the barrier.

18 – Surface Roughening

Definition

Providing a rough soil surface with horizontal depressions created by operating a tillage or other suitable implement on the contour, or by leaving slopes in a roughened condition by not fine-grading them.

Purpose

To aid in establishment of vegetative cover with seed.

To reduce runoff velocity and increase infiltration.

To reduce erosion and provide for sediment trapping.

Conditions Where Practice Applies

- Haul roads, log decks, skid trails and other areas requiring cut and fill slopes.
- All slopes steeper than 3:1 should be surface roughened by stair-stepped grading, grooving, furrowing or tracking to stabilize with vegetation.
- Areas with grades less steep than 3:1 should have the soil surface lightly roughened and loosened to a depth of two to six inches prior to seeding.
- Areas that have been graded and will not be stabilized immediately (within seven days) should be roughened to reduce runoff velocity until seeding takes place.
- Install on cut slopes and fill slopes of haul roads, log decks, skid trails, etc.
- Slopes with a stable rock face do not require roughening or stabilization.

Planning Considerations

It is difficult to establish vegetation on graded or fill areas with smooth, hard surfaces due to reduced water infiltration and the potential for erosion. Rough slope surfaces with uneven soil and small rocks left in place encourage water infiltration; speed the establishment of vegetation, and decrease runoff velocity.

Rough, loose soil surfaces give lime, fertilizer and seed some natural coverage. Niches in the surface provide microclimates that generally provide a cooler and more favorable moisture level than hard, flat surfaces; this aids seed germination.

There are different methods of achieving a roughened soil surface on a slope, and the selection of an appropriate method depends upon the type of slope. Roughening methods include stair-step grading, grooving and tracking. Factors to be considered in choosing a method are slope steepness; landowner desires regarding maintenance and future land use (mowing requirements, fire break, wildlife habitat, reforestation, etc.), and whether the slope is formed by cutting or filling.

1. Disturbed areas that will not require maintenance, such as mowing for wildlife habitat, may be stair-step graded, grooved or left rough after filling.

2. Stair-step grading is particularly appropriate in soils containing large amounts of soft rock. Each "step" catches material that sloughs from above and provides a level site where vegetation can become established.

3. Areas that will be mowed (these areas should have slopes less than 3:1) may have small furrows left by discing, harrowing, raking or seed planting machinery (such as seed drill or sod seeder) operated on the contour.

4. It is important to avoid excessive compacting of the soil surface when scarifying. Tracking with bulldozer treads is preferable to not roughening at all, but is not as effective as other forms of roughening because the soil surface is severely compacted and runoff is increased.

Recommended Specifications

Cut Slope Areas

Cut slopes with a gradient steeper than 3:1 should be stair-step graded or grooved.

1. Stair-step grading may be carried out on any material soft enough to be ripped with a bulldozer. Slopes consisting of soft rock with some subsoil are particularly suited to stair-step grading.

   The ratio of the vertical cut distance to the horizontal distance should be less than 1:1 and the horizontal portion of the "step" should slope toward the vertical wall (in-sloped).

   Individual vertical cuts should not be more than 30 inches on soft soil materials and not more than 40 inches in rocky materials.

2. Grooving is achieved by using machinery to create a series of ridges and depressions that run perpendicular to the slope (on the contour).

Grooves may be made with any appropriate implement that can be safely operated on the slope and that will not cause undue compaction. Suggested implements include discs, tillers, spring harrows and teeth on the front-end loader bucket. Such grooves should not be less than three inches deep nor farther apart than 15 inches.

Fill Slope Application

Fill slopes with a gradient steeper than 3:1 should be grooved or be allowed to remain rough as they are constructed. Method one or two below may be used.

1. Groove according to number two above.

2. As lifts of the fill are constructed, soil and rock materials may be allowed to fall naturally onto the slope surface.

Colluvial materials (soil deposits at the base of slopes or from old streambeds) should not be used in fills because they flow when saturated.

Slopes should not be bladed or scraped to produce a smooth, hard surface.

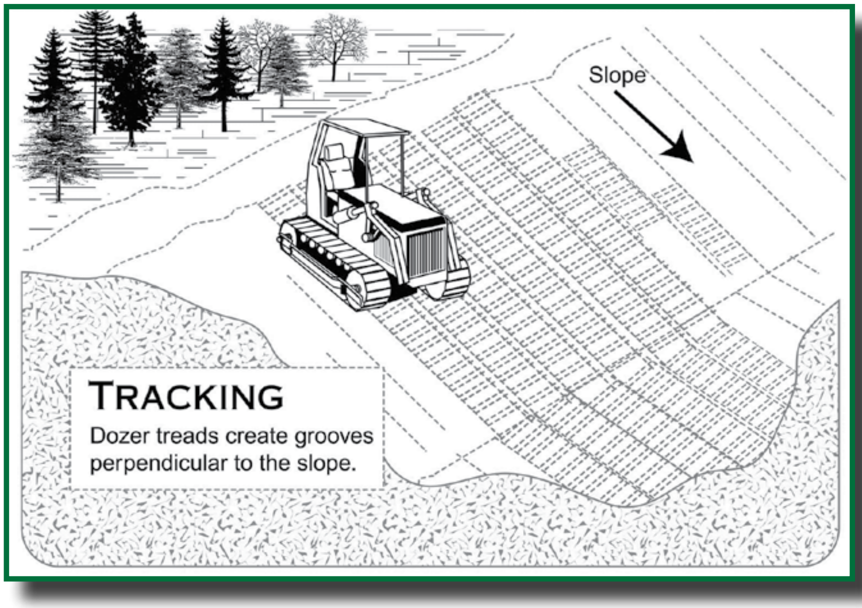
Mowed slopes (areas to be maintained as wildlife habitat, fire breaks, shoulders of access roads, etc.) should not be steeper than 3:1. Excessive roughness is undesirable where mowing is planned. These areas may be roughened with shallow grooves, such as remain after tilling, discing, harrowing, raking or after use of a cultipacker-seeder. The final pass of any such tillage implement shall be on the contour (perpendicular to the slope).

Grooves formed by such implements shall be not less than one inch deep and not farther than 12 inches apart. Fill slopes that are left rough as constructed may be smoothed with a dragline or pickchain to facilitate maintenance and/or mowing.

Roughening with Tracked Machinery – Roughening with tracked machinery on clay soils is not recommended. Undue compaction of surface soil results from this practice. Sandy soils do not compact severely, and may be tracked. In no case is tracking as effective as the other roughening methods described.

When tracking is the chosen surface-roughening technique, it should be done by operating tracked machinery up and down the slope to leave horizontal depressions in the soil. As few passes as possible of the machinery should be made to minimize compaction.

Seeding – Roughened areas should be seeded and mulched as soon as possible to obtain optimum seed germination and seedling growth.



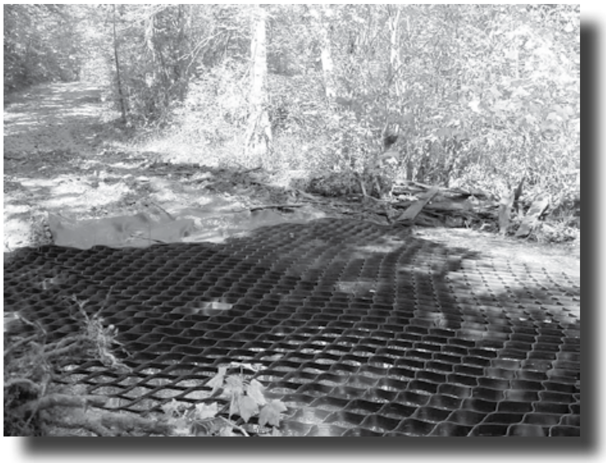
19 – Geotextile

Geotextile is a tough, nonwoven, porous 15-foot-wide roll of industrial polymer fabric. It is used to underlay gravel on soft sections of haul roads that are likely to rut excessively, and at logging road entrances where mud transfer to a public road may be a problem. The geotextile allows water on the road surface to flow through the gravel and fabric and into the ground but keeps the soil from working up through the fabric and into the gravel road surface as trafficking occurs. This dramatically reduces rutting and mud transfer and also decreases the amount of crushed rock necessary to keep the haul road serviceable.

Several types of geotextile are available in rolls ranging from 240 to 900 linear feet, depending on material composition and thickness. For maximum effectiveness, geotextile should be installed on critical haul road sections before trafficking begins or rutting occurs. Clear the road subgrade of any large stones or other sharp objects that could puncture the fabric, then carefully roll out the geotextile. Anchor it along the edges with rocks or soil, then dump a load of gravel along the leading edge and carefully spread it over the fabric with a bulldozer. Repeat this process until the geotextile is covered with the desired depth of gravel (typically four to six inches). Vehicles should not drive directly on the geotextile as the gravel is being spread.

Careful haul road planning, along with the proper use of geotextile to underlay crushed rock where appropriate; decreases haul road failure and equipment damage; eliminates problems with mud on public roads, and increases logging production and profitability.

20 – Geo Web® Improved Ford



Definition

A streambed modification to improve or "harden" a streambottom in a sandy-bottomed stream to provide support for logging trucks with minimal streambottom disturbance.

Purpose

To provide a permanent type of improved "ford" that will support the weight of a fully loaded logging truck without restriction of stream flow.

Conditions Where Practice Applies

- On stream crossings where the drainage area above the crossing is less than five square miles and where a design plan has been submitted to the Virginia Department of Forestry and has been approved by the Water Resources Team. This type of crossing is to provide a hardened stream bottom for a permanently improved ford in streams that are sandy or in silt bottomed streams.

Planning Considerations

Where a ford is to be considered as the least intrusive type of crossing to the stream with regard to the stream's stability. It should be considered an option when a bridge or culvert installation has been ruled out due to culvert sizes or bridge spans being too great to allow for economical and safe transport. The approaches to the ford should be stabilized by the installation of geotextile road fabric cover with six inches of VDOT #3 gravel.

Geo Web® is a polymer fabric eight feet wide that is designed in a honeycomb pattern of depths of four, six and eight inches. For load support options, only the six-inch and eight-inch material should be considered. When the fabric is pulled out, the formation of "cells" becomes evident. The Geo Web® should have an underlayment of geotextile road cloth to support the crushed gravel that will be backfilled into each cell, thus providing the support for the truck traffic. The greater the depth of the cell, the more load capacity the installation can handle. The stream should be crossed at a right angle to the stream flow.

Construction Recommendations

The streambed should be excavated to the depth of the Geo Web® being used. It is recommended for tractor and trailer traffic that a six-inch or eight-inch Geo Web® be used. The streambed should be lined with geotextile road fabric to the width of the desired ford. The geotextile should be installed at least 50 feet on either side of the ford on the ford approaches.

The Geo Web® fabric should be stretched across the stream bottom and backfilled with VDOT #5 crushed gravel or limestone. The depth of the installation should not exceed the depth of the original streambottom, and no restriction of stream flow should occur.

Geo Web® of at least six inches in depth may be considered on stream approaches of 50 feet on either side of the ford if a soft soil condition exists. This will ensure stability of the approaches. All bare soil areas should be graded and vegetated according to specifications in Appendix D. (See "APPENDIX D" on page 151.)

Maintenance

The crossing should be checked periodically for maintenance and gravel added if necessary. The approaches to the crossing should be maintained with clean stone to prevent the tracking of sediment on truck tires into the stream channel. The crossing should not be used during periods of extremely high water (conditions where bankfull flow is reached). Safety considerations should be of paramount importance.

21 – Logging Entrance

Definition

The entrance from the state highway onto the haul road that accesses the harvesting operation.

Purpose

To allow for the ingress and egress of logging trucks in a safe and efficient manner.

Conditions Where Practice Applies

- On all haul road entrances where they intersect with a state highway.

Planning Considerations

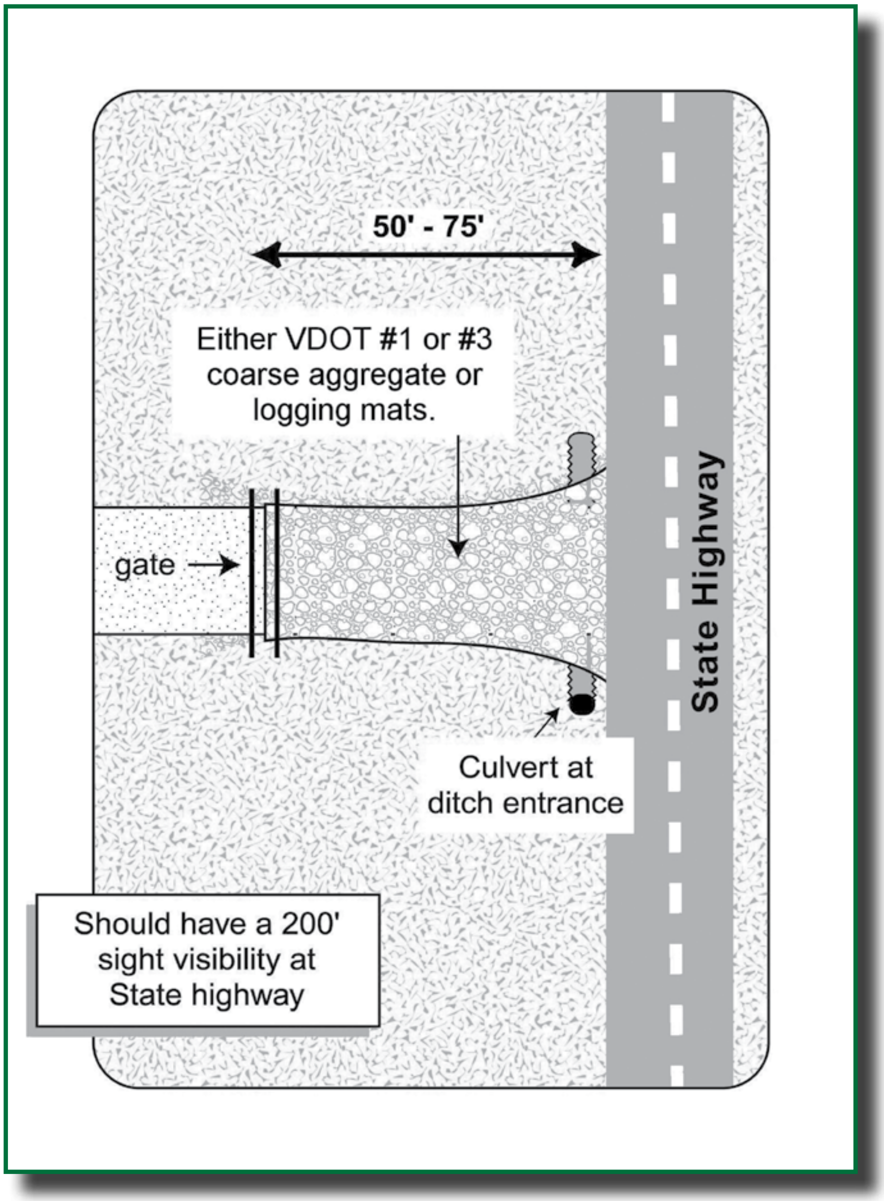
The entrance should be located in an area of good visibility to oncoming traffic. A minimum safe distance of 200 feet of visibility in both directions should be used as a guide for highway entrance. Consult with the Virginia Department of Transportation for areas of difficult access and/or limited visibility.

Entrance should be wide enough to accommodate the turning radius of the truck traffic anticipated.

A cross-drainage culvert for the highway ditchline should be installed according to Virginia Department of Transportation guidelines.

Clean, crushed gravel (VDOT #1 or #3) should be maintained at all logging road entrances to state highways. No mud should be tracked onto the state highway. The use of geotextile road fabric under the rock will save money for rock by providing a stable base for the rock. The use of wooden logging mats will also save money on rock expense.

Access to the logging site should be controlled by use of a clearly marked gate or cable.



NOTES

APPENDIX B

Planning Tools

Planning Tools

Evaluating Slope

Slope is the steepness of the land expressed as the amount (in percent) of vertical rise or fall per 100 feet of horizontal distance. For example, a five percent slope means a five-foot change in elevation per 100 feet of horizontal distance.

Slope, along with soil texture (sand, loam and clay) and ground cover, determines how fast water will drain from an area. Water drains quickly from steep slopes and erosion may be a problem. Flat surfaces may result in saturated soils. Slope can and should be managed during road design and layout. Slope can be divided into three broad categories: flat, moderate and steep. Standing downhill, and facing uphill, try to look level back into the hill. To help keep your line of site level, face uphill with your arm stretched out in front of you with a pencil pointing up out of your fist. Looking over the tip of the pencil will keep your site level. Estimate the horizontal distance between you and the point at which your site line hits the ground. Divide the height distance by horizontal distance to determine the percent of slope. Instruments that are readily available to measure slope with increased accuracy are an Abney Level; a clinometer, or a slope gauge.

Information on slope may also be obtained by using:

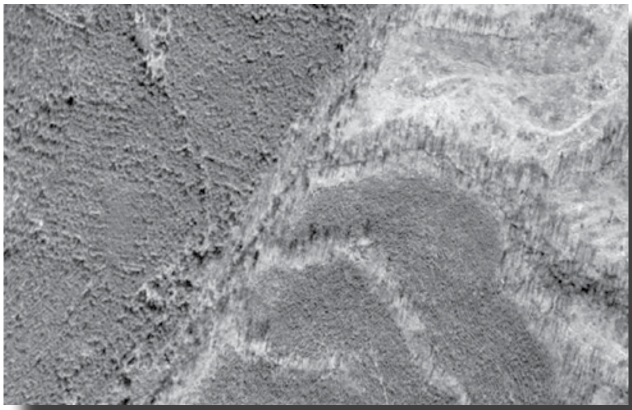
- USGS Topographic Maps
- Soil Surveys
- Soil Maps

Harvest planning maps are available (topographic maps, aerial imagery and culvert-sizing maps) when notifying via the Logger Notification website using latitude and longitude. http://www.ifris.dof.virginia.gov/harvestnotification/

Resource	Available From
USGS Topographic Maps	USGS Department of Mines, Minerals and Energy
Soil Surveys	Natural Resources Conservation Service
Aerial Photographs	Natural Resources Conservation Service Farm Services Agency Virginia Department of Forestry Field Offices Virginia Department of Transportation District Offices Private vendors

Evaluation of Aerial Photographs

Aerial photographs or "maps" are high altitude photos taken in a very concise and systematic manner. Although aerial photos can be made in color and even in infrared imagery, the most commonly used aerial photos are black and white. Generally, the top of the photograph is north. Information that can be delineated from aerial photographs is:



- Boundaries and timber types (for example, pines appear darker than hardwoods);
- Drainage patterns and streams;
- Roads, buildings and other areas of special interest; and
- Elevational changes if stereoscopic coverage is available.

Aerial photographs come in many scales such as 1 inch=660 feet, 1320 feet, 2000 feet, etc. It is very important that the individual using the photographs know the scale of the photograph so that the information will be accurate.

Evaluation of Soil Maps

Soil maps are aerial photographs on which the soil types are delineated. Soils are classified, mapped and ground truthed. They are published by the Natural Resources Conservation Service in a book called *A Soil Survey*, which can be obtained at your local NRCS office for most localities in Virginia.

Soil maps are excellent planning tools, especially in the coastal plain region of Virginia. They are very useful for:

1. Planning tract entry and operational routes;
2. Avoiding problem areas, such as wet areas;
3. Planning for stream crossing locations;
4. Estimating difficult slopes that may be encountered, and
5. Determining drainage patterns.

While soil surveys are an important tool for planning a silvicultural operation, it is still highly recommended that an on-site inspection occur to verify the exact soil type and slope on the site prior to beginning the operation.

Evaluation of Topographic Maps

Topographic maps, or "quad sheets," are printed maps that portray the relief of the landscape and display physical features, such as roads, buildings and perennial and intermittent streams.

The most commonly used topographic map is the 7.5 minute map, which has a scale of 1:24,000 or one inch = 2,000 feet. The scale of the map is always displayed at the bottom of the map.

Changes in elevation are shown by a series of contour interval lines. These lines represent a point's elevation above sea level. Any point along a line is the same elevation as any other point on the same line. The closer the contour lines are to each other, the steeper the slope. The elevation distance between the lines is usually five or 10 feet, and can be 20 or 40 feet in the mountains. The information is given at the bottom center of the map. The elevation is frequently printed along several of the contour lines.

To determine the slope from a topographic map, first determine the elevation change between two points from the contour lines, being careful to use the proper contour interval. Divide the change in elevation by the distance between the two points. Multiply by 100 to get the percent slope.

Evaluation of Drainage Area

Drainage area, or watershed, is the total number of acres that drain to a common point in a stream channel, such as a culvert, creek crossing or bridge. Determining the acreage in the watershed is important in sizing culverts, locating stream crossings or locating bridges.

The use of topographic maps is critical in determining a watershed area. The topo maps show changes in elevation by a series of contour lines. These lines can be used to determine which slopes drain through an area. To determine the watershed, it is helpful to remember two things:

1. On hilltops, contour lines will form a small, rough circular shape.
2. On contour lines with fingerlike projections, which identify the stream flow, the fingers point uphill.

The watershed can be defined by drawing arrows in the direction of drainage to the common point. After the watershed is drawn, the number of acres in the area can be estimated. For a topographic map with a scale of 1:24,000 (a 7.5 minute map), Table 18 can be used as a quick guide.

Table 18
Guide for Area Estimation on a 7.5 Minute Topographic Map

Shape	Acres
Head of a Pencil Eraser	5
Dime	40
Nickel	50
Quarter	70
1 in. x 1 in. square	90

NOTES

APPENDIX C

Road Surface Area

Road Surface Area

Determining Road Surface Area

The following is intended as an aid to determine the surface area of roads.

1. Determine the road acreage for each segment of the road system from the Road Surface Area table given below.
2. Combine the acreage of each road segment to determine the total acreage of the entire road system.

Multiply the total acreage of the road system by the recommended application/acre of the appropriate revegetating material (e.g., fertilizer, seed mix, mulch, etc.) to determine the total amount of materials needed.

Table 19
Guide for Determining Road Surface Area

Road Length (ft.)	Road Width						
	8 ft.	10 ft.	12 ft.	14 ft.	16 ft.	18 ft.	20 ft.
	Road System Acreage						
50	0.01	0.01	0.01	0.02	0.02	0.02	0.02
100	0.02	0.02	0.03	0.03	0.04	0.04	0.05
250	0.05	0.06	0.07	0.08	0.09	0.10	0.11
500	0.09	0.12	0.14	0.16	0.18	0.21	0.23
750	0.14	0.17	0.21	0.24	0.27	0.31	0.34
1,000	0.18	0.24	0.28	0.32	0.37	0.41	0.46
1,500	0.28	0.34	0.41	0.48	0.55	0.62	0.69
2,000	0.36	0.48	0.56	0.64	0.73	0.83	0.92
5,000	0.92	1.15	1.38	1.61	1.80	2.07	2.30
5,280	0.97	1.21	1.45	1.70	1.94	2.18	2.43
Wider road widths can be calculated by using multiples from this table.							

Determining Road Surface Material

The following is intended as an aid to determine the surface area of forest roads.

Table 20 Surface Material Determination for Roads			
Road Width (ft.)	Surfacing Material Thickness (yd.^{3})		
	2 in.	4 in.	6 in.
8	5	10	15
10	6	12	19
12	7	15	22
14	9	17	26
16	10	20	30
18	11	22	33
20	12	25	37
22	14	27	41
24	15	30	44
Cubic yards of surfacing material per 100 ft. of road length			

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APPENDIX D

Revegetation of Disturbed Areas

Revegetation of Disturbed Areas

Revegetation of Bare Soil Areas

This Appendix focuses on stabilization of disturbed soil or bare soil areas following silvicultural operations. A typical construction site erodes at a rate of up to 100,000 tons per square mile per year. This rate is 200 times greater than erosion from cropland and 2,000 times greater than erosion from Woodland (Pennsylvania Alliance for the Chesapeake Bay, Citizen's Guide to Soil Erosion Control, Chesapeake Bay Education Office). Proper harvest planning for the ongoing harvest, close-out and stabilization of the tract is required to prevent excessive erosion and sedimentation of streams and channels. Without proper planning, stabilization and maintenance of disturbed soil areas, the harvested site can erode at rates approaching those of construction sites.

The successful mitigation of soil losses on harvested sites results in the reduction of on-site and off-site environmental damage and substantial savings to landowners, loggers and, in the long term, the Commonwealth of Virginia. When implemented properly, Best Management Practices can control soil movement to a point where there is only minimal loss of this very precious resource; no appreciable damage to the waters of the Commonwealth; less future productive soil loss; enhanced project aesthetics before, during and after harvesting, and fewer complaints from concerned government agencies and citizens. Notably, there is a state law that dictates the use of such measures.

Soil stabilization practices are necessary where soil is exposed and is likely to erode to adjacent streams. Stabilization through revegetation is recommended on all soil areas. Permanent soil stabilization should be applied to all disturbed soil areas immediately after harvest. Temporary soil stabilization should be applied within seven days to denuded areas where timber harvesting may not be final but will remain dormant for longer than 30 days. If the total harvest time of the operation is likely to exceed 30 days, the tract should be divided into parcels and each parcel permanently stabilized as soon as it is completed. A temporary or permanent vegetative cover should be established on all denuded areas that will not be affected by skidding or other soil-disturbing activity immediately after construction of cut and fill slopes, haul roads, skid trails, log decks, etc.

Permanent vegetation should not be considered established until a ground cover is achieved that is uniform; mature enough to survive, and will inhibit erosion. If permanent vegetation is not established within a reasonable time period, additional attempts should be made and/or alternative measures considered.

Stabilization measures should be applied to earthen structures, such as water bars, broad-based dips and rolling dips, dikes, traps, basins and other diversions.

Cut and fill slopes should be constructed in a manner that will minimize erosion. Concentrated runoff should not flow down cut or fill slopes unless contained within an adequate temporary or permanent channel, flume or slope drain structure.

Whenever water seeps from a slope face, adequate drainage or other protection should be provided.

Specifications for Revegetation

- Prior to seeding, install all necessary water control structures, such as waterbars, broad-based dips and turnouts.
- Select a seed mix appropriate for the conditions and the landowner's objectives for future use of the site. Most of the species in the following tables are available in Virginia. Seed immediately following harvest using the seasonal seed variety mixes and application rates provided in the following tables. Choose a mixture of main crop, legumes and grains/grasses to equal a total of 100 to 150 pounds/acre seeding rate.
- Lime and fertilizer should not be applied to an area without first having the soil tested. Results from Virginia Tech take about two weeks and include lime and fertilizer application rates. There is a small charge for a soil test. Most Virginia soils are acidic and will require lime application. Proper pH helps ensure full use of applied fertilizer, so do not guess on lime and fertilizer application rates. In general, in areas with acidic soils, 1.5 tons of lime per acre and 600 pounds of fertilizer will assist germination and survival.
- To control erosion, seed must be able to germinate and grow. This requires adequate preparation of the seed bed. Disking, sub-soiling or dragging brush or a chain across the area to be seeded may be necessary to ensure good contact between the seed and soil.
- Seed shall be spread using a broadcast seeder, drill or hydro seeder. Most seed varieties will successfully germinate when planting 1/8 inch to 1/4 inch below the soil surface. Drag chains or brush over the area again after seed broadcast to ensure good seed-soil contact.
- Seed broadcast in dry summer months and fall can be helped with an application of mulch. Straw or hay mulch is effective and inexpensive. Often straw bales that the landowner cannot use for livestock are perfect sources of mulch for log roads and landings.

Critical Area Planting

Soil stabilization requirements may increase in severely disturbed or highly sensitive areas. The site should be prepared as indicated in the previous section. Higher seed rates that include fast-germinating grains and grasses are recommended in the table below. Critical areas include eroding skid trails leading directly to streams; areas where culverts were removed or disturbed, or areas impacted by severe storms or floods. Mulching should always occur for critical-area planting at rates of two tons to four tons of mulch per acre. If this type of planting occurs in mid-winter, consider mulch only until the spring seeding period occurs.

Table 21
Seeding Mixtures and Guidelines for Revegetation of Critical Areas in Virginia

Seeding Mixtures	Rates Per Acre	Northern Piedmont, Mountains, Valley	Southern Piedmont, Coastal Plain	Comments
MAIN CROP – Choose one of the following or a combination				
Perennial Ryegrass K-31 Fescue	Total 60-75 lbs.	Feb. 15 - May 15 Aug. 15 - Nov. 15	Feb. 1 - Apr. 15 Sept. 15 - Nov. 15	Choose one rye, perennial rye and/or fescue as a main crop grass. A combination can also be used in fall plantings. Use of annual rye outside peak seeding times is beneficial as a quick, temporary cover.
LEGUME – Choose one of the following or a combination				
Kobe orrean L. Koespedeza	15 lbs.	N/A	Mar. 1 - May 1	A legume will provide wildlife food and cover and add nitrogen to the soil. Choose one or a combination in addition to your main crop.
Hairy or Woodford	15 lbs.	N/A	Feb. 1 - May 15	
Bigflower	15 lbs.	Feb. 15 - May 1	N/A	
Lathco Flatpea Alfalfa	25 lbs.	Sept. 1 - Nov. 1	N/A	
GRAINS AND GRASSES – Choose one of the following or a combination				
Weeping Lovegrass	20 lbs.	Mar. 15 - May 15	N/A	Adding additional grains and grasses ensures plant diversity if the main crop does not successfully seed. Many of these grasses produce grain seeds critical to game birds. Use Weeping Lovegrass on steep slopes when seeding in warm seasons.
Foxtail Millet	20 lbs.	May 15 - Aug. 15	May 1 - Sept. 1	
Hybrid Bermudagrass	15 lbs.	N/A	Mar. 1 - May 15	
Choose a mixture of main crop, legumes and grains/grasses to equal a total of 100 to 150 lbs./acre seeding rate.				

The Use of Native Plants for Restoration

Native grasses, shrubs, wildflowers and trees are natural to the ecosystems of Virginia. Many natural habitats for some of our native plants are rapidly being lost and, along with them, the environmental benefits that they provide. Using native plants for restoration helps preserve native species and their ecological relationships with other plants and animals. Erosion and flood control, animal habitat and nitrogen fixation are but a few of the values provided to Virginia. By including native plant species in our land management prescriptions, we can help conserve natural ecosystems and the organisms that are dependent on these well-adapted communities.

Table 22
Critical Planting Area

Late Winter/Spring	Rate Per 1,000 Sq. Ft.	Rate Per Acre
Oats	2 lbs.	95 lbs.
Rye	3 lbs.	140 lbs.
Ryegrass	1 lb.	45 lbs.
Oats and Ryegrass	½ lb. - 1 lb.	45 - 60 lbs.
Oats and Korean Lespedeza	½ lb. - 1 lb.	45 - 60 lbs.
Summer	**Rate Per 1,000 Sq. Ft.**	**Rate Per Acre**
Sundangrass	1 lb.	35 - 45 lbs.
Browntop Millet	1 lb.	30 - 40 lbs.
Weeping Lovegrass	5 lbs.	25 lbs.
Late Summer/Early Winter	**Rate Per 1,000 Sq. Ft.**	**Rate Per Acre**
Rye	3 lbs.	140 lbs.
Ryegrass	1 lb.	45 lbs.
Oats (before Oct. 1)	2 lbs.	90 lbs.
Barley (before Oct. 15)	3 lbs.	140 lbs.
Wheat (after Oct. 1)	3 lbs.	140 lbs.

What are Native Plants?

Native species are classified as those that occur in the region in which they have evolved. Plants and animals evolve in specific habitats over extended periods of time. This selective development is a response to physical and biotic processes characteristic of that region, and is driven by a combination of interactive forces: vegetation and soil; soil and landform, and landform and vegetation. Drought, precipitation, solar radiation, slope position and orientation, geologic substrate and hydrologic factors all play a part in contributing to the ecological processes with which a plant evolves. Native plants, therefore, possess certain traits that make them uniquely adapted to local conditions.

Planting Methods for Native Warm Season Grasses

A specialized grass drill is necessary to plant big and little bluestem and Indiangrass. These drills may be locally available from the Virginia Department of Game and Inland Fisheries (804-598-3706) or from the local Soil and Water Conservation District. Conventional equipment can be used to plant switchgrass and coastal panicgrass (alfalfa seed box on grain drill) and eastern gamagrass (corn planter). Indiangrass and big and little bluestem seed are fluffy and will not pass through conventional equipment unless they are ordered as debearded or brushed, which is an extra expense.

Native warm season grasses can be planted using either the no-till method or with conventional tilling. With either technique, the seedbed should be cultipacked after drilling to ensure good seed contact with mineral soil. No-till planting is probably the preferred method since soil disturbance is lessened, thus reducing germination of competing weeds. Potential soil erosion is minimized, and buried rocks are not brought to the surface. May and June are the preferred planting months for native warm season grasses, although in Coastal Plain areas, late April may be suitable. Some have had good results planting into the first few days of July in the Piedmont and Blue Ridge regions.

Planting Rates

Warm season grass planting rates for grazing or wildlife (recommended by Virginia Department of Game and Inland Fisheries):

Table 23
Planting Rates

Grass Species	For Grazing		For Wildlife
	Drilled Rate Per Acre (lbs. per acre)	Broadcast Rate Per Acre	Broadcast Rate Per Acre
Switchgrass	7 lbs.	9 lbs.	5 lbs.
Big Bluestem	8 lbs.	10 lbs.	7 lbs.
Indiangrass	7 lbs.	10 lbs.	7 lbs.
Coastal Panicgrass	10 lbs.	10 lbs.	8 lbs.
Eastern Gamagrass	8 lbs.	*	7 lbs.

Pounds Pure Live Seed (PLS) per acre
* Not recommended

For More Information

Virginia Native Plant Society
Virginia State Arboretum
Blandy Experimental Farm
400 Blandy Farm Road, Unit 2
Boyce, Virginia 22620
Phone: (540) 540-837-1600
vnpsofc@shentel.net
www.vnps.org

Department of Conservation and Recreation
Division of Natural Heritage
217 Governor Street, Suite 312
Richmond, Virginia 23219
Phone: (804) 786-7951
Fax: (804) 371-2674
www.dcr.virginia.gov/dnh

Virginia Department of Game and Inland Fisheries
4010 West Broad Street
P.O. Box 11104
Richmond, Virginia 23230
Phone: (804) 367-1000
Fax: (804) 367-9147
www.dgif.virginia.gov

USDA Natural Resources Conservation Service
Richmond State Office
1606 Santa Rosa Road, Suite 209
Richmond, Virginia 23229-5014
Phone: (804) 287-1691
Fax: (804) 287-1737
www.va.nrcs.usda.gov

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APPENDIX E

Agency Listing

Agency Listing

The following information is designed to assist the forest operator with information requirements. This information is broken out by federal and state agencies and topic area.

Virginia Department of Forestry (VDOF)

For information and assistance from VDOF in the areas of pre-harvest planning, water quality law questions and/or general assistance, contact:

Virginia Department of Forestry
900 Natural Resources Drive, Suite 800
Charlottesville, Virginia 22903-0667
(434) 977-6555
Fax: (434) 296-2369

Western Region, Salem

210 Riverland Drive
Post Office Box 100
Salem, Virginia 24153-0100
(540) 387-5461
Fax: (540) 387-5445

Central Region, Charlottesville

900 Natural Resources Drive, Suite 800
Charlottesville, Virginia 22903
(434) 977-5193
Fax: (434) 296-3290

Eastern Region, Providence Forge

11301 Pocahontas Trail
Providence Forge, VA 23140
(804) 966-2209
Fax: (804) 966-9801

Department of Game and Inland Fisheries (DGIF)

For information and assistance on wildlife and habitat protection, contact the Department of Game and Inland Fisheries at the address and number below:

4010 West Broad Street
Post Office Box 11104
Richmond, Virginia 23230-1104
(804) 367-1000
Fax: (804) 367-9147
www.dgif.virginia.gov

Department of Mines, Minerals and Energy (DMME)

For acquisition of topographic maps for pre-harvest planning, contact the map sales office of DMME, or call VDOF.

Department of Mines, Minerals and Energy
Division of Geology and Mineral Resources
900 Natural Resources Drive, Suite 500
Charlottesville, Virginia 22903-0667
(434) 951-6340
Fax: (434) 951-6366
www.dmme.virginia.gov

U.S. Army Corps of Engineers

For information and assistance on wetlands and to determine if a permit is required, contact the regional office of the U.S. Army Corps of Engineers.

www.usace.army.mil

Norfolk District

803 Front St.
Norfolk, VA 23510
(757) 201-7606
www.nao.usace.army.mil

Department of Conservation and Recreation (DCR) Division of Natural Heritage

For information regarding rare, threatened or endangered species, please contact:

Project Review Coordinator
DCR–Division of Natural Heritage
217 Governor Street
Richmond, Virginia 23219
(804) 786-7951
www.dcr.virginia.gov/dnh

DCR Division of Chesapeake Bay Local Assistance

For information and assistance on whether the harvested tract lies within the Chesapeake Bay Resource Protection Area, contact the DCR Division of Chesapeake Bay Local Assistance at the following address and phone number; the local county zoning official, or the VDOF.

DCR Division of Chesapeake Bay Local Assistance
James Monroe Building, 101 North 14th Street, 17th Floor
Richmond, Virginia 23219
1-800-ChesBay (1-800-243-7229) or (804) 225-3440
www.dcr.virginia.gov/cbla

Virginia Marine Resources Commission

For information and assistance on stream crossing permits if the drainage area above a stream crossing is larger than 3,000 acres, contact the Virginia Marine Resources Commission at the address and number below:

Virginia Marine Resources Commission
2600 Washington Avenue
Newport News, Virginia 23607-0756
(757) 247-2200
Fax: (757) 247-8026
www.mrc.virginia.gov

Virginia Department of Environmental Quality (DEQ)

Oil spills of more than 50 gallons must be reported. Please contact the appropriate Regional Office:

Richmond State Office

629 East Main St.
P.O. Box 1105
Richmond, VA 23218
(804) 698-4000
Fax: (804) 698-4500

Southwest Regional Office

355 Deadmore Street
PO Box 1688
Abingdon, Virginia 24212
Phone: (276) 676-4800

Valley Regional Office

4411 Early Road
PO Box 3000
Harrisonburg, Virginia 22801
Phone: (540) 574-7800

Piedmont Regional Office

PO Box 4949-A Cox Road
Glen Allen, Virginia 23060
Phone: (804) 527-5020

West Central Regional Office

3019 Peters Creek Road
Roanoke, Virginia 24019
Phone: (540) 562-6700

Lynchburg Satellite Office

7705 Timberlake Road
Lynchburg, Virginia 24502
Phone: (434) 582-5120

Tidewater Regional Office

5636 Southern Blvd.
Virginia Beach, Virginia 23462
Phone: (757) 518-2000

Northern Virginia Regional Office

13901 Crown Court
Woodbridge, Virginia 22193
Phone: (703) 583-3800

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Logging Notification

www.dof.virginia.gov

1-800-939-LOGS

(1-800-939-5647)

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VDOF P00104; 03/2011

APPENDIX K: PRESCRIBED FIRE MANAGEMENT PROGRAM

1.0 INTRODUCTION

"Prescribed burning is a tool for reducing fuels and restoring a disturbance process to landscapes that historically experienced fire" (Knapp et al. 2009). The effective implementation of prescribed fire is necessary to achieve many of the military training and natural resources management goals and objectives discussed in Chapter 1. For the Fort Pickett INRMP prescribed fire is defined as "Fire applied in a knowledgeable manner to forest and field fuels on a specific land area under selected weather conditions to accomplish predetermined, well-defined management objectives" (Waldrop et al. 1992).

The Fort Pickett prescribed fire program is intended for use with other management tools, to manipulate vegetation in order to improve and maintain training land. This Appendix will be replaced with the Ft Pickett Integrated Wildland Fire Management Plan when it is completed in 2017. Prescribed fire is often the most cost effective alternative for controlling the encroachment of woody vegetation in open maneuver areas. In addition, prescribed fire has the added benefit of promoting native biodiversity, maintaining, and enhancing habitat for rare and endangered species and improving habitat for game and non-game species.

2.0 FORT PICKETT FIRE HISTORY

During the construction phase of Camp Pickett, there were several fires of unknown origin reported though it is likely that these fires were the result of the extensive construction activities occurring at this time. Since the initiation of military live fire training in 1942, periodic fires of all intensities have become the norm in the CAA. Training wildfires are typically caused by military operations during which heavy weapons fire, flares and tracer rounds ignite surrounding vegetation. Ignition caused by weapons fire is similar to a lightning strike, though it occurs much more frequently. Training-induced wildfires can occur at any time of the year, but have historically been more common from early fall through early spring. Permanent firebreaks surround the CAA; wildfires within the CAA are typically allowed to burn unhindered if there is no threat to range structures or human safety. The present Fort Pickett range operations procedure for wildfire in the CAA is to notify the forestry office and fire department who determines if protection measures are necessary for range facilities. Normally, a fire crew is dispatched to protect endangered structures (wooden observation towers, range buildings target, etc.) and/or the area immediately surrounding them. Suppression of fire in areas away from a range facility has historically been encouraged. Military training-caused wildfires outside of the CAA occur less frequently and historically these fires have been aggressively controlled.

The only natural ignition source for wildland fire in the southeastern United States is lightning. Fort Pickett is in the 'southern pine forest lightning fire bioclimatic region,' as identified by Komarek (1968). Thunderstorms and lightning strikes are more common in the southeast than any other region of North America (Komarek 1968). However, the percentage of strikes resulting in wildland fire is much lower than in the Rocky Mountain region, due to the fuel moisture content of the vegetation in the southeast as compared to the Rocky Mountains. Because of unsuitable fuel moisture conditions, less than 0.0005 percent of lightning strikes in the southeast actually result in fire (Komarek 1968). There is one recorded event of a lightning-induced wildfire at Fort Pickett. However, this low frequency does not preclude the probability of more such occurrences, since the region is subjected to numerous lightning strikes every year. It is safe to assume that the land comprising Fort Pickett experienced the same historical fire regime as the rest of the southeastern Piedmont.

Prescribed burns have historically been conducted in from January through mid-April and as fuel loads and weather conditions allow. Prescribed fire has been used to improve training land suitability, rare and endangered species habitat improvement, game and non-game species habitat improvement, forestry management, and fuel load reduction. Typically prescribed burns for fuel load reduction are conducted during the winter, when the training load is minimal and the risk of extreme fire behavior is low. Training land suitability and habitat management burns are typically conducted as the weather warms in order to control encroaching woody vegetation more effectively.

3.0 PRESCRIBED FIRE MANAGEMENT GOALS AND OBJECTIVES

The primary purpose of the Fort Pickett prescribed fire management program is to integrate the many uses of prescribed fire into the overall natural resources and training land management. The management program presented in this section omits the usage of prescribed fire performed exclusively as a silvicultural tool, which was presented in Section 6.1.

The NLEB Guidance will affect the timing and locations of prescribed burns and will be integrated into the planning process and the Integrated Wildland Fire Management Plan, updated 2012. See Section 5.3.4 Bat Management of the INRMP for more information.

There are five goals specifically for the prescribed fire program at Fort Pickett: (1) training land improvement and maintenance, (2) rare and endangered species management, (3) biodiversity, (4) fuel reduction, and (5) silviculture.

1. <u>Maintain and improve training suitability and sustainability</u>.

   The types of military training (see Chapter 4) that occur at Fort Pickett require large acreages that are open and accessible to military vehicles. There are approximately 3000 acres that are maintained as open grassland and shrubland for the purposes of military training. Prescribed fire is often the most cost effective and ecologically sound management tool to maintain these fields in a suitable condition for military training.

2. <u>Increase and improve rare and endangered species habitat</u>.

   Five of the rare and endangered species listed in Table 4 require fire at some stage of their life cycle for their continued existence at Fort Pickett. These five are: Michaux's sumac,[1] downy phlox (*Phlox pilosa*), old field milkvine (*Matelea decipiens*), velvety sedge, and grassland birds in general. For each of these species, fire provides the disturbance

[1] See section 5.3.1 for specific Michaux's sumac management goals.

necessary to maintain optimal habitat conditions (Fleming and Van Alstine 1994, Askins et al. 2007, Emrick and Jones 2008).

3. Increase overall installation biodiversity.

It is widely accepted that the re-introduction of fire into southeastern plant communities adapted to periodic fire increases overall biodiversity at the landscape level (Christensen 1977; Wright and Bailey 1982; Wade 1989; Whelan 1995).

4. Reduction in natural fuel accumulation.

Because Fort Pickett is located in a region of high vegetative productivity fuel levels can accumulate rapidly thus fuel reduction is an important goal of the prescribed fire management program

5. Improve productivity of forests.

The use of fire as a silvicultural tool to improve timber production, clear logging debris and prepare seed beds is widespread throughout the southeast. Prescribed fire is a recommended tool for the regeneration of southern yellow pines and can be used in combination with specific harvesting techniques to regenerate oak stands (Wright and Bailey 1982, Abrams 1992; Van Lear 1991).

The following are specific objectives for this five-year update of the Fort Pickett INRMP that support the overall long-term prescribed fire management goals.[2]

Objective 1: Implement prescribed fire on a minimum of 2,000 acres/year.

Objective 2: Insure that all Michaux's sumac colonies are subjected to fire (prescribed or training caused) at least once every three years.

Objective 3: Insure that all open grasslands and shrublands are subjected to fire (prescribed or training caused) at least once every three years.

Objective 4: Use existing vegetation/land-use maps to develop a GIS of wildland fire-carrying fuel types for Fort Pickett for use in standard fire spread geospatial models.

Objective 5: Identify and map critical areas of Fort Pickett where fuel reduction burns are required to maintain safe training conditions and insure training caused wildfires do not jump to adjacent private property.

Objective 6: Revise, update, and identify manageable burn units in a geodatabase. Each burn unit will have at least one long term goal identified.

Objective 7: Identify Fort Pickett prescribed fire working group.

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[2] All prescribed fire objectives are highly dependent upon safe and appropriate weather conditions

4.0 IMPLEMENTATION OF PRESCRIBED FIRE MANAGEMENT AT FORT PICKETT

Prescribed fire is a valuable and necessary tool for natural resources management at Fort Pickett. However, if applied in a careless manner, prescribed fire can result in damage to natural resources, human injury, and property loss. All fire plans and personnel must be pre-approved by the Fort Pickett Fire Manager/Marshall.

5.0 FORT PICKETT PRESCRIBED FIRE WORKING GROUP

Though prescribed fires may be performed at any time of year the primary "burn season" at Fort Pickett is from January – April. Because the timing, extent, location, and number of prescribed fires able to be implemented is highly dependent upon weather and military training, proposing a rigid schedule is useless. However, setting up a process where the burn units are prioritized based upon the goal(s) of the unit and assessed at the end of the season will facilitate the accomplishment of long-term goals while being flexible enough to adapt to yearly conditions.

One of the objectives is to identify a Fort Pickett Prescribed Fire Working Group. The purpose of this working group is to meet a minimum twice a year for:

1. Pre-planning and identifying potential burn units for the next burn season, and
2. Post burn assessment of the preceding fire season.

The working group should be comprised of Fort Pickett personnel and stakeholders that have management responsibilities that fall under at least one of the Fort Pickett prescribed fire program management goals.

The working group will be chaired by the Fort Pickett Forestry Program Manager who will be responsible for identifying members and convening the group. The Fort Pickett Prescribed Fire Working Group will have the following minimum responsibilities.

1. Identify and prioritize burn units prior to each burn season and the objectives for each individual proposed burn.
2. Identify, at minimum, 2,000 acres of proposed prescribed burns each season.
3. Update and alter burn unit boundaries and goals based upon changing management concerns and environmental conditions.
4. Identify resources available to implement the proposed burns.
5. Assess the success of each burn based upon the long term goals.

6.0 CONSIDERATIONS AND RECOMMENDATIONS PRESCRIBED FIRE MANAGEMENT AND PLANNING

As with most natural resources management manipulations, prescribed fire is used to alter the structure and floristic composition of the vegetation within the burn unit to achieve management goals and objectives. There are three critical aspects to a prescribed fire program that will determine its overall effectiveness in accomplishing long term goals: frequency, timing, and intensity.

Frequency

The implementation of prescribed fire at Fort Pickett is not a one-time endeavor, but a continuous program that must be performed with planned regularity in order to accomplish long-term management goals thus requiring a commitment that extends well past the period covered by this INRMP. The frequency in which a particular unit is burned will significantly affect the physiognomic structure and floristic composition of the plant communities within the burn unit. Therefore, the rotations (e.g. frequency) for each burn unit were determined based upon the goal(s) for the particular unit and the predominant vegetation type within each unit. The historical fire frequency in the southeastern United States (prior to fire suppression efforts that began in the early 20th Century) ranged from 1-10 years, with three to four years being the most commonly cited frequency (Pyne 1982).

In general, units that are predominately open fields and shrublands should be burned on a two-year rotation if conditions are within prescription to support Fort Pickett prescribed fire management goals. Biennial burning favors the establishment of native grasses and forbs (Vogl 1973; Bragg and Hurlbert 1976; Dale 1983; Gibson and Hurlbert 1987) thus supporting goals one through four. In addition, an annual or biennial burn rotation is effective in controlling hardwood coppice growth while also limiting the establishment of pine seedlings (Waldrop and Lloyd 1991; Van Lear 1991).

Units that are predominately forested are burned on a four-year rotation to support prescribed fire management goals 1-4[3]. A four-year rotation is frequent enough to reduce fuel accumulation and the buildup of forest floor litter, which will result in an increase in the cover and diversity of herbaceous species (Thor and Nichols 1974; DeSelm et al.1974; DeSelm et al. 1973; Cain et al. 1998). A four-year rotation will also assist in thinning dense, overstocked stands, while still allowing for recruitment of some saplings to the overstory (Van Lear 1991, Whelan 1995).

Seasonality

There are three potential burn seasons at Fort Pickett: winter (15 January-1 March), spring (16 March-1 May) and summer (1 August-15 September). Prescribed fires will usually not be scheduled from 1 May through 1 August because of the high level of military training. Due to the

[3] Prescribed fire to support Silvicultural goals is specific to the stand and management situation.

listing of the northern long-eared bat (NLEB), prescribed burns conducted in April and from September to November will require the streamlined consultation per the 4(d) rule. Such activity will probably be considered an adverse effect, but that won't affect the time frame of the streamlined consultation.

The season designated for each burn unit is based upon the goal(s) of the prescribed burn and the predominant vegetation type. As with frequency, the timing of a prescribed burn is dependent upon the type of vegetation within the burn unit. Numerous studies indicate that spring and summer burns are significantly more effective at controlling woody vegetation and selecting for native warm season grasses than are winter burns (Hodgkins 1958; Hurlbert 1969; Kucera 1978; Vogl 1973; Mushinksy and Gibson 1991; Whelan 1995; Ferguson 1998). Winter burns are conducted primarily in burn units that are predominately forested, though there are exceptions based upon the goal(s) for a particular unit.

Intensity

As with frequency and seasonality, the intensity will have a significant effect on the overall impact of a prescribed fire. Fire intensities can vary both spatially and temporally and is a function of available fuel, fuel type, fuel moisture, temperature, wind speed and topography (Whelan 1995). Controlling fire intensity allows natural resources managers to use fire as a tool to either maintain or change the floristic composition and physiognomic structure of vegetation based upon the goal (s) of a particular unit. There are many methods that can be used to measure fire intensity (e.g., heat penetration of soil and crown scorch). However, the level of fuel consumption and the effect on overstory vegetation are the most commonly utilized methods for measuring and defining fire intensity (Table 15).

Table 1. Fire Intensity definitions used at Fort Pickett (Whelan 1995).

Fire intensity	Definition
Low	Soil organic and duff layers not consumed; < 60% of nonwoody vegetation consumed; < of woody material < 8 cm diameter consumed; no crown scorch; char height on trees < 1 m.
Moderate	Some consumption soil organic and duff layers; > 60% of non- woody vegetation consumed; 5 % of woody material < 8 cm diameter consumed; crown scorch < 40 %; char height on overstory trees 1-3 m
High	Soil organic and duff layers largely consumed; essentially all non-woody plant material consumed; 75% of woody material < 8 cm diameter consumed; crown scorch > 40%; char height on overstory trees greater than 3 m.

The intensity of a prescribed fire will be greatly influenced by the ignition strategy. In general, there are two types of fire, based upon their relation to the prevailing wind: heading fire and backing fire. A heading fire moves with the wind, while a backing fire moves against the wind. In most instances, a prescribed fire has an ignition strategy that incorporates both types of fire[4].

[4] It is recognized that there are varied and complex ignition strategies that are dependent on the burn unit. The two presented are the most common and show the greatest contrast in fire behavior.

Heading Fires

Heading fires are set with the wind and therefore spread across the burn unit at a greater rate. Because heading fires move with the wind, the residence time for the flame zone at any one point on the landscape is relatively short (Wade 1989). The short residence time results in less heat penetration into the soil profile, thereby resulting in less damage to plant root systems, seeds and other soil biota (Wright and Bailey 1982). In addition, heading fires, because of their swift movement, often cause less damage to tree cambium (Whelan 1995). However, the larger flame height usually associated with heading fires sometimes results in greater crown scorch. Table 16 reviews other advantages and disadvantages of heading fires.

Table 2. Advantages and disadvantages of heading fires.

Advantages	Disadvantages
Fire movement is rapid and can therefore be used on large units, thus reducing costs.	Rapid movement of fire and greater flame lengths require a larger downwind firebreak.
It is useful in fuels, such as hardwood leaves, that are difficult to burn.	Should not be used in areas of high fuel accumulation.
Can accommodate wind shifts.	There is a higher potential for crown scorch when temperatures exceed 21°C (70°F).
Preferred technique for light fuels such as grasslands and herbaceous understories of mature forests.	Should not be used in young pine plantations.
Can be used during times of higher relative humidity and fuel moisture.	Great care should be taken when used on marginal days.

Backing Fires

A backing fire is set in a manner designed to move into the wind. Backing fires move more slowly than heading fires, thus exposing the soil to longer periods of elevated temperatures. Therefore, the potential for damage to plant root systems and other soil biota is greater than with heading fires (Wade 1989). Conversely, the potential for crown scorch is negligible with backing fires. Table 17 reviews the other advantages and disadvantages of backing fires.

Table 3. Advantages and disadvantages of backing fires.

Advantages	Disadvantages
Can be used in areas of heavy fuel accumulation.	Not flexible to changes in wind direction.
Useful in reducing slash in recently thinned pine plantations.	Costs are generally higher because of the longer time required to complete the burn.
Is the easiest and safest ignition strategy.	Does not burn well under high humidity and fuel moisture conditions.
	Requires steady within stand winds. Requires homogenous fuel to burn well.

6.1 PLANNING

6.1.1 Advanced Planning

The implementation of a prescribed fire program at Fort Pickett requires effective coordination and communication with a variety of organizations on the installation and governmental entities in the surrounding communities. By examining the spatial aspects and restrictions of a prescribed burn unit well in advance, the individual(s) responsible for conducting the burn can more effectively plan and safely implement the burn when temporal conditions are optimal. The following areas should be reviewed well in advance of setting a prescribed fire. The use of GIS will greatly assist advanced planning.

1. Check the boundaries of each scheduled burn unit and assess each firebreak. If additional firebreaks are required, plow along contours to prevent erosion.
2. Investigate whether there are any natural or cultural resources management restrictions on the use of fire within the scheduled burn units.
3. Determine when military training may be occurring in the scheduled burn units.
4. Examine terrain, vegetation, and other spatial features that could potentially impact the behavior of the prescribed fire.
5. Determine ignition strategy (head fire, backfire, etc.) based upon the purposes of the prescribed fire.
6. If a burn unit is near the edge of the installation, identify potential off-site hazards.
7. Examine predictive fire models to understand fire behavior under a variety of conditions.

6.1.2 Day of Burn Planning

The Fire Manager is responsible for determining when climatic and fuel conditions are appropriate for a specific burn. The decision to ignite a prescribed fire on any given day should be guided by the following considerations:

1. **Burn Unit Prescriptions**: Are climatic conditions and other parameters within the limits of the prescription for the burn units under consideration?
2. **Resources**: Are there sufficient resources (human and equipment) to safely burn the unit(s) being considered?
3. **Firebreaks**: Are the firebreaks sufficient to control the fire within the burn unit(s) under consideration?
4. **Maps**: Are detailed maps of the burn units (showing the locations of the firebreaks) available?

5. **Burn Plan**: Has a burn plan been prepared and signed, in accordance to Virginia Department of Forestry (VDOF) guidelines? A copy of the VDOF burn plan sheet is located in Appendix L.

6. **Smoke Management**: Have the potential effects of smoke from the prescribed fire been considered? Has the VDOF smoke management plan been completed?

7. **Coordination**: Has the Range Operations morning briefing been attended to ensure adequate coordination between training and the burn crew? Have the proper state and local officials been informed of the prescribed fire?

6.1.3 Smoke Management

The use of prescribed fire can assist natural resources managers in attaining desirable management goals. However, smoke caused by prescribed fire is a pollutant and steps must be taken to minimize the negative health effects. If steps are not taken to mitigate the negative effects of smoke from a prescribed fire, the responsible individual and organization can be held legally liable for property damage and injury resulting from the smoke (Wade 1989). The VDOF requires that a smoke management plan be written for each prescribed fire. The VDOF has specific guidelines and regulations for mitigating adverse environmental and health effects of smoke from prescribed fires (see http://state.vipnet.org/dof/). These guidelines will be followed at Fort Pickett. The wind directions in the prescriptions written for each burn unit have considered potential smoke targets. The climatic information for the smoke management must be completed on the day of the burn.

The following are rules of thumb developed by the USDA Forest Service when managing smoke from a prescribed fire (Wade 1989).

1. Explicitly define objectives for the prescribed fire.
2. Obtain accurate weather and smoke management forecasts.
3. Comply with air pollution control regulations and do not burn during pollution alerts or stagnant air conditions[5].
4. Burn when conditions are good for rapid smoke dispersion.
5. Use caution when near or upwind of smoke-sensitive areas.
6. Notify local government organizations, municipalities and private residents who may be potentially affected by smoke.
7. Use test fires to observe smoke behavior.
8. Burn during the middle of the day when possible.

[5]The airshed for Fort Pickett is not under any restrictions regarding air pollution.

9. Mop up along roads.

10. Put signs on roads that may be affected by smoke to warn motorists.

6.1.4 Igniting the Burn

Once all of the proper planning has been accomplished, the fire crew(s) should proceed to the location of the prescribed fire. It is advisable to ignite the burn as early as possible to allow sufficient time for mop up and monitoring. Each unit will have a single burn boss who is responsible for the safe and timely execution of the burn. The burn boss is also responsible for ensuring that the proper equipment is onsite and in good working order. The required and optional personal protective clothing and equipment that is necessary to perform controlled burns will be determined and approved by the Fire Marshall; Table 18 lists required and optional equipment for prescribed fires at Fort Pickett.

After all the required and optional equipment is onsite, the burn boss should review the burn plan with all crewmembers. The crew should know the size of the burn unit, the location of all firebreaks, and the location of additional equipment and safe areas. All crewmembers should understand the plan of ignition. Ignition strategies that are overly complicated or not properly coordinated can cause confusion among crewmembers and lead to unwanted results.

Table 4. Required and optional equipment for prescribed burns.

Required	Optional
Radios: Each crewmember must be able to communicate with the burn boss.	Bulldozer: If the firefighting bulldozer is not required for a prescribed fire, it should be on call in case of emergencies.
Maps: A map of the burn unit should be kept onsite for proper planning and be provided to each crew member.	Fire Trailer: If the fire trailer is not required for a prescribed fire, it should be on call in case of emergencies.
Proper Clothing: All burn crew members will wear proper safety clothing consisting of: fire-resistant long sleeve shirts, pants, boots, gloves, hard hats, and eye protection.	ATV: ATVs are useful in patrolling firebreaks and controlling spot fires in rough and inaccessible terrain.
Drinking Water: Plenty of drinking water should be provided for all crewmembers.	Fire Department: For some burn units near structures, especially within the CAA, it is advisable to have a truck with the Fort Pickett Fire Department on standby.
Fire Control Implements: Basic fire control implements such as rakes, shovels, flappers and backpack sprayers should be onsite.	Meals: Supplemental food supplies similar to military MREs are recommended on large burns.
Drip Torches and Slash Fuel: A sufficient number of drip torches and quantities of slash fuel should be available to complete the burn.	Signs: If smoke will potentially impact a public roadway, signs should be placed to warn motorists.
Transportation: Sufficient transportation must be available to transport crews and monitor firebreaks.	
First Aid: At minimum, one well-equipped first aid kit should be onsite for every three crew members.	

Once the crewmembers are aware of, and **understand,** the burn plan it is advisable to light a small, easily controlled test fire to observe the behavior of the fire and wind. If the test fire burns as expected, the burn should proceed. If the test fire burns erratically or acts unexpectedly, the burn boss should then reassess the conditions and consider canceling the burn. After the burn is ignited, the burn boss should closely observe the fire behavior and the perimeter of the burn should be monitored. At the conclusion of the burn, any hotspots near the firebreaks that could potentially spot over the control lines should be extinguished.

Within two to three days of the completion of the burn, an evaluation of the effectiveness should be conducted. The purpose of the evaluation is to examine the effectiveness of the burn in accomplishing the objectives for the unit. If the burn did not accomplish the objectives, changes can be made to the prescription parameters and in how the burn is conducted in order to better fulfill the objectives.

6.1.5 Red Flag Situations

The following are some red flag situations developed by USDA Forest Service for prescribed fire in southern forests (Wade 1989). If any of these situations exist, burning should not begin or should cease.

1. No written burn plan.
2. No map of the burn unit is available.
3. Heavy fuels coupled with drought.
4. Firebreaks are inadequate.
5. Updated weather forecast is not available.
6. Personnel and/or proper equipment are not available.
7. Inadequate communication with crewmembers.
8. Backup personnel and/or equipment not available to control an escaped fire.
9. Behavior of test fire is erratic and not as prescribed.
10. Fire behavior is erratic.
11. Frequent and/or difficult to control spot fires.
12. Unexpected change in weather conditions.

APPENDIX L: VIRGINIA DEPARTMENT OF FORESTRY SMOKE MANAGEMENT GUIDELINES

P R E F A C E

The use of prescribed fire as a resource management tool has long been regarded as indispensable. In order to lessen the impact of smoke generated from prescribed burning on public health and welfare, the Virginia Department of Forestry has developed voluntary smoke management guidelines. Application of these guidelines will minimize concentrations of smoke in sensitive areas and assist in maintaining air quality standards.

Promotional emphasis on fire prevention has created a misconception that all fire is bad. Various southern ecosystems depend on fire as do many silvicultural recommendations. Fire can be both good or bad depending on when, where, and how it occurs. With proper training and planning prescribed burn managers will know the when, where, and the how to use fire to benefit the resources. How well we manage smoke from prescribed fires will determine our future use of this valuable and indispensable resource management tool.

The general public has a great influence over how we manage the resources of the forest. Many forest regulations are based on public emotion instead of scientific facts. Public relations are an essential part of a prescribed burn. The prescribed fire manager should feel obligated to minimize effects on the nearby residents and be prepared to "sell" his or her job to the general public. The following statements have been taken from an article by Mark Glisson. His article is based on the premise that the public image of the prescribed burner is critical to the success and continuation of prescribed burning.

- Image has everything to do with how we are perceived and may have little to do with what we actually are.
- Attitude may be the most individualized of the ingredients of a good public image. Each burner must consciously strive to be friendly and courteous in their public encounters.
- The old adage that there is no substitute for experience should be capitalized on. If the public feels that the burner is a professional, that they know their stuff, there will be less fear. For government employees, the image of professionalism is ever more critical than for most. The common perception of "typical government employees" who waste taxpayers money with incompetence and laziness must be overcome. One of the best demonstrations of knowledge and ability are the best methods for dispelling myths.
- Attention to appearance should be considered essential to projecting a professional image. Particularly if the burner is a member of a uniformed agency, special care should be taken to create in others a positive association between the uniform and those who wear it.
- The equipment should be adequate and as modern as possible. It should look good also. Dented and scratched trucks, unpainted equipment, or tools poorly treated all combine to give the impression of haphazard operations. All equipment should be functional and treated with pride.

Be honest with yourself, and remember that whatever the image of the prescribed burner is, it is a direct result of our own success or failures. Never assume that the benefits of burning are understood or that the public is to blame for the image dilemma. The responsibility for improving image is ours alone.

A C K N O W L E D G M E N T S

The Forest Protection Team of the Virginia Department of Forestry would like to thank those who had the foresight to realize that smoke management would someday become critical to our profession. The first publication in Virginia on smoke management was prepared by Roland B. Geddes, District Forester, in March 1981 and was revised by Don T. Morton, Assistant Chief of Fire Management, in July 1989. The Virginia Department of Forestry is very fortunate to have had leadership in the past that provided a firm foundation for those of us who followed, and one to build upon. We would also like to thank our current State Forester, James W. Garner who continues to provide leadership and direction as prescribed burning increases in it's use as a valuable forest management tool, and smoke management becomes even more critical.

I N T R O D U C T I O N

This publication provides guidelines for planning and managing smoke from prescribed fires to:

A. Minimize ambient air quality impairment.

B. Prevent smoke from being carried to, or accumulating in, areas sensitive to smoke.

C. Recommend burning guidelines to supplement the regulations established by the State Air Pollution Control Board.

This guide applies to all prescribed fires, and is not limited to any one agency or region.

Prescribed fire stewardship emphasizes the immediate safety aspects of personnel conducting the burn; the health, safety, and property of others that may be directly affected by the fire, and the potential for off-site effects of smoke on public health and visibility. We emphasize, however that the prescribed fire manager cannot merely comply with standards and regulations. They must exercise professional and moral judgment in carrying out their duties.

CHAPTER 1

SMOKE MANAGEMENT OBJECTIVES AND REGULATORY REQUIREMENTS

Objectives

Prescribed fires produce varying quantities of smoke, an elusive by-product which can be a major concern. Therefore, smoke management must be considered in every prescribed fire plan. Awareness of smoke production and transport characteristics will enable us to refine existing smoke management prescriptions.

Three basic objectives of smoke management are:

1. Identify and avoid smoke-sensitive areas,
2. Reduce emissions, and
3. Disperse and dilute smoke before it reaches smoke-sensitive areas.

The key to good smoke management lies in the resource manager's ability to use prescribed fire with minimal smoke impact. This is done by combining favorable meteorological conditions with a variety of prescribed fire techniques designed to keep smoke emissions to a minimum.

Regulations For Open Controlled Burning

Open burning in Virginia is regulated by the State Air Pollution Control Board and the Virginia Department of Forestry.(Synopses of these regulations are included in the Appendix) The State Forester has accepted responsibility for the development, dissemination, and administration of a smoke management plan for burning related to forestry programs. Nothing contained in this plan shall be construed as allowing any person to be in violation of any regulations, laws, ordinances, or orders of the Commonwealth of Virginia or other governmental entity having jurisdiction, or to relieve any person from the consequences of damages or injuries which may result from the negligent conduct during any burning operation.

A typical definition of "open controlled burning" is: *Any fire from which the products of combustion are emitted into the atmosphere with out passing through a stack or chimney*.

The State Air Pollution Control Board has established regulations for the control and abatement of air pollution, which was last revised in 1997. Sections of the regulations that refer to and impact prescribed burning are #9 VAC 5-40-5600, 5610, 5620, 5630, and 5631. Section 9 VAC 5-40-5630, #9 specifically states that open burning is permitted for approved forest management practices provided the following conditions are met :

a. The burning shall be at least 1000 feet from any occupied building unless the occupants have given prior permission, other than a building located on the property on which the burning is conducted; and

b. The burning shall be attended at all times.

Please refer to the complete text of the "Emission Standards For Open Burning (Rule 4-40) available from the Air Pollution Control Board.

In the event that an Air Pollution Health Advisory, Alert, Warning, or Emergency is reported from the Department of Air Pollution Control, the Virginia Department of Forestry will suspend it's burning operations and recommend to all cooperators that their burning be suspended as well.

Prescribed Fire Managers have a professional, legal, and personal responsibility to assure the success of the smoke management program. They must voluntarily curtail burning if their portion of an air shed is becoming overloaded with smoke or local weather factors are likely to create such problems even though no burning restrictions have been issued.

CHAPTER 2

SMOKE PRODUCTION, CHARACTERISTICS, AND EFFECTS

This chapter discusses the combustion process, the effect of fuel properties on smoke production, the characteristics, and health hazards of smoke.

Stages of Combustion

Figure 1

Pre-ignition Phase

Heat is being absorbed by the fuel, water vapor moves to the fuels surface and escapes. In this phase the internal temperature of the fuel is being raised, causing certain components of wood to decompose, releasing organic gases and vapors. This processes is called pyrolysis. When these very hot gasses and vapors mix with oxygen they will ignite.

Flaming Phase

This begins when the fuel reaches ignition temperature and erupts into flames. The products of flaming combustion are predominately carbon dioxide ($CO2$) and water vapor. This water vapor is not the result of the heating of the fuels as in the pre-ignition phase but rather a product of the combustion process. The temperatures in this phase range between 600 and 2500 degrees Fahrenheit. When mixed with oxygen, the heated gasses ignite, oxidation occurs, and smoke is produced. Some organic gasses cool and condense without passing through the flame zone. Others pass through the flames and are only partially oxidized producing a great variety of emissions. Some compounds with higher molecular weights cool and condense into tar droplets and soot particles. These make up the visible smoke component with which we are primarily concerned. *The more inefficient the burning the more soot and tar particles produced.*

Smoldering Phase

In this phase the overall reaction rate of the fire has diminished to a point at which the concentration of combustible gases above the fuel is too low to support a persistent flame. The temperature drops and gasses condense, thereby producing smoke. The chemical process is incomplete and a large amount of smoke is produced. Emissions from a smoldering fire are at least **twice** that for a flaming fire. The heat released is seldom enough to sustain a convection column. The smoke produced during this phase is virtually soot-free consisting mostly of tar droplets. With insufficient heat to produce a convective column, the smoke is concentrated close to the ground.

Glowing Phase

All volatile material in the fuel has been driven off. Oxygen in the air can now reach the fuel, the surface of the charcoal begins to burn with a characteristic yellow glow. There is no visible smoke. Carbon monoxide and carbon dioxide are the main products. This phase continues until the temperature drops or until only non combustible gray ash remains.

Fuel Properties As They Affect Smoke Production

The total volume of smoke produced from a prescribed fire depends primarily upon the amount of fuel consumed. Smoke production can last from less than an hour to several weeks. The manner in which combustion and smoke production take place depends primarily on fuel moisture and such physical fuel properties as fuel size, fuel arrangement, and total amount of fuel.

Fuel Moisture

Fuel moisture is controlled by two major factors: weather and the curing stage.
The amount of moisture in fuels greatly affects the ease of ignition and the efficiency with which live and dead vegetation burn. By affecting flame temperature, hence combustion efficiency, moisture in the fuel affects the amount and character of emissions. The cleanest fire is the most efficient fire because, by definition, its combustion is the most complete. On the other hand, though the emissions per unit of fuel burned will be greater at higher fuel moistures, the total smoke produced from a burn may be less if some fraction of the fuel, typically the larger round fuels and the duff, have enough moisture that they do not totally burn.

Fuel Size and Arrangement

With a given fuel moisture, the time necessary to ignite and consume the fuels depend on the size (surface area) and arrangement. The greater the surface area and the greater the space between fuels, the faster they will burn. As the fuels become packed more tightly and surface area is reduced, the combustion efficiency is decreased and smoke production will increase.

Fuel Loading

When using fire in areas with light fuel loads such as grasslands and frequently burned pine stands (usually under 4 tons per acre), total smoke production is low because smoldering combustion is minimal. The heaviest fuel loadings are normally encountered in piled logging debris, and burning these areas will have the most adverse impact on smoke management.

Fuel Continuity

Both horizontal and vertical continuity affects the amount of fuel consumed. Sustained ignition will not occur when spacing between the fuel is too large. More smoldering will occur and thereby more smoke will be produced.

Chemical and Physical Characteristics of Smoke

Products from the combustion of forest fuels are mainly carbon-containing compounds. The most important pollutants being particulate matter and carbon monoxide(CO).

Two products of complete combustion are carbon dioxide(CO_2) and water, these make up over 90% of the total emissions. Under ideal conditions it takes 3.5 tons of air to completely burn 1 ton of fuel. The combustion of 1 ton of fuel will produce the following:

Carbon Dioxide(CO_2)	2,000 to 3,500 lbs
Water Vapor	500 to 1,500 lbs
Particulate Matter	10 to 2000 lbs
Carbon Monoxide(CO)	20 to 500 lbs
Hydrocarbons	4 to 40 lbs
Nitrogen Oxides	1 to 9 lbs
Sulfur Oxide	Negligible amounts

Carbon Dioxide is not considered a pollutant, but Carbon Monoxide, Hydrocarbons, Nitrogen Oxides, and Sulfur Oxides are.

Carbon Monoxide is the most abundant air pollutant produced by prescribed fires. Its negative effect on human health depends on duration of exposure, concentration, and level of activity during exposure. Dilution occurs rapidly enough to minimize the health hazards.

<u>Hydrocarbons</u> are an extremely diverse group of compounds that contain hydrogen, carbon, and sometimes oxygen. The majority of the hydrocarbons have no harmful effects.

<u>Nitrogen Oxides</u> are produced primarily from oxidation of the nitrogen contained in the fuels. Most forest fuels contain less than 1% nitrogen, of that amount 20% may be converted to nitrogen oxide when burned.

<u>Sulfur Oxides</u> are produced in negligible quantities because of the low elemental sulfur content of forest fuels. Sulfur is lost from the site during burning as is nitrogen.

<u>Particulate Matter</u> is the most important pollutant emitted by fire and is largely responsible for low visibility and aggravated respiratory conditions. It is a complex mixture of solids and tars. Particulate matter from wood smoke has a size range near the wavelength of visible light (0.4 - 0.7 micrometers). This makes the particles excellent scatters of light and, therefore, excellent reducers of visibility. Many are too small to be seen with the naked eye and may stay suspended in the atmosphere for weeks and even years. These very small particles may not be filtered out by smoke masks and may penetrate deeply into the lungs.

Particulate matter is *the* major problem from forestry smoke. All smoke management systems are based on it.

Particulate matter is described and regulated on the basis of it's size.

70% by mass are less than 2.5 microns (i.e., pollen)

20% by mass are between 2.5 and 10 microns (i.e., dust)

10% by mass are greater than 10 microns (i.e., fly-ash)

1 micron = 1/25,000 of an inch.

Emission Rates

A. Emission rate is defined as the amount of smoke produced per unit of time.
B. Down wind concentrations of particulate matter in smoke are related directly to the emission rate at the fire source; the emission rate, in turn, is affected by the amount of fuel being burned, and the rate at which it burns.
C. Backing fires are most efficient and produce the least amount of smoke.
D. Head fires consume half the available fuel, are less efficient and produce more smoke.
E. Ring fires are heavy smoke producers as are aerial ignited burns.

Residual Smoke

Residual smoke is defined as the smoke produced from smoldering combustion and not contained in a convection column. During the active combustion stage of almost all prescribed burns, smoldering combustion takes place near flaming fuels. Much of the smoke from the smoldering fuel is entrained into the convection column induced by the flames and carried aloft. When flaming ceases, the convection column dissipates and all subsequent smoke produced remains near the ground as residual smoke.

Smoldering combustion frequently causes visibility problems immediately down wind of a burn when the convection column dissipates.

If residual smoke persists into the night or the next day, special problems may arise. In flat terrain, wind is usually minimal at night, causing smoke to build up in the vicinity of the burn. Any nearby drainage's may also have an increased concentration of residual smoke. In addition, the particulate matter may serve as nuclei for fog formation if the relative humidity approaches the water saturation point. Residual smoke can and will flow down drainage's causing possible visibility and other problems.

Residual smoke persisting for several days poses additional problems because the burn manager cannot make reliable predications of the wind speed and direction much beyond the day of the burn. The best burn plans should contain provisions to minimize the residual smoke.

Secondary Emissions

Secondary emissions pollutants are formed in the atmosphere by photochemical transformation of primary emissions. They include oxidants such as ozone.

Health Hazards Of Smoke

Firefighters can face unhealthy levels of smoke when patrolling or holding fire lines on the downwind edge of a wildfire or prescribed fire, during direct attack of an escaped prescribed fire, or while mopping up.

The following is based on an article by Breysse, 1984, in which he discusses the health hazards of smoke.

Inhalation of smoke from whatever source can cause acute or chronic damage to health. The acute, or immediate, symptoms are caused by exposure to high concentrations of smoke over short periods of time. Manifestations range from irritation of the eyes and respiratory tract, to impaired judgment.

More critical are repeat exposures to relative low concentrations. These may result in respiratory allergies, bronchitis, emphysema, and cancer. Chronic health hazards are by far the more significant, because 15 or more years usually pass before the victim is disabled.

Some concerns have been expressed as to the amount, if any, of herbicide residue in the smoke that is produced from lands treated with herbicides. A recent study examined 14 sites that were treated with Arsenal, Garlon 4, Pronone 10G, Velpar ULW, and Tordon. The tract sizes ranged from 3 to 380 acres, and all were burned within 30 to 169 days after treatment. Seventy personal and seventy area monitors were employed in the study. NO herbicide residues were detected in any of the monitoring devices used in the study.

The health implications of short-term exposure and the potential health effects of long-term exposures have not yet been quantified.

CHAPTER 3

SMOKE MANAGEMENT

This chapter introduces principles of smoke management strategies for prescribed fire. Smoke management practices include;

- ❑ fuel management.
- ❑ fire prescriptions to reduce available fuel loading or improve combustion efficiency.
- ❑ firing and mop up techniques to reduce emissions.
- ❑ scheduling to enhance convection or dispersion.
- ❑ scheduling to ensure plume trajectory moves away from sensitive areas.
- ❑ coordinating burning locations for the best overall result.

Determining The Need For A Smoke Management Program

Smoke management techniques must be considered by anyone who uses fire as a management tool. Smoke management involves prioritizing individual burns, monitoring fuel conditions, monitoring surface and upper air meteorological parameters, predicting down wind particulate and visibility impacts. The following questions must be considered in developing the smoke management plan.

A. Will smoke from prescribed burning result in public health and safety problems such as on highways or airports?

B. Are there any other areas which should be considered as smoke sensitive?

C. Will smoke from prescribed burning result in complaints from the public?

D. Can the topography or weather conditions cause poor smoke dispersion? Mountainous terrain and stagnant high pressure systems usually cause the most problems.

E. Are there limitations on the number of days available for prescribed burning because of fire hazard or stagnation problems?

F. Will prescribed burning impact any areas where visibility is an important value?

G. How is the health and safety of the work force being impacted?

Control Strategies

Avoidance, dilution, and reduction of emissions are ways to manage smoke from prescribed fires.

Avoidance

Pollution can often be prevented by scheduling prescribed fires during conditions that make intrusions of smoke into smoke-sensitive areas unlikely. The most obvious way to avoid pollution impacts is to burn when the wind is blowing away from all smoke-sensitive areas. Most fires have an active burning period and a residual period. Wind direction during both periods must be considered.

At night, drainage winds can carry smoke toward smoke sensitive areas. Residual smoke is especially critical at night.

Dilution

Smoke concentration can be reduced by diluting smoke through a greater volume of air, either by scheduling during good dispersion conditions or burning at slower rates (burning smaller or narrower strips or smaller areas). **Caution:** Burning at slower rates may mean that burning continues into the late afternoon or evening, when atmospheric conditions become more stable.

The time of day at which ignition occurs is also an important consideration because mixing height and transport wind speed are likely to change during the day and night. Generally, a burn early in the day encounters improving ventilation factors; an evening burn encounters deteriorating ventilation factor.

Emission Reduction

Emission reduction can be an effective control strategy for attaining smoke management objectives. Effective firing techniques and proper scheduling can minimize the smoke output per unit area treated. For example, backing fires minimize the inefficient smoldering phase of a prescribed fire.

Techniques To Minimize Smoke Production And Impacts

Prescribed burning, though necessary for accomplishing certain resource management objectives, can degrade air quality. The practice of prescribed burning carries with it an obligation to eliminate or minimize any adverse environmental effects, including those cause by smoke. The following guidelines will help reduce impacts.

Have clear objectives

Be sure you have clear resource management objectives which consider the impact of smoke on the total environment - - both on site and off site.

Obtain and use weather forecasts

Weather information and fire-weather forecasts are available to all resource managers. Be sure to use them. To obtain forecast information, contact your nearest Department of Forestry office, or contact the Virginia Department of Forestry web site at (**www.state.va.us/~dof/dof.htm**). The weather information is needed to determine what will happen to the smoke, as well as to determine the behavior of the fire.

Do not burn when air pollution health advisories are in effect, during pollution episodes, or when temperature inversions exist

Under such conditions, smoke tends to stay near the ground and will not readily disperse.

Comply with air pollution control and smoke management regulations

Know the regulations for air pollution control in Virginia and your locality.

Burn when conditions are good for rapid dispersion

The atmosphere should be unstable so smoke will rise and dissipate; but not so unstable as to cause a control problem. Determine whether the direction and volume of smoke will affect public safety on highways and populated areas. Use caution when near or upwind of smoke-sensitive areas. Burning should be done when transport wind will carry smoke away from heavily traveled roads, airports, and populated areas.

Notify the Virginia Department of Forestry

This will allow the Department of Forestry to inform you of any weather conditions and/or any other burns that may impact your plans.

Notify the local Fire Department dispatcher, nearby residents and adjacent landowners

This is common courtesy, as well as a requirement in some areas. All concerned will know the burn is not a wildfire, and you will get advance notice of any adverse public reaction.

Burn under favorable moisture conditions

The prescribed fire manager can reduce smoke by selecting the correct combination of fuel moistures and burning only those fuels that must be removed to meet the burn objective. If the objective is to remove fine and intermediate fuels to reduce wildfire hazard, the burn should be accomplished when the relative humidity is low enough for fine and intermediate fuels to burn readily and larger fuels and duff are wet. If the objective is to expose the mineral soil, the burn should be conducted when the larger fuels and duff are dry enough to burn with a minimum of smoldering.

Use backing fires when applicable

This is because backing fires, with their slow rate of spread and relatively long residence time, cause a higher fraction of the fuel to be consumed in the flaming stage of combustion rather than in the smoldering stage. Since total smoke production per unit of fuel burned is considerably less during flaming combustion, backing fires favor lower total smoke production.

Burn in small blocks when appropriate

The larger the area being burned, the more visibility is reduced down wind and higher the concentration of particulate put into the air.

Mop-up

Burn out and start mop-up as soon as possible to reduce impacts of residual smoke on visibility and health.

Have an emergency plan

Be prepared to control traffic on nearby roads if wind direction changes. Be prepared to construct control lines and stop a prescribed burn if it is not burning according to plan or if weather conditions change.

Weather Interactions

As weather patterns change, so does smoke behavior. General pressure patterns and fronts have pronounced effects on transport wind and stability characteristics of the atmosphere and affect how well the smoke will disperse.

Wind

The obvious first consideration in evaluating whether a burn will impact a sensitive area is to determine which direction the wind is blowing or will blow. Both the surface wind and the wind aloft will affect behavior.

Surface wind

Surface wind can result from general large-scale weather patterns or from local effects such as the sea breeze and mountain-valley flows. Local winds can be reinforced or destroyed by the general wind depending on the strength and direction of each. Large-scale or general surface wind patterns are those associated with fronts, troughs, and ridges. Understanding surface wind characteristics, either from local wind or general wind, is important to smoke management. To avoid sensitive areas, lengthy low-intensity burns may have to be accomplished during periods when no significant wind changes are expected. Local winds will transport smoke to various locations at different times of the day and night.

Another point to consider is that strong surface winds tend to bend plumes over, thereby not allowing maximum height development. In such cases, the smoke produced from the convective and nonconvective phases will be under the influence of surface wind patterns.

Upper winds

Upper winds are also important in smoke management. Sudden changes in wind speed or direction (wind shear) as a result of terrain influences, stability changes, or frontal boundaries can profoundly affect fire behavior and plume rise. Another concern with upper winds is that, although surface wind direction may be acceptable in keeping smoke from impacting a sensitive area, upper winds from a different direction may blow smoke over or through another sensitive area. The smoke manager must fully understand the total wind pattern that is affecting the area during the burn, as well as the wind that will be affecting the area after the burn. Initial success at keeping smoke away from one sensitive area will be overshadowed by a failure to recognize wind shifts which result in impacts on other sensitive areas.

Fronts

Smoke movement and dispersion differ drastically with the type of front. The speed of an approaching front is an important consideration when executing burns. A slow moving front results in steadier wind speeds and gradually changing wind directions. A rapidly moving front has more sudden changes in wind speed direction.

Cold fronts

Cold fronts typically have rapid wind shifts and gusty winds. Behind a strong cold front, the air mass is generally unstable, which facilitates smoke dispersion and good visibility. Smoke impacts behind a strong cold front tend to be short, but high concentrations may occur locally. Control problems may be associated with strong cold-fronts, however.

Warm fronts

Burning associated with warm frontal activity can result in high smoke concentrations for long periods of time. Wind speeds are typically lighter and shifts in direction are more gradual compared to cold front. This results in a given area being down wind of a burn for a longer period.

Stationary fronts

The variable and changing wind conditions that characterize stationary fronts make forecasting smoke movement difficult within the frontal zone. Light wind generally blows in opposite directions on either side of the front. Poor mixing and dispersion can be expected near the front with light winds, precipitation, and reduced visibility.

Dispersion

Dispersion refers to those processes within the atmosphere which mix and transport pollutants away from a source. The concentration of smoke experienced at downwind locations greatly depends upon weather conditions at the fire site and on the down-wind smoke path. *Atmospheric dispersion mainly depends on three characteristics of the atmosphere: atmospheric stability, mixing height, and transport wind speed.*

Stability

Stability affects the mixing of smoke during the convective phase as well as during the nonconvective phase of the burn.

Stable atmosphere

A poor time to burn is when the atmosphere is stable. During the main convective phase in a stable atmosphere, smoke will-at best-rise to some altitude and remain there. More likely, the smoke will start settling to the lowest levels of the atmosphere, and high smoke concentrations will result.

The smoke from the smoldering phase will remain near the surface and be moved around by the surface wind. Stable conditions are readily apparent to the observant manager. Indicators are cloudless nights with light winds; hazy conditions and reduced visibility: clouds with a flattened or layered appearance; and light winds.

Unstable atmosphere

An unstable atmosphere tends to have cumulus clouds with good vertical height, good visibility, strong, gusty winds, and hot, clear days. Unstable air masses tend to aid good mixing of smoke plumes with little, if any, long-term volumes of smoke. For most prescribed burning, a slightly unstable atmosphere tends to produce an optimum dispersion pattern, particularly when surface wind speeds are moderate. (See Figure 2 on page 18)

Relative humidity

Other than its relationship to fine fuel moisture and subsequent fire behavior, the major impact of relative humidity is on visibility. As relative humidity increases, natural visibility may decrease due to increased water vapor in the air.

The significance of relative humidity to prescribed burning is that, as smoke particles are added to the atmosphere, they combine with the water vapor at these higher humidities to significantly reduce visibility. Smoke particles can also be the stimulus for fog or cloud formation, which reduces visibility.

Mixing height

Atmospheric mixing height is that height through which relatively vigorous mixing takes place. A mixing height exists only when the lower atmosphere is unstable or neutral. Above this height is a layer of stable air which acts to suppress vertical mixing. The result is as if a "lid" were placed upon the atmosphere, above which smoke penetrates very slowly.

Figure 2

The higher this "lid", the better are the conditions for smoke management. This is because a reasonably deep layer of vigorous mixing is needed to maintain low background concentrations in the lower atmosphere. During stable atmospheric regimes, there is no mixing height; that is, there is no height below which dispersion processes are rapid. Because high smoke concentrations are maintained for extended distances in such conditions, NO BURNING SHOULD OCCUR.

Visibility Protection

Visibility is the optical clarity of the atmosphere. It is usually expressed as the distance a small object can be just distinguished from a light background. At high relative humidities, a small concentration of smoke can trigger fog formation. On roadways, high humidity combined with smoke has led to tragedy. Poor visibility of this nature is caused by condensation of atmospheric moisture on smoke particles, resulting in a greatly increased number of particles of the size range that blocks out light. This condensation process begins for certain types of airborne particles at relative humidities around 70 percent. As the humidity increased to nearly 100 percent, condensation is much more likely. Visibility protection is an important goal of smoke management.

Prescribed Burning Parameters

The reasons for using prescribed fire in Forest Resource Management are many, they include the following;

- ❑ Reduce hazardous fuels
- ❑ Prepare sites for seeding and planting
- ❑ Dispose of logging debris
- ❑ Improve wildlife habitat
- ❑ Manage competing vegetation
- ❑ Control disease
- ❑ Improve forage for grazing
- ❑ Enhance appearance
- ❑ Improve access
- ❑ Perpetuate fire-dependent species
- ❑ Manage endangered species

Your management objectives will dictate how and when fire will be utilized.
Table 1 on the following page lists the recommended parameters for prescribed burning operations in Virginia. These parameters should be followed to help accomplish your objectives and to minimize problems associated with smoke management, fire control, and personnel safety.

Prescribed fires aren't always beneficial, however. When conditions are wrong, prescribed fire can severely damage the very resource it was intended to benefit.

Recommended Parameters for Prescribed Burning Operations in Virginia

Siteprep and Growing Season Burns

Parameter	Recommended Standard
Temperature	Use caution when temperatures exceed 90 degrees F
Relative Humidity	Minimum 25%, Maximum 65%
Wind	Not to exceed 15 mph at 20 feet
Mixing Height	Needs to exceed 500 meters
Cumulative Severity Index	Not to exceed 500
Ventilation Factor	Needs to exceed 2000

Non-Siteprep Burns and Dormant Season Burns

Parameter	Recommended Standard
Temperature	60 degrees F or below
Relative Humidity	Minimum 30%, Maximum 55%
Wind	In Stand wind of 1 - 3 mph
Mixing Height	Needs to exceed 500 meters
Cumulative Severity Index	Not to exceed 300
Ventilation Factor	Needs to exceed 2000

Smoke Management Burning Guidelines

Numerous variables affect the behavior and resulting smoke from a prescribed burn. They are intended to assist the prescribed burn manager in evaluating the downwind effect of the smoke and to assist in making those management decisions that will minimize the adverse effects of the burning activities within the limits set by the Virginia Air Pollution Control Board. The final decision to conduct the burn as prescribed remains with the burn manager.

No forestry burning should be done in that portion of Virginia covered by an Air Pollution Health Advisory, Alert, Warning or emergency issued by the Department of Environmental Quality. All open burning is prohibited when an Air Pollution Alert, Warning, or Emergency has been declared.

All burns regardless of size need to follow the recommendations listed on pages 23, 24, and 25, and should be subjected to the screening procedure listed below.

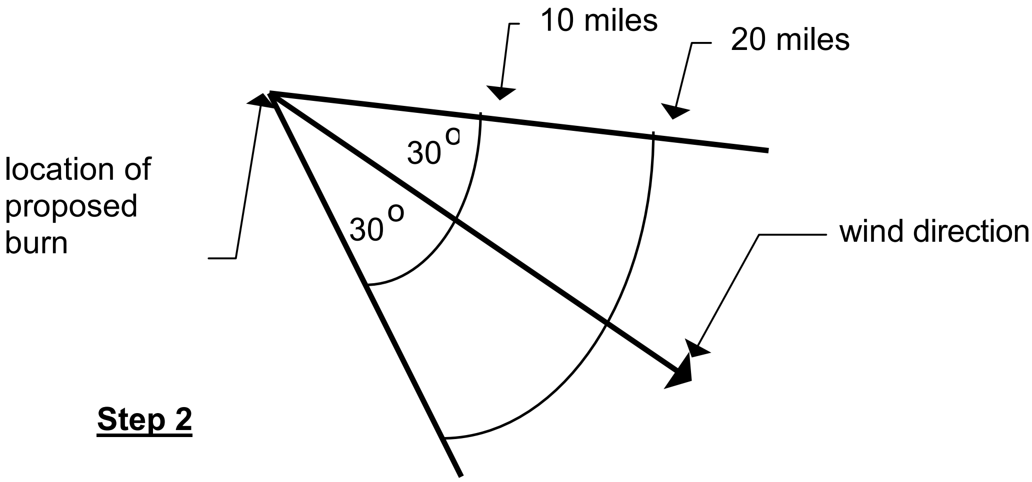
The following procedure, is adapted from the Southern Forestry Smoke Management Guidebook and A Guide For Prescribed Fire in Southern Forests and is used to identify those burns that pose smoke problems for specific sensitive areas.

Screening Procedure

Step 1

A. Locate the burn on a map. Draw a line representing the center line of the smoke plume (predicted wind direction) for twenty miles.

B. To allow for horizontal dispersion of the smoke, as well as shifts in wind direction, draw two other lines from the fire at an angle of 30 degrees from the center line as shown in the figure below.



Step 2

A. Identify and mark any smoke sensitive areas within the 30-degree lines plotted. These areas are potential targets for smoke from the burn. (Caution: If wind changes are predicted for the day of the burn or the night following the burn, plot the trajectory of the smoke for the second wind direction and locate any targets within 30 degrees of that line. The person planning the burn should also locate smoke sensitive targets in any direction that may be affected by an unanticipated wind change.) Examples of sensitive areas are airports, hospitals, nursing homes, interstate or other major high speed highways, heavily populated areas and Federal Class I air quality areas.

B. If no potential targets are found within 20 miles, you need only follow the recommendations to reduce smoke impact for all forestry burns found on the next page.

C. If targets are found, continue this screening system.

Step 3

A. If no targets are found within 10 miles, but are found between 10 and 20 miles, you may burn as prescribed provided the following recommended conditions are met:

   a) Afternoon mixing height is 500 meters (1,640 feet) or greater.

   b) Afternoon ventilation factor (mixing height in meters x transport wind speed in meters per second) is 2,000 or more.

   c) Visibility at burn site should be 5 miles or more.

   d) The area will be burned over by no later than one hour before sunset.

   If these conditions cannot be met, the burn should be postponed.

B. If targets are located within 10 miles, go to Step 4.

Step 4

Special caution should be exercised where targets are found within 10 miles of the burn. All of the minimum conditions listed in Step 3-A should be met. Other concerns such as the distance to the target, nature of the target, area of the burn, amount and nature of the fuel, fuel moisture, topography, presence of organic soil or a thick, root mat are only a part of the factors that combine to determine the quantity of smoke produced, its duration and concentration at various distances. Because of the complexity of these factors, a different wind direction for burns with smoke sensitive targets within 10 miles down wind should be considered.

If a different wind direction is not practical, an alternative to burning should be used.

Recommendations To Reduce Smoke Impact For All Forestry Burns:

A. Have a written prescribed burning plan including a sketch map prior to conducting the burn.

B. Obtain and use the best available weather forecasts. Use this information to predict fire and smoke behavior. Take wind and humidity measurements at the tract prior to and during the burning operation.

C. Comply with the provisions of the Virginia Air Pollution Control Board Regulations covering open burning and with all Virginia Forest Fire Laws.

D. Burn when atmospheric conditions are good for rapid dispersion of smoke. The atmosphere should be slightly unstable so smoke will rise and dissipate, but not so unstable as to cause a control problem.

E. Highway visibility must be considered. If an unexpected wind change should cause severe visibility reduction on any highway, be prepared to attempt to cut off the burn and to request assistance in traffic control from local law enforcement. Smoke warning signs should be placed on all roads where visibility may be reduced by smoke. Flaggers should be posted where visibility is significantly reduced. On all burns, mop-up along roads should begin as soon after burnout as possible to reduce the impact of residual smoke on visibility. Relative humidity is a critically important parameter for evaluating potential visibility hazard. A relative humidity at or above 70 percent indicates that a given concentration of smoke will restrict visibility more severely than in dry conditions. Relative humidities in the 80's and 90's may be associated with smoke-induced fog formation and visibility hazards, while natural fog often occurs when the relative humidity is in the 90's as well as at 100 percent. Burning within one mile of Interstate highways where fog can occur should be avoided. Fog problems may be greater in the fall months.

F. Virginia Air Pollution Regulations require that permission be obtained from the occupants of all dwellings located within 1,000 feet of the burn.

G. Volunteer Fire Departments (usually the local emergency dispatcher) and other local residents should be notified. This is very important to help prevent adverse public reaction.

H. If doubt exists concerning fire or smoke behavior, light a small test burn.

I. Use backing fires when possible. Backing fires give more complete combustion of fuel and produce less smoke. Even though slower and sometimes more expensive, less pollutants are put in the air and visibility is less restricted. In those cases where a backing fire in scattered logging debris would not give fires of sufficient intensity for adequate planting site preparation, ring or head fires must be used. In those cases, special attention must be paid to any smoke sensitive targets downwind. Head fires produce more smoke but do not last as long as backing fires. Burning during the middle of the day or early afternoon (time of more unstable conditions) may result in less smoke concentrations at sensitive targets.

J. Minimize residual smoke caused by fuels that may smolder for hours or days after the burn. Care should be taken to keep fires out of piled logging debris at log decks, sawdust piles, chip piles or bark piles. If fire gets in any material that will smolder for days or weeks, an attempt should be made to extinguish the fire as soon as it burns down enough to be practical. Mop-up activities should be directed toward residual smoke control as well as toward preventing the escape of the fire.

K. When drought conditions exist (Cumulative Severity Index over 400), residual smoke can be expected and additional mop-up may be needed to prevent smoke related problems. Areas with organic soil or a thick root mat should not be burned when the soil or root mat is dry enough to continue to burn for long periods. Termination of burning should be considered if the Cumulative Severity Index reaches 600.

L. The burnout phase should be completed no later than one hour before sundown. Predicting smoke drift is more difficult at night. The wind may lessen or die out completely. The smoke and fog may collect in low lying areas, causing serious problems if highways or residences are in those areas.

M. Aerial ignition is often advantageous to use because more complete combustion is accomplished with a more intense prescribed burn. Additionally, by burning large acreages quickly, smoke is dissipated very rapidly.

Potential Problems

On all prescribed burns, take time to observe (1) fire behavior, (2) smoke dispersion, and (3) effects on the vegetation. Document this information by making it a part of the written plan.

When a potential problem is observed, stop burning and put the fire out if possible. Notify your office and the State Forestry Office immediately. Request help in getting out flaggers and signs along roads. Also, notify people who may be affected if smoke is threatening communities, airports, farms, or homes.

What to Do After An Incident Occurs

A. Investigate the incident to determine if it was caused by smoke from the prescribed burn. If not, determine and document the actual cause immediately. Do not wait! Valuable evidence will be lost.

B. Secure names, addresses, and telephone numbers of witnesses.

C. If at night, check to determine if fog was present in the area.

D. Check for other sources of smoke. Remember - it takes only a very small amount to smell, but a lot to cause reduced visibility.

E. Take pictures of both the incident site and the burn.

F. Secure weather records.

G. Seek expert advice.

A P P E N D I X

Glossary

Term	Definition
Air Contaminant	A dust, fume, gas, mist, odor, smoke, vapor, soot, pollen, carbon, acid or particulate matter or any combination thereof.
Air Mass	A wide spread body of air having approximately the same characteristics of temperature and moisture content throughout its horizontal extent. In addition, the vertical variations of temperature and moisture are approximately the same over its horizontal extent.
Air Pollution	The general term alluding to the undesirable addition to the atmosphere of substances (gases, liquids, or solid particles) either that are foreign to the natural atmosphere or are in quantities exceeding their natural concentrations.
Air Quality	The composition of air with respect to quantities of pollution there in; used most frequently in connection with "standards" of maximum acceptable pollutant concentrations. Used instead of "air pollution" when referring to programs.
Air Pollution Health Advisory	A statement issued by a National Weather Service Forecast Office when atmospheric conditions are stable enough such that the potential exists for pollutants to accumulate in a given area. The statement is initially issued when conditions are expected to last at least 36 hours. See Air Pollution Alert.
Ambient Air	Literally, the air moving around us; the air of the surrounding outside environment.
Anticyclone	An area of high atmospheric pressure with closed anticyclonic circulation. Anticyclonic flow is clockwise
Atmospheric Stability	The degree to which vertical motion in the atmosphere is enhanced or suppressed. Vertical motions and pollution dispersion are enhanced in an unstable atmosphere. A stable atmosphere suppresses vertical motion and limits pollution dispersion.
Available Fuel	The portion of the total combustible material that fire will consume under given conditions. This could be duff, woody, herbaceous material or litter.
Backing Fire	A fire spreading against the wind or downhill. Flames tilt away from the direction of spread.

Term	Definition
Cold Front	The leading edge of a relatively cold air mass which moves in such a way that cold air displaces warmer air. The heavier cold air causes some of the warm air to be lifted. If the lifted air contains enough moisture, cloudiness, precipitation and even thunderstorms may result. If both air masses are dry there may be no cloud formation.
Convective Phase	The phase of a fire when most of the emissions are entrained into a definite convective column.
Convection Column	That portion of a smoke plume sharply defined by the buoyant forces of heated air and affluents.
CSI/Keetch-Byram Index	Cumulative Severity Index. An indication of drought, range from 0 to 800, with 800 indicating extreme drought conditions.
Cyclone	Loosely, a low pressure with counter-clockwise flow. On a very small scale the term is frequently misused to describe tornadoes. See Surface Low.
Deepening	A decrease in the central pressure of a low. This is usually accompanied by intensification of the cyclonic circulation (counter-clockwise wind flow around the low) See Filling.
Dispersion	In air pollution terminology, loosely applied to the removal (by whatever means) of pollutants from the atmosphere over a given area; or the distribution of a given quantity of pollutant throughout a volume of atmosphere.
Disturbance	A weather system usually associated with clouds, rain, and/or wind.
Divergence	The expansion or spreading out of a horizontal wind field. Generally associated with high pressure and light winds.
Emission	A release into the outdoor atmosphere of air contaminants.
Emission Rate	The amount of smoke produced per unit of time (lb/min). Emission Rate = Available Fuel x Burning Rate x Emission Factor.
Filling	An increase in the central pressure of a low. Counter-clockwise wind flow around the low usually decreases as filling occurs. See Deepening.

Term	Definition
Fine Particulate Matter	"Fine" particulates are those particles less than 10-15 microns in size. Fine particles have longer residence time in the atmosphere, are more harmful to health and have greater impact on visibility than larger particles. "Inhalable particulate" matter are those particles less than 10 microns in diameter. "Respirable particulate" matter are those particles less than 2.5 microns in size. Respirable particulates have an especially long residence time in the atmosphere and penetrate deeply into lungs. Particles from smoke are primarily in the respirable size range.
Firing Technique	A method of igniting an area to consume the fuel in a prescribed pattern; e.g., heading or backing fire, spot fire, strip-head fire, and ring fire.
Fuel Loading	The amount of fuel present expressed quantitatively in terms of weight per unit area.
Fuel Moisture Content	The quantity of moisture in fuel expressed as a percentage of the weight when thoroughly dried at 212 degrees F.
Fuel Type	An identifiable association of fuel elements of distinctive species, form, size, arrangement or other characteristics, that will cause a predictable rate of fire spread or difficulty of control, under specified weather conditions.
Head Fire	A fire spreading with the wind or uphill. Flames tilt in the direction of the spread.
Inversion	An increase of temperature with height in the atmosphere. Vertical motion in the atmosphere is inhibited allowing for pollution buildup. A "normal" atmosphere has temperature decreasing with height.
Micron	A unit of measurement equal to 1/25,000 of an inch.
Mixing Height	Measured from the surface upward, the height to which relatively vigorous mixing (random exchange of air parcels) due to convection occurs. Same as mixing depth. Use of this term normally implies presence of an inversion and the base of the inversion is the top of the mixed layer and defines the mixing height.
Non-convective-lift Fire Phase.	The phase of a fire when most emissions are not entrained into a definite convective column.

Term	Definition
Particulate Matter	Any liquid or solid particles. "Total suspended particulates" as used in air quality are those particles suspended in or falling through the atmosphere. They generally range in size from 0.1 to 100 microns.
Plume	The segment of the atmosphere occupied by the emissions from a single source or a grouping of sources close together. A convection column, if one exists, forms a specific part of the plume.
Prescribed Burning	Controlled application of fire to wild land fuels in either their natural or modified state, under such conditions of weather, fuel moisture, soil moisture, etc., as allows the fire to be confined to a predetermined area and at the same time to produce the intensity and heat and rate of spread required to further certain planned objectives of silviculture, wildlife habitat management, fire hazard reduction etc.
Pressure Gradient	The difference in atmospheric pressure between two points on a weather map. That is, the magnitude of pressure difference between two points at sea level, or at constant elevation above sea level. Wind speed is inversely related to pressure gradient. If distance between constant pressure lines is reduced by one-half, wind speed will be doubled. Conversely, if distance between lines is doubled, wind speed will be reduced by one-half.
Residual Combustion Stage	The smoldering zone behind the zone of an advancing front.
Residual Smoke	Smoke produced after the initial fire has passed through the fuel.
Smoke Management	Conducting a prescribed fire under fuel moisture and meteorological conditions, and with firing techniques that keep the smoke's impact on the environment within acceptable levels.
Smoldering Phase	The overall reaction rate of the fire has diminished to a point at which concentrations of combustible gases above the fuel is too low to support a persistent flame. The temperature drops and gases condense, the smoke produced is virtually soot-free, consisting mostly of tar droplets less than a micrometer in size.

Term	Definition
Stable Layer of Air	A layer of air having a temperature change (lapse rate) of less than dry adiabatic (approximately -5.4 degrees F per 1,000 feet) thereby retarding either upward or downward mixing of smoke.
Surface High	(High, High Pressure System, High Pressure Ridge) An area on the earth's surface where atmospheric pressure is at a relative maximum. Winds blow clockwise around highs in the Northern Hemisphere but, due to friction with the earth's surface, tend to cross constant pressure lines away from the high center. Air is usually subsiding within a surface high. This causes warming due to air compression. This in turn, results in stable atmospheric conditions and light surface winds.
Surface Low	An area on the earth's surface where atmospheric pressure is at a relative minimum. Winds blow counter-clockwise around lows in the Northern Hemisphere but, due to friction with the earth's surface, tend to cross constant pressure lines toward the low center. Upon converging at the low center, air currents are forced to rise. As air rises it cools due to expansion. Cooling reduces its capacity to hold moisture; so cloudiness and precipitation are common in lows. If a low center intensifies sufficiently it will take on the characteristics of a storm center with precipitation and strong winds.
Transport Wind Speed	A measure of the average rate of the horizontal transport of air within the mixing layer. May also be the wind speed at the final height of plume rise. Generally refers to the rate at which emissions will be transported from one area to another.
Ventilation Factor	Mixing Height in meters multiplied by Transport Wind speed in meters/sec.
Warm Front	The leading edge of a relatively warm air mass which moves in such a way so that warm air displaces colder air. Winds associated with warm frontal activity are usually light and mixing is limited. The atmosphere is relatively stable when compared to cold front activity.

Term	Definition
Wind Shear	A variation in wind speed and or direction in a layer of the atmosphere or between layers. The variation may be in the horizontal or vertical and may result in significant turbulence depending upon the magnitude of the wind speed/direction differences. A strong wind shear may act like an inversion and inhibit plume rise. It may also fracture the smoke plume, not allowing smoke to rise much above terrain levels. A strong horizontal anticylonic shear results in downward motion and may bring smoke aloft to the surface.

Synopsis of Forest Fire and Burning Laws

10.1-1141 -- ***Civil Action*** **- Liability for Escaped Fires -** If a person carelessly, negligently or intentionally without using reasonable care and precaution to prevent its escape, starts a fire on forestland, brushland or wasteland, he is liable for the costs of suppressing the fire.

10.1-1142-A -- Regulating the Burning of Woods, Brush, Etc. - Owner to cut and pile material for safe burning, and take reasonable care to prevent its escape. Class 3 Misdemeanor.

10.1-1142-B -- 4 PM Burning Law - During the period **February 15 through April 30** it shall be unlawful to burn before 4:00 p.m. within 300 feet of woodland, brushland or field containing dry grass, although the precautions have been taken. Class 3 Misdemeanor.

10.1-1142-C -- Unattended fire - Unlawful to leave open-air fires burning within 150 feet of woodland, brushland or field containing dry grass or other inflammable material. Class 3 Misdemeanor.

18.2-86 -- Arson - If any person maliciously sets fire to any wood, fence, grass, straw or other thing capable of spreading fire on land shall be guilty of a Class 6 felony.

18.2-87 -- Intentionally set fires - Class 1 Misdemeanor and liability for suppression of fire if a person intentionally sets fire to brush, woods, etc. and if he intentionally allows the fire to escape to lands of another whereby the adjoining property is damaged or jeopardized.

18.2-88 -- Carelessly set fires - Class 4 Misdemeanor and liability for costs of suppression if a person carelessly or intentionally set fire whereby the property of another is jeopardized or damaged.

10.1-1158 -- Prohibition of all open burning where serious fire hazards exist. - Governor may prohibit open burning due to extreme fire conditions. Class 3 Misdemeanor.

9 VAC 5-40-5630 (9a) -- Burning shall be at least 1000 feet from any occupied building, unless occupants have given prior permission.

9 VAC 5-40-5630 (9b) -- The burning shall be attended at all times.

*Note: For complete information on the Fire Laws of Virginia refer to the Code of Virginia or "Virginia's Forest Fire Laws", Department of Forestry, Publication No. 2, Revised 1996. For complete information on the Regulations for the Control and Abatement of Air Pollution contact the State Air Pollution Control Board.

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Produced by: Prescribed Fire and Fire Effects Working Team
PMS 420-2, NFES 1279

Health Hazards of Smoke, 1984
Written by: P.A.Breyssee

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USDA Forest Service Agricultural Handbook 360
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A Guide to Wildland Fuels Smoke Management, 1981, 1989
Virginia Department of Forestry
Prepared by: Roland B. Geddes, 1981
Revised by: Don T. Morton, 1989

Smoke Management Guide for Prescribed Burning in the Southeast, 1990

Hugh E. Mobley,Forestry Consultant
Montgomery, Alabama

A Drought Index For Forest Fire Control,

Keetch, John J., Byram, George M.
Southeastern Forest Experiment Station
USDA Research Paper SE-38

Directory of Department of Forestry Regional Offices

Central Office, Charlottesville (804) 977-6555

Region One, Waverly (804) 834-2300

Region Two, Tappahannock (804) 443-2211

Region Three, Charlottesville (804) 977-5193

Region Four, Farmville (804) 392-4159

Region Five, Salem (540) 387-5461

Region Six, Abingdon (540) 676-5488

Directory of Department of Environmental Quality Regional Offices

Toll Free 1-800-592-5482

Richmond (804) 527-5020

Woodbridge (703) 490-8922

Abingdon (540) 676-4800

Tidewater (804) 552-1840

Bridgewater (540) 828-2595

Roanoke (540) 562-3666

Prescribed Burn "Watch Out" Situations

IF ANY OF THE FOLLOWING CONDITIONS EXIST, ANALYZE FURTHER BEFORE BURNING:

- ❑ No written plan
- ❑ No map
- ❑ No safety/planning briefing
- ❑ Heavy fuels
- ❑ Dry duff and soil
- ❑ Extended drought
- ❑ Inadequate control lines
- ❑ No updated weather forecast
- ❑ Forecast does not agree with prescription
- ❑ Forecast does not agree with on site conditions
- ❑ Poor visibility
- ❑ Personnel and equipment stretched thin
- ❑ Burning a large area with hand crews
- ❑ Communications not available for all
- ❑ No backup plan or forces
- ❑ Notifications not made
- ❑ Behavior of test fire not as prescribed
- ❑ A smoke-management system has not been used
- ❑ Smoke-sensitive area downwind or down drainage
- ❑ Organic soil present
- ❑ Daytime Dispersion Index below 40
- ❑ Not enough personnel or equipment available to control an escaped fire
- ❑ Personnel on fire not qualified
- ❑ Area contains windrows
- ❑ A lot of dirt in piles
- ❑ Poor nighttime smoke dispersion forecast
- ❑ Have not looked down drainage
- ❑ Mixing Height is below 1,650 feet (500 meters)
- ❑ Debris was piled when wet
- ❑ Pile exteriors are wet

IF ANY OF THE FOLLOWING CONDITIONS EXIST, STOP BURNING AND PLOW OUT EXISTING FIRE:

- ❑ Fire behavior erratic
- ❑ Spot fire or slop-over occurs and is difficult to control
- ❑ Wind shifting or other unforeseen change in weather
- ❑ Smoke not dispersing as predicted
- ❑ Public road or other sensitive are smoked in
- ❑ Burn does not comply with all laws, regulations, and standards
- ❑ Large fuels igniting and burning, not enough personnel to mop-up before dark and likely to smoke in a smoke sensitive area

S A M P L E

Prescribed Burning
Smoke Management Plan

I. Location and Identification

County____________________ Coordinates______________________ Location____________

____

Acres________ Tract Number____________________ Parcel ____________Map attached _______

Reason for the burn: Siteprep Understory Wildlife

II. Weather

	Forecast				On Site			
	Day		Night		Prior		At Conclusion	
A. Surface Wind:	_______ Direction	_______ MPH	_______ Direction	_______ MPH	_______ Direction	_______ MPH	_______ Direction	_______ MPH
B. Transport Wind:	_______ Direction	_______ Meters/Sec	_______ Direction	_______ Meters/Sec	___________ Direction		___________ Direction	
C. Mixing Height: (Meters)	_____________		_____________					
D. Relative Humidity (%)	_____________		_____________		___________		___________	
E. Temperature:	_____________		_____________		___________		___________	

III. **Potential Smoke Targets**: Use double 30 degree template ------ Attach map

A. **None within 20 miles**: Proceed with burn, follow recommendations to reduce smoke impact for all forestry burns. (located on pages 23, and 24 in VA Smoke Management Guide)

B. **Target(s) within 10 to 20 miles**: The following minimum conditions must be met, and the above mentioned recommendations should also be followed.

Mixing Height: 500 meters (1,640 feet)
Ventilation Factor: 2,000 (mixing height in meters **multiplied by** transport wind speed in meters/sec)

C. **Target(s) within 5 to 10 miles----SPECIAL CAUTION NECESSARY**

Special caution should be exercised! All of the conditions in A and B above must be met and the following should be considered. The distance to the target, nature of the target, size of the burn, amount and nature of the fuel, fuel moisture, topography, and the presence of organic soil. These factors along with the meteorological conditions all combine to determine the quantity and duration of the smoke produced.

An alternative to burning may need to be prescribed unless conditions change allowing the potential target to not be impacted by the smoke from your burn.

IV. Other Considerations:

A. Notify Regional dispatcher, VFD, and adjacent homeowners of intent to burn. Remember permission is necessary from homeowners within 1,000 feet.
B. Post prescribed burning and if necessary smoke signs.
C. Comply with all Air Pollution Regulations, Local Ordinances, and Forest Fire Laws.
D. Keep fires out of large piles of debris and sawdust piles which may smoke for days.
E. If smoke crosses a road place a flag person at both ends with radio communication.
F. Burn completed 1 hour prior to sunset.

V. Burning Plan Strategy: Refer to attached map.

A. Burning Objectives ____

____

____

____

B. Equipment on site.
Number of tractor/fire plow units ________
Number of Pickups ________
Burn trailer yes / no
Number of hand carried radios ________
Other, specify ____

C. Personnel on site.
Number of Virginia Department of Forestry employees _______
Number of non DOF laborers ________
Number of property owners ________
Other, specify ____

D. Starting Point (Show on map)____

E. Ignition Method Drip Torch _____ Aerial _____ Other (specify) ____________________________

F. Special Fire Control and Smoke Considerations,(adjacent pine plantations, crops, cutover, etc.)

____

____

____

H. Planned Mop-up Activities ____

____

____

PREPARED BY:____ DATE ________________

Certification Number____________________

Emission Standards for Open Burning

State Air Pollution Control Board

APPENDIX M: BALD EAGLE MANAGEMENT GUIDELINES

NATIONAL BALD EAGLE MANAGEMENT GUIDELINES

U.S. Fish and Wildlife Service

May 2007

TABLE OF CONTENTS

INTRODUCTION

The bald eagle (*Haliaeetus leucocephalus*) is protected by the Bald and Golden Eagle Protection Act (Eagle Act) and the Migratory Bird Treaty Act (MBTA). The MBTA and the Eagle Act protect bald eagles from a variety of harmful actions and impacts. The U.S. Fish and Wildlife Service (Service) developed these National Bald Eagle Management Guidelines to advise landowners, land managers, and others who share public and private lands with bald eagles when and under what circumstances the protective provisions of the Eagle Act may apply to their activities. A variety of human activities can potentially interfere with bald eagles, affecting their ability to forage, nest, roost, breed, or raise young. The Guidelines are intended to help people minimize such impacts to bald eagles, particularly where they may constitute "disturbance," which is prohibited by the Eagle Act.

The Guidelines are intended to:

(1) Publicize the provisions of the Eagle Act that continue to protect bald eagles, in order to reduce the possibility that people will violate the law,

(2) Advise landowners, land managers and the general public of the potential for various human activities to disturb bald eagles, and

(3) Encourage additional nonbinding land management practices that benefit bald eagles (see Additional Recommendations section).

While the Guidelines include general recommendations for land management practices that will benefit bald eagles, the document is intended primarily as a tool for landowners and planners who seek information and recommendations regarding how to avoid disturbing bald eagles. Many States and some tribal entities have developed state-specific management plans, regulations, and/or guidance for landowners and land managers to protect and enhance bald eagle habitat, and we encourage the continued development and use of these planning tools to benefit bald eagles.

Adherence to the Guidelines herein will benefit individuals, agencies, organizations, and companies by helping them avoid violations of the law. However, the Guidelines themselves are not law. Rather, they are recommendations based on several decades of behavioral observations, science, and conservation measures to avoid or minimize adverse impacts to bald eagles.

The U.S. Fish and Wildlife Service strongly encourages adherence to these guidelines to ensure that bald and golden eagle populations will continue to be sustained. The Service realizes there may be impacts to some birds even if all reasonable measures are taken to avoid such impacts. Although it is not possible to absolve individuals and entities from liability under the Eagle Act or the MBTA, the Service exercises enforcement discretion to focus on those individuals, companies, or agencies that take migratory birds without regard for the consequences of their actions and the law, especially when conservation measures, such as these Guidelines, are available, but have not been implemented. The Service will prioritize its enforcement efforts to focus on those individuals or entities who take bald eagles or their parts, eggs, or nests without implementing appropriate measures recommended by the Guidelines.

The Service intends to pursue the development of regulations that would authorize, under limited circumstances, the use of permits if “take” of an eagle is anticipated but unavoidable. Additionally, if the bald eagle is delisted, the Service intends to provide a regulatory mechanism to honor existing (take) authorizations under the Endangered Species Act (ESA).

During the interim period until the Service completes a rulemaking for permits under the Eagle Act, the Service does not intend to refer for prosecution the incidental “*take*” of any bald eagle under the MBTA or Eagle Act, if such take is in full compliance with the terms and conditions of an incidental take statement issued to the action agency or applicant under the authority of section 7(b)(4) of the ESA or a permit issued under the authority of section 10(a)(1)(B) of the ESA.

The Guidelines are applicable throughout the United States, including Alaska. The primary purpose of these Guidelines is to provide information that will minimize or prevent violations only of *Federal* laws governing bald eagles. In addition to Federal laws, many states and some smaller jurisdictions and tribes have additional laws and regulations protecting bald eagles. In some cases those laws and regulations may be more protective (restrictive) than these Federal guidelines. If you are planning activities that may affect bald eagles, we therefore recommend that you contact both your nearest U.S. Fish and Wildlife Service Field Office (see the contact information on p.16) and your state wildlife agency for assistance.

LEGAL PROTECTIONS FOR THE BALD EAGLE

The Bald and Golden Eagle Protection Act

The Eagle Act (16 U.S.C. 668-668c), enacted in 1940, and amended several times since then, prohibits anyone, without a permit issued by the Secretary of the Interior, from “taking” bald eagles, including their parts, nests, or eggs. The Act provides criminal and civil penalties for persons who “take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or any manner, any bald eagle ... [or any golden eagle], alive or dead, or any part, nest, or egg thereof.” The Act defines “take” as “pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest or disturb.” “Disturb’’ means:

> "Disturb means to agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior."

In addition to immediate impacts, this definition also covers impacts that result from human-induced alterations initiated around a previously used nest site during a time when eagles are not present, if, upon the eagle=s return, such alterations agitate or bother an eagle to a degree that injures an eagle or substantially interferes with normal breeding, feeding, or sheltering habits and causes, or is likely to cause, a loss of productivity or nest abandonment.

A violation of the Act can result in a criminal fine of $100,000 ($200,000 for organizations), imprisonment for one year, or both, for a first offense. Penalties increase substantially for additional offenses, and a second violation of this Act is a felony.

The Migratory Bird Treaty Act
The MBTA (16 U.S.C. 703-712), prohibits the taking of any migratory bird or any part, nest, or egg, except as permitted by regulation. The MBTA was enacted in 1918; a 1972 agreement supplementing one of the bilateral treaties underlying the MBTA had the effect of expanding the scope of the Act to cover bald eagles and other raptors. Implementing regulations define "take" under the MBTA as "pursue, hunt, shoot, wound, kill, trap, capture, possess, or collect."

Copies of the Eagle Act and the MBTA are available at: http://permits.fws.gov/ltr/ltr.shtml.

State laws and regulations
Most states have their own regulations and/or guidelines for bald eagle management. Some states may continue to list the bald eagle as endangered, threatened, or of special concern. If you plan activities that may affect bald eagles, we urge you to familiarize yourself with the regulations and/or guidelines that apply to bald eagles in your state. Your adherence to the Guidelines herein does not ensure that you are in compliance with state laws and regulations because state regulations can be more specific and/or restrictive than these Guidelines.

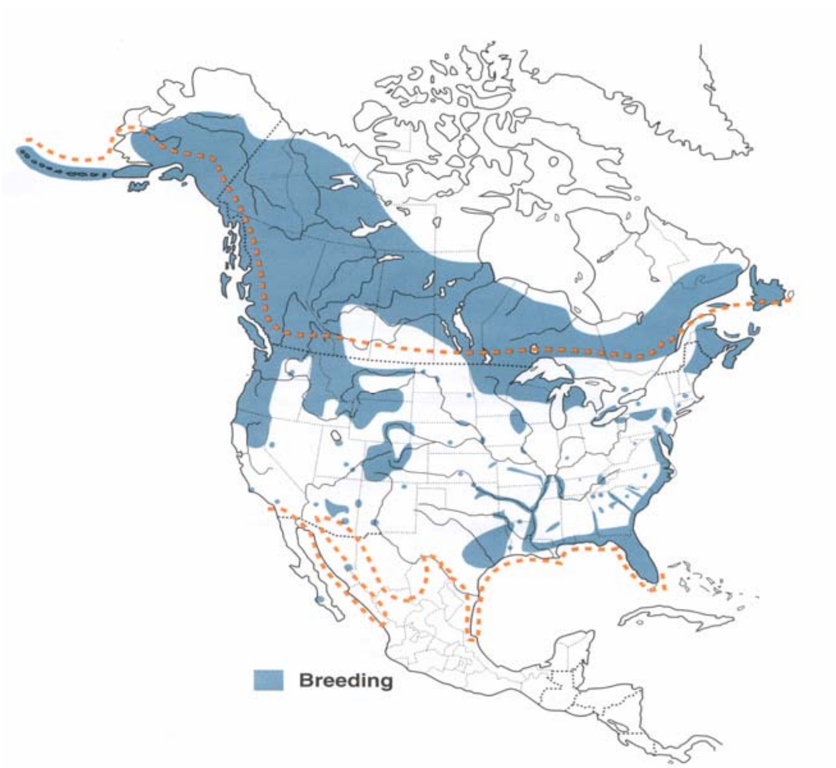
NATURAL HISTORY OF THE BALD EAGLE

Bald eagles are a North American species that historically occurred throughout the contiguous United States and Alaska. After severely declining in the lower 48 States between the 1870s and the 1970s, bald eagles have rebounded and re-established breeding territories in each of the lower 48 states. The largest North American breeding populations are in Alaska and Canada, but there are also significant bald eagle populations in Florida, the Pacific Northwest, the Greater Yellowstone area, the Great Lakes states, and the Chesapeake Bay region. Bald eagle distribution varies seasonally. Bald eagles that nest in southern latitudes frequently move northward in late spring and early summer, often summering as far north as Canada. Most eagles that breed at northern latitudes migrate southward during winter, or to coastal areas where waters remain unfrozen. Migrants frequently concentrate in large numbers at sites where food is abundant and they often roost together communally. In some cases, concentration areas are used year-round: in summer by southern eagles and in winter by northern eagles.

Juvenile bald eagles have mottled brown and white plumage, gradually acquiring their dark brown body and distinctive white head and tail as they mature. Bald eagles generally attain adult plumage by 5 years of age. Most are capable of breeding at 4 or 5 years of age, but in healthy populations they may not start breeding until much older. Bald eagles may live 15 to 25 years in the wild. Adults weigh 8 to 14 pounds (occasionally reaching 16 pounds in Alaska) and have wingspans of 5 to 8 feet. Those in the northern range are larger than those in the south, and females are larger than males.

Where do bald eagles nest?
Breeding bald eagles occupy "territories," areas they will typically defend against intrusion by other eagles. In addition to the active nest, a territory may include one or more alternate nests (nests built or maintained by the eagles but not used for nesting in a given year). The Eagle Act prohibits removal or destruction of both active and alternate bald eagle nests. Bald eagles exhibit high nest site fidelity and nesting territories are often used year after year. Some territories are known to have been used continually for over half a century.

Bald eagles generally nest near coastlines, rivers, large lakes or streams that support an adequate food supply. They often nest in mature or old-growth trees; snags (dead trees); cliffs; rock promontories; rarely on the ground; and with increasing frequency on human-made structures such as power poles and communication towers. In forested areas, bald eagles often select the tallest trees with limbs strong enough to support a nest that can weigh more than 1,000 pounds. Nest sites typically include at least one perch with a clear view of the water where the eagles usually forage. Shoreline trees or snags located in reservoirs provide the visibility and accessibility needed to locate aquatic prey. Eagle nests are constructed with large sticks, and may be lined with moss, grass, plant stalks, lichens, seaweed, or sod. Nests are usually about 4-6 feet in diameter and 3 feet deep, although larger nests exist.



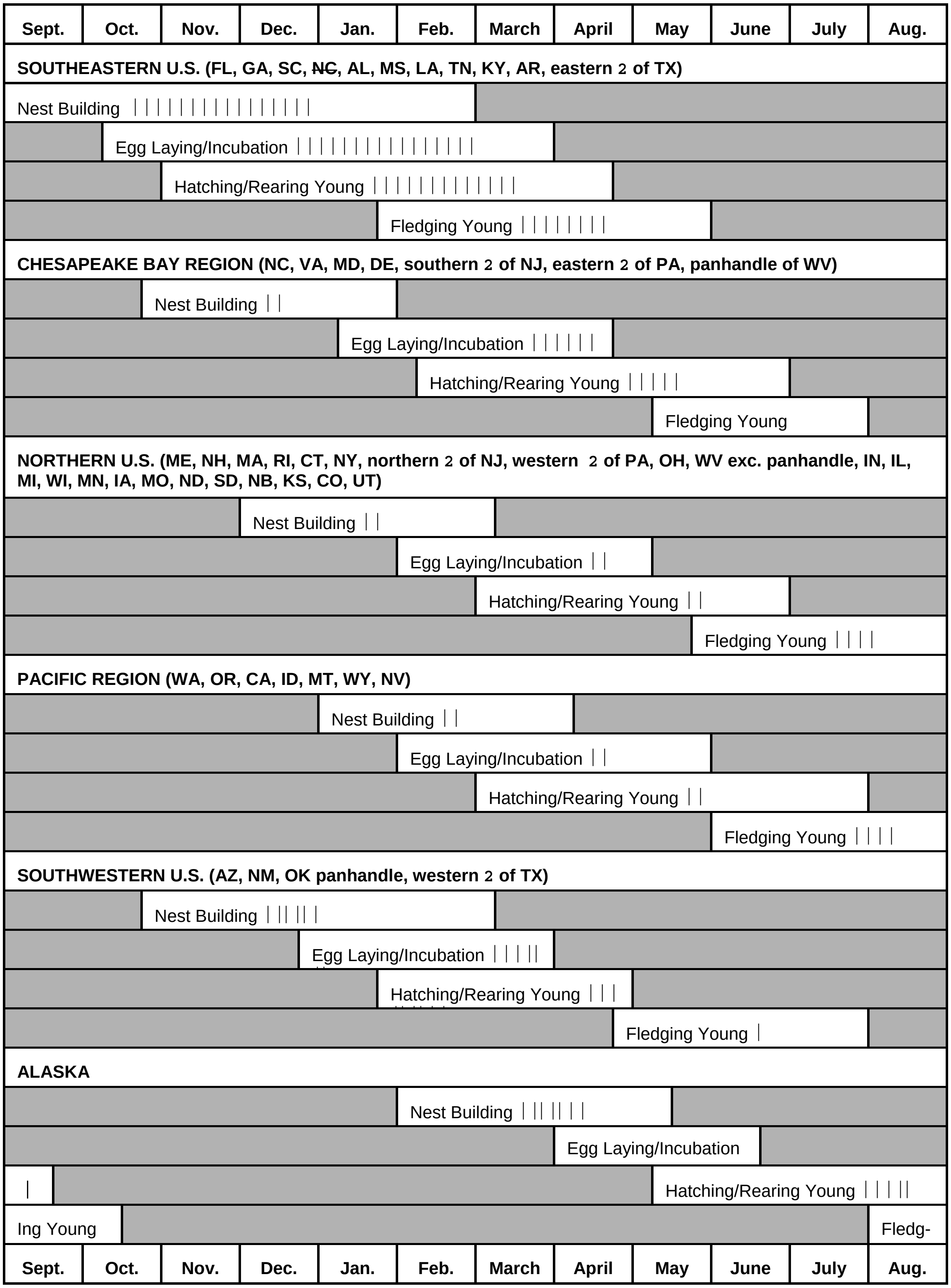
The range of breeding bald eagles in 2000 (shaded areas). This map shows only the larger concentrations of nests; eagles have continued to expand into additional nesting territories in many states. The dotted line represents the bald eagle's wintering range.

When do bald eagles nest?

Nesting activity begins several months before egg-laying. Egg-laying dates vary throughout the U.S., ranging from October in Florida, to late April or even early May in the northern United States. Incubation typically lasts 33-35 days, but can be as long as 40 days. Eaglets make their first unsteady flights about 10 to 12 weeks after hatching, and fledge (leave their nests) within a few days after that first flight. However, young birds usually remain in the vicinity of the nest for several weeks after fledging because they are almost completely dependent on their parents for food until they disperse from the nesting territory approximately 6 weeks later.

The bald eagle breeding season tends to be longer in the southern U.S., and re-nesting following an unsuccessful first nesting attempt is more common there as well. The following table shows the timing of bald eagle breeding seasons in different regions of the country. The table represents the range of time within which the majority of nesting activities occur in each region and does not apply to any specific nesting pair. Because the timing of nesting activities may vary within a given region, you should contact the nearest U.S. Fish and Wildlife Service Field Office (see page 16) and/or your state wildlife conservation agency for more specific information on nesting chronology in your area.

Chronology of typical reproductive activities of bald eagles in the United States.



How many chicks do bald eagles raise?
The number of eagle eggs laid will vary from 1-3, with 1-2 eggs being the most common. Only one eagle egg is laid per day, although not always on successive days. Hatching of young occurs on different days with the result that chicks in the same nest are sometimes of unequal size. The overall national fledging rate is approximately one chick per nest, annually, which results in a healthy expanding population.

What do bald eagles eat?
Bald eagles are opportunistic feeders. Fish comprise much of their diet, but they also eat waterfowl, shorebirds/colonial waterbirds, small mammals, turtles, and carrion. Because they are visual hunters, eagles typically locate their prey from a conspicuous perch, or soaring flight, then swoop down and strike. Wintering bald eagles often congregate in large numbers along streams to feed on spawning salmon or other fish species, and often gather in large numbers in areas below reservoirs, especially hydropower dams, where fish are abundant. Wintering eagles also take birds from rafts of ducks at reservoirs and rivers, and congregate on melting ice shelves to scavenge dead fish from the current or the soft melting ice. Bald eagles will also feed on carcasses along roads, in landfills, and at feedlots.

During the breeding season, adults carry prey to the nest to feed the young. Adults feed their chicks by tearing off pieces of food and holding them to the beaks of the eaglets. After fledging, immature eagles are slow to develop hunting skills, and must learn to locate reliable food sources and master feeding techniques. Young eagles will congregate together, often feeding upon easily acquired food such as carrion and fish found in abundance at the mouths of streams and shallow bays and at landfills.

The impact of human activity on nesting bald eagles
During the breeding season, bald eagles are sensitive to a variety of human activities. However, not all bald eagle pairs react to human activities in the same way. Some pairs nest successfully just dozens of yards from human activity, while others abandon nest sites in response to activities much farther away. This variability may be related to a number of factors, including visibility, duration, noise levels, extent of the area affected by the activity, prior experiences with humans, and tolerance of the individual nesting pair. The relative sensitivity of bald eagles during various stages of the breeding season is outlined in the following table.

Nesting Bald Eagle Sensitivity to Human Activities

Phase	Activity	Sensitivity to Human Activity	Comments
I	Courtship and Nest Building	Most sensitive period; likely to respond negatively	Most critical time period. Disturbance is manifested in nest abandonment. Bald eagles in newly established territories are more prone to abandon nest sites.
II	Egg laying	Very sensitive period	Human activity of even limited duration may cause nest desertion and abandonment of territory for the breeding season.
III	Incubation and early nestling period (up to 4 weeks)	Very sensitive period	Adults are less likely to abandon the nest near and after hatching. However, flushed adults leave eggs and young unattended; eggs are susceptible to cooling, loss of moisture, overheating, and predation; young are vulnerable to elements.
IV	Nestling period, 4 to 8 weeks	Moderately sensitive period	Likelihood of nest abandonment and vulnerability of the nestlings to elements somewhat decreases. However, nestlings may miss feedings, affecting their survival.
V	Nestlings 8 weeks through fledging	Very sensitive period	Gaining flight capability, nestlings 8 weeks and older may flush from the nest prematurely due to disruption and die.

If agitated by human activities, eagles may inadequately construct or repair their nest, may expend energy defending the nest rather than tending to their young, or may abandon the nest altogether. Activities that cause prolonged absences of adults from their nests can jeopardize eggs or young. Depending on weather conditions, eggs may overheat or cool too much and fail to hatch. Unattended eggs and nestlings are subject to predation. Young nestlings are particularly vulnerable because they rely on their parents to provide warmth or shade, without which they may die as a result of hypothermia or heat stress. If food delivery schedules are interrupted, the young may not develop healthy plumage, which can affect their survival. In addition, adults startled while incubating or brooding young may damage eggs or injure their young as they abruptly leave the nest. Older nestlings no longer require constant attention from the adults, but they may be startled by loud or intrusive human activities and prematurely jump from the nest before they are able to fly or care for themselves. Once fledged, juveniles range up to ¼ mile from the nest site, often to a site with minimal human activity. During this period, until about six weeks after departure from the nest, the juveniles still depend on the adults to feed them.

The impact of human activity on foraging and roosting bald eagles

Disruption, destruction, or obstruction of roosting and foraging areas can also negatively affect bald eagles. Disruptive activities in or near eagle foraging areas can interfere with feeding, reducing chances of survival. Interference with feeding can also result in reduced productivity (number of young successfully fledged). Migrating and wintering bald eagles often congregate at specific sites for purposes of feeding and sheltering. Bald eagles rely on established roost sites because of their proximity to sufficient food sources. Roost sites are usually in mature trees where the eagles are somewhat sheltered from the wind and weather. Human activities near or within communal roost sites may prevent eagles from feeding or taking shelter, especially if there are not other undisturbed and productive feeding and roosting sites available. Activities that permanently alter communal roost sites and important foraging areas can altogether eliminate the elements that are essential for feeding and sheltering eagles.

Where a human activity agitates or bothers roosting or foraging bald eagles to the degree that causes injury or substantially interferes with breeding, feeding, or sheltering behavior and causes, or is likely to cause, a loss of productivity or nest abandonment, the conduct of the activity constitutes a violation of the Eagle Act's prohibition against disturbing eagles. The circumstances that might result in such an outcome are difficult to predict without detailed site-specific information. If your activities may disturb roosting or foraging bald eagles, you should contact your local Fish and Wildlife Service Field Office (see page 16) for advice and recommendations for how to avoid such disturbance.

RECOMMENDATIONS FOR AVOIDING DISTURBANCE AT NEST SITES

In developing these Guidelines, we relied on existing state and regional bald eagle guidelines, scientific literature on bald eagle disturbance, and recommendations of state and Federal biologists who monitor the impacts of human activity on eagles. Despite these resources, uncertainties remain regarding the effects of many activities on eagles and how eagles in different situations may or may not respond to certain human activities. The Service recognizes this uncertainty and views the collection of better biological data on the response of eagles to disturbance as a high priority. To the extent that resources allow, the Service will continue to collect data on responses of bald eagles to human activities conducted according to the recommendations within these Guidelines to ensure that adequate protection from disturbance is being afforded, and to identify circumstances where the Guidelines might be modified. These data will be used to make future adjustments to the Guidelines.

To avoid disturbing nesting bald eagles, we recommend (1) keeping a distance between the activity and the nest (distance buffers), (2) maintaining preferably forested (or natural) areas between the activity and around nest trees (landscape buffers), and (3) avoiding certain activities during the breeding season. The buffer areas serve to minimize visual and auditory impacts associated with human activities near nest sites. Ideally, buffers would be large enough to protect existing nest trees and provide for alternative or replacement nest trees.

The size and shape of effective buffers vary depending on the topography and other ecological characteristics surrounding the nest site. In open areas where there are little or no forested or topographical buffers, such as in many western states, distance alone must serve as the buffer. Consequently, in open areas, the distance between the activity and the nest may need to be larger than the distances recommended under Categories A and B of these guidelines (pg. 12) if no landscape buffers are present. The height of the nest above the ground may also ameliorate effects of human activities; eagles at higher nests may be less prone to disturbance.

In addition to the physical features of the landscape and nest site, the appropriate size for the distance buffer may vary according to the historical tolerances of eagles to human activities in particular localities, and may also depend on the location of the nest in relation to feeding and roosting areas used by the eagles. Increased competition for nest sites may lead bald eagles to nest closer to human activity (and other eagles).

Seasonal restrictions can prevent the potential impacts of many shorter-term, obtrusive activities that do not entail landscape alterations (e.g. fireworks, outdoor concerts). In proximity to the nest, these kinds of activities should be conducted only outside the breeding season. For activities that entail both short-term, obtrusive characteristics and more permanent impacts (e.g., building construction), we recommend a combination of both approaches: retaining a landscape buffer *and* observing seasonal restrictions.

For assistance in determining the appropriate size and configuration of buffers or the timing of activities in the vicinity of a bald eagle nest, we encourage you to contact the nearest U.S. Fish and Wildlife Service Field Office (see page 16).

Existing Uses

Eagles are unlikely to be disturbed by routine use of roads, homes, and other facilities where such use pre-dates the eagles' successful nesting activity in a given area. Therefore, in most cases *ongoing* existing uses may proceed with the same intensity with little risk of disturbing bald eagles. However, some *intermittent, occasional, or irregular* uses that pre-date eagle nesting in an area may disturb bald eagles. For example: a pair of eagles may begin nesting in an area and subsequently be disturbed by activities associated with an annual outdoor flea market, even though the flea market has been held annually at the same location. In such situations, human activity should be adjusted or relocated to minimize potential impacts on the nesting pair.

ACTIVITY-SPECIFIC GUIDELINES

The following section provides the Service=s management recommendations for avoiding bald eagle disturbance as a result of new or intermittent activities proposed in the vicinity of bald eagle nests. Activities are separated into 8 categories (A – H) based on the nature and magnitude of impacts to bald eagles that usually result from the type of activity. Activities with similar or comparable impacts are grouped together.

In most cases, impacts will vary based on the visibility of the activity from the eagle nest and the degree to which similar activities are already occurring in proximity to the nest site. Visibility is a factor because, in general, eagles are more prone to disturbance when an activity occurs in full view. For this reason, we recommend that people locate activities farther from the nest structure in areas with open vistas, in contrast to areas where the view is shielded by rolling topography, trees, or other screening factors. The recommendations also take into account the existence of similar activities in the area because the continued presence of nesting bald eagles in the vicinity of the existing activities indicates that the eagles in that area can tolerate a greater degree of human activity than we can generally expect from eagles in areas that experience fewer human impacts. To illustrate how these factors affect the likelihood of disturbing eagles, we have incorporated the recommendations for some activities into a table (categories A and B).

First, determine which category your activity falls into (between categories A – H). If the activity you plan to undertake is not specifically addressed in these guidelines, follow the recommendations for the most similar activity represented.

If your activity is under A or B, our recommendations are in table form. The vertical axis shows the degree of visibility of the activity from the nest. The horizontal axis (header row) represents the degree to which similar activities are ongoing in the vicinity of the nest. Locate the row that best describes how visible your activity will be from the eagle nest. Then, choose the column that best describes the degree to which similar activities are ongoing in the vicinity of the eagle nest. The box where the column and row come together contains our management recommendations for how far you should locate your activity from the nest to avoid disturbing the eagles. The numerical distances shown in the tables are the closest the activity should be conducted relative to the nest. In some cases we have included additional recommendations (other than recommended *distance* from the nest) you should follow to help ensure that your activity will not disturb the eagles.

Alternate nests
For activities that entail permanent landscape alterations that may result in bald eagle disturbance, these recommendations apply to both active and alternate bald eagle nests. Disturbance becomes an issue with regard to alternate nests if eagles return for breeding purposes and react to land use changes that occurred while the nest was inactive. The likelihood that an alternate nest will again become active decreases the longer it goes unused. If you plan activities in the vicinity of an alternate bald eagle nest and have information to show that the nest has not been active during the preceding 5 breeding seasons, the recommendations provided in these guidelines for avoiding disturbance around the nest site may no longer be warranted. The nest itself remains protected by other provisions of the Eagle Act, however, and may not be destroyed.

If special circumstances exist that make it unlikely an inactive nest will be reused before 5 years of disuse have passed, and you believe that the probability of reuse is low enough to warrant disregarding the recommendations for avoiding disturbance, you should be prepared to provide all the reasons for your conclusion, including information regarding past use of the nest site. Without sufficient documentation, you should continue to follow these guidelines when conducting activities around the nest site. If we are able to determine that it is unlikely the nest will be reused, we may advise you that the recommendations provided in these guidelines for avoiding disturbance are no longer necessary around that nest site.

This guidance is intended to minimize disturbance, as defined by Federal regulation. In addition to Federal laws, most states and some tribes and smaller jurisdictions have additional laws and regulations protecting bald eagles. In some cases those laws and regulations may be more protective (restrictive) than these Federal guidelines.

Temporary Impacts
For activities that have temporary impacts, such as the use of loud machinery, fireworks displays, or summer boating activities, we recommend seasonal restrictions. These types of activities can generally be carried out outside of the breeding season without causing disturbance. The recommended restrictions for these types of activities can be lifted for alternate nests within a particular territory, including nests that were attended during the current breeding season but not used to raise young, after eggs laid in another nest within the territory have hatched (depending on the distance between the alternate nest and the active nest).

In general, activities should be kept as far away from nest trees as possible; loud and disruptive activities should be conducted when eagles are not nesting; and activity between the nest and the nearest foraging area should be minimized. If the activity you plan to undertake is not specifically addressed in these guidelines, follow the recommendations for the most similar activity addressed, or contact your local U.S. Fish and Wildlife Service Field Office for additional guidance.

If you believe that special circumstances apply to your situation that increase or diminish the likelihood of bald eagle disturbance, or if it is not possible to adhere to the guidelines, you should contact your local Service Field Office for further guidance.

Category A:
Building construction, 1 or 2 story, with project footprint of ½ acre or less.
Construction of roads, trails, canals, power lines, and other linear utilities.
Agriculture and aquaculture – new or expanded operations.
Alteration of shorelines or wetlands.
Installation of docks or moorings.
Water impoundment.

Category B:
Building construction, 3 or more stories.
Building construction, 1 or 2 story, with project footprint of more than ½ acre.
Installation or expansion of marinas with a capacity of 6 or more boats.
Mining and associated activities.
Oil and natural gas drilling and refining and associated activities.

	If there is no similar activity within 1 mile of the nest	***If there is similar activity closer than 1 mile from the nest***
If the activity will be visible from the nest	660 feet. Landscape buffers are recommended.	660 feet, or as close as existing tolerated activity of similar scope. Landscape buffers are recommended.
If the activity will not be visible from the nest	Category A: 330 feet. Clearing, external construction, and landscaping between 330 feet and 660 feet should be done outside breeding season. Category B: 660 feet.	330 feet, or as close as existing tolerated activity of similar scope. Clearing, external construction and landscaping within 660 feet should be done outside breeding season.

The numerical distances shown in the table are the closest the activity should be conducted relative to the nest.

Category C. Timber Operations and Forestry Practices

- Avoid clear cutting or removal of overstory trees within 330 feet of the nest at any time.

- Avoid timber harvesting operations, including road construction and chain saw and yarding operations, during the breeding season within 660 feet of the nest. The distance may be decreased to 330 feet around alternate nests within a particular territory, including nests that were attended during the current breeding season but not used to raise young, after eggs laid in another nest within the territory have hatched.

- Selective thinning and other silviculture management practices designed to conserve or enhance habitat, including prescribed burning close to the nest tree, should be undertaken outside the breeding season. Precautions such as raking leaves and woody debris from around the nest tree should be taken to prevent crown fire or fire climbing the nest tree. If it is determined that a burn during the breeding season would be beneficial, then, to ensure that no take or disturbance will occur, these activities should be conducted only when neither adult eagles nor young are present at the nest tree (i.e., at the beginning of, or end of, the breeding season, either before the particular nest is active or after the young have fledged from that nest). Appropriate Federal and state biologists should be consulted before any prescribed burning is conducted during the breeding season.

- Avoid construction of log transfer facilities and in-water log storage areas within 330 feet of the nest.

Category D. Off-road vehicle use (including snowmobiles). No buffer is necessary around nest sites outside the breeding season. During the breeding season, do not operate off-road vehicles within 330 feet of the nest. In open areas, where there is increased visibility and exposure to noise, this distance should be extended to 660 feet.

Category E. Motorized Watercraft use (including jet skis/personal watercraft). No buffer is necessary around nest sites outside the breeding season. During the breeding season, within 330 feet of the nest, (1) do not operate jet skis (personal watercraft), and (2) avoid concentrations of noisy vessels (e.g., commercial fishing boats and tour boats), except where eagles have demonstrated tolerance for such activity. Other motorized boat traffic passing within 330 feet of the nest should attempt to minimize trips and avoid stopping in the area where feasible, particularly where eagles are unaccustomed to boat traffic. Buffers for airboats should be larger than 330 feet due to the increased noise they generate, combined with their speed, maneuverability, and visibility.

Category F. Non-motorized recreation and human entry (e.g., hiking, camping, fishing, hunting, birdwatching, kayaking, canoeing). No buffer is necessary around nest sites outside the breeding season. If the activity will be visible or highly audible from the nest, maintain a 330-foot buffer during the breeding season, particularly where eagles are unaccustomed to such activity.

Category G. Helicopters and fixed-wing aircraft.
Except for authorized biologists trained in survey techniques, avoid operating aircraft within 1,000 feet of the nest during the breeding season, except where eagles have demonstrated tolerance for such activity.

Category H. Blasting and other loud, intermittent noises.
Avoid blasting and other activities that produce extremely loud noises within 1/2 mile of active nests, unless greater tolerance to the activity (or similar activity) has been demonstrated by the eagles in the nesting area. This recommendation applies to the use of fireworks classified by the Federal Department of Transportation as Class B explosives, which includes the larger fireworks that are intended for licensed public display.

RECOMMENDATIONS FOR AVOIDING DISTURBANCE AT FORAGING AREAS AND COMMUNAL ROOST SITES

1. Minimize potentially disruptive activities and development in the eagles' direct flight path between their nest and roost sites and important foraging areas.

2. Locate long-term and permanent water-dependent facilities, such as boat ramps and marinas, away from important eagle foraging areas.

3. Avoid recreational and commercial boating and fishing near critical eagle foraging areas during peak feeding times (usually early to mid-morning and late afternoon), except where eagles have demonstrated tolerance to such activity.

4. Do not use explosives within ½ mile (or within 1 mile in open areas) of communal roosts when eagles are congregating, without prior coordination with the U.S. Fish and Wildlife Service and your state wildlife agency.

5. Locate aircraft corridors no closer than 1,000 feet vertical or horizontal distance from communal roost sites.

ADDITIONAL RECOMMENDATIONS TO BENEFIT BALD EAGLES

The following are additional management practices that landowners and planners can exercise for added benefit to bald eagles.

1. Protect and preserve potential roost and nest sites by retaining mature trees and old growth stands, particularly within ½ mile from water.

2. Where nests are blown from trees during storms or are otherwise destroyed by the elements, continue to protect the site in the absence of the nest for up to three (3) complete breeding seasons. Many eagles will rebuild the nest and reoccupy the site.

3. To avoid collisions, site wind turbines, communication towers, and high voltage transmission power lines away from nests, foraging areas, and communal roost sites.

4. Employ industry-accepted best management practices to prevent birds from colliding with or being electrocuted by utility lines, towers, and poles. If possible, bury utility lines in important eagle areas.

5. Where bald eagles are likely to nest in human-made structures (e.g., cell phone towers) and such use could impede operation or maintenance of the structures or jeopardize the safety of the eagles, equip the structures with either (1) devices engineered to discourage bald eagles from building nests, or (2) nesting platforms that will safely accommodate bald eagle nests without interfering with structure performance.

6. Immediately cover carcasses of euthanized animals at landfills to protect eagles from being poisoned.

7. Do not intentionally feed bald eagles. Artificially feeding bald eagles can disrupt their essential behavioral patterns and put them at increased risk from power lines, collision with windows and cars, and other mortality factors.

8. Use pesticides, herbicides, fertilizers, and other chemicals only in accordance with Federal and state laws.

9. Monitor and minimize dispersal of contaminants associated with hazardous waste sites (legal or illegal), permitted releases, and runoff from agricultural areas, especially within watersheds where eagles have shown poor reproduction or where bioaccumulating contaminants have been documented. These factors present a risk of contamination to eagles and their food sources.

CONTACTS

The following U.S. Fish and Wildlife Service Field Offices provide technical assistance on bald eagle management:

Alabama	Daphne	(251) 441-5181
Alaska	Anchorage	(907) 271-2888
	Fairbanks	(907) 456-0203
	Juneau	(907) 780-1160
Arizona	Phoenix	(602) 242-0210
Arkansas	Conway	(501) 513-4470
California	Arcata	(707) 822-7201
	Barstow	(760) 255-8852
	Carlsbad	(760) 431-9440
	Red Bluff	(530) 527-3043
	Sacramento	(916) 414-6000
	Stockton	(209) 946-6400
	Ventura	(805) 644-1766
	Yreka	(530) 842-5763
Colorado	Lakewood	(303) 275-2370
	Grand Junction	(970) 243-2778
Connecticut	(See New Hampshire)	
Delaware	(See Maryland)	
Florida	Panama City	(850) 769-0552
	Vero Beach	(772) 562-3909
	Jacksonville	(904) 232-2580
Georgia	Athens	(706) 613-9493
	Brunswick	(912) 265-9336
	Columbus	(706) 544-6428
Idaho	Boise	(208) 378-5243
	Chubbuck	(208) 237-6975
Illinois/Iowa	Rock Island	(309) 757-5800
Indiana	Bloomington	(812) 334-4261
Kansas	Manhattan	(785) 539-3474
Kentucky	Frankfort	(502) 695-0468
Louisiana	Lafayette	(337) 291-3100
Maine	Old Town	(207) 827-5938
Maryland	Annapolis	(410) 573-4573
Massachusetts	(See New Hampshire)	
Michigan	East Lansing	(517) 351-2555
Minnesota	Bloomington	(612) 725-3548
Mississippi	Jackson	(601) 965-4900
Missouri	Columbia	(573) 234-2132
Montana	Helena	(405) 449-5225
Nebraska	Grand Island	(308) 382-6468
Nevada	Las Vegas	(702) 515-5230
	Reno	(775) 861-6300
New Hampshire	Concord	(603) 223-2541
New Jersey	Pleasantville	(609) 646-9310
New Mexico	Albuquerque	(505) 346-2525
New York	Cortland	(607) 753-9334
	Long Island	(631) 776-1401
North Carolina	Raleigh	(919) 856-4520
	Asheville	(828) 258-3939
North Dakota	Bismarck	(701) 250-4481
Ohio	Reynoldsburg	(614) 469-6923
Oklahoma	Tulsa	(918) 581-7458
Oregon	Bend	(541) 383-7146
	Klamath Falls	(541) 885-8481
	La Grande	(541) 962-8584
	Newport	(541) 867-4558
	Portland	(503) 231-6179
	Roseburg	(541) 957-3474
Pennsylvania	State College	(814) 234-4090
Rhode Island	(See New Hampshire)	
South Carolina	Charleston	(843) 727-4707
South Dakota	Pierre	(605) 224-8693
Tennessee	Cookeville	(931) 528-6481
Texas	Clear Lake	(281) 286-8282
Utah	West Valley City	(801) 975-3330
Vermont	(See New Hampshire)	
Virginia	Gloucester	(804) 693-6694
Washington	Lacey	(306) 753-9440
	Spokane	(509) 891-6839
	Wenatchee	(509) 665-3508
West Virginia	Elkins	(304) 636-6586
Wisconsin	New Franken	(920) 866-1725
Wyoming	Cheyenne	(307) 772-2374
	Cody	(307) 578-5939

National Office
U.S. Fish and Wildlife Service
Division of Migratory Bird Management
4401 North Fairfax Drive, MBSP-4107
Arlington, VA 22203-1610
(703) 358-1714
http://www.fws.gov/migratorybirds

State Agencies

To contact a state wildlife agency, visit the Association of Fish & Wildlife Agencies' website at http://www.fishwildlife.org/where_us.html

GLOSSARY

The definitions below apply to these National Bald Eagle Management Guidelines:

Communal roost sites – Areas where bald eagles gather and perch overnight – and sometimes during the day in the event of inclement weather. Communal roost sites are usually in large trees (live or dead) that are relatively sheltered from wind and are generally in close proximity to foraging areas. These roosts may also serve a social purpose for pair bond formation and communication among eagles. Many roost sites are used year after year.

Disturb – To agitate or bother a bald or golden eagle to a degree that causes, or is likely to cause, based on the best scientific information available, 1) injury to an eagle, 2) a decrease in its productivity, by substantially interfering with normal breeding, feeding, or sheltering behavior, or 3) nest abandonment, by substantially interfering with normal breeding, feeding, or sheltering behavior.

In addition to immediate impacts, this definition also covers impacts that result from human-caused alterations initiated around a previously used nest site during a time when eagles are not present, if, upon the eagle=s return, such alterations agitate or bother an eagle to a degree that injures an eagle or substantially interferes with normal breeding, feeding, or sheltering habits and causes, or is likely to cause, a loss of productivity or nest abandonment.

Fledge – To leave the nest and begin flying. For bald eagles, this normally occurs at 10-12 weeks of age.

Fledgling – A juvenile bald eagle that has taken the first flight from the nest but is not yet independent.

Foraging area – An area where eagles feed, typically near open water such as rivers, lakes, reservoirs, and bays where fish and waterfowl are abundant, or in areas with little or no water (i.e., rangelands, barren land, tundra, suburban areas, etc.) where other prey species (e.g., rabbit, rodents) or carrion (such as at landfills) are abundant.

Landscape buffer – A natural or human-made landscape feature that screens eagles from human activity (e.g., strip of trees, hill, cliff, berm, sound wall).

Nest – A structure built, maintained, or used by bald eagles for the purpose of reproduction. An **active** nest is a nest that is attended (built, maintained or used) by a pair of bald eagles during a given breeding season, whether or not eggs are laid. An **alternate** nest is a nest that is not used for breeding by eagles during a given breeding season.

Nest abandonment – Nest abandonment occurs when adult eagles desert or stop attending a nest and do not subsequently return and successfully raise young in that nest for the duration of a breeding season. Nest abandonment can be caused by altering habitat near a nest, even if the alteration occurs prior to the breeding season. Whether the eagles migrate during the non-breeding season, or remain in the area throughout the non-breeding season, nest abandonment can occur at any point between the time the eagles return to the nesting site for the breeding season and the time when all progeny from the breeding season have dispersed.

Project footprint – The area of land (and water) that will be permanently altered for a development project, including access roads.

Similar scope – In the vicinity of a bald eagle nest, an existing activity is of similar scope to a new activity where the types of impacts to bald eagles are similar in nature, and the impacts of the existing activity are of the same or greater magnitude than the impacts of the potential new activity. Examples: (1) An existing single-story home 200 feet from a nest is similar in scope to an additional single-story home 200 feet from the nest; (2) An existing multi-story, multi-family dwelling 150 feet from a nest has impacts of a greater magnitude than a potential new single-family home 200 feet from the nest; (3) One existing single-family home 200 feet from the nest has impacts of a lesser magnitude than three single-family homes 200 feet from the nest; (4) an existing single-family home 200 feet from a communal roost has impacts of a lesser magnitude than a single-family home 300 feet from the roost but 40 feet from the eagles' foraging area. The existing activities in examples (1) and (2) are of similar scope, while the existing activities in example (3) and (4) are not.

Vegetative buffer – An area surrounding a bald eagle nest that is wholly or largely covered by forest, vegetation, or other natural ecological characteristics, and separates the nest from human activities.

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APPENDIX N: ROANOKE LOGPERCH MANAGEMENT PLAN

ENDANGERED SPECIES MANAGEMENT PLAN FOR THE ROANOKE LOGPERCH *(PERCINA REX)* AT ARMY NATIONAL GUARD MANEUVER TRAINING CENTER FORT PICKETT, VIRGINIA

Prepared for:

Virginia Army National Guard
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Virginia Department of Military Affairs
Facilities Management – Environmental Division
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September 2005

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September 2005

CMI-MLD R-29

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Executive summary

The purpose of the Endangered Species Management Plan is to facilitate conservation within the scope of ARNG-MTC Fort Pickett mission by presenting pertinent species information and potential threats to the Roanoke logperch *(Percina rex)*, discussing species status on the installation and conservation goals for the species and critical habitat, and by outlining specific management actions, including inventory and monitoring efforts. Management will emphasize a watershed-level approach to minimize sediment loading and preserve natural river flow. Roanoke logperch have been documented in the mainstem of the Nottoway River on the installation 4 times (1999, 2000, and twice in 2001). Uncertainty of habitat use by Roanoke logperch in the Nottoway requires implementation of adaptive management strategies identified from population and habitat monitoring, and inherent in-stream habitat variability requires strict observation of the Roanoke Logperch Management Zone that prohibits any action that will disturb the stream bank or result in soil erosion within 300 meters of the Nottoway. Rapid Bioassessment shows that much of the Nottoway River on ARNG-MTC Fort Pickett is currently classified in the optimal and sub-optimal range, and management will maintain this integrity through the protection of the Nottoway macrobasin and the observation of best management practices and wetland and riparian management zones installation-wide. Population status and habitat conditions will be monitored at least every 3-5 years, with results integrated into the next management cycle. Ongoing survey efforts should provide additional information on population status and habitat use by Roanoke logperch on the installation. Rapid Bioassessment data emphasizing Roanoke logperch habitat suitability and suggested biological and habitat monitoring protocols are also presented.

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1.0 Introduction

The United States military is committed to protecting endangered species. Army Regulation 200-3 (AR 200-3) states that all personnel must ensure training can "carry out mission requirements in harmony with the requirements of the Endangered Species Act (ESA)." AR 200-3 requires Army installations to create an Endangered Species Management Plan (ESMP) for listed and proposed species and critical habitat present on the installation. ESMPs are the Army's primary means of ensuring ESA compliance and balancing mission requirements. The Roanoke logperch has been listed as a federally endangered species since August 18, 1989 (Federal Register Vol. No. 159) and was discovered at Army National Guard Maneuver Training Center-Fort Pickett (ARNG-MTC Fort Pickett) during the summer of 1999.

1.1 ESMP Goals:

1. Present pertinent species information and potential threats to the species.
2. Discuss current understanding of species status on the installation.
3. Define conservation goals for the species and critical habitat.
4. Outline specific management actions.
5. Describe ongoing inventory and monitoring plan.
6. Facilitate conservation within the scope of ARNG-MTC Fort Pickett mission.
7. Supplement the existing Integrated Natural Resources Management Plan.
8. Enumerate conservation criteria to support installation compliance with the ESMP.

2.0 Species Information

2.1 Reasons for Listing

The Roanoke logperch is endemic only to Virginia and is known only to inhabit four locations in Virginia: the upper Roanoke River, Pigg River, Nottoway River, and Smith River. Population density in these areas is low and thus sensitive to changes in the ecosystem. The lifestyle and foraging strategy of the logperch makes it especially vulnerable to the effects of the accumulation of fine sediments that can embed substrate, and fill in interstitial spaces used by the benthic prey species upon which it feeds. As a result of this vulnerability, low population densities, and very limited distribution the Roanoke logperch has been listed as a federally endangered species since 1989. Throughout its range the species is limited by turbidity and siltation, chemical spills and organic pollution, channelization, impoundment, cold water, and small stream size (VDGIF 2003). Siltation from agricultural and chemical spills has the potential to negatively impact all four populations and seems to be the biggest threat to this species (USFWS 1992).

2.2 Species Description

The body of the Roanoke logperch *(Percina rex)* averages 14 cm (5.5 in) in length, making it the largest member of the darter family – Percidae. Its body is elongate, cylindrical to slab-sided, with a conical snout and well-developed subocular bar and caudal spot. The back is dark green with darker markings and numerous small saddles that overlap onto the upper sides. Sides are greenish yellow with prominent bar markings usually separated from the dorsal markings. The belly is white to yellowish. The first dorsal fin has a broad yellowish to orange to red-orange band entirely bordered by a narrow black margin above and a broad black base below. The second dorsal, caudal, and large pectoral fins have black spots with a yellowish wash (USFWS 1992).

2.3 Life History/Ecology

The Roanoke logperch is an indicator of high stream quality and inhabits relatively shallow streams with rocky substrates suited to their very specialized foraging behavior. They are benthic predators that flip over stones on the stream bottom with their pig-like snouts to expose potential prey items that hide in the crevices between the rocks (aquatic insects, roundworms, young crayfish, etc.). They are able to flip stones that are quite large relative to their body size by using their head like a prying lever and pushing up and forward with stout pectoral fins. This feeding behavior exploits prey that may be unavailable to other benthic hunters, but is dependant on the availability of loosely embedded substrate. As a result, logperch are especially vulnerable to accumulation of fine sediments that can embed the substrate and fill the tiny interstitial spaces between rocks, depriving them of their source of food. The Roanoke logperch is considered a diurnal, visual predator and corresponding reductions in visibility from sedimentation likely interfere with foraging success. In addition, species reproduction includes elaborate spawning behaviors, and waters muddied by excessive sedimentation may also interfere with reproductive success and egg burying. Spawning occurs in mid-April to early May in medium and large, warm streams during the time when increased turbidity from coincident rains can exacerbate the problem. The life span of this species averages 5-6 years. The maximum age detected is about 6.5 years (Burkhead and Jenkins 1991). Males mature in two years; most females mature in three years. All *Percina* species bury their eggs, with no subsequent parental care.

2.4 Regional Distribution:

The Roanoke logperch is one of only six species of fish that are endemic to Virginia (Jenkins and Burkhead 1994), and occur in only the Roanoke and Chowan River drainages. Simonson and Neves (1986) state that the Roanoke logperch occupies 94.9 stream km of the Nottoway River system in the Chowan River drainage reported by the USFWS Roanoke logperch recovery plan (1992) to include a 52 km reach of the mainstem of the Nottoway in Sussex and Greenville counties, Stoney Creek (a tributary of the Nottoway) in Dinwiddie and Sussex counties, and Butterwood Creek (a tributary to Stoney Creek). In the Roanoke River drainage, the Roanoke logperch also occupies the upper Roanoke River system in Roanoke and Montgomery counties, the Pigg River system in Franklin and Henry counties, and the Smith River System in Patrick and Henry counties. These disjunct populations probably represent remnants of much larger populations. Jenkins and Burkhead (1994) found this species to be rare to uncommon and never abundant throughout its range.

Prior to its discovery on ARNG-MTC Fort Pickett Roanoke logperch distribution in the mainstem of the Nottoway was known from State Route 619 bridge in Sussex County, downstream to just above State Route 40 bridge east of Sussex, VA. Population levels are likely low, as evidenced by collection records that indicate that specimens have been mostly taken as singles or doubles (never in great numbers) (McIninch and Garman 2002).

2.4.A Distribution on ARNG-MTC Fort Pickett:

Roanoke logperch were first observed on MTC-Fort Picket on September 2, 1999. A Virginia Department of Conservation and Recreation, Division of Natural Heritage zoologist observed one adult specimen for 4-5 minutes at close range through an aquascope in the mainstem of the Nottoway River, approximately 0.5-0.75 river kilometers upstream of Shacks Hole Road (Roble pers. comm. 1999; Chazal and Derge 2001). Virginia Tech biologists observed another specimen in approximately the same area on September 15, 2000 (Mayne pers.comm. 2000; Angermeier and Rosenberger 2000).

McIninch and Garman (2002) used qualitative backpack-based electrofishing sampling to target Roanoke logperch and captured 2 individuals. While sampling efforts included tributaries, logperch were found only in the mainstem of the Nottoway. One was captured just downstream of the first ford upstream of Gills Bridge/ “Bailey Bridge” Road on September 20, 2001. Another Roanoke logperch was captured downstream of the Tower Road crossing on November 17, 2001 (Table 1, Figure 1).

Quantitative sampling of the fish population in the Nottoway River on ARNG-MTC Fort Pickett is currently underway and should provide additional information on current distribution on the installation.

Table 1. Coordinates of Roanoke logperch observations in the Nottoway River on ARNG-Fort Pickett as of September 2005. Coordinates are estimations based on site descriptions and interpretation of hardcopy maps.

	UTM coordinates		
observation date	easting	northing	observation type
9/2/1999	245204	4097755	sighting
9/15/2000	245268	4097824	sighting
9/20/2001	246647	4097841	capture
11/17/2001	243664	4097733	capture

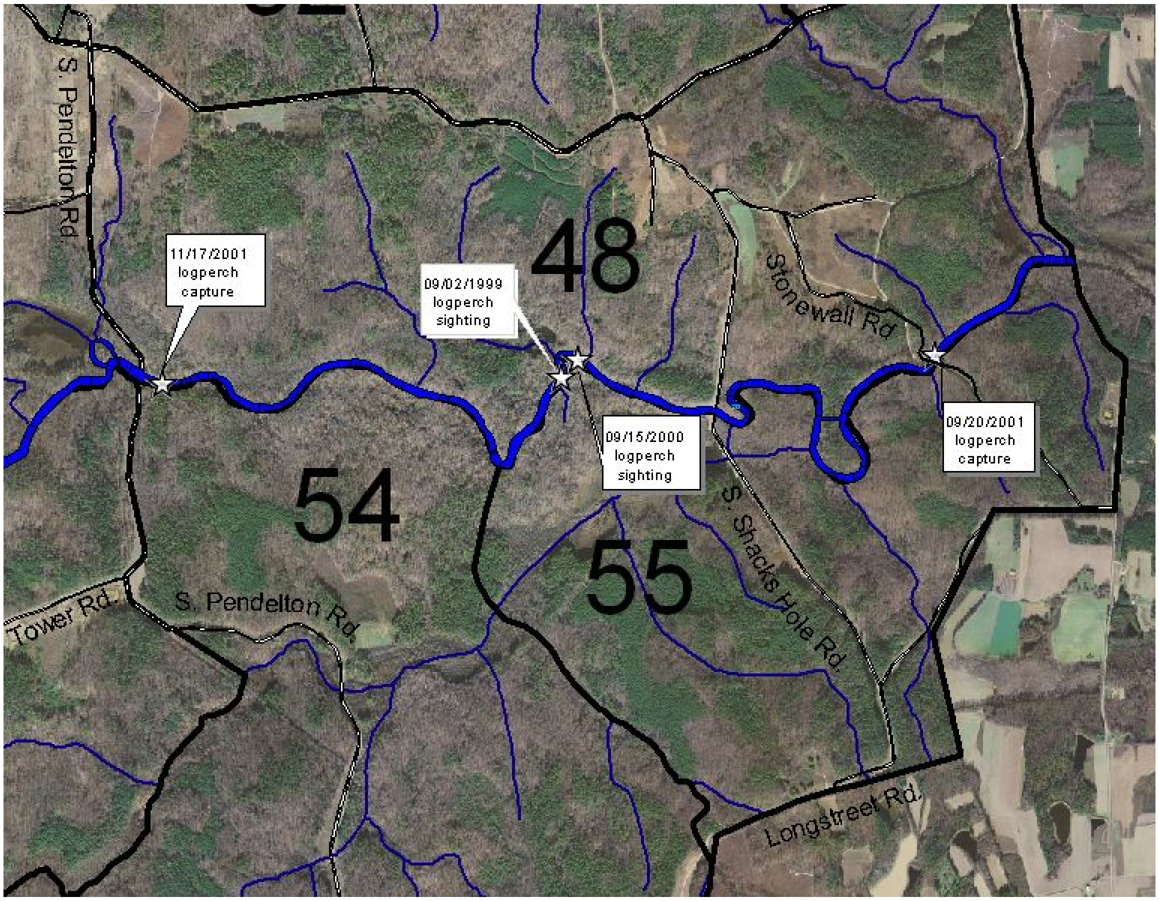

Figure 1. Locations where Roanoke logperch have been found in the mainstem of the Nottoway River on ARNG-MTC Fort Pickett. Image shows south-eastern portion of the base bisected by the Nottoway and surrounding Training Areas.

2.5 Habitat/Ecosystem

The Nottoway River is unique among the river systems used by Roanoke logperch. Rosenberger and Angermeier (2002) found that the Nottoway was the largest and most lowland (low gradient) of the river systems where Roanoke logperch have been documented, and is comprised of a greater proportion of wide channels, with a dominance of pool habitats and smaller substrate sizes. The Nottoway was also found to be the least silted of the rivers used by Roanoke logperch, the least embedded, and relatively pristine with complete riparian zones. The Nottoway also had a higher abundance of aquatic insects preferred by adults, with more large woody debris found in all mesohabitat types (pool, riffle, run) (Rosenberger and Angermeier 2002).

Rosenberger 2002 observed adult and subadult logperch primarily in pools, occasionally in runs, and rarely in riffles, over sand and gravel in deep, low velocity habitats. That logperch were more likely to be found in pools on the Nottoway than in other mesohabitat types perhaps follows intuitively from the differences in habitat availability found in the Nottoway as compared to elsewhere in their range. Use of pools in other river systems where Roanoke logperch have been found may be precluded by excessive sedimentation, requiring the greater energy costs of navigating faster water habitat to find suitable feeding substrate. Logperch in the Nottoway may be able to take advantage of the relative abundance of pools with slower flow velocities, low silt loads, and the shelter from predators and foraging potential provided by the relative abundance of large woody debris. Logperch were observed consistently over small to large gravel in areas dominated by large gravel to boulders, with loosely embedded substrate and little or no silt cover. Both age classes selected habitat with little to no silt cover. Individuals found in deep pools were often observed near woody debris that may have served as cover from predators and as a source of food. These habitat configurations are common and widespread in the Nottoway River (Rosenberger 2002).

During different phases of life history and season, every major riverine habitat type is utilized by the logperch, and can vary with age class, spawning condition, and seasonal temperature (Burkhead 1983). Adults occupy a greater range of velocity and substrate characteristics and more scoured and fast flowing habitats than other age classes. Adults in the Nottoway occupy locations with faster velocities and less silt cover than subadults. Variations in habitat use by age class in the Nottoway may be due to predation pressure, feeding preferences, swimming ability, and/or stresses related to human activity.

While Burkhead (1983) proposed that logperch make greater use of deep pools for winter habitat, Rosenberger and Angermeier (2002) found less dramatic shifts in seasonal use. Adults were observed in high-velocity, deep microhabitat in riffles and runs over exposed, silt-free gravel in areas dominated by cobble and boulder substrates in both summer and winter. Logperch observed in winter appeared to occupy lower water velocities and were found over substrate less embedded with smaller substrates and less covered with silt. Use of lower water velocities would reduce energy requirements and accommodate potentially diminished swimming ability resulting from colder temperatures and reduced metabolism of winter quiescent individuals. The need for interstitial pockets within cobble and boulders for resting in winter may additionally influence seasonal habitat requirements.

While it is evident that a variety of habitat conditions are required for successful utilization by Roanoke logperch, the unifying feature appears to be their substrate requirements. Current understanding indicates that they require silt-free, exposed substrate for foraging, energetic, and reproductive success. The availability of suitable substrate is the most limiting factor for Roanoke logperch.

2.5.A Habitat on ARNG-MTC Fort Pickett:

Habitat at the Shacks Hole site where the logperch was sighted in 1999 was described as a 0-1.5 meter deep sand and gravel bottomed run with moderate flow in a sharp bend in the river (Roble *pers. comm.* 1999). Angermeier and Rosenberger (2000) reported that the location of their sighting appeared to be near the original site, with habitat consisting of deep pools, runs and a riffle with extreme variations in flow velocity. The logperch was sighted in riffles over heterogeneous substrate (gravel, cobble, and boulder) described as comparatively silt-free. The Roanoke logperch that was captured just downstream of the first ford upstream of Gills Bridge/ "Bailey Bridge" Road was found where swift water dropped into a slight pool about 60 cm deep over a rubble and gravel substrate kept clean by the swift water. The Roanoke logperch that was captured downstream of the Tower Road crossing was found where the substrate was mostly sand with sporadic patches of small gravel with pockets of bedrock in the river and projecting out from the river banks. This individual was captured near the confluence of a small tributary at the end of a pool where flow increased due to large woody debris and small patches of gravel (McIninch and Garman 2002).

The Nottoway River on ARNG-MTC Fort Pickett has a predominantly sandy substrate and does not exhibit extensive gravel and rubble substrate used by Roanoke logperch in other systems. However, sampling efforts by McIninch and Garman (2002) recorded the presence of other species with similar habitat preferences, including species that spawn over nests of gravel and rubble, consumers of a wide variety of benthic macroinvertebrates, and species that are also intolerant of siltation, suggesting that sufficient habitat and an abundance of food exists on ARNG-MTC Fort Pickett to support Roanoke logperch.

Quantitative sampling of the fish population in the Nottoway River on ARNG-MTC Fort Pickett is currently underway and should provide additional information on habitat use by Roanoke logperch on the installation.

3.0 Conservation Goals

1. Develop and maintain an ecological assessment and monitoring system providing efficient data storage, retrieval, and presentation to facilitate fully informed management decisions for use in the Endangered Species Act Coordination process (Figure 2).

2. Employ adaptive management strategies to incorporate developing knowledge in answer to current species uncertainties.

3. Avoid conditions likely to inhibit potential range expansion, and promote viable populations at ARNG-MTC Fort Pickett within habitat constraints.

4. Utilize best management practices for all in-stream and riparian corridor activity.

5. Develop training guidelines and training uses compatible with both training goals for protection of Roanoke logperch and habitat.

6. Develop feasible alternatives when training activities are incompatible with Roanoke logperch conservation.

7. Avoid incidental taking.

8. Remain current with literature and developments regarding species distribution, dispersal, and habitat requirements and incorporate latest information.

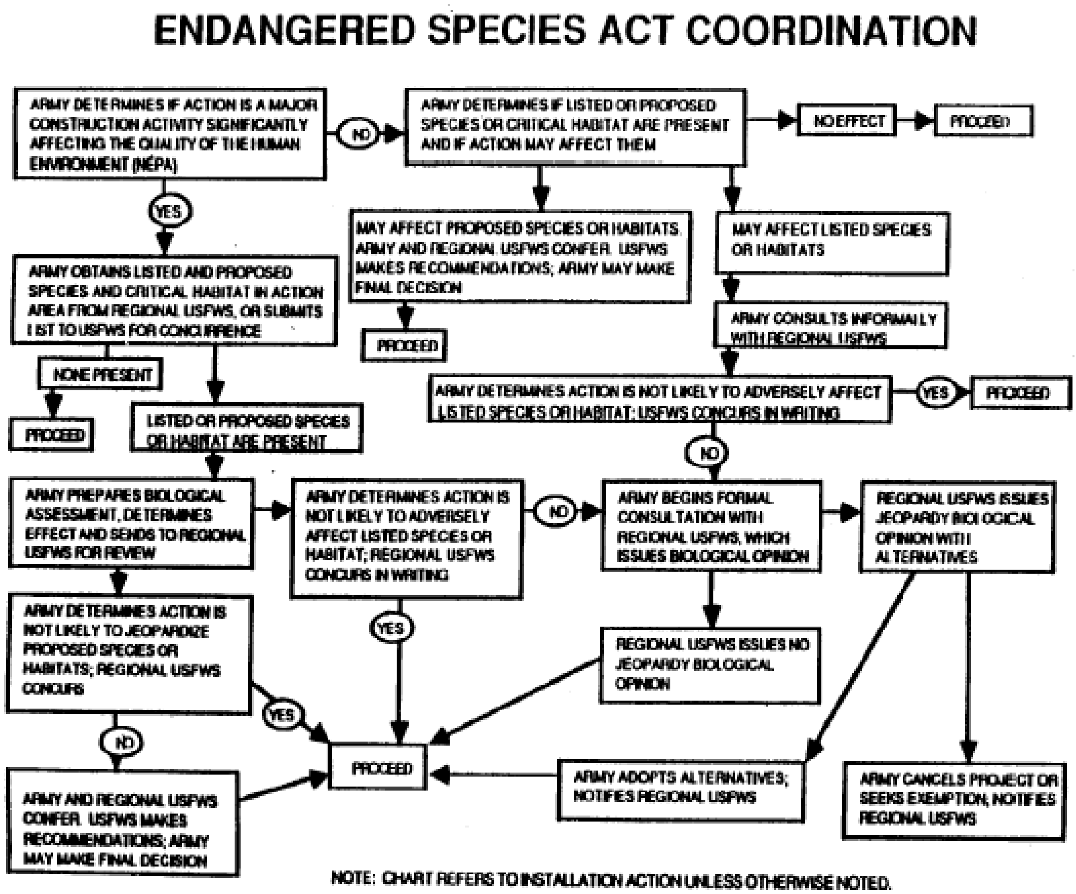

Figure 2. Endangered species actions excerpted from Army Regulation 200-3 (1995).

4.0 Management Objectives

Endangered Species Act (ESA) requirement for the Army (AR 200-3):

1. To conserve listed species

2. Not to jeopardize listed species or habitat

3. To consult and confer

4. Conduct a biological assessment

5. Not to “take” listed fish and wildlife species or to remove or destroy listed plant species

4.1 General Management Guidelines

Rosenberger and Angermeier (2002) recommend a watershed-level approach that addresses sediment loading and preserves natural river flow. Human interference should be minimized, such as construction on the riverbank that affects hydrology. It is also important to protect habitat that is important for all age classes, not just for adults. Below are general management guidelines that should be followed:

- Promote natural flow regime of the Nottoway River.
- Do not constrict river channel.
- Implement measures to reduce stream sedimentation.
- Educate Fort Pickett employees and troops about the Roanoke logperch.
- Identify data gaps
- Develop training guidelines and training uses compatible with both training goals and habitat management practices for Roanoke logperch.
- Evaluate any construction projects or training activities that may affect logperch habitat for potential impacts on logperch habitat and overall water quality.
- Monitor population levels and habitat conditions.
- Assist the Commander in compliance with Army regulations and The Endangered Species Act (1973) through planning processes, technical advice and ecological protection.

4.2 Specific Management Actions/Checklist

Management will emphasize the prevention of degradation of Roanoke logperch habitat on ARNG-MTC Fort Pickett, requiring the following management actions:

- Strictly observe the Roanoke Logperch Management Zone which prohibits any action that will disturb the stream bank or result in soil erosion within 300 meters of the Nottoway River (Figure 3).

- Protect areas identified as potential spawning, incubation, or foraging sites based on most current understanding.

- Maintain integrity of Nottoway riparian corridor and macrobasin in order to protect the Nottoway River from activities that result in soil erosion or stream bank degradation.

- Observe Virginia Department of Forestry's best management practices for silvicultural activities installation-wide in order to reduce and control soil erosion, including well-marked hardened areas at crossings.

- Observe the wetland and riparian management zones installation-wide.

- No in-stream work within the Logperch Management Zone between March 15 and June 30 will be conducted to protect spawning adults and newly laid eggs.

- Determine the population status, viability, and distribution throughout the Nottoway River within the boundaries of ARNG-MTC Fort Pickett. Population levels and habitat condition should be monitored at least every 3-5 years.

- Utilize Global Positioning Systems (GPS) to accurately map habitat features and environmental conditions relevant to the protection of Roanoke logperch and habitat.

- Cooperate with USFWS to determine the feasibility of rehabilitating habitat in Nottoway River, and/or reintroducing the logperch in appropriate habitat

- Implement adaptive management strategies identified from population and habitat monitoring.

Fulfillment of these specific management actions are to be used as a checklist to insure installation compliance with the ESMP as mandated by AR 200-3.

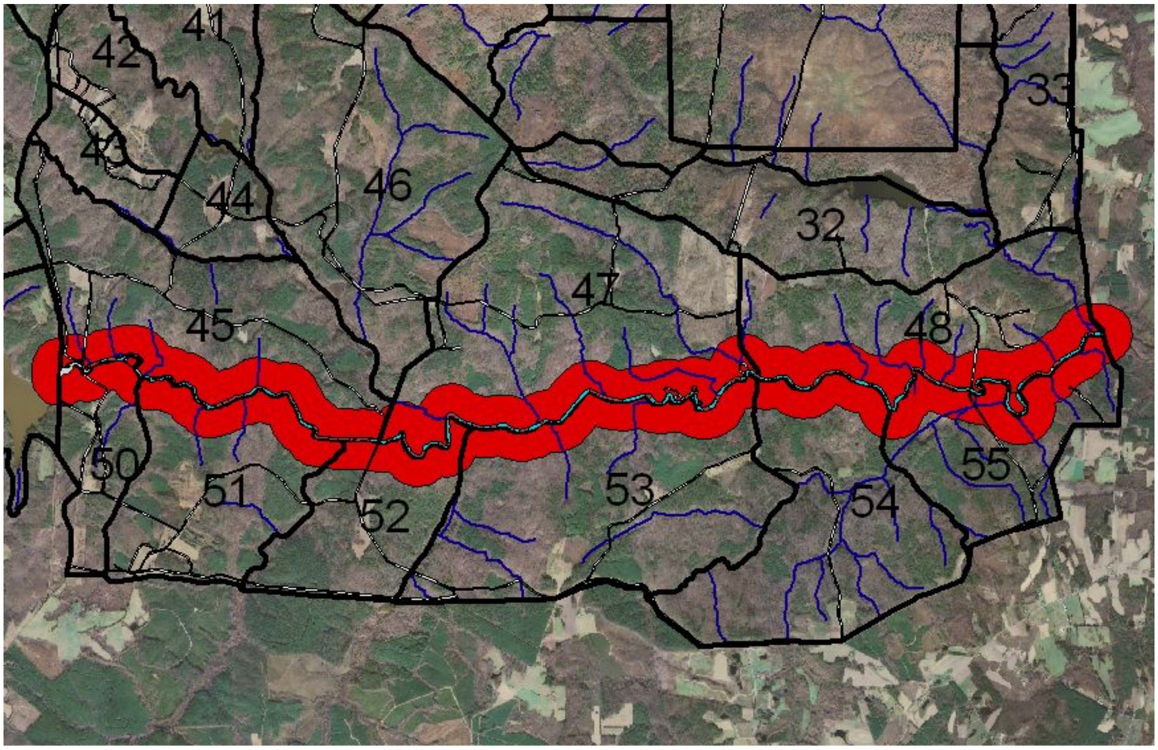

Figure 3. Roanoke logperch management zone, depicting the 300 meter buffer around the Nottoway River on ARNG-MTC Fort Pickett. Image shows southern portion of the base bisected by the Nottoway and surrounding Training Areas.

5.0 Ecological Monitoring

Ecological monitoring relevant to Roanoke logperch should include both habitat and biological monitoring components. Stream habitat inventories are a fundamental source of information for the evaluation of watershed conditions and the management of aquatic resources. Data collected in comprehensive replicable surveys form the basis of habitat monitoring and serve to document baseline conditions, identify potentially critical habitat, provide a mechanism for monitoring changes in the quality and quantity of the resource, and facilitate compliance with legal mandates, including the National Environmental Protection Act, Endangered Species Act, Sikes Act, AR-200-3, and USFWS Recovery Plan requirements. In addition to the knowledge that can be gained by documenting habitat use or directly observing animals as they interact with their surroundings, the monitoring of biological communities can be used to help assess the overall ecological integrity of a system. Population levels and habitat condition should be monitored at least every 3-5 years.

5.1 Habitat Monitoring:

Habitat monitoring can serve in the identification of potential use areas of the Roanoke logperch and to identify potential impacts of management and military training actions. Because the Roanoke logperch is difficult to detect in the Nottoway River and on ARNG-MTC Fort Pickett, habitat data can be used to target subsequent search efforts and assess overall habitat suitability. Identification and protection of suitable habitat not only preserves the potential for future population expansion, but will also help protect any existing meta-population structure.

Initial baseline stream habitat inventory surveys took place summer 2004 and summer 2005 (Appendix A). This survey utilizes relevant features of the Environmental Protection Agency (EPA) Rapid Bioassessment Protocol (RBP) (Barbour et al. 1999) to gather topographic, hydrological, descriptive, and specific locational data along the length the Nottoway on Fort Pickett to establish a general representation of stream structure, habitat characteristics, and establish a baseline for reference in future habitat assessments. This survey additionally sought to identify specific areas of potential use by Roanoke logperch based on criteria observed in areas of use documented elsewhere on the Nottoway by Rosenberger (2002). The limits of the habitat parameters utilized by Roanoke logperch in the Nottoway are not clearly defined, and use can vary by age-class and include a variety of depths, velocities, and substrates. Consequently, the criteria for selecting areas of potential use must be broad, with the slit-cover criterion as the most important variable. A hierarchical approach should be used in identification of suitable habitat using the following guidelines:

1. Select mesohabitats deemed most potentially suitable from the results of the EPA RBP survey of the Nottoway on Fort Pickett.

2. Select a random subset of these potentially suitable areas for more detailed assessment of microhabitat characteristics that can then be compared with habitat characteristics of areas used by Roanoke logperch elsewhere in the Nottoway as documented by Rosenberger 2002.

3. Select a random subset of areas with habitat parameters most consistent with observed use areas for actual survey for Roanoke logperch. Since the limits of suitable habitat are not clearly defined, inclusion of some sub-optimal or marginally suitable areas in the survey efforts will provide a more complete picture and help refine suitable habitat parameters.

Results from the initial rapid bioassessment survey of the Nottoway River on ARNG-MTC Fort Pickett are included in Appendix A as are habitat use data documented by Rosenberger (2002). It is significant to note that areas identified as within the suggested potential habitat range in May 2004 no longer satisfied those same criteria when revisited in June 2005. Substrate classified as mixed small gravel in 2004 was classified as sand in 2005. This observation suggests that substrate composition and other conditions in the Nottoway can fluctuate widely from area to area and from season to season. It is reasonable to suggest that substrate materials are redistributed, dispersed, or concentrated by the highly variable stream flows exhibited by the Nottoway on Fort Pickett (Figure A.5), resulting in a fluid spatial distribution of suitable habitat. In light of this phenomenon, and given the lack of clearly defined localized habitat parameters, it is necessary that the entire Nottoway corridor on ARNG-MTC Fort Pickett, including a buffer of 300 meters from each bank be considered in its entirety as the Roanoke Logperch Management Zone. Additionally, while rapid bioassessment data provides a useful starting point for future logperch surveys, areas identified therein must not be viewed as the only existing potentially suitable habitat units, and search efforts should be distributed in other areas as well.

It is very important to note that restrictions related to areas of documented logperch use or specific isolated habitat units, while very important, cannot alone be considered adequate protection for the Roanoke logperch on ARNG-MTC Fort Pickett. Awareness of potential negative impacts to logperch habitat, primarily from sedimentation, must be extended to the Nottoway macrobasin as a whole, and the integrity of the entire Logperch Management Zone must be observed.

It is also important to note that failure to observe Roanoke logperch as the result of a survey based on habitat composition is insufficient to support the conclusion that Roanoke logperch are not present in a given area. The objective is to maximize the effectiveness of any sampling efforts, and to identify habitat areas that are most likely suitable for potential use.

5.2 Biological Monitoring:

5.2.A Direct survey for Roanoke logperch

Areas targeted for potential monitoring in the habitat assessment procedures should be monitored every at least 3-5 years using either quantitative electrofishing survey techniques outlined in Appendix B, Murphy and Willis (1996) and Cowx and Lamarque (1990), quantitative underwater observation by line transect snorkeling methods described in Ensign et al. (1995) as described by Rosenberger 2002 or the transect cross method described by Rosenberger and Angermeier 2002. As previously stated, given the uncertainties regarding the limits of the habitat parameters utilized by Roanoke logperch in the Nottoway, sampling efforts must also include as many habitat types as possible, and reflect a variety of depths, velocities, and substrates. Appendix B provides specific guidelines for sampling efforts and is provided as a reference resource. Refinements and/or revisions to sampling protocols based on most current information and additional data provided by ongoing survey efforts should be incorporated as a part of the adaptive management process, remembering that the failure to observe Roanoke logperch during such a survey does not prove that they are not there. An adaptive management strategy/feedback loop should also be applied in order to incorporate latest knowledge and survey results into a continuing refinement of the understanding of what constitutes potential habitat areas.

5.2.B Macroinvertebrate Survey

The EPA RBP also includes Benthic Macroinvertebrate Protocols (Barbour et al. 1999) that can be a fundamental source of information for the evaluation of watershed conditions, and the management of aquatic resources. Biological communities reflect overall ecological integrity, and so bio-survey results can be used to directly assess the status of aquatic systems both locally and on the watershed-level as recommended by Rosenberger and Angermeier (2002). Benthic macroinvertebrate assemblages reflect a broad range of trophic levels, life cycles, and conditional tolerances and so provide strong information for interpreting cumulative effects and are well-suited for assessing site-specific impacts. Macroinvertebrate sampling according to EPA RBPs is a relatively efficient and inexpensive method that is widely accepted as a means to monitor the health of aquatic systems. In addition to supplementing overall habitat assessment, data from regular macroinvertebrate surveys can be used as an important part of management for Roanoke logperch to make inferences about availability of potential prey species, monitor relative siltation levels, and track any spatial or temporal hydrological changes that may impact the suitability of Roanoke logperch habitat on ARNG-MTC Fort Pickett.

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APPENDIX A

Rapid Bioassessment of the Nottoway River on ARNG-MTC Fort Pickett

A.1 Introduction

Stream habitat inventories are a fundamental source of information for the evaluation of watershed conditions and the management of aquatic resources. Data collected in comprehensive replicable surveys can form the basis of habitat monitoring, serving to document baseline conditions, identify potentially critical habitat, providing a mechanism for tracking changes in the quality and quantity of the resource, and facilitating compliance with legal mandates, including the National Environmental Protection Act, and the Endangered Species Act requirements.

A.2 Justification

The Nottoway River is the primary surface water drainage system for Army National Guard Military Training Center Fort Pickett (ARNG-MTC Fort Pickett), dissecting the southern portion of the facility, and is responsible for draining 3,680 square kilometers of Southside Virginia (Murray and Emrick 2002), making the waterway an important part of the cultural and ecological resources of the region. ARNG-MTC Fort Pickett has a long incorporated proactive natural resource management in the fulfillment their military mission, ensuring that activities on mission lands are integrated and consistent with federal land stewardship objectives (Emrick 2002). In support of these ongoing efforts, we conducted a stream habitat assessment survey of the Nottoway on Fort Pickett, based on a combination of relevant features of the Environmental Protection Agency (EPA) Rapid Bioassessment Protocol (RBP) (Barbour et al. 1999).

A.3 Purpose

The goals of this survey effort were two-fold: we visited every reach of the Nottoway on Fort Pickett to gather topographic, hydrological, descriptive, and specific locational data along the length the watercourse to establish a general representation of stream structure, habitat characteristics, and establish a baseline for reference in future habitat assessments. Within the habitat parameters surveyed, we additionally sought to identify specific areas of potential use by Roanoke logperch (*Percina rex)*, based on criteria observed in areas of use documented elsewhere on the Nottoway by Rosenberger (2002). The results can be used to support the informed land use decisions required for the completion of a comprehensive management plan, facilitate the monitoring for habitat changes due to perturbation or management activity, and enhance any future sampling efforts for the Roanoke logperch in the Nottoway on Fort Pickett.

The limits of the habitat parameters utilized by Roanoke logperch in the Nottoway are not clearly defined, and use can vary by age-class and include a variety of depths, velocities, and substrates, so the criteria for selecting areas of potential use must be broad, with the slit-cover criterion as the most important variable.

A.4 Methods:

A.4.1 Mesohabitat Description:

Observers started at the downstream point where the Nottoway leaves the Fort Pickett boundary, at the point where last survey effort ended, or a previously un-surveyed section, recording UTM coordinates by GPS, and walking and/or wading upstream along the river corridor. To facilitate efficient movement along the river observers also traveled downstream with the aid of appropriate floatation devices under suitable conditions. Since hydraulic variables and turbulence are the best discriminators of mesohabitat types (Vadas and Orth 1998), channel reaches were classified as riffle, run, pool, cascade, or complex. Habitat unit divisions were patterned after those of Platts et al. (1986), Frissel et al. (1986), Dolloff and Owen (1991), Dolloff et al. (1993), Hawkins et al. (1993), and Vadas and Orth (1998) as follows:

<u>Riffles</u>: relatively high gradient areas with convex (possibly flat) stream bottoms, turbulent water surfaces, and fast water are considered riffle habitat. Typically, riffles have the least depth of the habitat types, often marked by numerous protrusions from the streambed.

<u>Pools</u>: deep, low gradient, slow moving areas with concave stream bottoms, typically with the greatest depth of these habitat types. Surface is generally smooth, sometimes with eddies or other flow irregularities due to protrusions from streambeds or woody debris.

<u>Runs</u>: intermediate gradient areas with flat stream bottoms, fast water, and smooth water surfaces.

Cascade: Cascades are typically found in very steep, often most upstream portions of a stream profile. Streambeds range from relatively straight bedrock slides to stepped series of small pools forming behind rocks or woody debris, with water flowing over the edge of the obstacle and into the next pool in line. Primarily separated from riffles by greater gradient (>12%).

Complex: Every effort should be made to fit habitat units into one of the four categories above. If two features exist side by side the unit should be given the classification of the habitat type making up the majority of the unit area. If a predominant type is not clear (e.g. a unit that is 50% pool and 50% riffle) it is classified as complex. Where pools and riffles occur side-by-side, the reach will be assigned the name of the predominant habitat type (Dolloff et al. 1993). Each habitat unit encountered was assigned a unique sequential alpha-numeric code, with the UTM coordinates (and any other recorded characteristics) at beginning and end of each habitat unit designated as follows:

PL1A = beginning of Pool 1, PL1B = end of Pool 1, delineating Pool #1;
RF1A = beginning of Riffle 1, RF1B = end of Riffle 1, delineating Riffle #1;
RN1A = beginning of Run 1, RN1B = end of Run 1, delineating Run #1;
CS1A = beginning of Cascade 1, CS1B = end of Cascade 1, delineating Cascade #1;
CX1A = beginning of Complex 1, CX1B = end of Complex 1, delineating Complex #1;

with each similar habitat type encountered given the next higher sequential number.

UTM coordinates were recorded at transitions between habitat types, and channel width and wetted flow width (m) recorded by laser range finder. If the point of transition from one habitat type to another was not clear, observers tried to "think like a fish" (per Dolloff et al. 1993) by considering the physical conditions at the margins of the unit and trying to anticipate the reaction of the fish.

Notational observations were recorded as observers moved along the stream corridor as to general features that may influence fish populations such as landslides, tributary junctions, bridges, trail crossings, debris dams, and major changes in riparian vegetation.

In order to standardize observations and support the goal of a general description of the watercourse, observers quantified additional relevant habitat variables based on the ranking criteria described in the RBP (Barbour et al. 1999). Each reach was ranked on a 0-20 scale for:

-degree of sediment deposition;
-channel flow status;
-channel alteration;
-bank stability;
-vegetative protection;
-and embededdness.

Presence of large woody debris (LWD) was recorded as percentage of reach with LWD present on the r-6 modified Braun-Blanquet cover-abundance scale as follows:

r = rare
+ = <1%
1 =1-5%
2 = 5-25%
3 = 25-50%
4 = 50-75%
5 = 75-95%
6 = 95-100%

An example of reference and field data sheets are provided in Figures A.1 and A.2.

Figure A.1. Habitat assessment reference sheet for Rapid Bioassessment Protocol survey of wadeable streams and rivers (from Barbour et. al. 1999)

RAPID HABITAT ASSESMENT SCORING FOR LOW GRADIENT STREAMS

Habitat Parameter	Condition Category: Optimal	Suboptimal	Marginal	Poor
Sediment Deposition	Little or no enlargement of islands or point bars and <20% [*<5% high gradient stream*] of the bottom affected by sediment deposition.	Some new increase in bar formation, mostly from gravel, sand, or fine sediment; 20-50% [*5-30% high gradient stream*] of the bottom affected; slight deposition in pools.	Moderate deposition of gravel, sand, or fine sediment on old and new bars; 50-80% [*30-50% high gradient stream*] of the bottom affected; sediment deposits at obstructions, constrictions, and bends; moderate deposition of pools prevalent.	Heavy deposits of fine material, increased bar development; more than 80% [*50% high gradient stream*] of the bottom changing frequently; pools almost absent due to substantial sediment deposition.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Channel Flow Status	Water reaches base of both lower banks, and minimal amount of channel substrate is exposed.	Water fills >75% of the available channel; or 25 % of the substrate is exposed.	Water fills 25-75% of the available channel, and/or riffle substrates are mostly exposed.	Very little water in channel and mostly present as standing pools.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Channel Alteration	Channelization or dredging absent or minimal; stream with normal pattern.	Some channelization present, ususally in areas of bridge abutments; evidence of past channelization, i.e., dredging, (>past 20 yr) may be present, but recent channelization is not present.	Channelization may be extensive; embankments or shorinig structures present on both banks; and 40 to 80% of stream reach channelization and disrupted.	Banks shored with gabion or cement; over 80% of the stream reach channelized and disrupted. Instream habitat greatly altered or removed entirely.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0
Bank Stability (score each bank) Note: determine left or right side by facing downstream	Banks stable; evidence of erosion or bank failure absent or minimal; little potential for future problems. <5% of bank affected.	Moderately stable; infrequent, small areas of erosion mostly healed over. 5-30% of bank in reach has areas of erosion.	Moderately unstable; 30-60% of bank in reach has areas of erosion; high erosion potential during floods.	Unstable; many eroded areas; "raw" areas frequent along straight sections and bends; obvious bank sloughing; 60-100% of bank has erosional scars.
SCORE__LB:	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE__RB:	Right Bank 10 9	8 7 6	6 4 3	3 1 0

Figure A.1 (cont.) Habitat assessment reference sheet for Rapid Bioassessment Protocol survey of wadeable streams and rivers (from Barbour et. al. 1999)

Vegetative Protection (score each bank) Note: determine left or right side by facing downstream	More than 90% of the streambank surfaces and immediate riparian zone covered by native vegetation, including trees, understory shrubs, or non-woody macrophytes; vegetative disruption grazing or mowing minimal or not evident; almost all plants allowed to grow naturally.	70-90% of the streambank surfaces covered by native vegetation, but one class of plants is not well-represented; disruption evident but not affecting full plant growth potential to any great extent; more than one-half of the potential plant stubble height remaining.	50-70% of the streambank surfaces covered by vegetation; disruption obvious; patches of bare soil or closely cropped vegetation common; less than one-half of the potential plant stubble height remaining.	Less than 50% of the streambank surfaces covered by vegetation; disruption of streambank vegetation is very high; vegetationhas been removed to 5 cm or less in average stubble height.
SCORE__LB:	Left Bank 10 9	8 7 6	5 4 3	2 1 0
SCORE__RB:	Right Bank 10 9	8 7 6	6 4 3	3 1 0
Embededness	Gravel, cobble, and boulder particles are 0-25% surrounded by fine sediment. Layering of cobble provides diversity of niche space.	Gravel, cobble, and boulder particles are 25-50% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 50-75% surrounded by fine sediment.	Gravel, cobble, and boulder particles are 75% surrounded by fine sediment.
SCORE:	20 19 18 17 16	15 14 13 12 11	10 9 8 7 6	5 4 3 2 1 0

Figure A.2. General field data sheet for Rapid Bioassessment Protocol survey of wadeable streams and rivers (from Barbour et. al. 1999)

data sheet #: START TIME: START POINT: LOCATION: Nottoway on Fort Pickett

DATE: Start unit designation: (description) DATA FORM: **GENERAL**

PL ________

observers[R]: RN ________ CONDITIONS:

r=	rare	3=	25-50%
+=	0-1%	4=	50-75%
1=	1-5%	5=	75-95%
2=	5-25%	6=	>95%

habitat unit	point coordinates easting	northing	elevation (f)	width (m) wetted	width (m) channel	unit length (m)	comments (LWD, trib junction, bridge, debris dam, landslide,trail crossing, major veg Δ , other observations…)
A:			x			(dist A-B)	
B:			x				
sediment deposition (20-0)	flow status (20-0)	evidence of alteration? (20-0)	bank stabitlity L(10-0) R(10-0)	bank veg protection L(10-0) R(10-0)	embededness (20-1)		% of reach w/ LWD present (r-6)
A:						(dist A-B)	
B:							
sediment deposition (20-0)	flow status (20-0)	evidence of alteration? (20-0)	bank stabitlity L(10-0) R(10-0)	bank veg protection L(10-0) R(10-0)	embededness (20-1)		% of reach w/ LWD present (r-6)
A:						(dist A-B)	
B:							
sediment deposition (20-0)	flow status (20-0)	evidence of alteration? (20-0)	bank stabitlity L(10-0) R(10-0)	bank veg protection L(10-0) R(10-0)	embededness (20-1)		% of reach w/ LWD present (r-6)
A:						(dist A-B)	
B:							
sediment deposition (20-0)	flow status (20-0)	evidence of alteration? (20-0)	bank stabitlity L(10-0) R(10-0)	bank veg protection L(10-0) R(10-0)	embededness (20-1)		% of reach w/ LWD present (r-6)

A.4.2 Micro-habitat Assessment:

Additional habitat measures were taken at each habitat unit encountered that was judged to be in the suggested potential range (Tables A.1 – A.3). Both adult and subadult logperch have been observed primarily in pools on the Nottoway (Rosenberger 2002) but all habitat unit types that met these criteria also had detailed data recorded. Decision criteria as to whether a habitat unit was suitable for detailed micro-habitat sampling was as follows:

1. gravel (large or small) substrate or sand with gravel patches
2. mean depth approximates suggested potential habitat range (~37-118 cm).
3. flow rate approximates suggested potential habitat range:
   Mean velocity (m/s): 0.0 - 0.37
   Mean bottom velocity (m/s): 0.0 - 0.11

If criteria #1 was satisfied in the presence of criteria 2 or 3 (not necessarily both), then detailed sampling was conducted. Data recorded included:

-unit length (m) as above;

-maximum, minimum, and mean width (m) based on ≥3 measurements parallel to the thalweg along the length of the unit, with the number of width measurements and the intervals between them to be reflective of the complexity of the shape of the habitat unit (i.e. the more irregular the shape of the unit, the greater the number of width measurements required);

-presence and abundance of woody debris (ranked on r-6 Braun-Blanquet scale) (Braun-Blanquet 1932);

-minimum, maximum, and average depth (cm) determined by measuring at multiple points (≥3) while walking the length of the feature in a zig-zag pattern. For small reaches, take 3 (or *n*) equidistant measures and divide the sum by *n*+1 (i.e. 3 equidistant measures equals 4 sections) (Platts 1983);

-mean velocity (m/s), measured by flowmeter at a point 60% of the depth below the surface when water depth ≤ 0.75 m, or the average of points 20% and 80% of the total depth when water depth >0.75 m, with more measurements taken in the case of non-uniform flow rates in the presence of channel structures such as logs, boulders, or deflector dams (McMahon et. al 1996) $n \geq 3$;

-mean bottom velocity (m/s) measured by flow meter resting on the stream bottom, $n \geq 3$;

-dominant substrate, measured by Wolman pebble count method (Wolman 1954; Kondolf and Li 1992), whereby observers traverse the stream channel from bank to bank. At each step, the observer touches a substrate particle at the tip of the boot (without looking to prevent bias toward larger, more visible stones), and classifies it using a Federal Interagency Sedimentation Project (FISP) US SA-97 substrate template (also referred to as a gravelometer), using the "passing or smaller than" method whereby the smallest hole through which the particle could be passed is recorded, until ≥ 50 points are sampled, with larger habitat units requiring greater sample size.

-embeddedness, measured as % of the surface of individual substrate particles (gravel, cobble, or boulders) in main stream channel (away from stream margins) covered on average by fine sediment (such as silt or sand) (Platts 1983) will be ranked on two scales:
-the r-6 Braun-Blanquet scale (in $1m^2$ area, $n \geq 3$);
-and the 20-0 RBP score (reachwide)
To avoid confusion with sediment deposition measures, observations of embeddedness should be taken in the upstream and central portions of riffles and cobble substrate areas (Barbour et al. 1999).

-siltation rank, measured as % of $1m^2$ area blanketed with deposited silt, estimated by aquascope, and ranked on the r-6 Braun-Blanquet scale ($n \geq 3$).

An example of the Detail data sheets is provided in Figure A.3.

Table A.1. Suggested potential habitat range (includes subadult and adult means and standard deviation) documented by Rosenberger (2002) in the Nottoway River, Virginia [adapted from Tables 2.2 and 3.1 (Rosenberger 2002) presented in Table A.2 and A.3 below]:

Habitat Variable	suggested range
Mean Depth (cm):	37.1.1 - 117.5
Mean velocity (m/s):	0.0 - 0.37
Mean bottom velocity (m/s):	0.0 - 0.11
Substrate (mean rank) [1]:	2.5 – 8.0 (5-6 preferred)
Embededness (mean rank) [2]:	1.4 - 5.0
Silt (mean rank) [3]:	2.5 – 4.9
Distance to like habitat (m):	0 – 656
Width (m):	19.9 – 38.9
Length (m):	0 – 596
Maximum depth (cm):	58.4 – 163.1
Total Woody Debris (#) [4]:	0 – 82.3

[1]Substrate categories used by Rosenberger 2002:

9 category scale modified from Wentworth (1922) per Doloff and Owen (1992)

9 = Bedrock; 8 = Boulder (diameter >300mm); 7 = Cobble (diameter 101-300 mm); 6 = Large gravel (diameter 11-100 mm); 5 = Small gravel (diameter 3-10 mm); 4 = Sand (diameter >silt – 2mm); 3 = Silt; 2 = Clay; 1 = Organic debris.

[2]Embeddedness categories used by Rosenberger 2002:

1 ≥ 95% embedded, 2 = 50-94%, 3 = 25-49%, 4 = 5-24%, 5 = 0-5%, i.e. exposed).

[3]Silt cover categories used by Rosenberger 2002:

1 = 76-100% of area blanketed with deposited silt, 2 = 51-75%, 3 =26-50%, 4 = 1-25%, 5 = 0%).

[4]Woody debris categories used by Rosenberger 2002:

Average number of woody debris pieces of sizes 1 through 4. Woody debris >50cm diameter or >5m long was counted and assigned to classes measured along a four category scale following Flebbe (1999): 1: >50 cm diameter, 1-5 m length; 2: 10-50 cm diameter, >5 m length; 3: >50 cm diameter, > 5 m length; and 4: root wads).

Table A.2. Habitat used by Roanoke logperch and suggested range of potential use in the Nottoway River, Virginia [excerpted from Table 3.1 (Rosenberger 2002)]. Suggested potential habitat range reflects subadult and adult observed means ± standard deviation.

	YOY	Subadult	Adult	Suggested Range
Fish length (cm)		4-8	>8	
Mesohabitat unit types (% occurrence)				
Pools		60%	69%	
Runs		40%	21%	
Riffles		0%	10%	
Mean Depth (cm), SD		81.8 ± 35.7	84.4 ± 27.8	46.1 – 117.5
Mean velocity (m/s), SD		0.07 ± 0.09	0.20 ± 0.17	0.0 – 0.37
Mean bottom velocity (m/s), SD		0.0 ± 0.04	0.02 ± 0.09	0.0 – 0.11
Substrate (mean rank), SD [1]		4.9 ± 2.3	5.1 ± 2.0	2.6 – 7.2
Embeddedness (mean rank), SD [2]		4.0 ± 1.2	4.2 ± 1.0	2.8 – 5.0
Silt (mean rank), SD [3]		3.8 ± 0.9	4.5 ± 0.07	2.9 – 4.7
N	0	40	39	

Table A.3. Summary of mesohabitat characteristics of habitat units (pools, riffles, or runs) where adult Roanoke logperch were observed during snorkeling surveys in the Nottoway River, Virginia [excerpted from Table 2.2 (Rosenberger 2002)]. Suggested potential habitat range reflects observed means ± standard deviation.

		Nottoway	Suggested Range
% Total logperch observed in	Pools	69%	
	Riffles	21%	
	Runs	10%	
Unit type (mean rank, SD)		1.5 ± 0.6	
Distance to like habitat (m, SD)		322 ± 334	0 - 656
Width (m, SD)		29.4 ± 9.5	19.9 - 38.9
Length (m, SD)		224 ± 372	0 - 596
Area (m^2, SD)		6360 ± 10136	0 - 16496
Maximum Depth (cm, SD)		104.7 ± 46.3	58.4 - 163.1
Average Depth (cm, SD)		72.5 ± 35.4	37.1 - 107.9
Dominant Substrate (mean rank, SD) [1]		5.6 ± 2.4	3.2 - 8.0
Subdominant Substrate (mean rank, SD) [1]		5.2 ± 2.7	2.5 - 7.9
Embededness (mean rank, SD) [2]		2.5 ± 1.1	1.4 - 3.6
Silt Cover (mean rank, SD) [3]		3.7 ± 1.2	2.5 - 4.9
Total Woody Debris (#, SD) [4]		27.4 ± 54.9	0 - 82.3
N		15	

Figure A.3. Detail field data sheet for Rapid Bioassessment Protocol survey of wadeable streams and rivers (from Barbour et. al. 1999) for microhabitat assessment of areas meeting current criteria for potential Roanoke logperch habitat.

data sheet #:

START TIME:

START POINT:

LOCATION: Nottoway on Fort Pickett

DATA FORM: **DETAIL**

DATE:

observers[R]:

Start unit designation:
PL ________
RN ________

(description)

CONDITIONS:

habitat unit	point coordinates easting	northing	elevation (f)	width (m) wetted	width (m) channel	unit length (m)	comments (LWD, trib junction, bridge, debris dam, landslide, trail crossing, major veg Δ other observations…)
A:			x			(dist A-B)	
B:			x				

sediment deposition (20-0)	flow status (20-0)	evidence of alteration? (20-0)	bank stabitlity L(10-0) R(10-0)	bank veg protection L(10-0) R(10-0)	embededness (20-1)

POOL WIDTH (m)								
DEPTH (cm)								
MEAN VELOCITY								
BOTTOM VELOCITY								

r=	rare	1=	1-5%	3=	25-50%	5=	75-95%
+=	0-1%	2=	5-25%	4=	50-75%	6=	>95%

Figure A.3 (cont.). Detail field data sheet for Rapid Bioassessment Protocol survey of wadeable streams and rivers (from Barbour et. al. 1999) for microhabitat assessment of areas meeting current criteria for potential Roanoke logperch habitat.

SUBSTRATE CLASS (*n*>49)

organic debris?

LWD (% of reach w/ LWD present)

notes:

(*n* depends on size of reach)

EMBEDDEDNESS (% of surface of substrate particles covered by fine sediment/1m2)

(*n* depends on size of reach)

SILTATION RANK (% 1m^2 blanketed with silt)

The result is a detailed representation of the topographic and hydrological structure of the length of the Nottoway on Fort Pickett, including characteristics and locations of likely potential habitat for Roanoke logperch. This survey can be used to provide the baseline information needed to track subsequent changes in stream structure, evaluate impacts of perturbations or management actions, and provide a standardized methodology for comprehensive long-term monitoring of stream habitat composition, as well as greatly enhance any future sampling efforts for Roanoke logperch on Fort Pickett.

A.5 Results and Discussion:

14.7 river kilometers of the mainstem of the Nottoway River on ARNG-MTC Fort Pickett were surveyed May 24-26, 2004 and June 13-16 2005 from the first bridge below the Fort Pickett Reservoir dam near the western edge of the installation to the point where the river leaves ARNG-MTC Fort Pickett boundary on the eastern edge. Habitat units were divided into 85 runs, 73 pools, and 1 riffle (the result of surface disruptions from large woody debris).

The Nottoway on ARNG-MTC Fort Pickett is a wide, low-gradient river and did not fit the habitat designation categories precisely. Habitat units were not clearly defined nor were transitions between habitat types. Divisions were made between pool and run based primarily on changes in streambed contours and changes in perceived flow rate, flow pattern, and surface disruptions, often marked by the presence of large woody debris. Breaks in long, continuous habitat units were inserted so as to best capture variations in the parameters being measured, and to keep maximum habitat unit length from exceeding roughly 200-250 meters. Distinctions between habitat units are likely to vary based on variations in discharge rates. Discharge rates during the survey presented here are given in Figure A.4. Rapid Bioassessment data collected is provided below in Tables.A.4 – A.9.

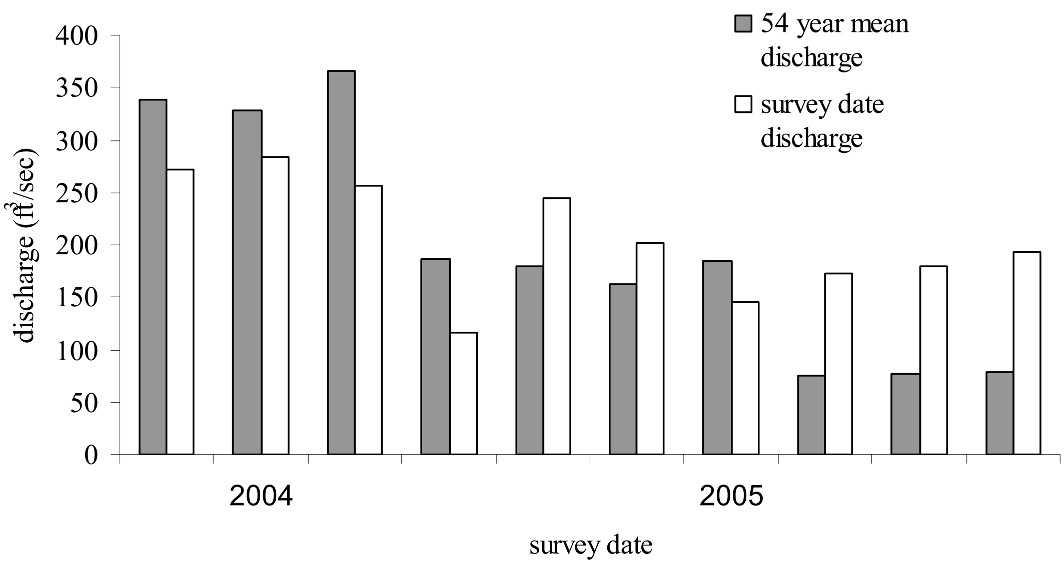

Figure A.4. Discharge rate (ft^3/sec) mean for the Nottoway River recorded at the USGS Rawlings Station during Rapid Bioassessment Survey of the Nottoway River on ARNG-MTC Fort Pickett, VA.

Table A.4. Rapid Bioassessment data from survey of the Nottoway River on ARNG-MTC Fort Pickett in May 2004 and June 2005.

Reach_id_	Transpt_id	Habtype	Detail	Transpt_y	Transpt_x	Date_	Observers	wetted width (m)	channel width (m)	sediment deposition	flow status	alteration	left bank stability	right bank stability
1	PL026B	pool	no	4097873	236601	20050615	EW, MD	36.4	40.1	20	20	19	10	10
2	PL027B	pool	no	4097924	236718	20050615	EW, MD	28.4	28.4	20	20	20	9	9
3	RN034B	run	no	4097952	236782	20050615	EW, MD	26.7	30.2	20	20	20	10	7
4	PL028B	pool	no	4097935	236877	20050615	EW, MD	19.2	19.2	19	20	20	10	8
5	RN035B	run	no	4097981	236965	20050615	EW, MD	36.8	52.3	10	20	20	10	10
6	PL029B	pool	no	4097977	237052	20050615	EW, MD	25.9	25.9	19	20	20	10	10
7	PL030B	pool	no	4097930	237138	20050615	EW, MD	11.9	11.9	20	20	20	10	10
8	RN036B	run	no	4097904	237126	20050615	EW, MD	10.6	10.6	19	20	20	7	10
9	PL031B	pool	no	4097878	237085	20050615	EW, MD	13.4	13.4	17	20	20	9	10
10	RN037B	run	no	4097852	237088	20050615	EW, MD	20.7	23.2	20	20	20	10	7
11	PL032B	pool_detail	yes	4097793	237122	20050615	EW, MD	20.7	23.2	20	20	20	2	1
12	RN038B	run	no	4097769	237128	20050616	EW, JD	21.3	21.3	18	20	20	6	8
13	PL033B	pool_detail	yes	4097753	237155	20050616	EW, JD	-	-	-	-	-	-	-
14	RN039B	run	no	4097724	237278	20050616	EW, JD	33.9	24.4	4	18	20	4	6
15	PL034B	pool	no	4097730	237325	20050616	EW, JD	25.9	26.8	15	20	20	8	7
16	RN040B	run	no	4097761	237370	20050616	EW, JD	24.1	24.1	6	20	20	8	8
17	RN041B	run	no	4097753	237440	20050616	EW, JD	18.5	18.5	15	20	20	9	9
18	PL035B	pool	no	4097701	237472	20050616	EW, JD	17.7	22.2	5	15	20	6	8
19	RN042B	run	no	4097686	237515	20050616	EW, JD	14.2	22.4	11	17	20	9	0
20	RN043B	run	no	4097661	237672	20050616	EW, JD	26	26	16	20	20	6	8
21	PL036B	pool	no	4097640	237684	20050616	EW, JD	-	-	18	20	20	8	8
22	RN044B	run	no	4097527	237711	20050616	EW, JD	18.3	24.3	16	18	20	8	9
23	RN045B	run	no	4097443	237921	20050616	EW, JD	-	-	6	20	20	8	7
24	PL037B	pool	no	4097478	237972	20050616	EW, JD	23.1	23.1	20	20	20	9	10
25	PL038B	pool	no	4097516	238040	20050616	EW, JD	22.6	22.6	18	20	20	8	10
26	PL039B	pool	no	4097573	238200	20050616	EW, JD	24.8	24.8	19	20	20	9	10
27	RN046B	run	no	4097659	238322	20050616	EW, JD	12.5	31.5	7	6	20	9	8
28	PL040B	pool	no	4097642	238398	20050616	EW, JD	21.3	27.6	13	15	20	8	7
29	RN047B	run	no	4097588	238532	20050616	EW, JD	27.8	27.8	18	20	20	8	5
30	PL041B	pool	no	4097595	238605	20050616	EW, JD	25.4	28.3	15	20	20	8	5
31	PL042B	pool	no	4097511	238716	20050616	EW, JD	24.5	24.5	20	20	20	10	7
32	RN100B	run	no	4097443	238747	20050627	EW, BD	25.9	28.2	12	9	20	8	8
33	PL044B	pool	no	4097403	238771	20050627	EW, BD	27.3	27.3	19	20	20	8	8
34	RN101B	run	no	4097319	238789	20050627	EW, BD	28.4	28.4	12	20	20	9	8
35	RN102B	run	no	4097238	238932	20050627	EW, BD	22.2	28.5	9	13	20	6	9
36	PL045B	pool	no	4097193	238964	20050627	EW, BD	18.5	25	19	19	20	8	8
37	RN103B	run	no	4097162	238963	20050627	EW, BD	14.6	24.9	11	15	20	8	9
38	PL046B	pool	no	4097122	239088	20050627	EW, BD	26.5	26.5	20	20	20	6	7

Table A.4 (cont.). Rapid Bioassessment data from survey of the Nottoway River on ARNG-MTC Fort Pickett in May 2004 and June 2005.

Reach_id_	left bank veg protection	right bank veg protection	Embededness	LWD	Comments
1	10	10	NA	3	started pool at bridge; side channel from tributary from right bank; coarse sandy bottom
2	10	10	NA	2	coarse gravel bottom
3	10	7	NA	3	sandy bottom w/ gravel patch
4	10	10	NA	1	-
5	10	10	16	2	coarse sand w/ gravel patches; oxbow on right; mussels along sandbar
6	10	10	NA	1	mussels on sandbar
7	10	10	NA	2	substrate entirely mussels at end of pool; coarse sand
8	9	10	NA	2	sandy bottom w/ mussels; washout in left bank
9	10	10	NA	4	intermittent stream entering left bank; much organic debris at tree falls
10	10	10	NA	1	tributary entering right
11	10	10			Refer to Detail PL032
12	10	10	NA	1	sandbar right; bank scour left; lots of mussel shells
13	-	-	-	-	Refer to Detail PL033
14	10	10	20		.69 bottom; 1.07 average flow; gravel substrate; 28-32 cm depth;embeddednedd =1; too fast but maybe slower with less water; lots of mussel shells
15	10	10	NA	3	lots of mussel shells
16	10	10	NA	5	-
17	10	10	17	3	right half of channel is gravel
18	7	10	NA	3	sandy bottom
19	9	0	NA	2	runs around bend w/ pool and sandy deposition on inside of bend (left side); lots of mussel shells
20	6	9	13	5	gravel deposition on inside of bend (river right) (gravel upstream?); sandy bottom mostly
21	10	8	NA	1	coarse sandy bottom; shallow pool
22	8	8	18	3	gravel deposition; gravel patches; lots of mussel shells
23	7	7	too deep	4	deposition river both sides; lots of mussel shells at top; rocky bank at end with gravel substrate
24	10	10	NA	3	right bank solid rock; coarse sandy bottom
25	8	8	NA	2	deposition at end; coarse sandy bottom; rocky bank right
26	10	10	NA	2	coarse sandy bottom
27	9	9	NA	3	coarse sandy bottom
28	8	8	NA	3	coarse sandy bottom
29	8	7	NA	3	coarse sandy bottom
30	9	6	too deep	1	coarse sandy bottom
31	8	8	too deep	1	left bank rocky
32	7	6	NA	3	trib. Left; gravel patches; coarse sandy bottom
33	9	8	NA	2	coarse sandy bottom
34	9	8	NA	3	small blowout at intermittant input; sandy bottom
35	9	8	NA	1	large (~14-20 m) sand bar river left inside of curve
36	7	7	NA	1	-
37	8	8	NA	4	sand bar right bank, inside of curve
38	9	9	NA	1	rocky strewn bank right; rip-rap to boulder-sized

Table A.4 (cont.). Rapid Bioassessment data from survey of the Nottoway River on ARNG-MTC Fort Pickett in May 2004 and June 2005.

Reach_id_	Transpt_id	Habtype	Detail	Transpt_y	Transpt_x	Date_	Observers	wetted width (m)	channel width (m)	sediment deposition	flow status	alteration	left bank stability	right bank stability
39	PL047B	pool	no	4097117	239186	20050627	EW, BD	32.9	36	18	18	20	8	9
40	PL048B	pool	no	4097123	239313	20050627	EW, BD	33.1	33.1	14	20	20	9	9
41	PL049B	pool	no	4097106	239519	20050627	EW, BD	31.7	31.7	19	20	20	9	8
42	RN104B	run	no	4097100	239633	20050627	EW, BD	40.7	40.7	19	20	15	8	8
43	RN110B	run	no	4097099	239702	20050628	EW, LH	15.7	37.2	10	8	15	10	7
44	PL050B	pool	no	4097109	239750	20050628	EW, LH	29.3	29.3	13	15	20	7	8
45	RN111B	run	no	4097170	239847	20050628	EW, LH	15.3	22.6	6	8	20	9	7
46	PL051B	pool	no	4097166	239880	20050628	EW, LH	21.6	27.6	14	13	20	1	9
47	PL052B	pool	no	4097121	239883	20050628	EW, LH	24.8	25.4	19	19	20	9	9
48	PL053B	pool	no	4097030	239910	20050628	EW, LH	16.6	34.3	13	15	20	9	8
49	RN112B	run	no	4096980	239953	20050628	EW, LH	23.9	30.1	15	18	20	9	7
50	PL054B	pool	no	4096981	240077	20050628	EW, LH	20	27.6	19	18	20	9	7
51	RN113B	run	no	4097069	240236	20050628	EW, LH	34.2	36.8	6	11	20	6	8
52	PL055B	pool	no	4097060	240290	20050628	EW, LH	25.8	28.6	18	17	20	8	9
53	RN114B	run	no	4097034	240345	20050628	EW, LH	21.8	21.8	17	18	20	7	7
54	PL056B	pool	no	4097072	240347	20050628	EW, LH	26.5	34.5	19	18	20	9	9
55	RN115B	run	no	4097318	240334	20050628	EW, LH	38.8	38.8	17	17	20	6	8
56	PL057B	pool	no	4097319	240445	20050628	EW, LH	27.8	30.8	19	20	20	7	9
57	RN116B	run	no	4097296	240494	20050628	EW, LH	35.1	35.1	16	17	20	8	8
58	PL058B	pool	no	4097273	240530	20050628	EW, LH	34.9	34.9	17	19	20	9	9
59	RN117B	run	no	4097264	240588	20050628	EW, LH	27.3	27.3	18	19	20	9	9
60	PL059B	pool	no	4097240	240704	20050628	EW, LH	31.7	31.7	18	20	20	9	8
61	RN118B	run	no	4097257	240775	20050628	EW, LH	16.9	16.9	20	20	20	9	8
62	PL060B	pool	no	4097267	240843	20050628	EW, LH	32.6	32.6	20	20	20	8	8
63	RN119B	run	no	4097232	240993	20050628	EW, LH	29.1	29.1	18	20	20	8	9
64	PL061B	pool	no	4097208	241029	20050628	EW, LH	33.4	33.4	18	18	20	9	8
65	RN120B	run	no	4097205	241089	20050628	EW, LH	22.8	27.3	16	18	20	9	7
66	PL062B	pool	no	4097214	241177	20050628	EW, LH	35.6	35.6	20	20	20	9	7
67	RN121B	run	no	4097276	241294	20050628	EW, LH	16.8	28.2	8	13	20	9	8
68	PL063B	pool	no	4097296	241337	20050628	EW, LH	28.8	28.8	17	19	20	9	8
69	RN122B	run	no	4097300	241507	20050628	EW, LH	28.5	28.5	11	16	20	6	6
70	RN123B	run	no	4097475	241662	20050628	EW, LH	32.3	32.3	14	16	20	8	8
71	RN124B	run	no	4097625	241808	20050628	EW, LH	31.7	31.7	17	18	20	8	8
72	PL064B	pool	no	4097580	241914	20050629	EW, BD	33.3	33.3	19	20	20	7	8
73	PL065B	pool	no	4097519	242162	20050629	EW, BD	39.4	39.4	18	19	20	7	7
74	RN125B	run	no	4097562	242402	20050629	EW, BD	16.2	34.7	8	10	20	9	9
75	PL066B	pool	no	4097543	242464	20050629	EW, BD	17	34.7	14	10	20	8	9
76	RN126B	run	no	4097507	242508	20050629	EW, BD	18.5	34.9	16	14	20	9	7

Table A.4 (cont.). Rapid Bioassessment data from survey of the Nottoway River on ARNG-MTC Fort Pickett in May 2004 and June 2005.

Reach_id_	left bank veg protection	right bank veg protection	Embededness	LWD	Comments
39	9	8	NA	+	bank made of rock right; pool toy hanging in flood debris
40	8	8	NA	2	large bar in middle at LWD; inlet intermittent oxbow
41	9	8	NA	1	-
42	8	8	NA	1	Bridge
43	9	7	1	2	Bridge; gravel deposits below bridge; lots of sediment (5); snady with gravel pockets, long bar
44	9	9	NA	2	partial sandbar (left bank)
45	9	7	NA	1	bars on both banks; course sandy bottom with gravel patches; intermittant trib. Right bank large cut bank tapers off
46	5	8	NA	1	dry oxbow bend on left bank; pool at sharp bend; left scour
47	9	9	NA	+	-
48	9	8	NA	2	left bar
49	9	8	NA	1	gravel patches at start of run; left bar; trib (intermittant)
50	9	8	NA	+	left bar; large scour right bank; bare soil rock strewn on right (rip-rap to boulder)
51	8	8	NA	4	sandbars on both banks; large cut bank; entire right bank sandbar; gravel patches
52	9	9	NA	+	sandbars right bank; shallow pool
53	9	6	NA	2	big cut in bank on right; sand bar on right outside of bend
54	9	8	NA	+	gravel pockets; left bank sand bar; right bank boulders on bank @ start of pool
55	7	8	NA	1	left and right sandbars
56	7	9	NA	1	Hurricane Branch on Left; large cut bank on left; rocks
57	8	8	NA	2	-
58	7	6	NA	1	trib and sandbar on left
59	8	9	NA	2	-
60	9	8	NA	2	trib entering right
61	9	8	NA	1	-
62	7	7	NA	1	-
63	8	8	NA	1	Slow run
64	9	8	NA	2	-
65	9	7	NA	1	-
66	8	7	NA	2	rocks on right bank
67	9	8	NA	2	gravel pockets
68	9	8	NA	3	-
69	7	7	NA	1	trib on right; right bank degraded, then left bank degraded; left and right sand bars
70	8	8	NA	1	rocks on right bank
71	8	8	NA	1	-
72	8	8	NA	1	bow cut into left bank; large rocks
73	8	8	NA	+	trib on left
74	8	8	NA	2	>50% constriction in spots
75	8	8	NA	+	-
76	8	8	NA	+	trib on right

Table A.4 (cont.). Rapid Bioassessment data from survey of the Nottoway River on ARNG-MTC Fort Pickett in May 2004 and June 2005.

Reach_id_	Transpt_id	Habtype	Detail	Transpt_y	Transpt_x	Date_	Observers	wetted width (m)	channel width (m)	sediment deposition	flow status	alteration	left bank stability	right bank stability
77	PL067B	pool	no	4097499	242576	20050629	EW, BD	25.1	35.1	17	17	20	8	6
78	RN127B	run	no	4097505	242773	20050629	EW, BD	22.8	22.8	12	15	20	7	6
79	RF001B	riffle	no	4097538	242781	20050629	EW, BD	21.1	21.1	17	20	20	8	6
80	RN128B	run	no	4097535	242816	20050629	EW, BD	29.1	29.1	19	20	20	10	9
81	PL068B	pool	no	4097581	242878	20050629	EW, BD	25.2	44.8	17	15	20	10	8
82	RN130B	run	no	4097599	242914	20050629	EW, BD	32.1	43.5	16	17	20	9	8
83	PL069B	pool	no	4097587	242915	20050629	EW, BD	34.7	34.7	15	15	20	8	9
84	RN129B	run	no	4097521	242908	20050629	EW, BD	14	24.3	9	8	20	6	7
85	RN131B	run	no	4097434	242997	20050629	EW, BD	30.5	30.5	18	20	20	8	7
86	PL070B	pool	no	4097442	243058	20050629	EW, BD	38.4	38.4	19	20	20	8	7
87	RN132B	run	no	4097525	243130	20050629	EW, BD	29.3	29.3	15	19	20	8	6
88	PL071B	pool	no	4097570	243160	20050629	EW, BD	35.3	35.3	17	20	20	8	8
89	RN133B	run	no	4097715	243289	20050629	EW, BD	29.5	29.5	17	19	20	7	7
90	PL072B	pool	no	4097756	243387	20050629	EW, BD	36	36	16	18	20	7	8
91	RN200A	run	no	4097826	243484	20050629	EW	20.7	26.8	13	18	11	10	10
92	RN001A	run_detail	yes	4097809	243493	20040524	EW	15.2	26	-	-	-	-	-
93	RN134B	run	no	4097793	243540	20050629	EW, BD	40.3	40.3	15	20	20	8	8
94	PL073B	pool	no	4097756	243596	20050629	EW, BD	-	-	19	20	10	10	10
95	RN002B	run	no	4097737	243650	20040525	EW	24.7	24.7	8	18	14	5	3
96	RN003B	run_detail	yes	4097736	243678	20040525	EW	24.3	24.3	6	20	20	8	7
97	RN004B	run	no	4097746	243731	20040525	EW	17.2	17.2	9	20	17	5	5
98	RN005B	run	no	4097756	243768	20040525	EW	18.4	18.4	13	20	20	8	8
99	RN006B	run	no	4097771	243834	20040525	EW	22.5	22.5	14	20	20	9	9
100	RN007B	run	no	4097749	243874	20040525	EW	17.9	18.9	18	20	20	10	10
101	RN008B	run	no	4097678	243964	20040525	EW	14.2	14.2	19	20	20	10	10
102	RN009B	run	no	4097642	244037	20040525	EW	25.1	30.7	19	20	20	9	9
103	RN010B	run	no	4097654	244124	20040525	EW	19.4	19.4	20	20	20	9	10
104	PL011B	pool	no	4097674	244163	20040526	EW	24.4	24.4	NR	20	20	10	10
105	PL012B	pool	no	4097709	244181	20050613	EW, JD, PS	24.8	24.8	13	20	20	8	7
106	RN019B	run	no	4097744	244206	20050613	EW, JD, PS	23.9	23.9	9	20	20	7	6
107	PL013B	pool	no	4097822	244386	20050613	EW, JD, PS	23.8	23.8	18	20	20	7	7
108	PL014B	pool	no	4097799	244464	20050613	EW, JD, PS	20.3	20.3	13	20	20	2	8
109	PL015B	pool	no	4097777	244517	20050613	EW, JD, PS	22.7	22.7	19	20	20	9	8
110	RN020B	run	no	4097755	244548	20050613	EW, JD, PS	23.9	23.9	19	20	20	8	8
111	PL016B	pool	no	4097730	244589	20050613	EW, JD, PS	28.7	28.7	19	20	20	8	9
112	RN021B	run	no	4097685	244734	20050613	EW, JD, PS	24.9	24.9	10	20	20	9	9
113	PL017B	pool	no	4097676	244767	20050613	EW, JD, PS	27.2	27.2	17	20	20	8	8
114	RN022B	run	no	4097643	244844	20050613	EW, JD, PS	24.2	24.2	18	20	20	9	9

Table A.4 (cont.). Rapid Bioassessment data from survey of the Nottoway River on ARNG-MTC Fort Pickett in May 2004 and June 2005.

Reach_id_	left bank veg protection	right bank veg protection	Embededness	LWD	Comments
77	8	7	NA	R	-
78	7	7	NA	2	large dry stream bed on left; trib on right
79	8	7	NA	5	riffle created by large woody debris; end of dry stream bed from RN127
80	8	8	NA	2	-
81	9	8	NA	1	forks at end
82	8	8	NA	2	long fork; sandy bottom channel out left bank, wetted
83	8	8	NA	1	-
84	8	8	NA	2	short fork
85	8	8	NA	1	two tribs on left
86	8	7	NA	+	-
87	8	8	NA	2	-
88	7	8	NA	1	-
89	8	8	NA	2	-
90	6	6	NA	1	-
91	10	10	NA	-	Refer to Detail RN001; large woody debris present; sandy substrate
92	-	-	-	-	Refer to Detail RN001
93	8	8	N	3	island
94	8	8	N	+	at bridge and rocky ford site
95	9	9	NA	-	downstream at bridge; sandy bottom
96	10	10	18	2	approximate site of 2002 logperch collection - refer to Detail RN003
97	8	8	NA	-	sandy bottom
98	9	9	NA	-	sandy bottom
99	10	10	NA	-	sandy bottom; observed several gravel patches
100	10	10	NA	-	sandy bottom; observed isolated patches of gravel; flow rate high/depth~1.0-1.25 meters
101	10	10	NA	-	observed a beaver exit at den in the left bank just below the start of the reach; sandy bottom; LWD
102	10	10	NA	-	prim. Sandy bottom but side pocket (~3 m pool; <90cm deep w/gravel bottom; potential subadult habitat? Mean flow 0.12; bottom .08; ehemeral pool on abandoned channel
103	9	10	NA	-	sandy bottom w/ boulders; submerged large woody debris
104	10	10	NR	-	large woody debris present; NR = not recordable
105	10	10	sandy	1	sand bar edge left bank; pool right bank
106	10	10	sandy	+	-
107	10	10	sandy	2	-
108	10	10	sandy	2	-
109	10	10	sandy	2	-
110	10	10	sandy	2	-
111	10	10	sandy	2	-
112	10	10	sandy	4	lots of sedimentation
113	10	10	sandy	4	-
114	10	10	sandy	4	-

Table A.4 (cont.). Rapid Bioassessment data from survey of the Nottoway River on ARNG-MTC Fort Pickett in May 2004 and June 2005.

Reach_id_	Transpt_id	Habtype	Detail	Transpt_y	Transpt_x	Date_	Observers	wetted width (m)	channel width (m)	sediment deposition	flow status	alteration	left bank stability	right bank stability
115	RN023B	run	no	4097473	244931	20050614	EW, JD, PS	26.7	26.7	8	20	20	8	9
116	PL018A	pool	no	4097470	244953	20050614	EW, JD, PS	23	23	18	20	20	7	6
117	RN024B	run	no	4097423	244967	20050614	EW, JD, PS	21.7	21.7	11	20	20	8	6
118	RN025B	run	no	4097581	245096	20050614	EW, JD, PS	26.9	26.9	11	20	20	9	10
119	RN026B	run	no	4097711	245148	20050614	EW, JD, PS	22.8	24.6	14	20	20	10	10
120	RN027B	run	no	4097777	245208	20050614	EW, JD, PS	14.9	14.9	14	20	20	10	9
121	PL019B	pool	no	4097829	245190	20050614	EW, JD, PS	19.4	19.4	12	20	20	10	9
122	RN028B	run	no	4097855	245196	20050614	EW, JD, PS	16.6	20.9	16	20	20	9	10
123	PL020B	pool	no	4097843	245268	20050614	EW, JD, PS	22	22	18	20	20	7	8
124	RN029B	run	no	4097804	245296	20050614	EW, JD, PS	19.6	19.6	19	20	20	7	8
125	PL021B	pool	no	4097741	245379	20050614	EW, JD, PS	27	27	19	20	20	8	9
126	PL022B	pool	no	4097714	245435	20050614	EW, JD, PS	27.7	27.7	16	20	20	8	7
127	RN030B	run	no	4097708	245483	20050614	EW, JD, PS	23.6	23.6	19	20	20	8	8
128	PL023B	pool	no	4097641	245622	20050614	EW, JD, PS	25.4	25.4	15	20	20	7	7
129	RN031B	run	no	4097604	245854	20050614	EW, JD, PS	27.2	27.2	18	20	20	9	9
130	RN032B	run	no	4097603	245909	20050614	EW, JD, PS	17.2	21.6	14	20	20	-	-
131	PL024B	pool	no	4097653	245901	20050614	EW, JD, PS	20.1	23.3	18	20	20	8	8
132	RN033B	run	no	4097653	245866	20050614	EW, JD, PS	26	26	20	20	20	9	6
133	PL025B	pool	no	4097682	245849	20050614	EW, JD, PS	21	30	12	20	20	7	8
134	RN105B	run	no	4097731	245891	20050627	EW, BD	18.1	23.7	9	15	20	7	9
135	RN106B	run	no	4097717	246113	20050627	EW, BD	22.6	28.2	15	19	20	8	8
136	RN107B	run	no	4097701	246185	20050627	EW, BD	26.3	31.3	17	18	20	8	9
137	RN026B	run	no	4097609	246202	20050627	EW, BD	25.2	25.2	19	20	20	8	7
138	RN108B	run	no	4097390	246246	20050627	EW, BD	16.8	27.1	17	15	20	8	7
139	PL027B	pool	no	4097384	246269	20050627	EW, BD	29.3	29.3	15	20	20	9	8
140	RN109B	run	no	4097374	246331	20050627	EW, BD	25.1	32.8	16	17	20	8	2
141	RN018A	run	no	4097416	246383	20040526	EW	18.3	20.4	20	20	20	10	10
142	RN017A	run	no	4097499	246318	20040526	EW	28.6	18.6	NR	20	20	10	10
143	RN016A	run	no	4097622	246295	20040526	EW	24.4	24.4	NR	20	20	10	10
144	RN016A	run	no	4097714	246329	20040526	EW	24.1	24.1	16	20	20	9	10
145	PL010A	pool	no	4097794	246440	20040526	EW	25.9	25.9	15	20	20	10	9
146	PL009A	pool	no	4097785	246491	20040526	EW	21.2	26.3	8	18	20	9	9
147	PL008A	pool	no	4097796	246531	20040526	EW	27	28.1	17	20	18	10	10
148	PL007A	pool	no	4097825	246644	20040526	EW	22.2	18.4	-	-	-	-	-
149	RN011B	run_detail	yes	4097860	246649	20040525	EW	27.8	26.3	17	20	18	10	9
150	PL003A	pool	no	4097935	246735	20040525	EW	29.6	29.6	17	20	20	10	9
151	RN012A	run	no	4097991	246851	20040525	EW	22	26	15	17	20	9	9
152	RN015A	run	no	4098113	246962	20040526	EW	21.8	21.8	16	18	20	10	10

Table A.4 (cont.). Rapid Bioassessment data from survey of the Nottoway River on ARNG-MTC Fort Pickett in May 2004 and June 2005.

Reach_id_	left bank veg protection	right bank veg protection	Embededness	LWD	Comments
115	10	10	sandy	4	lots of fallen logs; flowing fairly quickly; fairly gravelly
116	10	10	sandy	1	-
117	10	10	sandy	2	runs out in the bed of the river; GPS location not taken Nav. Point 4
118	10	10	sandy	2	giant sand bar
119	10	10	sandy	2	contains 1999 logperch sighting
120	10	10	sandy	2	-
121	10	10	sandy	1	-
122	10	10	sandy	3	-
123	10	10	sandy	+	-
124	10	10	sandy	+	-
125	10	10	sandy	2	-
126	10	10	sandy	2	-
127	10	10	sandy	2	-
128	10	10	NA	2	-
129	10	10	sandy	+	bridge underneath
130	7	5	sandy	1	tributary from ford/wetland site; deep cuts in bend
131	10	10	sandy	1	-
132	10	10	NA	R	-
133	10	10	NA	+	-
134	7	8	NA	1	inside bank sand bar; trib on left
135	8	8	NA	5	some silty bottom
136	7	7	NA	1	-
137	8	7	NA	+	large rocky left bank; wide intermittant trib with standing water
138	8	7	NA	1	center bar; small trib on right
139	7	7	NA	1	trib on right; left sand bar, small pool
140	8	6	NA	1	large scour
141	10	10	NA	-	large woody debris present; sandy bottom
142	10	10	NR	-	large woody debris present; NR=not recordable
143	10	10	NR	-	large woody debris present; NR=not recordable
144	10	10	NA	-	large woody debris present (~20%); sandy bottom
145	10	10	NA	-	large woody debris present; sandy bottom
146	10	10	NA	-	large woody debris present; sandy bottom
147	10	10	NA	-	large woody debris present; sandy bottom
148	-	-	-	-	-
149	10	10	17	-	approximate site of 2002 logperch collection - refer to Detail RN011
150	10	10	NA	-	large woody debris present; sandy bottom; <20 cm depth in some areas
151	10	10	NA	-	sandy bottom; downstream has bedrock and boulders with patches of gravel; may warrant more detailed sampling
152	10	10	NA	-	sandy bottom

Table A.4 (cont.). Rapid Bioassessment data from survey of the Nottoway River on ARNG-MTC Fort Pickett in May 2004 and June 2005.

Reach_id_	Transpt_id	Habtype	Detail	Transpt_y	Transpt_x	Date_	Observers	wetted width (m)	channel width (m)	sediment deposition	flow status	alteration	left bank stability	right bank stability
152	RN015A	run	no	4098113	246962	20040526	EW	21.8	21.8	16	18	20	10	10
153	RN014A	run	no	4098180	246981	20040526	EW	16.7	27.4	7	8	20	10	10
154	PL006A	pool	no	4098214	247023	20040526	EW	14.7	27.7	7	8	20	8	10
155	PL005A	pool	no	4098222	247088	20040526	EW	28.8	30.4	7	20	20	9	10
156	RN013A	run	no	4098199	247152	20040526	EW	23.7	23.7	18	20	16	3	5
157	PL004A	pool	no	4098224	247177	20040526	EW	29.1	29.5	-	-	-	-	-

Reach_id_	left bank veg protection	right bank veg protection	Embededness	LWD	Comments
152	10	10	NA	-	sandy bottom
153	10	10	NA	-	sandy bottom; large sand bar
154	10	10	NA	-	sandy bottom; over half of bottom is a sand bar; beach-like deposition w/ no plant encroachment so not considered as the bank
155	10	9	NA	-	sandy bottom
156	6	8	NA	-	bridge at east of base; sandy bottom
157	-	-	-	-	-

Reach_id = numeric code assigned to habitat unit starting with number 1 near the western edge of the installation at the first bridge below the dam.

Transpt_id = alpha-numeric code assigned to the points marked as the end of one habitat unit and the beginning of another (transition points).

Habtype = habitat type, either riffle, run, or pool.

Detail = yes or no. Yes indicates that conditions at that habitat unit met criteria as likely potential habitat for Roanoke logperch described above and additional data were recorded (Tables A.5-A.9).

Transpt_y and Transpt_x = UTM northing and easting (respectively) recorded at each transition point.

Date = date unit was assessed.

Observers = Initials of observers in the field conducting assessment.

Table A.4 (cont.). Rapid Bioassessment data from survey of the Nottoway River on ARNG-MTC Fort Pickett in May 2004 and June 2005.

Wetted width (m) = wetted width at transition point.

Channel width (m) = channel width at transition point.

Sediment deposition, flow status, alteration, bank stability, veg bank protection, and Embededness are parameters evaluated in the Rapid Bioassessment process and are further explained in Figure A.1 above.

LWD = large woody debris quantified using the r-6 modified Braun-Blanquet cover-abundance scale as explained in section *A.4.1 Mesohabitat Description* above. Data points in which no value is listed (-) no large woody debris estimates were made. This does not mean that no large woody debris was present.

Comments = any additional comments recorded by field observers.

Table A.5. Microhabitat data recorded at each site that met criteria as likely potential habitat for Roanoke logperch described above.

reach _id	92	Date:	5/24/2004		Detail Sheet
transition point_id	RN001				

	Easting	Northing	Wetted Width (m)	Channel Width (m)	Length
A	243493	4097809	15.2	26.0	
B	243484	4097826	20.7	26.8	'-

Sediment Deposition	Flow Status	Evidence of alteration	Bank Stability L	Bank Stability R	Bank veg protection L	Bank veg protection R	Large Woody Debris	Embededness
8	11	20	7	9	10	10	2	13

Pool Width (m)	24.5	18.9	15.2	22.2	20.7		
Depth (cm)	80.5	54	58	65.5	29	79	70
Mean Velocity (m/sec)	0.33	0.4	0	0.47	0.45	0.18	
Bottom Velocity (m/sec)	0.32	0.36	0	0.47	0.45	0.18	

Substrate Class (mm)

2.8	2.8	4	4	8	2.8	2.8	2	2	2
2.8	2	5.6	4	4	2	2	2	2	2
2	2.8	4	2	2	4	2	2	2	2.8
2.8	4	4	2	4	4	2	2.8	5.6	4
5.6	5.6	8	2.8	4	5.6	2	4	2.8	2.8
8	11	8	11	8	16	16	11	11	5.6
16	16	22.6							

Embededness	4	3	3	3
Siltation Rank	4			

average substrate class	6.5
average feature width	20.3 m
average feature depth	62.29 cm
average mean velocity	0.31 m/sec
average bottom velocity	0.3 m/sec

Daily mean streamflow value (ft^3/sec) recorded at USGS Station 02044500 on the Nottoway River near Rawlings VA on date site was assessed and median daily streamflow for that day based on 54 year record: 5/24/2004 | 271 | 54 year median | 339

Table A.6. Microhabitat data recorded at each site that met criteria as likely potential habitat for Roanoke logperch described above.

reach _id **96**

transition point_id RN003 Date: 5/25/2004 **Detail Sheet** Comments: small gravel area (<25%), rest sandy

	Easting	Northing	Wetted Width (m)	Channel Width (m)	Unit Length
A	243650	4097737	24.7	24.7	-
B	243678	4097736	24.3	24.3	28.7 m

Sediment Deposition	Flow Status	Evidence of alteration	Bank Stability L	Bank Stability R	Bank veg protection L	Bank veg protection R	Large Woody Debris	Embededness
6	20	20	8	7	10	10	2	18

Pool Width (m)	23.4	17.9	24	23.7
Depth (cm)	52	103	54	
Mean Velocity (m/sec)	0.21	0.72		0.33
Bottom Velocity (m/sec)	0.37	0.6		0.25

Substrate Class (mm)

<2	5.6	2	2.8	2	4	5.6	16	8
8	8	16	16	<2	16	8	8	5.6
<2	5.6	<2	<2	<2	<2	<2	<2	<2
2	<2	<2	<2	2	2.8	2	<2	4
2	22.6	4	5.6	8	8	16	22.6	2.8
5.6	2	2						

Embededness	5	NA	NA
Siltation Rank	5	1	3

average substrate class	5.1[1]
average feature width	22.3 m
average feature depth	70 cm
average mean velocity	0.42 m/sec
average bottom velocity	0.41 m/sec

Daily mean streamflow value (ft^3/sec) recorded at USGS Station 02044500 on the Nottoway River near Rawlings VA on date site was assessed and median daily streamflow for that day based on 54 year record: 5/25/2004 283 54 year median 329

[1]Where substrate recorded as <2, a value of 1 was used to calculate average substrate class

Table A.7. Microhabitat data recorded at each site that met criteria as likely potential habitat for Roanoke logperch described above.

reach _id	**149**	Date:	5/25/2004		**Detail Sheet**
transition point_id	RN011				

	Easting	Northing	Wetted Width (m)	Channel Width (m)	Unit Length
A					
B	246649	4097860	27.8	26.3	23.3

Sediment Deposition	Flow Status	Evidence of alteration	Bank Stability L	Bank Stability R	Bank veg protection L	Bank veg protection R	Large Woody Debris	Embededness
17	20	18	10	9	10	10		17

Pool Width (m)									
Depth (cm)	31	18	63	85	64	52	73	98	94
Mean Velocity (m/sec)	0.83	0.69	0.76	0.77	0.56	0.68	0	0.53	0.69
Bottom Velocity (m/sec)	0.67	0.47	0.41	0.65	0.25	0.47	0	0.33	0.36

Substrate Class (mm)

32	22.6	45	2.8	8	22.6	2	B	2	2
2	128	64	2	22.6	32	B	B	22.6	22.6
2	22.6	45	22.6	4	45	16	32	45	32
32	45	32	16	16	B	32	22.6	16	32
32	32	64	22.6	32	22.6	45	32	45	45

Embededness	3	4	3	5	5
Siltation Rank	1	5	4	2	5

average substrate class	50.4[1]
average feature width	-
average feature depth	64 cm
average mean velocity	0.61 m/sec
average bottom velocity	0.40 m/sec

Daily mean streamflow value (ft^3/sec) recorded at USGS Station 02044500 on the Nottoway River near Rawlings VA on date site was assessed and median daily streamflow for that day based on 54 year record: 5/25/2004 | 283 | 54 year median | 329

[1]Substrate recorded as B = boulder. A value of 301 was used to calculate average substrate class.

Table A.8. Microhabitat data recorded at each site that met criteria as likely potential habitat for Roanoke logperch described above.

reach _id	**11**	Date:	6/15/2005		**Detail Sheet**
transition point_id	PL032				

	Easting	Northing	Wetted Width (m)	Channel Width (m)	Unit Length
A					
B	237122	4097793	20.7	23.2	74.9 m

Sediment Deposition	Flow Status	Evidence of alteration	Bank Stability L	Bank Stability R	Bank veg protection L	Bank veg protection R	Large Woody Debris	Embededness
20	20	20	2	1	10	10	1	

Pool Width (m)	21.6	22	22.4	22.4	22.9	23.1	21.1	21.1	24.5
Depth (cm)									
Mean Velocity (m/sec)	0.27	0.39	0.4	0.45	0.36	0.38	0.33	0.3	0.28
Bottom Velocity (m/sec)	0.11	0.14	0.17	0.23	0.17	0.16	0.18	0.13	0.17

Substrate Class

16	8	22	16	5.6	8	2.8	11	sand	sand
128	45	22.6	11	22.6	22.6	5.6	boulder	32	sand
11	16	32	sand	45	32	32	boulder	22.6	22.6
16	sand	22.6	16	22.6	8	16	sand	4	32
16	22.6	22.6	22.6	128	128	11	16	5.6	64

Embededness	3	2	2	2	2	2
Siltation Rank	5	5	5	5	5	5

average substrate class	35.4[1]
average feature width	22.3 m
average feature depth	-
average mean velocity	0.35 m/sec
average bottom velocity	0.16 m/sec

[1]Substrate recorded as B = boulder. A value of 301 was used to calculate average substrate class. Sand was calculated as 0.5.

Daily mean streamflow value (ft^3/sec) recorded at USGS Station 02044500 on the Nottoway River near Rawlings VA on date site was assessed and median daily streamflow for that day based on 54 year record: 6/15/2005 | 116 | 54 year median | 163 |

Table A.9. Microhabitat data recorded at each site that met criteria as likely potential habitat for Roanoke logperch described above.

reach _id **13** Date: 6/16/2005 **Detail Sheet**

transition point_id PL033

	Easting	Northing	Wetted Width (m)	Channel Width (m)	Unit Length
A					
B	237155	4097753	-	-	35.2 m

Sediment Deposition	Flow Status	Evidence of alteration	Bank Stability L	Bank Stability R	Bank veg protection L	Bank veg protection R	Large Woody Debris
							1

Pool Width (m)	29.2	28.8	24.1	26.3	27.7	20.2	26.1	23.5	26.3
Depth (cm)	49	64	88	104	120	103	112	118	84
Mean Velocity (m/sec)	0.33	0.29	0.15	0.11	0.09	0.12	0.14	0.1	0.12
Bottom Velocity (m/sec)	0.24	0.22	0.13	0.06	0.03	0.05	0.08	0.07	0.1

Substrate Class

32	16	sand	11	16	22.6	32	16	sand	32
16	11	5.6	sand	sand	sand	8	4	22.6	45
45	45	45	32	16	22.6	22.6	22.6	11	16
22.6	sand	sand	22.6	16	sand	sand	8	16	45
16	16	22.6	sand	8	16	22.6	11	22.6	32

Embededness	2	2	4	3	2	1	1
Siltation Rank	3	3	5	4	3	2	1

average substrate class	17.4[1]
average feature width	25.8 m
average feature depth	94 cm
average mean velocity	0.16 m/sec
average bottom velocity	0.11 m/sec

[1]Where substrate recorded as sand, a value of 0.5 was used to calculate average substrate class.

Daily mean streamflow value (ft^3/sec) recorded at USGS Station 02044500 on the Nottoway River near Rawlings VA on date site was assessed and median daily streamflow for that day based on 54 year record: 6/16/2005 97 54 year median 185

Five habitat units were found to have parameters that were assessed to be within the suggested potential habitat range based on areas used by Roanoke logperch as documented during snorkeling surveys elsewhere on the Nottoway River by Rosenberger (2002), primarily based on substrate characteristics, depth, and flow velocity. However it is significant to note that areas identified as within the suggested potential habitat range in May 2004 no longer satisfied those same criteria when revisited in June 2005. Substrate classified as mixed small gravel in 2004 was classified as sand in 2005. This observation suggests that substrate composition and other conditions in the Nottoway can fluctuate widely from area to area and from season to season. It is reasonable to suggest that substrate materials might be redistributed, dispersed, or concentrated by the highly variable stream flows exhibited by the Nottoway River (Figure A.5) resulting in a fluid spatial distribution of suitable habitat.

In light of this phenomenon, and given the lack of clearly defined localized habitat parameters, it would be prudent to be sensitive to potential negative impacts all along the river course as well as around the Roanoke Logperch Management Zone and other specific habitat units. Additionally, while rapid bioassessment data will be useful as a starting point for future logperch surveys, areas identified therein must not be viewed as the only existing potentially suitable habitat units, and search efforts should be distributed in other areas as well.

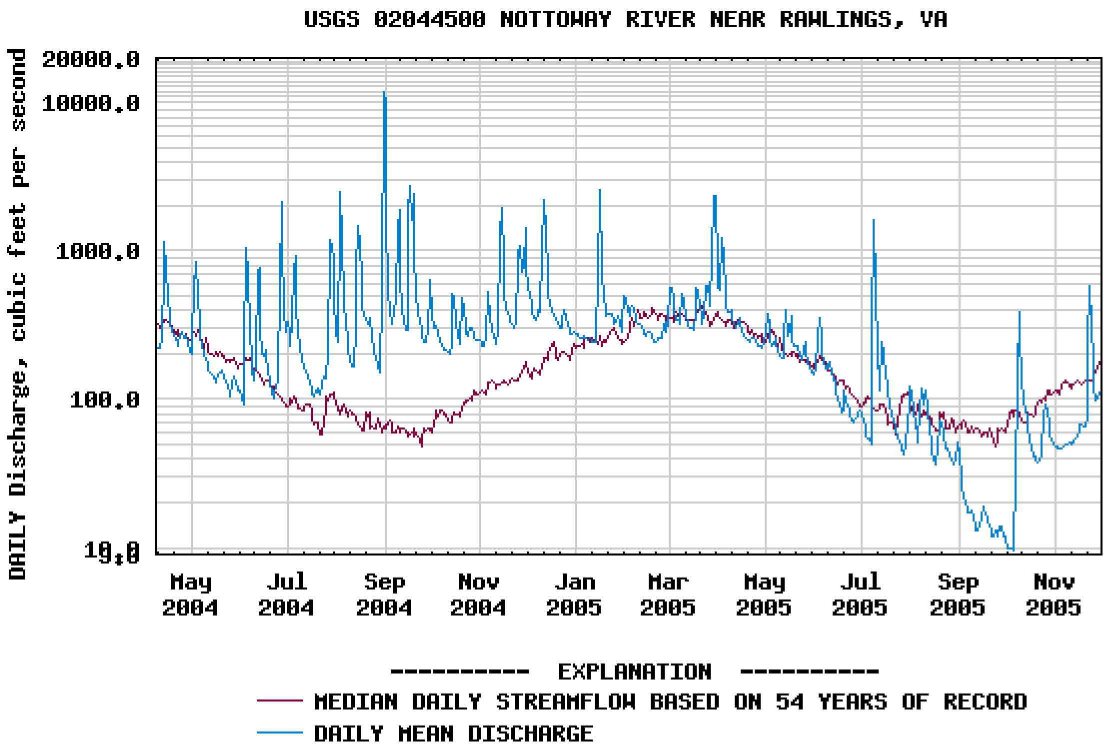

Figure A.5. Daily Streamflow Statistics for the Nottoway River recorded at the USGS Rawlings Station during Rapid Bioassessment Survey of the Nottoway River on ARNG-MTC Fort Pickett, VA

Restrictions related to areas of documented logperch use or specific isolated habitat units, while very important, cannot alone be considered adequate protection for the Roanoke logperch on ARNG-MTC Fort Pickett. Awareness of potential negative impacts to logperch habitat, primarily from sedimentation, must be extended to the Nottoway macrobasin as a whole, and the integrity of the entire Logperch Management Zone must be observed.

RBPs rank wadeable rivers and streams along a gradient of "optimal, suboptimal, marginal, and poor", and while rankings are compared to the "best attainable" situation as a reference condition that varies across different regions, rapid bioassessment data show that the Nottoway River on ARNG-MTC Fort Pickett and surrounding riparian area currently compare very well. Current conditions are a complimentary reflection of ongoing management strategies. The overall intact nature of the Nottoway stream corridor on base is indicated by a high optimal ($\bar{x}$ = 19.7 of 20) ranking in the RBP "channel alteration" category. "Channel flow status", intended to quantify the amount of substrate available to aquatic organisms, was also ranked as optimal. Ranking for most other categories, including "sediment deposition", "bank stability", and "bank vegetative protection" were high in the sub-optimal range (Table A.10).

Table A.10. Summary of Rapid Bioassessment data of the Nottoway River on ARNG-MTC Fort Pickett as assessed in May 2004 and June 2005.

	mean	minimum	maximum
wetted width (m)	23.0	10.6	40.7
channel width (m)	24.4	10.6	52.3
sediment deposition	14.8	4	20
flow status	19.2	6	20
evidence of channel alteration	19.7	10	20
left bank stability	8.3	1	10
right bank stability	8.3	0	10
left bank veg protection	9.5	5	10
right bank veg protection	9.5	0	10

While Rapid Bioassessment data show that habitat previously identified as used by Roanoke logperch in the more upland Roanoke River system is relatively rare on ARNG-MTC Fort Pickett, the fact that the population of Roanoke logperch has remained viable in the Nottoway show that there must be some level of tolerance of the conditions found there. In addition, sampling efforts by McIninch and Garman (2002) recorded the presence of other species with similar habitat preferences, including species that spawn over nests of gravel and rubble, consumers of a wide variety of benthic macroinvertebrates, and species that are also intolerant of siltation, suggesting that sufficient habitat and an abundance of food exists on ARNG-MTC Fort Pickett to support Roanoke logperch. Rapid Bioassessment data also show that the Nottoway River on ARNG-MTC Fort Pickett ranks in the optimal or sub-optimal categories as compared to an ideal stream condition for many habitat parameters currently deemed as important to Roanoke logperch habitat suitability. Quantitative sampling of the fish population in the Nottoway River on ARNG-MTC Fort Pickett is currently underway and may provide additional information on habitat use by Roanoke logperch on the installation.

These factors suggest that the Nottoway River on ARNG-MTC Fort Pickett provides suitable habitat for potential use and possible range expansion for the Roanoke logperch. Management of the Logperch Management Zone as detailed in the Endangered Species Management Plan is vital to the maintenance of the resource.

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APPENDIX B

Examples of logperch (*Percina rex*) and habitat sampling methods

B.1 Electrofishing Sampling

Electofishing is a fish capture method that is widely applied and has proven to be a tool of great value to resource managers, but it can be ineffective and even dangerous depending on the application and the operators involved, and is best undertaken by experienced personnel. In addition, proper permitting is required. Careful planning and in-depth research into the practical and technical aspects of electrofishing are essential to any electrofishing effort and require more detail than can be adequately presented here. Following is an outline of sampling protocols to be applied in ongoing survey efforts on ARNG-MTC Fort Pickett and is provided for general reference. Users should consult detailed texts such as Murphy and Willis (1996) and Cowx and Lamarque (1990) for further guidance.

The length of the river will be divided into sections using bridge crossings as initial dividing lines and then splitting the areas between the crossings into sections and randomly selecting from those. The selection process for those depends on the total number of sites desired. Additionally, qualitative targeting of potential logperch habitat based on Rapid Bioassessment survey data and observer experience may also be applied, with the goal of documenting the presence of species

Single-pass, pulsed-DC backpack electrofishing will be used to sample fish in each study reach. One technician will operate the electrofishing unit while one or two technicians will collect fish using dipnets. There will be a bag seine at the bottom of each section of the reach that is being sampled to catch uncollected fish. Any pools too deep to sample with a backpack will not be sampled. Two backpack electrofishing units should be used to sample when time and number of technicians permit. The reach length sampled should ideally be 40 times the mean channel wetted width at the midpoint of each site but due to the size of the river, a maximum distance of 500 m and minimum of 150 m will be sampled at each site. Sampling duration will be recorded in minutes in order to calculate catch per unit effort (CPUE). Stream temperature and conductivity should also be recorded at each sampling location.

Collected fish will be transferred to buckets equipped with aerators or other suitable livewells. Fish will be identified to species, counted, and then immediately returned to the river. Length and weight of Roanoke logperch will also be recorded. Location and habitat parameters [substrate type, flow, and depth, etc (see Appendix A, section *A.4.1 Micro-habitat Description*)] should be recorded for areas possessing Roanoke logperch. Voucher specimens of smaller individuals or unidentified species will be preserved for later identification (Duncan 2005). Sampling methods are subject to modification pending initial pilot sampling and additional management input.

B.2 Underwater Observation

Underwater observation by divers is a highly versatile and cost-effective means of acquiring a range of information about aquatic organisms, and can be used to observe behavior and habitat use parameters not available by other methods. However the effectiveness of the technique is dependant on adequate visibility (often precluded by high turbitity), and results may vary depending on the skill of the observer. As is true of any specialized sampling method, there are technical skills to be acquired and safety precautions to follow (Murphy and Willis 1996). Any underwater observation survey will be greatly enhanced by the presence of experience observers and careful planning. Following are techniques used by Rosenberger (2002) and Rosenberger and Angermeier (2002) to survey for Roanoke logperch elsewhere on the Nottoway.

Sites containing a riffle, run, and pool, the most commonly studied strata in stream reaches, are selected for stratified, systematic sampling of habitat to increase the probability of detecting discontinuities in a species' distribution (Angermeier et al. 2002). Representative percentage of riffle-run-pool sites are selected for quantitative underwater observation by line transect snorkeling methods used by Rosenberger (2002) and described in Ensign et al. (1995) or by transect cross methods described in Rosenberger and Angermeire (2002).

B.2.1 Line Transect Sampling

The line transect sampling method used for sampling during summer months by Rosenberger (2002) employs one to three parallel lines oriented with river flow that were marked with yellow line on the day of sampling. Spacing between lines is a minimum of 1.5 times maximum underwater visibility on the day of sampling. The length of the lines was based on the length of the habitat units, not to exceed 50 m per unit (150 m per site).

Visibility is determined by suspending a Secchi disk in the water column in front of a snorkeler. The snorkeler moves away from the disk until the black patterns on the disk are no longer distinguishable from the water. The distance between the snorkeler and the disk is measured to serve as the maximum visibility for that day. Surveys are not conducted if maximum visibility is less than 1.5 meters (Leftwich et al. 1997). To minimize effects of disturbance and to allow fish to settle, snorkelers will not begin sampling until at least one hour after placement of the transect lines. Snorkelers enter the water downstream of the area to be sampled and move slowly upstream along the lines, keeping the center of the body over the line. Each observer scans the stream bottom, mid-water, and upper-water column directly in front and to both sides of the line of travel. If a Roanoke logperch is sighted, a numbered weighted marker is placed on the stream bottom precisely where the fish was first spotted. The number-code of markers and age class (adult or subadult) are recorded on dive slates. Double counting of logperch is avoided by simultaneously sampling all three transect lines with snorkelers staying even with each other while moving upstream. Continuous communication between snorkelers also minimizes double counting. After the riffle-run-pool sequence is sampled, snorkelers return to the base of transects to count markers and collect habitat data.

B.2.1.A Microhabitat Sampling

Microhabitat data refer to characteristics of the habitat immediately surrounding observed fishes (1 m^2). Microhabitat data recorded at each marker where a logperch is sighted includes water depth (cm), bottom and mean water velocities (m/s), and point substrate size (9-category Wentworth scale). Also recorded are substrate characteristics within a 1-m^2 area around the marker, including dominant and subdominant substrate size, embeddedness, and silt cover.

Microhabitat availability is recorded by horizontal transects placed along the wetted width of the river at 10-meter intervals along the length of the site within 24 hours of the snorkeling run. Every three meters along the horizontal transects, depth, mean and bottom water velocities, and silt cover are recorded. Dominant and subdominant substrates, silt cover, and embeddedness within a 1-m^2 area are also recorded for each of the availability locations.

B.2.1.B Macrohabitat Sampling

Mesohabitat refers to characteristics of commonly used habitat strata at the reach scale (pool, run, or riffle). Mesohabitat is described by closest distance to like habitat unit (m); unit width, length, and area; average and maximum depth; average dominant and subdominant substrate, and average substrate embeddedness and silt cover by meso-habitat type (rank 1 = pools, rank 2 = runs, and rank 3 = riffles); and abundance of large woody debris.

A two- to three-person crew classifies and inventories habitat strata along each surveyed reach of river. One crew member identifies each habitat unit by type (pool, run, or riffle), records data, and takes channel width measurements along the stream. The second crew member visually classifies the dominant and subdominant substrate by particle size, average silt cover, and embeddedness of larger substrates (i.e. boulders, cobble, and gravel) in smaller substrates (i.e. silt and sand). This crewmember also estimates the minimum, maximum, and average depth of each habitat unit by measuring these parameters at multiple points along the habitat unit while traveling downstream and across the channel in a zigzag pattern. The final crew member measures the length of each habitat unit and the presence and abundance of woody debris.

B.2.2 Transect Cross Sampling

The transect cross method was as described in Rosenberger and Angermeire (2002) was devised to address the limited success of line transect sampling during the winter months. This method allows the sampling of a greater variety of habitat types, and, unlike the strip transect method does not restrict the divers to the thalweg of the river, and allows three divers to search for logperch rather than a single diver. A team of three snorkelers move up a previously delineated mesohabitat sequence (riffle, run, pool) in a zig-zag fashion, turning all lightly embedded cobbles, boulders, and dead-fall substrate in a shoulder-wide (~50 cm) strip to count logperch, deliberately concentrating on sampling a variety of habitats. When a logperch is observed, a weighted marker is placed at the site of the observation.

At each location where a logperch was observed, the following distance is recorded: distance from nearest stream bank (right or left), description of rock formation, and mesohabitat type. Habitat use and availability are recorded at the site where each fish was observed using a cross-shaped transect centered on the sighting location (Figure 3). Habitat use data are taken along transect arms set at 45º, 135º, 225º, and 315º in relation to stream flow from the center sighting location in order to minimize collection of habitat data in areas where the divers have disturbed the substrate. Habitat use is measured at five points, including the site of the observation and 0.25 m from the center along each transect line. Habitat availability is measured at 16 points, including 1, 1.5, 2.0, and 3.0 m from the center point along each transect, recording the following habitat variables at each points: depth, mean water velocity (measured behind the rock where the logperch was sighted if possible), rank embededness and rank substrate size (Rosenberger and Angermeir 2002).

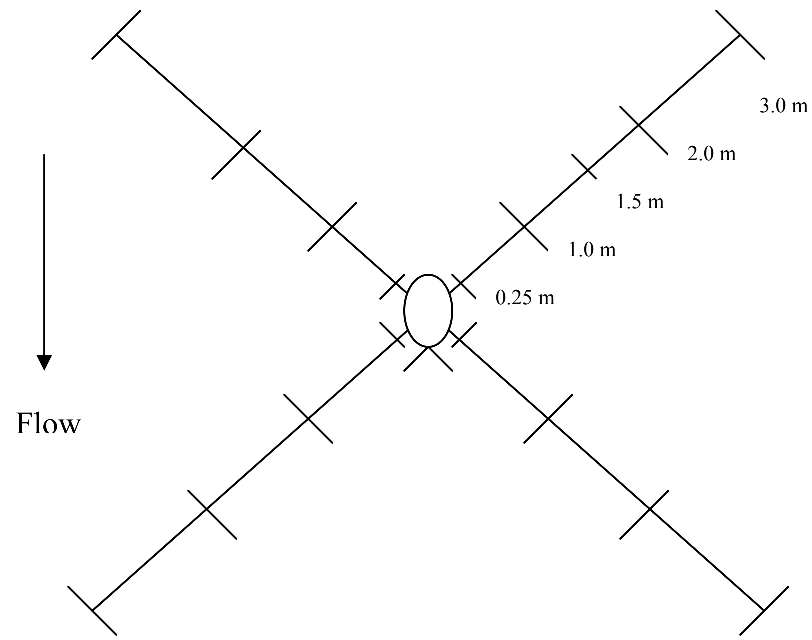

Figure 6. Schematic of transect cross used to sample for Roanoke logperch during winter months (Rosenberger and Angermeire 2002).

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APPENDIX O: BAT MANAGEMENT GUIDES

Programmatic Biological Opinion on Final 4(d) Rule for the Northern Long-Eared Bat and Activities Excepted from Take Prohibitions

U.S. Fish and Wildlife Service
Regions 2, 3, 4, 5, and 6

Prepared by:
U.S. Fish and Wildlife Service
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Bloomington, Minnesota
January 5, 2016

Lynn Lewis

Lynn Lewis, Assistant Regional Director, R3

1/5/16

Date

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EXECUTIVE SUMMARY

This Endangered Species Act (Act) Biological Opinion (BO) addresses the effects to the northern long-eared bat (NLEB) resulting from the Service's finalization of a special rule under the authority of section 4(d) of the Act. It also evaluates activities that the Service proposes to prohibit and except from take prohibitions under the final 4(d) rule. In the request for intra-Service consultation, the Service proposes a framework for streamlined section 7 consultation for other federal actions that may affect the NLEB and are consistent with the provisions of the 4(d) rule. This is a programmatic intra-Service consultation, because it addresses multiple actions on a program basis conducted under the umbrella of the final 4(d) rule. The Service has not designated or proposed critical habitat for the NLEB; therefore, this BO does not address effects to critical habitat. Because we anticipate continued NLEB declines as white-nose syndrome (WNS) spreads, this BO will cover the next 7 years that the disease is minimally expected to spread and impact the NLEB throughout its entire range. The Service will reinitiate consultation by the end of 2022 or earlier if the standard reinitiation criteria are triggered.

The final rule addresses both purposeful take and incidental taking of the NLEB, with certain differences distinguished based on the occurrence of WNS as follows:

- The final 4(d) rule prohibits purposeful take of NLEBs throughout the species' range, except when (1) necessary to protect human health; (2) in instances of removal of NLEBs from human structures; or (3) the authorized capture and handling of NLEBs by individuals permitted to conduct these same activities for other bat species until May 3, 2016.
- The final 4(d) rule does not prohibit incidental take resulting from otherwise lawful activities in areas not yet affected by WNS (i.e., areas outside of the WNS zone).
- Within the WNS zone, the final 4(d) rule prohibits incidental take of NLEBs in their hibernacula, which may be caused by activities that disturb or disrupt hibernating individuals when they are present as well as the physical or other alteration of the hibernaculum's entrance or environment when bats are not present.
- Incidental take of NLEBs outside of hibernacula resulting from activities other than tree removal is not prohibited provided they do not result in the incidental take of NLEBs inside hibernacula.
- Incidental take resulting from tree removal is prohibited if it: (1) occurs within 0.25 miles (0.4 km) of known NLEB hibernacula; or (2) cuts or destroys known, occupied maternity roost trees or any other trees within a 150-foot (45-meter) radius around the known, occupied maternity tree during the pup season (June 1 to July 31).
- Removal of hazardous trees for the protection of human life and property is not prohibited.

Federal agencies can rely upon the finding of this BO to fulfill their project-specific section 7(a)(2) responsibilities if they utilize the optional framework as described. The framework requires prior notification of activities that may affect the NLEB, along with a determination that the action would not cause prohibited incidental take. Service concurrence with the action agency determination is not required, but the Service may advise the action agency whether additional information indicates project-level consultation for the NLEB is required. If the Service does not respond within 30 days, the action agency may consider its project responsibilities under section 7(a)(2) with respect to the NLEB fulfilled through this programmatic BO. Action agencies must also report if actions deviate from the determination, along with the surveys of any surveys.

The Action Area addressed in this BO includes the entire range of the NLEB within the United States, which includes all or portions of 37 States and the District of Columbia from Maine west to Montana, south to eastern Kansas, eastern Oklahoma, Arkansas, and east to South Carolina. Within the Action Area, the WNS zone currently includes all or most of the states within the species' range except North Dakota, Montana, South Dakota, and Wyoming.

Status of the NLEB

The disease WNS is the primary factor affecting the status of the NLEB, which has caused dramatic and rapid declines in abundance. Data support substantial declines in the Eastern range and portions of the Midwest range. We expect further declines as the disease continues to spread across the species' range. NLEBs continue to be distributed across much of the historical range, but there are many gaps where bats are no longer detected or captured, and in other areas, their occurrence is sparse given local declines and extirpations. Although significant NLEB population declines have only been documented due to the spread of WNS, other sources of mortality could further diminish the species' ability to persist as it experiences ongoing dramatic declines.

We estimate that the range-wide population of NLEBs is comprised of about 6.5 million adults. This population estimate was calculated for the purposes of assessing the potential relative impact of activities contemplated in this BO, and it has limitations and a substantial amount of uncertainty.

Effects of the Action

The NLEB is likely to be affected by many activities which are not prohibited in the final 4(d) rule. We address the general effects of different activities, which we categorized into 7 general groups: (1) capture and handling of NLEBs by individuals with section 10(a)(1)(A) permits for other listed bats or State permits until May 3, 2016; (2) removal from human structures; (3)

timber harvest; (4) prescribed fire; (5) forest conversion; (6) wind turbine operation; and (7) other activities that may affect the NLEB. The effects of category #1 are not addressed in this consultation.

Based on the available scientific literature, we identified various pathways by which environmental changes (stressors) caused by the Action may affect individual NLEB and the expected responses of individuals exposed to the stressors. General response categories include potentially increased fitness, reduced fitness, disturbance, and harm. We do not have enough information to quantify the effects of removal from human structures and the “other” category of activities that may affect the NLEB. For pathways associated with timber harvest, prescribed fire, and forest conversion, we estimate the number of NLEB individuals exposed by computing the expected overlap between the activities and NLEB-occupied habitats in each state. For wind turbine operation, we estimate the number of bats that could be killed using the current and projected amount of wind energy development and information on bat mortality rates.

Based on these estimations, we anticipate that up to 117,267 NLEB (1.2% of the total population) will be disturbed and 3,285 pups (0.1% of the total pup population) and 980 adults (less than 0.02% of the total adult population) will be harmed annually from timber harvest, prescribed fire, forest conversion, and wind turbine operation. We consider these numbers to be overestimates based on our methodology. Additional harm is anticipated for the unquantified effects from removal from human structures and “other” activities that may affect the NLEB; however, we do not expect the additional impacts to substantially change the total numbers estimated. In addition, we also expect that the numbers affected over time will be reduced as WNS continues to affect the range-wide population.

Although local populations could be affected by the implementation of the final 4(d) rule, most of the states have larger populations and more maternity colonies. In addition, less than 2.3% of NLEBs will be disturbed in all states, less than 1% of pups will be harmed in all states, and less than 1% of adults will be harmed in all states. Therefore, the vast majority of individuals and populations that survive WNS will be unaffected by these activities. Based on the relatively small numbers affected annually compared to the state population sizes, we conclude that adverse effects from timber harvest, prescribed fire, forest conversion, wind energy, and other activities will not lead to population-level declines in this species.

Conclusion

WNS is the primary factor affecting the status of the NLEB, which has caused dramatic and rapid declines in abundance, resulting in the local extirpation of the species in some areas. Our analysis of the effects of activities that may affect the NLEB, but do not cause prohibited take, indicates that the additional loss of individual NLEB resulting from these activities would not exacerbate the effects of WNS at the scale of states within its range. Even if all anthropogenic activities that might adversely affect NLEB ceased, we do not believe that the resulting reduction in adverse effects would materially change the devastating impact WNS has had, and will continue to have, on NLEB at the local population level or at larger scales.

After reviewing the current status of the NLEB, environmental baseline, effects of the Action, and cumulative effects, it is the Service’s biological opinion that the Action, as proposed, is not likely to jeopardize the continued existence of the NLEB.

This BO has evaluated major categories of actions that may affect the NLEB, but for which incidental take is not prohibited. Accordingly, there are no reasonable and prudent measures or terms and conditions that are necessary and appropriate for these actions. Federal agencies may rely on this BO to fulfill their project-specific section 7(a)(2) responsibilities under the framework specified in this BO. Prohibited incidental take requires either a separate consultation (federal actions) or an incidental take permit (non-federal actions).

BIOLOGICAL OPINION

A Biological Opinion (BO) is the document required under the Endangered Species Act of 1973 (Act), as amended, that states the opinion of the U.S. Fish and Wildlife Service (Service) as to whether a proposed federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat.

The action evaluated in this BO is the Service's finalization of a special rule under the authority of section 4(d) of the Act for the northern long-eared bat (*Myotis septentrionalis*) (NLEB). Section 9 of the Act generally prohibits the "take" of a species listed as endangered. The Act and its implementing regulations (50 CFR 17) define take as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. The Act does not specify particular prohibitions for threatened species. Instead, under section 4(d), the Secretary of the Interior has the discretion to issue such regulations to provide for the conservation of threatened species, which may include prohibitions under section 9. This BO also evaluates activities that the Service proposes to prohibit and except from take prohibitions under the final 4(d) rule. In the request for intra-Service consultation, the Service proposes a framework for streamlined section 7 consultation for other federal actions that may affect the NLEB and are consistent with the provisions of the 4(d) rule. This is a programmatic intra-Service consultation, because it addresses multiple actions on a program basis under the umbrella of activities excepted from take prohibitions in the Service's final 4(d) rule.

"To jeopardize the continued existence of a listed species" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of the species (50 CFR §402.02). This BO examines whether projects and activities implemented that are likely to adversely affect the NLEB, but would not cause take prohibited under the final 4(d) rule , are likely to jeopardize the continued existence of the NLEB.

The Service anticipates that white-nose syndrome (WNS), the disease causing the decline of the species, will spread throughout the range of the NLEB by 2023-2028 (Federal Register [FR]80[63]:17974). In listing rule, we determined that the NLEB is not currently in danger of extinction throughout all of its range, but if similar declines occur after WNS spreads throughout its entire range, the NLEB may be in danger of extinction. We expect that the status of the species will continue to decline as WNS reaches new areas; therefore, this BO will cover the next 7 years that the disease is minimally expected to spread and impact the NLEB throughout its entire range. The Service will reinitiate consultation by the end of 2022 or earlier if the reinitiation criteria described in Section 7 (Reinitiation Notice) of this BO are triggered. We believe this is a reasonable approach given that the range-wide decline of the NLEB due to WNS may reveal that the action may affect the NLEB in a manner or to an extent not previously considered.

1 DESCRIPTION OF THE PROPOSED ACTION

1.1 BACKGROUND

The proposed action is the finalization of the interim 4(d) rule for the NLEB and evaluation of activities excepted from take prohibitions. This rule replaces an interim 4(d) rule established concurrently with the listing of the NLEB as a threatened species on April 2, 2015 (FR 80[63]:17974), under the Act. The interim 4(d) rule:

(1) prohibits purposeful take of NLEBs throughout the species' range, except in instances of removal of NLEBs from human structures;
(2) authorized capture and handling of NLEB by individuals permitted to conduct these same activities for other bats (for a period of 1 year after the effective date of the interim 4(d) rule);
(3) in areas not yet affected by white-nose syndrome (WNS), all incidental take resulting from any otherwise lawful activity is excepted from prohibition;
(4) in areas currently known to be affected by WNS, all incidental take prohibitions apply, except take attributable to forest management practices, maintenance and limited expansion of transportation and utility rights-of-way, prairie habitat management, and limited tree removal projects, provided these activities protect known maternity roosts and hibernacula; and
(5) removal of hazardous trees for the protection of human life or property is excepted from the take prohibition.

The listing and interim 4(d) rule went into effect on May 4, 2015, and the interim 4(d) rule remains in effect until a final 4(d) rule is published in the Federal Register.

1.2 U.S. FISH AND WILDLIFE SERVICE ACTION

The Service is finalizing the interim 4(d) rule for the NLEB. The final rule will address both purposeful take and incidental taking of the NLEB, with certain differences distinguished based on the occurrence of WNS. The final 4(d) rule prohibits purposeful take of NLEBs throughout the species' range, except when:

- necessary to protect human health;
- in instances of removal of NLEBs from human structures; or

- the authorized capture and handling of NLEBs by individuals permitted to conduct these same activities for other bat species until May 3, 2016.

After May 3, 2016, a permit pursuant to Section 10(a)(1)(A)[1] of the Act is required for the capture and handling of NLEBs outside of human structures. We define human structures as houses, garages, barns, sheds, and other buildings designed for human entry.

"Incidental taking" is defined at 50 CFR 17.3 as "any taking otherwise prohibited, if such taking is incidental to, and not the purpose of, an otherwise lawful activity." Incidental take within the context of the final 4(d) rule is regulated in distinct and separate manners relative to the geographic location of the proposed activity and the occurrence of WNS. The WNS zone provides the boundary for implementation of the final rule. It is defined as the set of counties with confirmed evidence of the fungus causing the disease (*Pseudogymnoascus destructans*, or Pd) or WNS, plus a 150-mile (241 km) buffer from the Pd-positive county line to account for the spread of the fungus from one year to the next. In instances where the 150-mile (241 km) buffer line bisects a county, the entire county is included in the WNS zone. The final 4(d) rule does not prohibit incidental take resulting from otherwise lawful activities in areas not yet affected by WNS (i.e., areas outside of the WNS zone).

Within the WNS zone, the final 4(d) rule prohibits incidental take of NLEBs in their hibernacula (which includes caves, mines, and other locations where bats hibernate in winter). Take of NLEBs inside of hibernacula may be caused by activities that disturb or disrupt hibernating individuals when they are present as well as the physical or other alteration of the hibernaculum's entrance or environment when bats are not present, if the activity will impair essential behavioral patterns (e.g., sheltering) and cause harm. Known hibernacula are defined as locations where one or more NLEBs have been detected during hibernation or detected at the entrance during fall swarming or spring emergence. Any hibernaculum with NLEBs observed at least once is considered a known hibernaculum as long as it remains suitable for NLEB use. A hibernaculum remains suitable for NLEBs even when Pd or WNS has been detected.

For NLEBs outside of hibernacula within the WNS zone, the final 4(d) rule establishes separate incidental take prohibitions for activities involving tree removal and those that do not involve tree removal. Incidental take of NLEBs outside of hibernacula resulting from activities other than tree removal is not prohibited provided they do not result in the incidental take of NLEBs inside hibernacula or otherwise impair essential behavioral patterns at known hibernacula. Incidental take resulting from tree removal is prohibited if it: (1) occurs within 0.25 miles (0.4 km) of known NLEB hibernacula; or (2) cuts or destroys known, occupied maternity roost trees or any other trees within a 150-foot (45-meter) radius around the known, occupied maternity tree during the pup season (June 1 to July 31). Removal of hazardous trees for the protection of human life

[1] Section 10(a)(1)(A) describes recovery/scientific permits issued for the enhancement of the survival of the species.

and property is not prohibited. Known, occupied maternity roost trees are defined as trees that have had female NLEBs or juvenile bats tracked to them or the presence of female or juvenile bats is known as a result of other methods. Known, occupied maternity roost trees are considered known roosts as long as the tree and surrounding habitat remain suitable for the NLEB.

The final 4(d) rule individually sets forth prohibitions on possession and other acts with unlawfully taken NLEBs, and on import and export of NLEBs. Under this rule, take of the NLEB is also not prohibited for the following: removal of hazardous trees for protection of human life and property; take in defense of life; and take by an employee or agent of the Service, of the National Marine Fisheries Service, or of a State conservation agency that is operating a conservation program pursuant to the terms of a cooperative agreement with the Service.

Section 4(d) of the Act states that the Secretary shall issue such regulations as she deems “necessary and advisable to provide for the conservation” of species listed as threatened species. The Service determined that the final 4(d) rule is necessary and advisable to provide for the conservation of the NLEB, because it provides for temporary protection of known maternity roost trees during the pup season and to known hibernacula within the WNS zone, and it prohibits most forms of purposeful take throughout the species range. The final rule describes how prohibiting certain types of take is not necessary for the long-term survival of the species, and it acknowledges the importance of addressing the threat of WNS as the primary measure to arrest and reverse the decline of the species.

1.3 OTHER FEDERAL AGENCY ACTIONS

Federal agency actions that involve activities that involve activities not prohibited under the final 4(d) rule may result in effects to the NLEB if the species is exposed to action-caused stressors. Incidental take resulting from these activities is not prohibited; however, the final 4(d) rule does not alter the requirements for consultation under section 7 of the Act, which apply to all federal actions that may affect listed species and designated critical habitat. Section 7(a)(2) of the Act, directs federal agencies, in consultation with the Secretary, to insure that their actions are not likely to jeopardize the continued existence of any listed species, or result in the destruction or adverse modification of designated critical habitat. Therefore, the purpose of section 7(a)(2) is broader than an evaluation of anticipated take and issuance of an Incidental Take Statement.

To address the broader purpose of 7(a)(2) for federal actions that may affect the NLEB but would not cause take prohibited under the final 4(d) rule, the Service’s Headquarters Office has requested intra-agency formal consultation with the Service’s Midwest Regional Office on the effects of all such federal actions. Because the Service has determined with the final 4(d) rule that regulating incidental take associated with the excepted activities is not necessary or advisable for the conservation of the NLEB, Service Headquarters proposes an optional framework for subsequent federal agency reliance on the findings of an intra-Service consultation that would streamline section 7(a)(2) compliance for such activities. The primary objective of the framework is to provide an efficient means for Service verification of federal agency determinations that their proposed actions are consistent with those evaluated in the intra-Service consultation and do not require an incidental take statement for the NLEB. Such verification is necessary because incidental take is prohibited in the vicinity of known hibernacula and known roosts, and these locations are continuously updated. We do not include specific action agencies or their specific actions in this BO; rather, we focus on the types of activities that may affect the NLEB and conduct our jeopardy analysis on these activities. Federal agencies may rely on this BO to fulfill their project-specific section 7(a)(2) responsibilities under the following framework:

1. For all federal activities that may affect the NLEB, the action agency will provide project-level documentation describing the activities that are excepted from incidental take prohibitions and addressed in this consultation. The federal agency must provide written documentation to the appropriate Service Field Office when it is determined their action may affect (i.e., not likely to adversely affect or likely to adversely affect) the NLEB, but would not cause prohibited incidental take. This documentation must follow these procedures:

    a. In coordination with the appropriate Service Field Office, each action agency must make a determination as to whether their activity is excepted from incidental taking prohibitions in the final 4(d) rule. Activities that will occur within 0.25 mile of a known hibernacula or within 150 feet of known, occupied maternity roost trees during the pup season (June 1 to July 31) are not excepted pursuant to the final 4(d) rule. This determination must be updated annually for multi-year activities.
    b. At least 30 days in advance of funding, authorizing, or carrying out an action, the federal agency must provide written notification of their determination to the appropriate Service Field Office.
    c. For this determination, the action agency will rely on the definitions of prohibited activities provided in the final 4(d) rule and the activities considered in this consultation.
    d. The determination must include a description of the proposed project and the action area (the area affected by all direct and indirect project effects) with sufficient detail to support the determination.
    e. The action agency must provide its determination as part of a request for coordination or consultation for other listed species or separately if no other species may be affected.
    f. Service concurrence with the action agency determination is not required, but the Service may advise the action agency whether additional information indicates consultation for the NLEB is required; i.e., where the proposed project includes an activity not covered by the 4(d) rule and thus not addressed in the Biological Opinion and is subject to additional consultation.
    g. If the Service does not respond within 30 days under (f) above, the action agency

may presume its determination is informed by best available information and consider its project responsibilities under section 7(a)(2) with respect to the NLEB fulfilled through this programmatic Biological Opinion.

2. Reporting
    a. For monitoring purposes, the Service will assume all activities are conducted as described. If an agency does not conduct an activity as described, it must promptly report and describe such departures to the appropriate Service Field Office.
    b. The action agency must provide the results of any surveys for the NLEB to the appropriate Service Field Office within their jurisdiction.
    c. Parties finding a dead, injured, or sick NLEB must promptly notify the appropriate Service Field Office.

If a Federal action agency chooses not to follow this framework, standard section 7 consultation procedures will apply.

Section 7(a)(1) of the Act directs Federal agencies, in consultation with and with the assistance of the Secretary (a function delegated to the Service), to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Service Headquarters provides to federal action agencies who choose to implement the framework described above several conservation recommendations for exercising their 7(a)(1) responsibility in this context. Conservation recommendations are discretionary federal agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. Service Headquarters recommends that the following conservation measures to all Federal agencies whose actions may affect the NLEB:

1. Perform NLEB surveys according to the most recent Range-wide Indiana Bat/NLEB Summer Survey Guidelines. Benefits from agencies voluntarily performing NLEB surveys include:
    a. Surveys will help federal agencies meet their responsibilities under section 7(a)(1) of the Act. The Service and partners will use the survey data to better understand habitat use and distribution of NLEB, track the status of the species, evaluate threats and impacts, and develop effective conservation and recovery actions. Active participation of federal agencies in survey efforts will lead to a more effective conservation strategy for the NLEB.
    b. Should the Service reclassify the species as endangered in the future, an agency with a good understanding of how the species uses habitat based on surveys within its action areas could inform greater flexibility under section 7(a)(2) of the Act. Such information could facilitate an expedited consultation and incidental take statement that may, for example, exempt taking associated with tree removal during the active season, but outside of the pup season, in known occupied habitat.
2. Apply additional voluntary conservation measures, where appropriate, to reduce the

impacts of activities on NLEBs. Conservation measures include:

a. Conduct tree removal activities outside of the NLEB pup season (June 1 to July 31) and/or the active season (April 1 to October 31). This will minimize impacts to pups at roosts not yet identified.
b. Avoid clearing suitable spring staging and fall swarming habitat within a 5-mile radius of known or assumed NLEB hibernacula during the staging and swarming seasons (April 1 to May 15 and August 15 to November 14, respectively).
c. Manage forests to ensure a continual supply of snags and other suitable maternity roost trees.
d. Conduct prescribed burns outside of the pup season (June 1 to July 31) and/or the active season (April 1 to October 31). Avoid high-intensity burns (causing tree scorch higher than NLEB roosting heights) during the summer maternity season to minimize direct impacts to NLEB.
e. Perform any bridge repair, retrofit, maintenance, and/or rehabilitation work outside of the NLEB active season (April 1 to October 31) in areas where NLEB are known to roost on bridges or where such use is likely.
f. Do not use military smoke and obscurants within forested suitable NLEB habitat during the pup season (June 1 to July 31) and/or the active season (April 1 to October 31).
g. Minimize use of herbicides and pesticides. If necessary, spot treatment is preferred over aerial application.
h. Evaluate the use of outdoor lighting during the active season and seek to minimize light pollution by angling lights downward or via other light minimization measures.
i. Participate in actions to manage and reduce the impacts of white-nose syndrome on NLEB. Actions needed to investigate and manage white-nose syndrome are described in a national plan the Service developed in coordination with other state and federal agencies (Service 2011).

1.4 ACTION AREA

The action area is defined as all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). In delineating the action area, we evaluated the farthest reaching physical, chemical, and biotic effects of the action on the environment.

The “Action Area” for this consultation includes the entire range of the NLEB within the United States, which includes all or portions of the following 37 States and the District of Columbia: Alabama, Arkansas, Connecticut, Delaware, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Vermont, Virginia, West Virginia, Wisconsin, and Wyoming. Within the Action Area, the WNS zone currently includes all or most of the states within the species' range except North Dakota, Montana, South Dakota, and Wyoming (Figure 1.1) (note: tables and figures for each major section of this BO appear at the end of the section). The WNS zone map is updated on the first of every month (http://www.fws.gov/midwest/endangered/mammals/nleb/pdf/WNSZone.pdf).

1.5 ACTIVITIES NOT EVALUATED IN THIS BIOLOGICAL OPINION

The following general categories of activities are prohibited under the final 4(d) rule within the WNS zone:

1. Activities resulting in the disruption or disturbance of NLEBs in their hibernacula.
2. Activities resulting in the physical or other alteration of a hibernaculum's entrance or its environment at any time of year.
3. Tree clearing activities within 0.25 miles of a known NLEB hibernaculum.
4. Tree clearing activities that result in cutting or destroying known, occupied maternity roost trees or any other trees within a 150 ft radius around the roost tree during the pup season (June 1 – July 31).

Separate project-specific section 7 consultation is required for these activities; therefore, they are not addressed further in this consultation.

1.6 TABLES AND FIGURES FOR DESCRIPTION OF THE ACTION

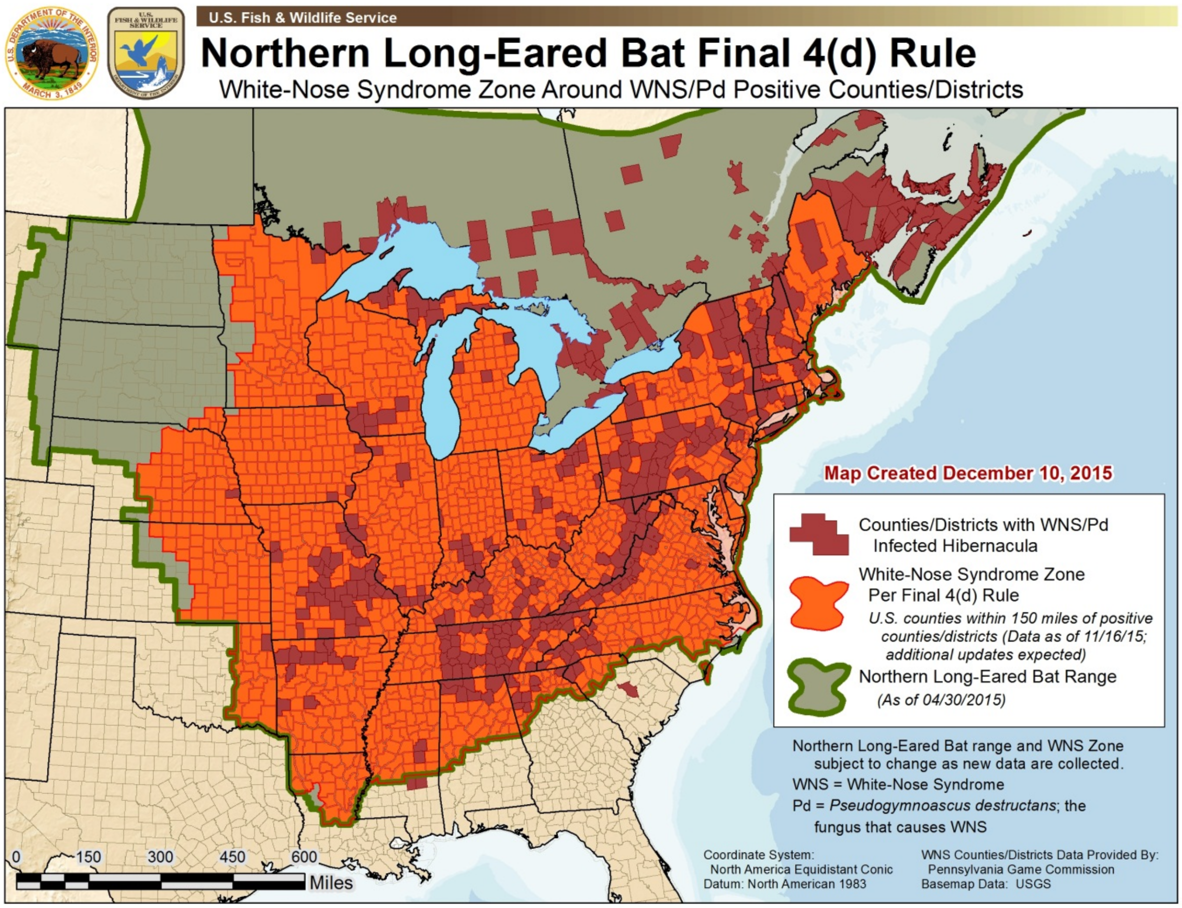

Figure 1.1. The NLEB WNS Zone around WNS/Pd positive counties or districts.

2 STATUS OF THE SPECIES/CRITICAL HABITAT

As described in Section 1, the Service listed the NLEB as a threatened species on April 2, 2015. The final rule determined that critical habitat designation for the NLEB was prudent, but not determinable at the time. The final listing rule describes the status of the species in detail and is hereby incorporated by reference. We summarize and paraphrase portions of the final rule in this section that are most relevant to an evaluation of the proposed Action. Additional information and citations can be found in the final listing rule.

2.1 SPECIES BACKGROUND & HABITAT

The NLEB is a temperate, insectivorous, migratory bat that hibernates in mines and caves in the winter and spends summers in wooded areas. The key stages in its annual cycle are: hibernation, spring staging and migration, pregnancy, lactation, volancy/weaning, fall migration and swarming. NLEB generally hibernate between mid-fall through mid-spring each year. The spring migration period likely runs from mid-March to mid-May each year, as females depart shortly after emerging from hibernation and are pregnant when they reach their summer area. Young are born between June and early July, with nursing continuing until weaning, which is shortly after young become volant (able to fly) in mid- to late-July. Fall migration likely occurs between mid-August and mid-October.

2.1.1 SUMMER HABITAT AND ECOLOGY

Suitable summer habitat for NLEB consists of a wide variety of forested/wooded habitats where they roost, forage, and travel and may also include some adjacent and interspersed non-forested habitats. This includes forests and woodlots containing potential roosts, as well as linear features such as fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure.

After hibernation ends in late March or early April (as late as May in some northern areas), most NLEB migrate to summer roosts. For purposes of this BO, we define the NLEB active season as the period between emergence and hibernation from April 1 – October 31. We recognize that the active season is variable across the action area depending on latitude, elevation, and weather conditions; however, we believe this range captures most of the period throughout the range in most years. The spring migration period typically runs from mid-March to mid-May (Caire et al. 1979; Easterla 1968; Whitaker and Mumford 2009). The NLEB is not considered to be a long distance migrant (typically 40-50 miles). Males and non-reproductive females may summer near hibernacula, or migrate to summer habitat some distance from their hibernaculum.

After emergence, female NLEBs actively form colonies in the summer (Foster and Kurta 1999) and exhibit fission-fusion behavior (Garroway and Broders 2007), where members frequently coalesce to form a group, but composition of the group is in flux (Barclay and Kurta 2007). As part of this behavior, NLEBs switch tree roosts often (Sasse and Pekins 1996), typically every 2 to 3 days (Foster and Kurta 1999; Owen et al. 2002; Carter and Feldhamer 2005; Timpone et al. 2010). NLEB maternity colonies range widely in size (reported range of 7 to 100; Owen et al. 2002; Whitaker and Mumford 2009), although about 30-60 may be most common (Whitaker and Mumford 2009; Caceres and Barclay 2000; Service 2014).

NLEBs show interannual fidelity to roost trees and/or maternity areas. They use networks of roost trees often centered around one or more central-node roost trees (Johnson et al. 2012) with multiple alternate roost trees. NLEB roost in cavities, underneath bark, crevices, or hollows of both live and dead trees and/or snags (typically ≥3 inches dbh). NLEB are known to use a wide variety of roost types, using tree species based on presence of cavities or crevices or presence of peeling bark. NLEBs have also been occasionally found roosting in structures like buildings, barns, sheds, houses, and bridges (Benedict and Howell 2008; Krochmal and Sparks 2007; Timpone et al. 2010; Service 2014).

Summer home range includes both roosting and foraging areas, and range size may vary by sex. Maternity roosting areas have been reported to vary from mean of 21 to 179 acres (Owen et al. 2003; Broders et al. 2006; Lacki et al. 2009) to a high of 425 acres (Lacki et al. 2009). Foraging areas are six or more times larger (Broders et al. 2006; Henderson and Broders 2008). The distance traveled between consecutive roosts varies widely from 20 ft (Foster and Kurta 1999) to 2.4 miles (Timpone et al. 2010). Likewise, the distance traveled between roost trees and foraging areas in telemetry studies varies widely, e.g., a mean of 1,975 ft (Sasse and Perkins 1996) and a mean of 3,609 ft (Henderson and Broders 2008). Circles with a radius of these distances have an area of 281 and 939 acres. Based on reported maximum individual home range (425 acres) and travel distances between roosts and foraging areas described above (939 acres), we use 1,000 acres for purposes of this BO as the area a colony uses. An analysis of mist net survey data in Kentucky (Service 2014, unpublished data cited in the final listing rule) shows that most males and non-reproductive females are captured in the same locations as reproductively active females, suggesting substantial overlap in the summer home range of reproductive females and other individuals (94%).

NLEBs are typically born in late-May or early June, with females giving birth to a single offspring. Lactation then lasts 3 to 5 weeks, with pups becoming volant between early July and early August. For purposes of this BO and the final 4(d) rule, we define the pup season (i.e., the period of non-volancy) as June 1 – July 31.

2.1.2 WINTER HABITAT AND ECOLOGY

Suitable winter habitat (hibernacula) includes underground caves and cave-like structures (e.g. abandoned or active mines, railroad tunnels). There may be other landscape features being used by NLEB during the winter that have yet to be documented. Generally, NLEB hibernate from October to April depending on local climate (November-December through March in southern areas with emergence as late as mid-May in some northern areas).

Hibernacula for NLEB typically have significant cracks and crevices for roosting; relatively constant, cool temperatures (0-9 degrees Celsius) and with high humidity and minimal air currents. Specific areas where they hibernate have very high humidity, so much so that droplets of water are often seen on their fur. Within hibernacula, surveyors find them in small crevices or cracks, often with only the nose and ears visible.

NLEB tend to roost singly or in small groups (Service 2014), with hibernating population sizes ranging from just a few individuals to around 1,000 (Service unpublished data). NLEB display more winter activity than other cave species, with individuals often moving between hibernacula throughout the winter (Griffin 1940; Whitaker and Rissler 1992; Caceres and Barclay 2000). NLEB have shown a high degree of philopatry (i.e., using the same site multiple years) to the hibernacula used, returning to the same hibernacula annually.

2.1.3 SPRING STAGING AND FALL SWARMING HABITAT AND ECOLOGY

Upon arrival at hibernacula in mid-August to mid-November, NLEB “swarm,” a behavior in which large numbers of bats fly in and out of cave entrances from dusk to dawn, while relatively few roost in caves during the day. Swarming continues for several weeks and mating occurs during the latter part of the period. After mating, females enter directly into hibernation but not necessarily at the same hibernaculum at which they had been mating. A majority of bats of both sexes hibernate by the end of November (by mid-October in northern areas).

Reproductively active females store sperm through the winter from autumn copulations. Ovulation takes place after the bats emerge from hibernation in spring. The period after hibernation and just before spring migration is typically referred to as “staging,” a time when bats forage and a limited amount of mating occurs. This period can be as short as a day for an individual, but not all bats emerge on the same day.

In general, NLEB use roosts in the spring and fall similar to those selected during the summer. Suitable spring staging/fall swarming habitat consists of the variety of forested/wooded habitats where they roost, forage, and travel, which is most typically within 5 miles of a hibernaculum.

2.2 DISTRIBUTION AND RANGE

The NLEB ranges across much of the eastern and north central United States, and all Canadian provinces west to the southern Yukon Territory and eastern British Columbia (Figure 2.1) (Nagorsen and Brigham 1993; Caceres and Pybus 1997; Environment Yukon 2011). In the United States, the species' range reaches 37 states from Maine west to Montana, south to eastern Kansas, eastern Oklahoma, Arkansas, and east to South Carolina (Whitaker and Hamilton 1998; Caceres and Barclay 2000; Amelon and Burhans 2006). Historically, the species has been most frequently observed in the northeastern United States and in Canadian Provinces, Quebec and Ontario. However, throughout the majority of the species' range it is patchily distributed, and historically was less common in the southern and western portions of the range than in the northern portion of the range (Amelon and Burhans 2006).

The U.S. portion of the NLEB's range is discussed in this BO in four parts: Eastern, Midwest, Southern, and Western. This is done solely for purposes of analysis and discussion; there is currently no indication that these are distinct populations. The Eastern range comprises Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and West Virginia. The Midwest range includes Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. The Southern range comprises Alabama, Arkansas, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, and Tennessee, and the Western range includes Kansas, Montana, Nebraska, North Dakota, South Dakota, and Wyoming.

Although NLEBs are typically found in low numbers in inconspicuous roosts, most records of NLEB are from winter hibernacula surveys (Caceres and Pybus 1997). There are currently 1,508 hibernacula known throughout the species' range in the United States (Table 2.1). The majority of the known hibernacula occur within the Eastern (39%) and the Midwest range (38), followed by 21 percent in the Southern range, and 2 percent in the Western range. Even prior to WNS, many hibernacula contained only a few (1 to 3) individuals (Whitaker and Hamilton 1998). There are likely many more unknown hibernacula.

There have also been many summer mist-net and acoustic surveys conducted within the range of the NLEB, but the surveys have not been complied into a central database across the species' range. The data is housed with the state natural resources programs, state natural heritage programs, or the local Service field offices. We are unable to report the total number of locations with NLEBs; however, we have compiled the total number of known maternity roost trees in each state (Table 2.1). There are 1,744 known maternity roost trees in 19 of 37 states, with 42% occurring in the Southern range, 30% in the Midwest, and 28% in the Eastern range. There are no known maternity roost trees in the Western range. There are limitations to these data because most states and natural heritage programs have not been tracking NLEB occurrences or individual roosts.

The current range and distribution of NLEB must be described and understood within the context of the impacts of WNS. Prior to the onset of WNS, the best available information on NLEB came primarily from surveys (primarily focused on Indiana bat or other bat species) and some targeted research projects. In these efforts, NLEB was very frequently encountered and was considered the most common myotid bat in many areas. Overall, the species was considered to be widespread and abundant throughout its historic range (Caceres and Barclay 2000). NLEBs continue to be distributed across much of the historical range, but there are many gaps within the range where bats are no longer detected or captured, and in other areas, their occurrence is sparse given local declines and extirpations.

2.3 STATUS AND THREATS

2.3.1 WHITE-NOSE SYNDROME

WNS is an emerging infectious wildlife disease caused by a fungus of European origin, Pd, which poses a considerable threat to hibernating bat species throughout North America, including the NLEB (Service 2011). WNS is responsible for unprecedented mortality of insectivorous bats in eastern North America (Blehert et al. 2009; Turner et al. 2011). No other threat is as severe and immediate for the NLEB as the disease WNS. There is no doubt that NLEB populations would be declining so dramatically without the impact of WNS. Since the disease was first observed in New York in 2007 (later biologists found evidence from 2006 photographs), WNS has spread rapidly in bat populations from the East to the Midwest and the South. As of November 2015, WNS or Pd was confirmed in 30 of the 37 states within the species' range (Figure 1.1; Table 2.2). Data support substantial declines in the Eastern range and portions of the Midwest range. In addition, there are apparent population declines at most hibernacula with WNS in the Southern range. We expect further declines as the disease continues to spread across the species' range.

Post-WNS hibernacula counts available from the northeast U.S. show the most substantial population declines for the NLEB. Turner et al. (2011) compared the most recent pre-WNS count to the most recent post-WNS count for six cave bat species and reported a 98 percent total decline in the number of hibernating NLEB at 30 hibernacula in New York, Pennsylvania, Vermont, Virginia, and West Virginia through 2011. For the final listing rule, the Service conducted an analysis of additional survey information at 103 sites across 12 U.S. States and Canadian provinces (New York, Pennsylvania, Vermont, West Virginia, Virginia, New Hampshire, Maryland, Connecticut, Massachusetts, North Carolina, New Jersey, and Quebec) and found comparable declines in winter colony size. At these sites, total NLEB counts declined by an average of 96 percent after the arrival of WNS; 68 percent of the sites declined to zero NLEB, and 92 percent of sites declined by more than 50 percent. Frick et al. (2015) consider the NLEB now extirpated from 69 percent of the hibernacula in Vermont, New York, Pennsylvania, Maryland, Virginia, and West Virginia that had colonies of NLEB prior to WNS. Langwig et al. (2012) reported that 14 populations of NLEB in New York, Vermont, and Connecticut became locally extinct within 2 years due to disease.

Long-term summer survey data (including pre- and post-WNS) for the NLEB, where available, corroborate the population decline evident in hibernacula survey data. For example, summer surveys from 2005 – 2011 near Surry Mountain Lake in New Hampshire showed a 98 percent decline in capture success of NLEB post-WNS, which is similar to the hibernacula data for the State (a 95 percent decline) (Moosman et al. 2013). Mist-netting data from Pennsylvania indicate that NLEB captures declined by 46 percent in 2011, 63 percent in 2012, 76 percent in 2013, and 94 percent in 2014, compared to the average pre-WNS capture rate between 2001 to 2007 (Butchkoski 2014; Pennsylvania Game Commission, unpublished data). The NLEB is more commonly encountered in summer mist-net surveys in the Midwest; however, similar rates of population decline are already occurring in Ohio and Illinois. Early reports also indicate declines in Missouri and Indiana (80 FR 17979-17980). Other data, much of it received as comments on the proposed listing rule from State wildlife agencies, demonstrate that various measures of summer NLEB abundance and relative abundance (mist net surveys, acoustic surveys) have declined following detection of WNS in the state.

Although the dispersal rate of Pd across the landscape and the onset of WNS after the fungus arrives at a new site are variable, it appears unlikely that any site within the range of the NLEB is not susceptible to WNS. Some evidence suggests that certain microclimatic conditions may hinder disease progression at some sites, but given sufficient exposure time, WNS has had similar impacts on NLEB everywhere the disease is documented. Absent direct evidence that some NLEB exposed to the fungus do not contract WNS, available information suggests that the disease will eventually spread throughout the species' range. As described in Section 1 of this BO, we anticipate that WNS will spread throughout the range of the NLEB by 2023-2028.

2.3.2 OTHER THREATS

Although significant NLEB population declines have only been documented due to the spread of WNS, other sources of mortality could further diminish the species' ability to persist as it experiences ongoing dramatic declines. The final listing rule for the NLEB describes known threats to the species under each of the five statutory factors for listing decisions, of which disease/predation, discussed above, is the dominant factor. We summarize here the findings of the final listing rule regarding the other four factors that are relevant to this consultation.

Human and non-human modification of hibernacula, particularly altering or closing hibernacula entrances, is considered the next greatest threat after WNS to the NLEB. Some modifications, e.g., closure of a cave entrance with structures/materials besides a bat-friendly gate, can cause a partial or complete loss of the utility of a site to serve as hibernaculum. Humans can also disturb hibernating bats, either directly or indirectly, resulting in an increase in energy-consuming arousal bouts during hibernation (Thomas 1995; Johnson et al. 1998).

During the summer, NLEB habitat loss is primarily due to forest conversion and forest management. Throughout the range of NLEB, forest conversion is expected to increase due to commercial and urban development, energy production and transmission, and natural changes. The 2010 Resources Planning Act Assessment projects forest losses of 16–34 million acres (or 4–8 percent of 2007 forest area) across the conterminous United States, and forest loss is expected to be concentrated in the southern United States, with losses of 9–21 million acres (USFS 2012). Forest conversion causes loss of potential habitat, fragmentation of remaining habitat, and if occupied at the time of the conversion, direct injury or mortality to individuals. Forest management activities, unlike forest conversion, typically result in temporary impacts to the habitat of NLEB, but like forest conversion, may also cause direct injury or mortality to individuals. The net effect of forest management may be positive, neutral, or negative, depending on the type, scale, and timing of various practices. The primary potential benefit of forest management to the species is perpetuating forests on the landscape that provide suitable roosting and foraging habitat.

Wind energy facilities are known to cause mortality of NLEB. While mortality estimates vary between sites and years, sustained mortality at particular facilities could cause declines in local populations. Wind energy development within portions of the species' range is projected to continue.

Climate change may also affect this species, as NLEB are particularly sensitive to changes in temperature, humidity, and precipitation. Climate change may indirectly affect the NLEB through changes in food availability and the timing of hibernation and reproductive cycles.

Environmental contaminants, in particular insecticides, other pesticides, and inorganic contaminants, such as mercury and lead, may also have detrimental effects on NLEB. Contaminants may bio-accumulate (become concentrated) in the tissues of bats, potentially leading to a myriad of sub-lethal and lethal effects. NLEBs may also be indirectly affected through a reduction in available insect prey.

Fire is one of the environmental stressors that contribute to the creation of snags and damaged trees on the landscape, which NLEB frequently use as summer roosts. Fire may also kill or injure bats, especially flightless pups. Prescribed burning is a common tool for forest management in many parts of the species' range.

There is currently no evidence that the natural or manmade factors discussed above (hibernacula modification, forest conversion, forest management, wind energy, climate change, contaminants, fire) have separately or cumulatively contributed to significant range-wide population effects on the NLEB prior to the onset of WNS. However, declines due to WNS have significantly reduced the number and size of NLEB populations in some areas of its range. This has reduced these populations to the extent that they may be increasingly vulnerable to other stressors that they may have previously had the ability to withstand. These impacts could potentially be seen on two levels. First, individual NLEB sickened or struggling with infection by WNS may be less able to survive other stressors. Second, NLEB populations impacted by WNS, with smaller numbers and reduced fitness among individuals, may be less able to recover making them more prone to extirpation. The status and potential for these impacts will vary across the range of the species.

2.4 POPULATION DYNAMICS

Hibernacula counts are generally the best census method for most bats that hibernate, because individuals are concentrated and relatively stationary. However, because the NLEB is difficult to detect in hibernacula, moves between hibernacula during the winter, and many hibernacula are likely not known, a range-wide population estimate for the species is not available. The NLEB is most widely dispersed on the landscape during the summer where it is most likely exposed, directly or indirectly (i.e., later in time), to the widely dispersed (i.e., not concentrated in a given area) activities that are excepted from take prohibitions under the 4(d) rule.

For purposes of this BO, we estimate NLEB numbers based on total forested acres in each state and assumptions about:

- state-specific occupancy rates;
- forested acres in each state;
- maternity colony home-range size;
- number of adult females per colony;
- overlap between adult male home range and maternity colony home range;
- overlap between maternity colonies; and
- landscape-scale adult sex ratio (we assume 1:1).

We explain these data and assumptions in the following sub-sections.

2.4.1 OCCUPANCY RATES

We requested summer survey results from the three most recent years available from our field offices to provide an estimate of recent occupancy rates. Field offices provided the total number of survey sites (typically mist-net surveys), by state and by year, and the number of sites that captured at least one NLEB. Occupancy rates were calculated using the proportion of sites occupied with NLEB from the total number of sites sampled (Table 2.3). Where no data were available, we used the post-WNS survey data provided by the Forest Service for National Forests within the respective state (Table 2.3). Some states have only 1 or 2 years of data, and others have 8 or more consecutive years of data. In most cases, the numbers and locations of these survey sites do not constitute a representative sample of the available forest habitat in each state. Regardless, the alternative to using these data is to consider the NLEB ubiquitous within forested habitat in each state, which would greatly overestimate occupancy. Instead, we use these data as the best available information from which to make inferences about the extent of NLEB occupancy in each state[2].

Table 2.2 identifies the years in which WNS was detected in the state. We compute pre- and post-WNS occupancy rates as the number of net sites with NLEB divided by the total number of bat capture sites in each state. We applied the occupancy rate listed in Table 2.3 to each state.

2.4.2 TOTAL FORESTED ACRES IN EACH STATE

We compiled the total forested acres for each state from the U.S. Forest Service's 2015 State and Private Forestry Fact sheets (available at http://stateforesters.org/regional-state). We assumed that all forested acres within each state are suitable for the NLEB, which probably overestimates habitat availability but it is not unreasonable given the NLEB's ability to use very small trees (≥ 3 in dbh). We could have estimated the amount of forest in each state in more detail, but our analysis of other factors unrelated to forest cover was limited to statewide data, so we used statewide data throughout the analysis for all factors.

[2] The occupancy data used in this analysis has many limitations and a substantial amount of uncertainty. Occupancy as used here is the proportion of suitable habitat that is likely to have NLEB present. This is sensitive to the accuracy of the suitable habitat data, the accuracy of the survey data used to estimate the occupancy, and biases in the survey data collection methodology. The definition of suitable habitat used for this analysis is necessarily very general (forested areas) to be applicable across the entire species range. The surveys used to generate the occupancy data were often very sparse and not designed for this purpose. Repurposing of the data may increase the effects of bias in distribution of sample points (in relation to both suitable habitat and bat distributions), sampling methodologies, and sampling timing. We believe that because much of the sampling was not targeted specifically at NLEB and often involves surveys for development or construction projects, survey locations are unlikely to be closely correlated to NLEB distributions, which may minimize the influence of some biases. However, the limitations of the available data and its biases are potentially significant to the occupancy estimates, and this creates uncertainty that we acknowledge. Given these factors, our estimates of population are meant as tool for assessing potential relative impact by providing a scale for comparison, not as a precise estimate of the northern long-eared bat populations.

Not every state is wholly within the range of the NLEB (Figure 2.1), and including the total forested acreage from states not fully within the species' range could greatly overestimate the population size. Therefore, we excluded states with less than 50% of its area within the species range, which eliminated Montana, Wyoming, Oklahoma, Louisiana, Alabama, Georgia, and South Carolina. The inclusion of the full states of Nebraska, Kansas, Mississippi, and North Carolina should compensate for any individuals not included in the excluded states. The list of states included, along with the total forested acres are reported in Table 2.4.

2.4.3 COLONY SIZE (NUMBERS OF BATS AND OCCUPIED AREA)

In addition to the occupancy rates described above, we rely in this BO primarily on colony characteristics reported in the literature to estimate state-wide bat numbers. NLEB colonies are comprised of variable numbers of adult females. Two important studies give a range of 30–60 adult females per colony (see Section 2.1.1). Given the number of colonies that a state likely supports (see Section 2.4.4) (see Section 2.4.4), we then estimate total NLEB numbers in the occupied available habitat using the number of females per colony and assuming a 1:1 adult female/adult male ratio and a maximum of 1 pup per female.

While colony sizes of 30-60 bats may be typical in areas unaffected by WNS, in areas with clear declines in bat populations, these estimates may no longer be appropriate. Declines in total population appear to exceed what could be explained by declines in occupancy rates alone. The total reproductive female population can be described as the product of the average colony size in females and the number of colonies:

[Total female reproductive population = Number of colonies * Mean females per colony] OR N=C*F

If the rate of total population decline exceeds the rate of decline in number of colonies (as described by declines in occupancy) there must also be an additional reduction in the average colony size as well.

Information about total population sizes or average colony sizes is not available on a wide scale. However, there are a few instances where we have obtained data that could be used to approximate rates of population decline without knowing the actual sizes of populations. In Pennsylvania, captures of bats per unit effort have been tracked for several years. Changes in this number of bats per unit effort captured across a wide area could be assumed to mirror changes in the total population for that area. So if the total population declined by 50%, we would expect to see a 50% decline in captures of bats per unit effort as well. The number of bats per unit effort in Pennsylvania declined to 22.3% of pre-WNS levels (averaging capture rates across 2012-2014). Over the same time period, occupancy declined 49.8%. Pre-WNS occupancy was 67.9% of suitable habitat, while the last three years of data indicate an occupancy rate of 33.8% of suitable habitat (0.338/0.679=0.498).

The change over time of the total female population is going to be a function of the change in the number of colonies and the change in the mean number of females per colony. Or, put another way, the change in females per colony over time can be described by the change in the number of colonies in relation to the change in total female population. So:

$N_t/N_0 = (C_t*F_t)/(C_0*F_0)$ OR $C_t = (N_t/N_0)*(C_0*F_0)/ F_t$ OR $C_t = (N_t/N_0)*C_0/(F_t/ F_0)$

Assuming changes in captures per unit effort is a good approximation for changes in the proportion of remaining bats, and using the decline in occupancy to represent the decline in the number of colonies, with a decline in occupancy of 49.8%, the average colony size is likely to have declined by 55% to approximately 20 bats per colony. (((0.223/1)*45)/(0.498)=20.2)

Similarly, Ohio has seen declines in captures per mist net site to 91.2% of pre-WNS levels, using the average of 2012-2014 rates. While likely to be less accurate to represent population declines than captures per unit effort, captures per mist net site may be a reasonable approximation for total population changes as well. Occupancy rates have been relatively stable in Ohio, increasing slightly from 39.6% over 2007-2010 to 42.1% over 2012-2014 (although with a large drop in 2014). Assuming the captures per mist net site is also a reasonable estimate of the rate of total population decline, a slightly increasing occupancy indicates that declines must be occurring within colonies. The average colony is likely to have declined 14%, to about 39 bats. (((0.912/1)*45)/(1.06) = 38.7)

WNS was first documented in Pennsylvania in 2008-2009 and in Ohio in 2010-2011 (Table 2.2). For the purposes of this BO, we assume that colonies are comprised of 20 females in all states where WNS was documented prior to the winter of 2010-2011 (Table 2.4). Rhode Island does not have any hibernacula; therefore, WNS has not been confirmed in the state. We assume that bats in summer habitat in Rhode Island have been affected by WNS in the surrounding states, and colonies are comprised of 20 females. For all states with WNS documented during or after the winter of 2010-2011, we assume colonies are comprised of 39 females. For states that do not have WNS (including states that have only documented Pd), we use 45 females per colony (the mid-point of the 30–60 range) as the basis for estimating bat numbers. For each colony present in a state, we assume a NLEB population is comprised of 20, 39, or 45 adult females and the same number of sympatric adult males and juveniles following parturition, depending on the status of WNS (Table 2.4).

As described in Section 2.1.1, we use 1,000 acres for purposes of this BO as the area a colony uses. Within this area, one or more members of a colony and sympatric adult males would likely appear in mist net or acoustic surveys. Such appearance is the basis for the occupancy rates we use to estimate the acreage of available forested habitat that NLEB may use during the active season in the states, which are given in Table 2.4.

Maternity roosting areas are a subset of the 1,000-acre colony size we use in this BO. As described above, Broders et al. (2006) and Henderson and Broders (2008) found that foraging areas were six or more times larger than maternity roosting areas. One sixth of our 1,000-acre colony size is 167 acres, which is within the range of other maternity roosting areas reported (Carter and Feldhamer 2005; Silvis et al. 2015). For purposes of this BO, we use a maternity roosting area of 167 acres. Table 2.5 shows our estimates of the percentage of each state that is used as maternity roost areas based on the number of expected colonies (Table 2.4) and 167 acres per colony.

2.4.4 OVERLAP

Lacking information about the degree of spatial overlap between NLEB maternity colonies, for this BO we assume that colonies do not overlap, e.g., we assume that 1,000 acres of occupied habitat supports one colony. Estimated or assumed occupancy rates in all of the states are all less than 70 percent (Table 2.3); therefore, it is unlikely that limited habitat availability would contribute to substantial colony-range overlap. If incorrect, the possible effect of this assumption is to underestimate the population size in each state (i.e., 1,000 acres supports more than 1 colony).

As described in Section 2.1.1, mist net survey data in Kentucky indicate substantial overlap in the summer home range of reproductive females and males and non-reproductive females (1,712 of 1,825 capture records, or 94 percent). The Service further analyzed this data to determine the percentage of capture locations for males and non-reproductive females that were not capture locations for reproductive female captures or within 3 miles of a reproductive female capture location (Service 2015b). Of 909 capture locations, 87 (9.57 percent) did not have reproductively active females and were more than 3 miles away from captures of reproductive females, suggesting a 100 – 9.57 = 90.43 percent overlap between the home range of individuals belonging to maternity colonies and other individuals. We lack state-specific information about the overlap between reproductively active females and other bats; therefore, for this BO, we assume the 90.43 percent overlap suggested by the Kentucky data. We multiply occupied forest acres by 0.9043 to compute the number of probable maternity colonies; e.g., 100,000 occupied acres × 0.9043 = 90,430 acres supporting 90,430 ÷ 1000 = 91 maternity colonies, rounding up any fractional remainder.

2.4.5 POPULATION ESTIMATES

Table 2.4 provides our estimates of the summer adult population size of NLEB in the 30 states included in the analysis. It relies on the total forested acres and the other assumptions described above; i.e., occupancy rates for each state in Table 2.3, 90.43 percent overlap between the range of males and maternity colonies, 1,000 acres per colony, no overlap between colonies, the number of adult females per colony (20, 39, or 45 depending on WNS), and a 1:1 male/female sex ratio. Here are example calculations for Iowa as reported in Table 2.4:

- 3,013,759 forested acres × 0.417 occupancy rate = 1,256,738 occupied acres;
- 1,256,738 occupied acres × 0.9043 overlap with males = 1,136,467 colony-occupied acres;
- 1,136,467 acres ÷ 1,000 acres per colony = 1,137 colonies;
- 1,137 colonies × 45 adult females per colony = 51,165 adult females; and
- 51,165 adult females + 1 adult male per female (or 51,165 adult males) = 102,330 total adults.

We estimate that the range-wide population of NLEBs is comprised of 6,546,718 adults based on these calculations and the assumption that the 30 states included in the analysis represent the range-wide population. Arkansas supports the largest population (863,850 adults; 13%), followed by Minnesota with 829,890 (13%). Delaware and Rhode Island support the smallest populations with 640 and 1,240 adults, respectively. Based on these estimates, the Midwest supports 43% of the total population followed by the Southern range (38%), the Eastern range (17%), and the Western range (2%).

It is likely that the state populations are overestimates in areas affected by WNS. We used the occupancy data from the last 3 years, but in nearly all WNS areas there is a clear downward trend and most data are at least a year old. Therefore, the occupation rates and resulting population estimates are likely lower in many areas.

2.5 ANALYSIS OF THE SPECIES/CRITICAL HABITAT LIKELY TO BE AFFECTED

As described in Section 1, the NLEB is likely to be adversely affected by the activities which are excepted from incidental take prohibitions in the final 4(d) rule. Many federally listed, proposed, and candidate species, and their designated or proposed critical habitats, occur within the Action Area for this consultation. However, the Service Headquarters has determined that the proposed action will have no effect on any other listed, proposed, or candidate species or designated or proposed critical habitats. The action is the Service’s finalization the 4(d) rule for the NLEB. It sets forth the prohibitions for take under section 9(a)(1) of the Act and the exceptions to those prohibitions. It does not alter in any way the consultation requirements under section 7(a)(2) of the Act. Although this BO provides a framework for streamlined section 7 consultation for federal actions that are consistent with the provisions of the 4(d) rule, the framework only applies to the NLEB. Federal agencies will still be required to consult on activities that may affect other listed species within the Action Area. Therefore, only the NLEB will be considered further in this BO.

2.6 TABLES AND FIGURES FOR STATUS OF THE SPECIES

Table 2.1. Known NLEB hibernacula and known maternity roosts trees by state.

Range	State	Known Hibernacula	Known Occupied Maternity Roost Trees
Midwest	Iowa	2	14
Midwest	Illinois	44	39
Midwest	Indiana	69	193
Midwest	Michigan	77	25
Midwest	Minnesota	15	102
Midwest	Missouri	269	58
Midwest	Ohio	32	4
Midwest	Wisconsin	67	84
Eastern	Connecticut	8	0
Eastern	Delaware	2	0
Eastern	Maine	3	0
Eastern	Maryland	8	0
Eastern	Massachusetts	7	16
Eastern	New Hampshire	11	0
Eastern	New Jersey	9	47
Eastern	New York	90	27
Eastern	Pennsylvania	322	157
Eastern	Rhode Island	0	0
Eastern	Vermont	16	0
Eastern	Virginia	11	12
Eastern	West Virginia	104	231
Southern	Alabama	11	0
Southern	Arkansas	77	310
Southern	Georgia	6	20
Southern	Kentucky	122	254
Southern	Louisiana	0	0
Southern	Mississippi	0	0
Southern	North Carolina	29	101
Southern	Oklahoma	9	0
Southern	South Carolina	3	0
Southern	Tennessee	61	50
Western	Kansas	1	0
Western	Montana	0	0
Western	Nebraska	2	0
Western	North Dakota	0	0
Western	South Dakota	21	0
Western	Wyoming	0	0
	Total	1,508	1,744

Table 2.2. White-nose syndrome (WNS) and *Pseudogymnoascus destructans* (Pd) occurrence in the 37 States.

REGION	STATE	WNS or Pd Present?	First Winter WNS Confirmed	Documented WNS Mortality in Bats?
Midwest	Iowa	Pd	Pd only (2011-2012)	No
Midwest	Illinois	WNS	2012-2013	Yes
Midwest	Indiana	WNS	2010-2011	Yes
Midwest	Michigan	WNS	2014-2015	Yes
Midwest	Minnesota	Pd	Pd only (2011-2012)	No
Midwest	Missouri	WNS	2011-2012	Yes
Midwest	Ohio	WNS	2010-2011	Yes
Midwest	Wisconsin	WNS	2013-2014	Yes
Eastern	Connecticut	WNS	2008-2009	Yes
Eastern	Delaware	WNS	2009-2010	Yes
Eastern	Maine	WNS	2010-2011	Yes
Eastern	Maryland	WNS	2009-2010	Yes
Eastern	Massachusetts	WNS	2007-2008	Yes
Eastern	New Hampshire	WNS	2008-2009	Yes
Eastern	New Jersey	WNS	2008-2009	Yes
Eastern	New York	WNS	2006-2007	Yes
Eastern	Pennsylvania	WNS	2008-2009	Yes
Eastern	Rhode Island	No	NA	NA
Eastern	Vermont	WNS	2007-2008	Yes
Eastern	Virginia	WNS	2008-2009	Yes
Eastern	West Virginia	WNS	2008-2009	Yes
Southern	Alabama	WNS	2011-2012	Yes
Southern	Arkansas	WNS	2013-2014	Yes
Southern	Georgia	WNS	2012-2013	Yes
Southern	Kentucky	WNS	2010-2011	Yes
Southern	Louisiana	No	NA	NA
Southern	Mississippi	Pd	Pd only (2013-2014)	No
Southern	North Carolina	WNS	2010-2011	Yes
Southern	Oklahoma	Pd	Pd only (2014-2015)	No
Southern	South Carolina	WNS	2012-2013	Yes
Southern	Tennessee	WNS	2009-2010	Yes
Western	Kansas	No	NA	NA
Western	Montana	No	NA	NA
Western	Nebraska	Pd	Pd only (2014-2015)	No
Western	North Dakota	No	NA	NA
Western	South Dakota	No	NA	NA
Western	Wyoming	No	NA	NA

Table 2.3. NLEB summer state-wide occupancy estimates, based on summer survey results.

Range	State	Description	Pre-WNS Years (Combined)		Pre-WNS Occupancy Rate	Sum of 3 Most Recent WNS Years	WNS Impacted Occupancy Rate	Occupancy Rate Used
Midwest	IA	Total Mist Net Sites	2009-2011	24		0		
		Sites with NLEB Captures		10	41.7%	0	N/A	41.7%
	IL	Total Mist Net Sites	2009-2011	40		0		
		Sites with NLEB Captures		25	62.5%	0	N/A	62.5%
	IN	Total Mist Net Sites				283		
		Sites with NLEB Captures			N/A	106	37.5%	37.5%
	MI	Total Mist Net Sites	2004-2014	149		0		
		Sites with NLEB Captures		47	31.5%	0	N/A	31.5%
	MN	Total Mist Net Sites	2013-2014	121		0		
		Sites with NLEB Captures		71	58.7%	0	N/A	58.7%
	MO	Total Mist Net Sites				42		
		Sites with NLEB Captures			N/A	11	26.2%	26.2%
	OH	Total Mist Net Sites	2007-2010	733		2485		
		Sites with NLEB Captures		290	39.6%	1046	42.1%	42.1%
	WI	Total Mist Net Sites				78		
		Sites with NLEB Captures			N/A	35	44.9%	44.9%
Eastern	CT[$]	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	9.4%
	DE^	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	5.0%	5.0%
	ME*	Total Acoustic Sites				180		
		Sites with NLEB Captures			N/A	17	9.4%	9.4%
	MD^	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	5.0%	5.0%
	MA*	Total Acoustic Sites				132		
		Sites with NLEB Captures			N/A	9	6.8%	6.8%
	NH[#]	Total Mist Net Sites	2002-2004	13		173		
		Sites with NLEB Captures		12	92.3%	17	9.8%	9.8%
	NJ	Total Mist Net Sites	1995-2008	132		25		
		Sites with NLEB Captures		89	67.4%	8	32.0%	32.0%
	NY[+#]	Total Mist Net Sites	2000-2005	56		45		
		Sites with NLEB Captures		39	69.6%	15	33.3%	33.3%
	PA	Total Mist Net Sites	2001-2007	1069		1469		
		Sites with NLEB Captures		726	67.9%	497	33.8%	33.8%
	RI[$]	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	9.4%
	VT[+#]	Total Mist Net Sites	2000-2005			12		
		Sites with NLEB Captures			See NY	3	25.0%	9.8%
	VA[#]	Total Mist Net Sites	2010	27		60		
		Sites with NLEB Captures		27	100.0%	29	48.3%	48.3%
	WV	Total Mist Net Sites	1997-2008	508		97		
		Sites with NLEB Captures		401	78.9%	52	53.6%	53.6%

Table 3.1. Continued.

Range	State	Description	Pre-WNS Years (Combined)		Pre-WNS Occupancy Rate	Sum of 3 Most Recent WNS Years	WNS Impacted Occupancy Rate	Occupancy Rate Used
Southern	AL[#]	Total Mist Net Sites	2001-2011	179		38		
		Sites with NLEB Captures		48	26.8%	13	34.2%	34.2%
	AR[#]	Total Mist Net Sites	2009-2013	568		95		
		Sites with NLEB Captures		399	70.2%	62	65.3%	65.3%
	GA[#]	Total Mist Net Sites	2001-2011	62		18		
		Sites with NLEB Captures		37	59.7%	10	55.6%	55.6%
	KY	Total Mist Net Sites	2005-2010	503		305		
		Sites with NLEB Captures		263	52.3%	124	40.7%	40.7%
	LA[$]	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	34.2%
	MS[$]	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	34.2%
	NC[#]	Total Mist Net Sites	2000-2012	244		35		
		Sites with NLEB Captures		199	81.6%	14	40.0%	40.0%
	OK	Total Mist Net Sites	2013-2015	28		0		
		Sites with NLEB Captures		13	46.4%	0	N/A	46.4%
	SC[$]	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	34.2%
	TN[#]	Total Mist Net Sites	2000-2008	221		90		
		Sites with NLEB Captures		153	69.2%	37	41.1%	41.1%
Western	KS[+]	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	22.5%
	MT[+]	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	22.5%
	NE[+]	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	22.5%
	ND[+]	Total Mist Net Sites	2009-2014	42		0		
		Sites with NLEB Captures		3	7.1%	0	N/A	22.5%
	SD[+]	Total Mist Net Sites	2003-2006	13		0		
		Sites with NLEB Captures		10	76.9%	0	N/A	22.5%
	WY[+]	Total Mist Net Sites	2010-2014	56		0		
		Sites with NLEB Captures		12	21.4%	0	N/A	22.5%

* Acoustic data used due to limited amount of mist net data

^ Statewide occupancy estimates from a more in-depth analysis used

[#] Based on data from National Forests in the state

[$] Data from nearby states used because statewide data was inadequate or unavailable

[+] Data from multiple states were aggregated due to small datasets

Table 2.4. NLEB adult summer population estimates for the 30 states included in analysis.

Region	State	Forested Acres	Percent Occupancy	Occupied Acres	Maternity Colonies	Maternity Colony Size	Adult Females	Total Adults	Total Pups
Midwest	Iowa	3,013,759	41.7%	1,256,738	1,137	45	51,165	102,330	51,165
Midwest	Illinois	4,847,480	62.5%	3,029,675	2,740	39	106,860	213,720	106,860
Midwest	Indiana	4,830,395	37.5%	1,811,398	1,639	39	63,921	127,842	63,921
Midwest	Michigan	20,127,048	31.5%	6,340,020	5,734	39	223,626	447,252	223,626
Midwest	Minnesota	17,370,394	58.7%	10,196,421	9,221	45	414,945	829,890	414,945
Midwest	Missouri	15,471,982	26.2%	4,053,659	3,666	39	142,974	285,948	142,974
Midwest	Ohio	8,088,277	42.1%	3,405,165	3,080	39	120,120	240,240	120,120
Midwest	Wisconsin	16,980,084	44.9%	7,624,058	6,895	39	268,905	537,810	268,905
Eastern	Connecticut	1,711,749	9.4%	160,904	146	20	2,920	5,840	2,920
Eastern	Delaware	339,520	5.0%	16,976	16	20	320	640	320
Eastern	Maine	17,660,246	9.4%	1,660,063	1,502	39	58,578	117,156	58,578
Eastern	Maryland	2,460,652	5.0%	123,033	112	20	2,240	4,480	2,240
Eastern	Massachusetts	3,024,092	6.8%	205,638	186	20	3,720	7,440	3,720
Eastern	New Hampshire	4,832,408	9.8%	473,576	429	20	8,580	17,160	8,580
Eastern	New Jersey	1,963,561	32.0%	628,340	569	20	11,380	22,760	11,380
Eastern	New York	18,966,416	33.3%	6,315,817	5,712	20	114,240	228,480	114,240
Eastern	Pennsylvania	16,781,960	33.8%	5,672,302	5,130	20	102,600	205,200	102,600
Eastern	Rhode Island	359,519	9.4%	33,795	31	20	620	1,240	620
Eastern	Vermont	4,591,280	9.8%	449,945	407	20	8,140	16,280	8,140
Eastern	Virginia	15,907,041	48.3%	7,683,101	6,948	20	138,960	277,920	138,960
Eastern	West Virginia	12,154,471	53.6%	6,514,796	5,892	20	117,840	235,680	117,840
Southern	Arkansas	18,754,916	65.3%	12,246,960	11,075	39	431,925	863,850	431,925
Southern	Kentucky	12,471,762	40.7%	5,076,007	4,591	39	179,049	358,098	179,049
Southern	Mississippi	19,541,284	34.2%	6,683,119	6,044	45	271,980	543,960	271,980
Southern	North Carolina	18,587,540	40.0%	7,435,016	6,724	39	262,236	524,472	262,236
Southern	Tennessee	13,941,333	41.1%	5,729,888	5,182	20	103,640	207,280	103,640
Western	Kansas	2,502,434	22.5%	563,048	510	45	22,950	45,900	22,950
Western	Nebraska	1,576,174	22.5%	354,639	321	45	14,445	28,890	14,445
Western	North Dakota	759,998	22.5%	171,000	155	45	6,975	13,950	6,975
Western	South Dakota	1,910,934	22.5%	429,960	389	45	17,505	35,010	17,505
	Total	281,528,709	37.8%	106,345,057	96,183		3,273,359	6,546,718	3,273,359

Table 2.5. Estimated acreage of NLEB maternity roosting areas for the 30 states included in analysis.

Region	State	Forested Acres	Maternity Colonies[1]	Maternity Roost Area Acres (167 acres per Colony)	Percent of Forest Habitat Used as Maternity Roost Areas
Midwest	Iowa	3,013,759	1,137	189,879	6.30%
Midwest	Illinois	4,847,480	2,740	457,580	9.44%
Midwest	Indiana	4,830,395	1,639	273,713	5.67%
Midwest	Michigan	20,127,048	5,734	957,578	4.76%
Midwest	Minnesota	17,370,394	9,221	1,539,907	8.87%
Midwest	Missouri	15,471,982	3,666	612,222	3.96%
Midwest	Ohio	8,088,277	3,080	514,360	6.36%
Midwest	Wisconsin	16,980,084	6,895	1,151,465	6.78%
Eastern	Connecticut	1,711,749	146	24,382	1.42%
Eastern	Delaware	339,520	16	2,672	0.79%
Eastern	Maine	17,660,246	1,502	250,834	1.42%
Eastern	Maryland	2,460,652	112	18,704	0.76%
Eastern	Massachusetts	3,024,092	186	31,062	1.03%
Eastern	New Hampshire	4,832,408	429	71,643	1.48%
Eastern	New Jersey	1,963,561	569	95,023	4.84%
Eastern	New York	18,966,416	5,712	953,904	5.03%
Eastern	Pennsylvania	16,781,960	5,130	856,710	5.10%
Eastern	Rhode Island	359,519	31	5,177	1.44%
Eastern	Vermont	4,591,280	407	67,969	1.48%
Eastern	Virginia	15,907,041	6,948	1,160,316	7.29%
Eastern	West Virginia	12,154,471	5,892	983,964	8.10%
Southern	Arkansas	18,754,916	11,075	1,849,525	9.86%
Southern	Kentucky	12,471,762	4,591	766,697	6.15%
Southern	Mississippi	19,541,284	6,044	1,009,348	5.17%
Southern	North Carolina	18,587,540	6,724	1,122,908	6.04%
Southern	Tennessee	13,941,333	5,182	865,394	6.21%
Western	Kansas	2,502,434	510	85,170	3.40%
Western	Nebraska	1,576,174	321	53,607	3.40%
Western	North Dakota	759,998	155	25,885	3.41%
Western	South Dakota	1,910,934	389	64,963	3.40%
	Total	281,528,709	96,183	16,062,561	5.71%

[1] From Table 2.4

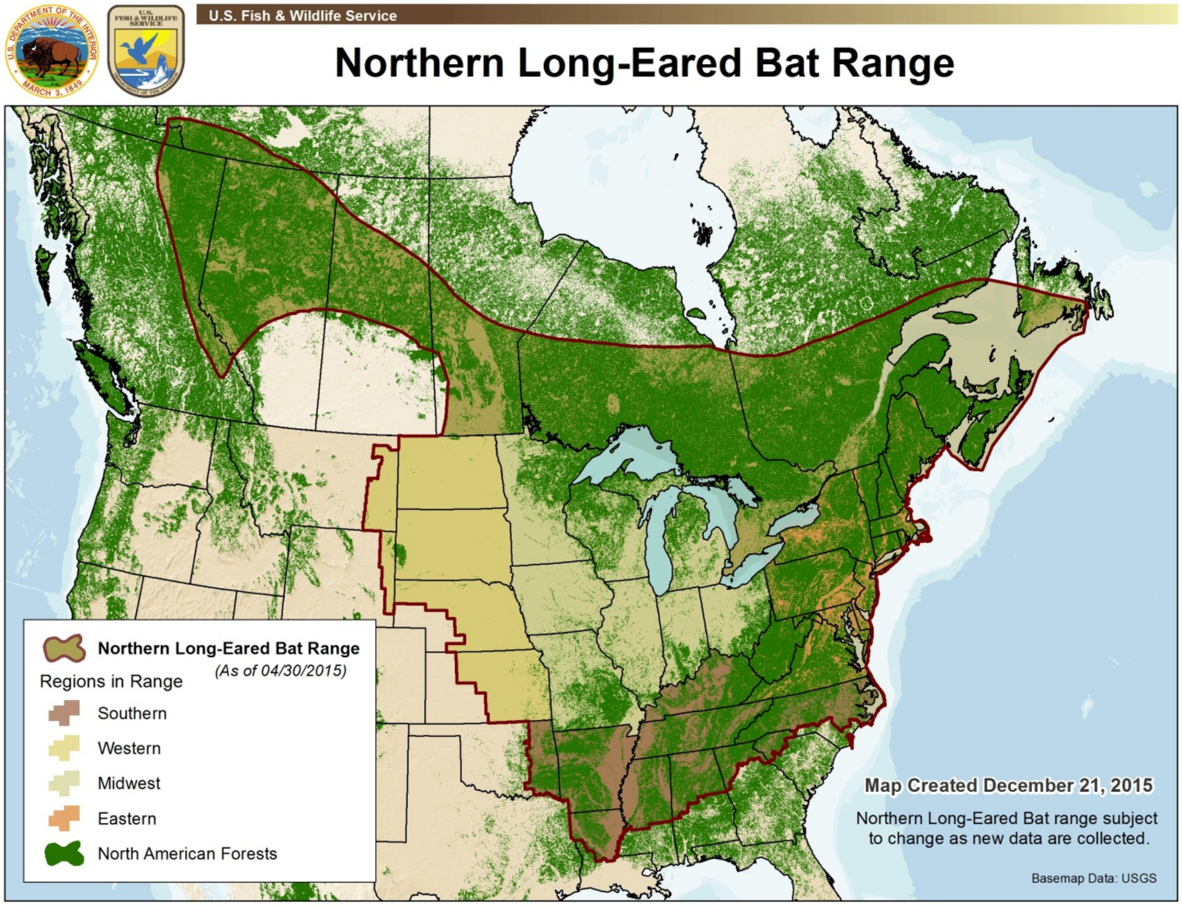

Figure 2.1. Range of the NLEB.

3 ENVIRONMENTAL BASELINE

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the Action Area. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the Action Area that have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress. The environmental baseline is a “snapshot” of the species’ health in the Action Area at the time of the consultation, and does not include the effects of the action under review.

Because the Action Area covers the entire range of the species within the United States, the environmental baseline is the same as the status of the species discussed in detail in Section 2. No further discussion is needed in this section.

4 EFFECTS OF THE ACTION

This section addresses the direct and indirect effects of the Action on the NLEB, including the effects of interrelated and interdependent activities. Direct effects are caused by the action and occur at the same time and place. Indirect effects are caused by the proposed action and are later in time but still are reasonably certain to occur.

The NLEB is likely to be affected by many activities which are excepted from incidental take prohibitions in the final 4(d) rule. Instead of describing all of the activities, we address the general effects of different activities, which we categorized into 7 general groups:

1. Capture and handling of NLEBs by individuals with section 10(a)(1)(A) permits for other listed bats or State permits until May 3, 2016
2. Removal from human structures
3. Timber harvest
4. Prescribed fire
5. Forest conversion
6. Wind turbine operation
7. Other activities that may affect the NLEB

The effects of category #1 are not addressed in this consultation because a separate section 10(a)(1)(A) permit and section 7 consultation will be required for those activities after May 3, 2016, as required by the final 4(d) rule. Until that time, we expect limited effects because NLEBs are currently hibernating and most surveys are conducted during the summer. Winter hibernacula surveys could affect the NLEB until May 3, 2016; however, researchers conducting winter surveys must have a section 10(a)(1)(A) permit for other listed bat species. The Service completed three BOs for the effects of existing bat section 10(a)(1)(A) permits on the NLEB in the Midwest, Mountain/Prairie and Southeast Regions. The adverse effects from winter hibernacula surveys are addressed in those BOs, which were non-jeopardy opinions.

The final 4(d) rule does not prohibit incidental take outside of the WNS zone. This effects analysis does not address the differences in prohibitions outside of the WNS zone because current actions that may affect the NLEB have not been shown to have significant impacts on NLEBs before WNS was detected. We expect that the impacts will be further reduced in the areas outside of the WNS zone because less than 2% of the total estimated population of NLEB occurs in the areas outside of the WNS zone (Section 2.4.5), and the habitat is more sparse (Figure 2.1). In addition, we anticipate that the WNS zone will expand further into the western states fairly quickly. Therefore, we did not attempt to analyze the different prohibitions between the zones.

4.1 EFFECTS ANALYSIS METHODOLOGY

For each of the remaining six categories of activities described above, we apply the following steps to analyze effects at the programmatic level:

- **Effects of the Activity –** We review best available science and commercial information about how the activity may affect the NLEB. Based on the literature review, we identify the stressor(s) (alteration of the environment that is relevant to the species) that may result from the proposed activity. For each stressor, we identify the circumstances for an individual bat's exposure to the stressor (overlap in time and space between the stressor and a NLEB). Given exposure, we identify the likely individual response(s), both positive and negative. For this consultation, we group responses into one of four categories: (1) potentially increased fitness (e.g., increased access to, or availability of, prey organisms); (2) reduced fitness (e.g., reduced food resources, reduced suitable roosting sites); (3) disturbance (e.g., day-time disturbance in a maternity roosting area, causing bats to flee and increasing the likelihood of injury or predation); and (4) harm (e.g., harvesting a tree occupied by adults and flightless bat pups resulting in death or injury; predation resulting from disturbance). This analysis is captured in the Exposure-Response Table (Table 4.1). This table provides the complete record of the effects analysis for this species and is intended to be read in concert with and support this effects analysis section.
- **Quantifying Effects to Individuals –** Estimating the numbers of individuals of a species exposed to stressors in a programmatic consultation is difficult because programs do not usually specify with sufficient detail when and where projects will occur relative to the species' occurrence. For this consultation, we have very little site-specific data about NLEB distribution and abundance in the Action Area; however, we do not assume that the species is ubiquitous, which would grossly overestimate effects. We do not have

enough information to quantify the effects of the pathways associated with removal from human structures and the “other” category of activities that may affect the NLEB. These effects are discussed in general in the sections below. For pathways associated with timber harvest, prescribed fire, and forest conversion, we apply the annual average acreage of the activity, NLEB occupancy rates, and NLEB density within occupied areas to estimate individual-level effects (numbers of individual bats included in the pathway), which we describe in Section 4.1.2.2 below. For wind turbine operation, we estimate the number of bats that could be killed using the current and projected amount of wind energy development and information on bat mortality rates, which we describe in Section 4.1.5.2 below.

We then aggregate all of the effects to individuals and examine:

- **Population-level Effects –** We evaluate the aggregated consequences of the effects to individuals/habitat on the fitness of the population(s) to which those individuals belong. This step closes with our conclusions on the likely fate or ultimate response of the population(s) and is couched in terms of population fitness (i.e., persistence and reproductive potential, long and short-term).
- **Species Range-wide** - This step determines whether the anticipated reductions in population fitness will reduce the likelihood of survival and recovery of the species by reducing its range-wide reproduction, numbers, or distribution (RND). If the Service and other action agencies have insured that the population-level risks do not noticeably, detectably, or perceivably reduce the likelihood of progressing towards or maintaining the RND needs, then the action is not likely to appreciably reduce the likelihood of both survival and recovery of the species.

4.2 REMOVAL FROM HUMAN STRUCTURES

4.2.1 EFFECTS OF REMOVAL FROM HUMAN STRUCTURES

As described in Section 2.1.1., NLEBs have occasionally been found roosting in human structures such as barns, houses, and sheds. Humans and bats often conflict when bats roost in human structures. Public misconception and health concerns from rabies, bat droppings, and urine often result in the need to remove bats from human structures. Many techniques used to remove bats are harmful and may result in mortality, including poisoning, trapping (e.g., cages, sticky traps), exterminating, and translocating (WNS Conservation and Recovery Working Group 2015). Bats can also be removed through humane methods (if used during the proper time of year) such as eviction/venting and exclusion. Eviction/venting refers to the use of one-way doors and exits to remove bats from a structure by utilizing their natural tendency to leave the roost at night. Exclusion refers to closing gaps and sealing holes to prevent bats from entering or re-entering a structure (WNS Conservation and Recovery Working Group 2015). Eviction and exclusion are widely-used, popular methods because poisons and traps are messy and might result in dead bats rotting in walls and attics.

Table 4.1 shows the four pathways we identified for NLEB responses to removal from human structures and the range of individual responses expected. The use of rodenticides and sticky traps to remove bats is likely to result in mortality. NLEBs may also be euthanized for rabies testing. Roost closure during the maternity season has been documented to result in lower reproductive success (Brigham and Fenton 1986). Attempts to evict or exclude bats at this time can result in the death of flightless young, as well as an increase in the number of adult bats and orphaned pups that enter the living space, potentially heightening the risk of human/bat contact (WNS Conservation and Recovery Working Group 2015). In addition, NLEBs can be indirectly affected through the loss of the roost by exclusion if additional energy is required during their search for a new roost site when NLEBs return to the site after hibernation.

The WNS Conservation and Recovery Group, in coordination with states and wildlife control operators, recently developed Best Management Practices (BMPs) for bat control activities in human structures (WNS Conservation and Recovery Working Group 2015) to ensure that adverse effects are minimized. The National Wildlife Control Operators Association recently released a new training on bat standards, affecting at least 48 wildlife control operators in 20 States within the NLEB range that are Certified Wildlife Control Professionals. This certification requires training, seminars, and continued education, and we anticipate that these professionals (and probably others) will follow the bat standards.

States within the range of the NLEB vary in requirements for removal of bats from human structures. States with state- or federally-listed bat species may require permits for bat removal or may require wildlife control operators to use BMPs when removing or excluding bats from houses or structures. Within the range of the NLEB, only Maine, Montana, and the Dakotas do not have another state- or federally-listed bat species, so it is likely that many of these states already have a program to recommend or require BMPs for bat removal prior to the NLEB listing in 2014. We surveyed states to determine if: (1) wildlife control operators are required to obtain authorization for bat removal or exclusions; (2) BMPs are required or recommended; and (3) exclusions and evictions are conducted outside of the NLEB maternity season.

We were able to speak with representatives from state natural resource programs in Illinois, Wisconsin, Michigan, Missouri, Minnesota, Ohio, Vermont, and South Carolina. Five of the eight states require authorization for wildlife control operators to remove or exclude bats from buildings. Of these five states, all but Michigan require that evictions and exclusion occur after NLEB pups are capable of flight, unless in the unusual case of a severe health hazard. Even though three states do not require authorization for wildlife control operators, only two states

(Missouri and Michigan) do not communicate or recommend BMPs for bat exclusion or removals.

We also obtained rabies testing data from the state health departments in New York and Missouri. If a single or pair of bats enter a household, wildlife control operators generally trap the bats and euthanize them for rabies testing. These data indicate that an average of 7 NLEBs were killed per year for rabies testing during the most recent three years. In both New York and Missouri, NLEB make up a small fraction (typically less than 2%) of the bats in houses.

Although removal from human structures can result in NLEB mortality, we anticipate that few bats are impacted per year in each state based on the relatively rare use of human structures, the implementation of bat removal BMPs (either required or recommended) throughout most of the range of the NLEB, and the relatively small amount of NLEBs killed for rabies testing.

4.3 TIMBER HARVEST

Timber harvest is one of two categories of forest management described in this BO. Unlike forest conversion, forest management maintains forest habitat on the landscape, and the impacts from management activities are for the most part considered temporary in nature. Impacts from forest management are expected to range from positive (e.g., maintaining or increasing suitable roosting and foraging habitat within NLEB home ranges) to neutral (e.g., minor amounts forest removal, areas outside NLEB summer home ranges or away from hibernacula) to negative (e.g., death of adult females or pups or both).

Timber harvest is the removal of trees associated with forest management. It includes a wide variety of practices from selected harvest of individual trees to clearcutting. Timber harvest is often partitioned according to the forest management treatment type used to accomplish the harvest: even-aged management; uneven-aged management; thinning; and salvage/sanitation. It is conducted for a variety of purposes including, but not limited to, harvests (commercial and non-commercial) for timber production and for ecosystem restoration, endangered/threatened/sensitive species conservation, stand regeneration for forest health, wildlife habitat improvement, insect and disease control, and fuel reduction. All of these activities are categorized under the general category of timber harvest for the purposes of this BO.

4.3.1 EFFECTS OF TIMBER HARVEST

<u>Literature Review</u>

The best available data indicate that the NLEB shows a varied degree of sensitivity to timber-harvesting practices. Menzel et al. (2002) found NLEB roosting in intensively managed stands in West Virginia. At the same study site, Owen et al. (2002) concluded that NLEB roosted in areas with abundant snags, and that in intensively managed forests of the central Appalachians, roost availability was not a limiting factor. Perry and Thill (2007) tracked NLEB in central Arkansas and found roosts in eight different forest classes, of which 89 percent were in three classes of mixed pine-hardwood forest. The mixed pine-hardwood forest stands that supported most of the roosts were partially harvested or thinned, unharvested (50–99 years old), or harvested by group selection.

Timber harvest accomplished through thinning, group selection, and individual selection may create canopy openings in an otherwise densely-forested setting, which may promote more rapid development of bat pups. In central Arkansas, Perry and Thill (2007) found female NLEB bat roosts were more often located in areas with partial harvesting than males, with more male roosts (42 percent) in un-harvested stands than female roosts (24 percent). They postulated that females roosted in relatively more open forest conditions because they may receive greater solar radiation, which may increase developmental rates of young or permit young bats a greater opportunity to conduct successful initial flights (Perry and Thill 2007). Cryan et al. (2001) found several reproductive and non-reproductive female NLEB roosts in recently harvested (less than 5 years) stands in the Black Hills of South Dakota where snags and small stems (dbh of 5 to 15 cm (2 to 6 inches)) were the only trees left standing. In this study, however, the largest colony (n=41) was found in a mature forest stand that had not been harvested in more than 50 years. Lacki and Schwierjohann (2001) stated that silvicultural practices could meet both male and female roosting requirements by maintaining large-diameter snags, while allowing for regeneration of forests.

Forest patch size and contiguity are factors that appear to influence habitat use by NLEB. Henderson et al. (2008) observed gender-based differences in mist-net capture rates of NLEB on Prince Edward Island related to forest patch size. The area of deciduous stands had a consistent positive relationship with the probability of presence of both males and females, but males were found more often in smaller stands than females. In southeastern Missouri, Yates and Muzika (2006) reported that NLEB showed a preference for contiguous tracts of forest cover (rather than fragmented or open landscapes) for foraging or traveling, and that different forest types interspersed on the landscape increased the likelihood of occupancy.

In West Virginia, Owen et al. (2003) radio-tracked nine female NLEB that spent their foraging and travelling time in the following habitat types (in descending order of use):

- 70–90-year-old stands without harvests in more than 10–15 years (“intact forest”) (mean use 52.4 percent);

- 70–90 year-old stands with 30–40 percent of basal area removed in the past 10 years (“diameter-limit harvests”) (mean use 42.9 percent);
- open areas (clearcuts and roads) (clear cut = all trees > 2.5 cm (1.0 inch) dbh removed) (mean use 4.6 percent); and
- clearcuts with approximately 4.5 m^2/ha (19.6 ft^2/acre) tree basal area remaining (“deferment harvests”) (mean use 0.03 percent).

Habitat selection differed significantly relative to habitat availability, with diameter-limit harvests ranking as the strongest habitat preference, where percent use exceeded percent availability for 7 of the 9 bats.

In Alberta, Canada, NLEB avoided the center of clearcuts and foraged more in intact forest than expected (Patriquin and Barclay 2003). On Prince Edward Island, Canada, female NLEB preferred to forage in areas centered along creeks running through forests (Henderson and Broders 2008). In mature forests on the Sumter National Forest in northwestern South Carolina, 10 of the 11 stands in which NLEB were detected were mature stands (Loeb and O’Keefe 2006). Within those mature stands, NLEB were recorded more often at points with sparse or medium-density vegetation than at points with dense vegetation, suggesting that small openings within forest stands facilitate commuting and/or provide suitable foraging habitat. However, in southwestern North Carolina, Loeb and O’Keefe (2011) found that NLEB rarely used forest openings, but often used roads.

At Fort Knox in Kentucky, Silvis et al. (2014) tracked three maternity colonies of NLEB to evaluate their social and resource networks, i.e., roost trees. Roost and social network structure differed between maternity colonies, and roost availability was not strongly related to network characteristics or space use. In model simulations based on the tracking data, removal of more than 20 percent of roosts initiated social network fragmentation, with greater loss causing more fragmentation. The authors suggested that flexible social dynamics and tolerance of roost loss are adaptive strategies for coping with ephemeral conditions in dynamic forest habitats. Sociality among bats may contribute to reproductive success, and fragmented colonies may experience reduced success.

In the same Fort Knox study area with the same three maternity colonies, Silvis et al. (2015) removed during winter a primary maternity roost tree from one colony, 24 percent of the secondary roosts from another colony, and none from the third. Neither removal treatment altered the number of roosts used by individual bats, but secondary roost removal doubled the distances moved between sequentially used roosts. Overall location and spatial size of colonies was similar pre- and post-treatment. Patterns of roost use before and after removal treatments also were similar. Roost height, diameter at breast height, percent canopy openness, and roost species composition were similar pre- and post-treatment. NLEB use a wide range of tree species and sizes as roosts, and potential roosts were not limited in the treatment areas.

Although the literature we reviewed contains no reports of NLEB mortality resulting from tree harvest, there have been three documented instances of Indiana bat adults and pups killed or injured when an occupied roost tree was felled. Indiana bats and NLEB are closely related and have similar behavior (i.e., forest-dwelling, forming maternity colonies, roosting in trees in the summer). Cope et al. (1974) reported the first felling of an occupied Indiana bat maternity roost tree in Wayne County, Indiana. The landowner observed bats exiting the tree when it was bulldozed down. The original account stated that eight bats (2 adult females and 6 juveniles) were "captured and identified as Indiana bats," and that about 50 bats flew from the tree. Although the original account did not specify how the eight bats were captured, J. Whitaker (Indiana State University, pers. comm., 2005) recounted that those bats were killed or disabled, retrieved by the landowner, and subsequently identified by a biologist. In another case, Belwood (2002) reported on the felling of a dead maple in a residential lawn in Ohio. One dead adult female and 33 non-volant young were retrieved by the researcher. Three of the young bats were already dead when they were picked up, and two more died subsequently. The rest were apparently retrieved by adult bats that had survived. In a third case, 11 dead adult female Indiana bats were retrieved (by people) when their roost was felled in Knox County, Indiana (J. Whitaker, pers. comm., 2005).

These accounts suggest that some individuals, including non-volant pups, can survive the felling of a maternity roost tree. It is not possible to infer injury rates from these studies. It is only possible to crudely estimate mortality rates from the Belwood case. If we assume that there were 66 individuals in the tree (the 33 pups observed plus 1 dead adult female and 32 presumed additional adult females who retrieved their pups), the overall survival rate was high at 91%. Only 1 adult bat was observed dead (about 3% of adults), and the juvenile mortality rate was about 15%. We acknowledge that timber harvest operations in a forest bear little resemblance to these three instances, but available evidence indicates that both adults and pups can be killed when an occupied roost tree is felled. For the purposes of this consultation, we assume that 15% of non-volant bats have the potential to be harmed, and 3% of adult bats could be killed or injured in a felled tree. Adults may be at greater risk during the spring during colder temperatures and increased use of torpor. It is also possible that trees felled adjacent to roost trees could strike roosting bats and result in injury or death.

Disturbance associated with harvest activity could cause NLEB to flee or abandon day-time roosts, which increases the likelihood of predation. This may also result in females aborting or not being impregnated depending on the time of year. Gardner et al. (1991) reported that Indiana bats continued to roost and forage in an area with active timber harvest, but this will depend on the scale of harvest and whether there is any remaining suitable habitat. Callahan (1993) attributed the abandonment of a primary maternity roost tree to disturbance from a bulldozer clearing brush adjacent to the tree.

Surface-disturbing activities in the vicinity of hibernacula may affect bat populations if those activities result in changes to the microclimate (temperature, humidity, and air flow) of the cave or mine (Ellison et al. 2003). Tree removal in karst areas can alter soil characteristics, water quality, local hydrology to the extent that it alters cave microclimates and affects bats (Bilecki 2003, Hamilton-Smith 2001). Bats in hibernation are susceptible to dehydration due to high evaporative loss from their naked wings and large lungs (Perry 2013). Richter et al. (1993) documented temperature increases resulting from structural modifications to a cave entrance that substantially reduced its suitability for bats. The creation of new openings or filling in existing openings could also result from obstructing cave entrances with dirt or logging slash.

Summary of Exposure-Response Table

Table 4.1 shows the five pathways we identified for NLEB responses to timber harvest and the range of individual responses expected. The primary alteration of the environment associated with timber harvest that is relevant to the NLEB is the removal of trees that provide roosts or serve as foraging, spring staging, or fall swarming habitat. Removing occupied trees is likely to kill or injure pups and adults. Loss of forest habitat decreases opportunities for growth and successful reproduction. Alteration of hibernacula can harm NLEBs. The disturbance (noise, exhaust from machinery, etc.) that accompanies harvest activities may result in disturbance because fleeing during daylight increases the likelihood of predation. A small subset of disturbed individuals may be harmed. Thinning mid-story clutter may have a beneficial effect on the suitability of adjacent maternity roost trees when done when bats are not present. The species' responses to these stressors depends on the type of harvest (e.g., thinning, salvage, even-aged management, clear cut, etc.) and the context of exposure, i.e., when and where it occurs.

4.3.2 METHODOLOGY FOR QUANTIFYING EFFECTS OF TIMBER HARVEST

To estimate the potential impacts of timber harvest through 2022, we calculated the average annual amount of timber harvest in states within the NLEB's range using data available through the USDA Forest Service's Forest Inventory Analysis (available only on internet: http://apps.fs.fed.us/Evalidator/evalidator.jsp; accessed November 2015). This database reports the total harvest (acres) of federal, state and local, and private entities by state for various combinations of years. We used the most recent combination of years available and calculated the mean annual harvest (Table 4.2). We assumed that the mean annual harvest from recent years will be consistent through the period of this consultation and recognize that many types of harvest leave a remaining forest that is available for NLEB use. The information in this database may be overestimated for certain states and underestimated for others. For instance, we estimated that 163,971 acres would be harvested on average in National Forests in South Dakota; however, the U.S. Forest Service is currently projecting up 35,000 acres of harvest annually. In Illinois, the database reports 0 acres of harvest, but the Forest Service projects 1,300 acres of average annual harvest.

Similar to the population estimation methods in Section 2.4.2, we excluded a state from our analyses if less than 50% of it is within the NLEB range. These estimates are likely conservative and underestimate the number of acres harvested; however, some harvest reports may reflect a few tree removals and not necessarily a clear cut or selected harvest. We anticipate that 3,669,077 acres will be harvested annually through 2022, which is 1.3% of the available forested habitat, or 9.1% over seven years (Table 4.2). Timber harvest is expected to occur in similar proportions in the Midwest, Eastern, and Southern ranges (29, 35, and 34%, respectively), but only about 2% of the total harvest will occur in the Western range. We anticipate that habitat losses from timber harvest will be temporary.

We further analyzed these data by partitioning the average annual acreage expected during the NLEB active season and the pup season. Lacking a breakdown of the acres harvested during the active and non-volant seasons, we assume that timber harvest will occur with equal frequency throughout the year. The NLEB active season (April 1 – October 31) is 214 days, or 58.6% of the year. The NLEB non-volant season (June 1 – July 31) is 61 days, or 16.7% of the year. Therefore, the average annual acres of timber harvest during the active season is 58.6% of the total average annual acres, and 16.7% of the total timber harvest is estimated to occur in the non-volant season.

For spatial exposure to stressors, we must consider that timber harvest and NLEB-occupied areas may occur anywhere within the forested acreage of each state, but we recognize there are some forests in National or State Parks or Wilderness areas that may not be subject to harvest. NLEB occupancy estimates vary by state from about 9 to 60 percent (see section 2.4.1). It is possible for timber harvest, which annually affects about 1.3 percent of the available forested habitat, to occur entirely on the 5 to 65 percent of the habitat in each state that we consider occupied, or not at all, because we have no information indicating whether certain activities are more or less likely to occur in occupied areas. Therefore, our effects analyses compute the expected (probable) degree of spatial overlap between activities and occupied areas as the product of two independent probabilities, namely, the percentage of the forested habitat that is proposed for timber harvest multiplied by the percentage of the forested habitat that the NLEB occupies in a particular manner, e.g., for roosting or foraging.

The following example demonstrates our methodology for estimating individual-level direct effects corresponding to the stressor-exposure-response pathway for timber harvest during the non-volant season (June 1–July 31) within a maternity roost, which may kill or injure non-volant pups.

a. State A, with 500,000 acres of forested habitat, will annually harvest 2,500 acres (0.5 percent of the total habitat) during the non-volant season.
b. State A has a 30 percent occupancy rate for NLEB, i.e., 150,000 acres of State A are within the active-season home range of individuals of this species.
c. We assume that individuals belonging to maternity colonies collectively occupy 90 percent (co-capture rate of reproductive females with males and non-reproductive females; see section 2.4 for the basis of this and other NLEB distribution and abundance assumptions) of these 150,000 acres, or 0.90 × 150,000 = 135,000 acres.
d. We assume maternity colonies do not overlap and occupy 1,000 acres each; therefore State A supports 135,000 ÷ 1,000 = 135 colonies.
e. We assume that individuals in a maternity colony roost in trees within an area of 167 acres; therefore, the colonies of State A occupy 135 × 167 acres = 22,545 acres for roosting, which is 4.5 percent of State A.
f. State A has not yet been affected by WNS; therefore, each colony supports 45 non-volant pups during the harvest time frame (1 pup per adult female, section 2.4).

In this example, 2,500 acres (0.5 percent) of the forested acres in the state are proposed for harvest during the non-volant season, and 22,545 acres (4.5 percent) harbors non-volant pups. The mathematically expected (probable) degree of spatial overlap is the product of the two percentages, or 0.5 percent × 4.5 percent = 0.0225 percent, which is 112.7 acres of the 500,000 acres in State A. To estimate the number of bat pups affected, we multiply the density of bat pups in maternity roosting areas (45 pups per 167 acres) by the expected acreage of overlap: (45 ÷ 167) × 112.7 = 30.3, which we round up to 31 pups. We aggregate the results of this type of analysis for all timber harvest actions within a state and across all 30 states included in the analysis, which provides a basis for estimating the total expected effects of multiple project-level actions at a scale not exceeding the total amount of timber harvest estimated per year.

Consistent with the example above, our calculations for estimating the effects corresponding to each stressor-exposure-response pathway that we quantify are presented in tabular form in section 4.3. Each table lists the 30 states with the following six columns of data:

a. annual, active-season, or non-volant-season extent (acres) of timber harvest (or the proposed activity causing the stressor), depending on the pathway;
b. total forest habitat acres;
c. percent of the forest habitat receiving the activity (a ÷ b);
d. percent of the forest habitat that NLEB use at a time and in a manner (from section 2.4) that the stressor could affect causing a specific type of individual response;
e. expected overlap (acres) of the activity and the bat-occupied area (b × c × d); and
f. expected number of individuals affected (e × bat density in the occupied area).

In the final step of the calculations described above, the density we multiply by the expected area of overlap depends on the manner in which NLEB use the habitat exposed to the stressor. In the preceding example, non-volant pups in maternity roosting areas are the individuals responding to the stressor, and the density is 45 pups per 167 acres (0.2695). Based on the data and assumptions identified in section 2.4 about NLEB populations in the Action Area, we use the following NLEB densities in computing column "e" of each effects estimation table:

Habitat	NLEB individuals	Density for 45 females per Maternity Colony	Density for 39 females per Maternity Colony	Density for 20 females per Maternity Colony
Summer home range	Adult females and sympatric adult males	0.0814	0.0362	0.0705
Maternity roosting areas	Non-volant pups	0.2695	0.1198	0.2335
Roosting areas	Adult females, volant juveniles, and sympatric adult males	0.8084	0.3593	0.7006

This methodology generates results in terms of numbers of individual NLEB affected, but we must acknowledge its inherent imprecision. It relies on assumptions about state-specific occupancy rates and applies values for colony size, sex ratios, etc., that we believe are reasonable and based on best available information, but which are either uncertain or variable across the Action Area. Although it is coarse, this methodology provides a transparent basis for quantifying effects for interpretation relative to the status of the species, which is the purpose of an effects analysis in a BO.

4.3.3 QUANTIFYING EFFECTS OF TIMBER HARVEST

We quantify the two pathways expected to result in direct effects to the NLEB: disturbance from fleeing human activity (Table 4.3), and harm from removing occupied roost trees (Table 4.4 for pups and Table 4.5 for adults). Human disturbance from timber harvest during the active season (April – October) within maternity roosting areas may disturb up to 76,846 volant NLEB annually (Table 4.3). A small subset of these disturbed individuals may be harmed. Timber harvests that remove occupied roost trees during the non-volant season may harm up to 1,109 pups annually (Table 4.4). Removal of occupied roost trees during the active season may harm up to 247 adults annually (Table 4.5).

In addition to these two pathways, timber harvest activities could alter the flow of air and water through unknown hibernacula which could also harm NLEBs. We do not have enough information to quantify the effects of this pathway because we do not know where projects will occur relative to the unknown hibernacula that are likely on the landscape. Although the alteration of unknown hibernacula is reasonably certain to occur, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed (i.e., not concentrated in a given area) nature of timber harvest activities. In addition, the hibernacula often selected by NLEB are "large, with large passages" (Raesly and Gates 1987), and may be less affected by relatively minor surficial micro-climatic changes that might result from timber harvest around unknown roosts. Further, bats rarely hibernate near the entrances of structures (Grieneisen 2011). Davis et al (1999) reported that partial clearcutting "appears not to affect winter temperatures deep in caves."

We also do not quantify the potential reductions in fitness that may result as indirect effects from loss of habitat. We anticipate that 1.3% (3,669,077 acres) of available habitat will be harvested annually through 2022; however, we anticipate that habitat losses from timber harvest will be temporary. In addition, the NLEB does not appear to be limited by habitat, as demonstrated by a great deal of plasticity within its environment (e.g., living in highly fragmented forest habitats to contiguous forest blocks from the southern United States to Canada's Yukon Territory) in the absence of WNS. Therefore, reductions in fitness from habitat loss are anticipated to be small. Further, timber harvest practices that reduce mid-story clutter likely also benefit NLEB habitat and may increase fitness of local NLEB populations. We do not quantify the potential increases in fitness because we lack the scientific support to interpret the degree to which survival or reproductive success rates of local populations may be influenced; however, management of existing forests is likely to maintain roosting or foraging habitat.

4.4 PRESCRIBED FIRE

Prescribed fire is the other category of forest management described in this BO. Prescribed burning is deliberately burning wild-land fuels under specified environmental conditions in a predetermined area with a predetermined fire-line intensity and rate of movement in order to attain resource management objectives. It is typically classified as dormant-season and growing-season burning. The seasonality varies by latitude and elevation, but the dormant season is generally October –April and the growing season is April 15 – August 15. Dormant-season burning is primarily used to reduce the buildup of hazardous fuels and thereby reduce the likelihood of catastrophic wildfires or to achieve ecological stand objectives. Growing-season burning is used for site preparation, control of undesirable species, and restoration and maintenance of fire-dependent plant communities and associated wildlife. Most growing season burning takes place in the spring and fall; however, growing season burning occurs through the active and pup seasons in the rest of the range. For example, we recently completed programmatic consultations for the NLEB with the U.S. Forest Service on Forest Plans in their Southern and Eastern regions, which includes the Midwest, Southern, and Eastern ranges of the NLEB. Twenty-one and 16 percent of prescribed burning was projected to occur during the pup season (defined by the Forest Service as May 1 to July 30) in the Southern and Eastern regions, respectively.

4.4.1 EFFECTS OF PRESCRIBED FIRE

Literature Review

Perry (2012) provides a review of fire effects on bats in the eastern oak region of the U.S., and Carter et al. (2002) provides a similar review for bats in the southeastern and mid-Atlantic states. Forest-dwelling bats, including the wide-ranging NLEB, were presumably adapted to the fire-driven disturbance regime that preceded European settlement and fire suppression in many parts of the eastern U.S. Concurrent changes in habitat conditions preclude any reasonable inferences about the overall impact of fire suppression on populations of forest-dwelling bats. It is apparent that fire may affect individual bats directly (negatively) through exposure to heat, smoke, and carbon monoxide, and indirectly (both positively and negatively) through habitat modifications and resulting changes in their food base (Dickinson et al. 2009).

Direct Effects – Summer Roosting

Little is known about the direct effects of fire on cavity and bark roosting bats, such as the NLEB, and few studies have examined escape behaviors, direct mortality, or potential reductions in survival associated with effects of fire. Dickinson et al. (2009) monitored two NLEB (one male and one female) in roosts during a controlled summer burn. Within 10 minutes of ignition near their roosts, both bats flew to areas that were not burning. Among four bats they tracked before and after burning, all switched roosts during the fire, with no observed mortality. Rodrigue et al. (2001) reported flushing a *Myotis* bat from an ignited snag during an April controlled burn in West Virginia.

Carter et al. (2002) suggested that the risk of direct injury and mortality to southeastern forest-dwelling bats resulting from summer prescribed fire is generally low. During warm temperatures, bats are able to arouse from short-term torpor quickly. Most adult bats are quick, flying at speeds > 30 km/hour (Patterson and Hardin 1969), enabling escape to unburned areas. NLEB use multiple roosts, switching roost trees often (see *Summer Roosting Behavior* in Section 2.4.3), and could likely use alternative roosts in unburned areas, should fire destroy the current roost. Non-volant pups are likely the most vulnerable to death and injury from prescribed fire. Although most eastern bat species are able to carry their young for some time after they are born (Davis 1970), the degree to which this behavior would allow females to relocate their young if fire threatens the nursery roost is unknown.

Dickinson et al. (2010) used a fire plume model, field measurements, and models of carbon monoxide and heat effects on mammals to explore the risk to the Indiana bat and other tree-roosting bats during prescribed fires in mixed-oak forests of southeastern Ohio and eastern Kentucky. Carbon monoxide levels did not reach critical thresholds that could harm bats in low-intensity burns at typical roosting heights for the Indiana bat (8.6 m) (28.2 ft). NLEB roost height selection is more variable, but on average lower (6.9 m) (22.8 ft) than the Indiana bat (Lacki et al. 2009b). In this range of heights, direct heat could cause injury to the thin tissue of bat ears. Such injury would occur at roughly the same height as tree foliage necrosis (death) or where temperatures reach 60 °C (140 °F). Most prescribed fires for forest management are planned to avoid significant tree scorch.

Direct and Indirect Effects – Winter Roosting

Little is known about the direct effects of fire on bats in adjacent caves and mines. Smoke and noxious gases could enter caves and mines, depending on airflow characteristics and weather conditions (Carter et al. 2002; Perry 2011). Although smoke from winter fires may not reach toxic levels in caves and mine, introduced gases could arouse bats from hibernation, causing energy expenditure and reduced fitness (Dickinson et al. 2009). Caviness (2003) observed smoke intrusion into hibernacula during winter burning in Missouri, but did not observe any bat arousal. Fire could alter vegetation surrounding the entrances to caves and mines, which could indirectly affect temperature and humidity regimes of hibernacula by modifying airflow (Carter et al. 2002, Richter et al. 1993).

Indirect Effects – Roost Availability/Suitability

Fire can affect the availability of roosting substrate (cavities, crevices, loose bark) by creating or consuming snags, which typically provide these features, or by creating these features in live trees. Although stand-replacing or intense wildfires may create large areas of snags, the effects of multiple, low-intensity prescribed burning on snag dynamics are less obvious, especially for forests consisting mostly of fire-adapted species. Low-intensity, ground-level fire may injure larger hardwood trees, creating avenues for pathogens such as fungi to enter and eventually form hollow cavities in otherwise healthy trees (Smith and Sutherland 2006). Fire may scar the base of trees, promoting the growth of basal cavities or hollowing of the bole in hardwoods (Nelson et al. 1933, Van Lear and Harlow 2002). Repeated burning could potentially create forest stands with abundant hollow trees. Trees located near down logs, snags, or slash may be more susceptible to damage or death, and aggregations of these fuels can create clusters of damaged trees or snags (Brose and Van Lear 1999, Smith and Sutherland 2006).

Bats are known to take advantage of fire-killed snags and continue roosting in burned areas. Boyles and Aubrey (2006) found that, after years of fire suppression, initial burning created abundant snags, which evening bats (*Nycticeius humeralis*) used extensively for roosting. Johnson et al. (2010) found that after burning, male Indiana bats roosted primarily in fire-killed maples. In the Daniel Boone National Forest, Lacki et al. (2009a) radio-tracked adult female NLEB before and after prescribed fire, finding more roosts (74.3 percent) in burned habitats than in unburned habitats. Burning may create more suitable snags for roosting through exfoliation of bark (Johnson et al. 2009a), mimicking trees in the appropriate decay stage for roosting bats.

In addition to creating snags and live trees with roost features, prescribed fire may enhance the suitability of trees as roosts by reducing adjacent forest clutter (see *Canopy Cover/Closure* in Section 2.4.3). Perry et al. (2007) found that five of six species, including NLEB, roosted disproportionally in stands that were thinned and burned 1-4 years prior but that still retained large overstory trees. Boyles and Aubrey (2006) found evening bats used burned forest exclusively for roosting.

Indirect Effects – Summer Foraging

Adult insects are the predominant prey of NLEB (see Section 2.2.4 Foraging Behavior). On the Daniel Boone National Forest, Lacki et al. (2009a) found that abundance of coleopterans (beetles), dipterans (flies), and all insects combined captured in black-light traps increased following prescribed fires. The mechanism of this increase is presumably the new growth of ground vegetation that a burn stimulates. In fecal samples of NLEB, lepidopterans (moths), coleopterans, and dipterans were the three most important groups of insect prey, with dipteran consumption increasing after burning. NLEB appeared to track the observed changes in insect availability, i.e., home ranges were closer to burned habitats following fires than to unburned habitats, but home range size did not vary before and after fires.

<u>Summary of Exposure-Response Table</u>

Table 4.1 shows the eight pathways we identified for NLEB responses to prescribed fire and the range of individual responses expected. In general, exposure to prescribed burning can cause direct adverse responses (disturbance, injury, death) and indirect adverse and beneficial responses via changes to roosting and foraging resources and forest health maintenance. Stressors caused by burning include heat and smoke during the actual movement of a fire through forested areas and fire-induced changes in vegetation structure and composition. Bat exposure to these direct and indirect stressors depends on timing of the burn and how bats may use the burned area, e.g., for roosting, foraging, spring staging, fall swarming, or hibernation in a cave/mine where the entrance is within or near the burned area.

4.4.2 METHODOLOGY FOR QUANTIFYING EFFECTS OF PRESCRIBED FIRE

To estimate the potential impacts of prescribed fire through 2022, we compiled the mean, minimum, and maximum acres of prescribed burns in each state from 2002 to 2014 (Table 4.6) using data available through the National Interagency Fire Center (available on internet: https://www.nifc.gov/fireInfo/fireInfo_stats_prescribed.html; accessed November 2015). We assumed the mean annual use of prescribed fire from 2002-2014 will be consistent through the period of this consultation. Similar to the population estimation methods in Section 2.4.2, we excluded a state from our analyses if less than 50% of it is within the NLEB range.

These data represent the total amount of prescribed burning in each state without regard to habitat type. We further parsed these data using information from the 2012 National Prescribed Fire Use Survey Report (Melvin 2012) to exclude burned grassland habitats as these are not relevant to the NLEB. The burn report estimated the percent of prescribed fire used to manage grassland or agriculture habitat and forested land in 2012. We recognize that this percentage likely varies to some degree every year, but we assume that the proportion of prescribed fire in forested habitat is similar. We use the mean annual acres of prescribed fire in forested habitat reported in Table 4.6 for the purposes of this BO. We anticipate that 648,908 acres will be burned annually through 2022, which is 0.2% of the available forested habitat (Table 4.2). The majority of prescribed burning is expected to occur in the Southern range (64%), followed by 29% in the Midwest, 4% and 3% in the Eastern and Western ranges, respectively.

Similar to timber harvest, we lack a breakdown of the acres burned during the active and non-volant seasons, and we assume that prescribed burning will occur with equal frequency throughout the year. Therefore, the average annual acres of prescribed burning during the active season are 58.6% of the total average annual acres, and 16.7% of the total is estimated to occur in the non-volant season. This estimate is similar to the recent estimates from programmatic consultations for the NLEB on U.S. Forest Service lands, where 21 and 16 percent of prescribed burning was projected to occur during the pup season (defined by the Forest Service as May 1 to July 30) in the Southern and Eastern regions, respectively. This may be an overestimate for the western range.

We use the same methods described for timber harvest (see Section 4.1.2.2) to estimate individual-level effects corresponding to the stressor-exposure-response pathways for prescribed burning. Our calculations for each pathway that we quantify are presented in tabular form in Section 4.3.

4.4.3 QUANTIFYING EFFECTS OF PRESCRIBED FIRE

We quantify the two pathways expected to disturb or harm the NLEB: disturbance from fleeing the fire (Table 4.7), and harm to pups from heat and smoke during the non-volant season (Table 4.8). Prescribed fires during the active season within maternity roosting areas may disturb up to 19,417 volant NLEB annually through fleeing and increased predation (Table 4.7). A small subset of disturbed individuals may be harmed. Prescribed burning during the non-volant season may harm up to 1,859 pups annually (Table 4.8).

In addition to these two pathways, prescribed burning could alter the flow of air and water through unknown hibernacula and also harm NLEBs. We do not have enough information to quantify the effects of this pathway because we do not know where projects will occur relative to the unknown hibernacula that are likely on the landscape. Although the alteration of unknown hibernacula may occur, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of prescribed burning. In addition, Caviness (2003) reported that prescribed burns were found to have no notable influence on bats hibernating in various caves in the Ozark National Forest. All bats present in caves at the beginning of the burn were still present and in "full hibernation" when the burn was completed, and bat numbers increased in the caves several days after the burn. There were minute changes in relative humidity and temperature during the burn and elevated short-term levels of some contaminants from smoke were noted.

We also do not quantify the potential reductions or increases in fitness that may result as indirect effects from the loss of roost trees (adverse) or the creation of roost trees, increased prey availability, or reduction of mid-story clutter (beneficial). We anticipate that only 0.2% of available habitat will be burned annually, and any habitat losses from prescribed fire will be temporary. In addition, the NLEB does not appear to be limited by roost trees, as demonstrated through a great deal of plasticity within its environment (e.g., roosting in a wide variety of trees and sizes). Therefore, reductions in fitness from habitat loss are anticipated to be small. Further, prescribed fire likely also benefits NLEB habitat and may increase fitness of local populations as described above. We do not quantify the potential increases in fitness because we lack the scientific support to interpret the degree to which survival or reproductive success rates of local populations may be influenced; however, management of existing forests is likely to maintain roosting or foraging habitat.

4.5 FOREST CONVERSION

Forest conversion is the loss of forest to another land cover type (e.g., grassland, cropland, development). For the purposes of this BO, we define forest conversion as any activity that removes forested habitat that is suitable for the NLEB. This includes, but is not limited to, tree removal from commercial or residential development, energy production and transmission (oil, gas, solar, wind), mining, agriculture, transportation, military training, and other ecosystem management. Unlike forest management, forest conversion permanently removes forested habitat on the landscape, or in some cases, there is no forest for decades as in the case of mining.

4.5.1 EFFECTS OF FOREST CONVERSION

In the final listing rule for the NLEB, we note that forest conversion could result in the following impacts: (1) loss of suitable roosting or foraging habitat; (2) fragmentation of remaining forest patches, leading to longer flights between suitable roosting and foraging habitat; (3) removal of (fragmenting colonies/networks) travel corridors; and (4) direct injury or mortality from the removal of occupied roosts during active season clearing. Forest conversion could also alter the flow of air and water through unknown hibernacula and impact NLEBs.

The literature review for timber harvest describes the loss of suitable roosting or foraging habitat, direct injury or mortality from removal of occupied roost, and alteration of hibernacula (see section 4.1.2.1). Fragmentation of forests patches and travel corridors may result in longer flights to find alternative suitable habitat and colonial disruption. NLEBs emerge from hibernation with their lowest annual fat reserves and return to their summer home ranges. Because NLEBs have summer home range fidelity (Foster and Kurta 1999; Patriquin et al. 2010; Broders et al. 2013), loss or alteration of forest habitat may put additional stress on females when returning to summer roost or foraging areas after hibernation. Females (often pregnant) have limited energy reserves available for use if forced to seek out new roosts or foraging areas. Hibernation and reproduction are the most energetically demanding periods for temperate-zone bats, including the NLEB (Broders et al. 2013). Bats may reduce metabolic costs of foraging by concentrating efforts in areas of known high prey profitability, a benefit that could result from the bat's local roosting and home range knowledge and site fidelity (Broders et al. 2013). Cool spring temperatures provide an additional energetic demand, as bats need to stay sufficiently warm or enter torpor. Entering torpor comes at a cost of delayed parturition; bats born earlier in the year have a greater chance of surviving their first winter and breeding in their first year of life (Frick et al. 2010). Delayed parturition may also be costly because young of the year and adult females would have less time to prepare for hibernation (Broders et al. 2013). Female NLEBs typically roost colonially, with their largest population counts occurring in the spring (Foster and Kurta 1999), presumably as one way to reduce thermal costs for individual bats (Foster and Kurta 1999). Therefore, similar to other temperate bats, NLEBs have multiple high metabolic demands (particularly in spring) and must have sufficient suitable roosting and foraging habitat available in relatively close proximity to allow for successful reproduction.

Table 4.1 shows the six pathways we identified for NLEB responses to forest conversion and the range of individual responses expected. The primary alteration of the environment associated with forest conversion that is relevant to the NLEB is the removal of trees that provide roosts or serve as foraging, spring staging, or fall swarming habitat. Removing occupied trees is likely to kill or injure pups and adults. Fragmentation and loss of forest habitat decreases opportunities for growth and successful reproduction. Alteration of hibernacula can harm NLEBs. The disturbance (noise, exhaust from machinery, etc.) that accompanies conversion activities may result in disturbance because fleeing during daylight increases the likelihood of predation. A small subset of disturbed individuals may be harmed. The species' responses to these stressors depend on the timing, location, and extent of the removal. In areas with little forest or highly fragmented forests (e.g., western U.S. edge of the range, central Midwestern states; see Figure 1.1, above), impact of forest loss would be disproportionately greater than similar-sized losses in heavily forested areas (e.g., Appalachians and northern forests). Also, the impact of habitat loss within a NLEB's home range is expected to vary depending on the scope of removal.

4.5.2 METHODOLOGY FOR QUANTIFYING EFFECTS OF FOREST CONVERSION

To estimate the potential impacts of forest conversion through 2022, we examined the total forested acres in each state from 2001 to 2011 using the National Land Cover Datasets (Homer et al. 2015). We calculated the approximate acres of forest lost per state per year by subtracting the acres of total forest in 2011 from the forested acres in 2001 and calculating the annual loss over the 10 year period (Table 4.9). We assume that the mean annual forest conversion from 2001-2011 will be consistent through the period of this consultation. Similar to the population estimation methods in Section 2.4.2, we excluded a state from our analyses if less than 50% of it is within the NLEB range. We anticipate that 914,237 acres will be converted from forested habitat annually through 2022, which is 0.3% of the available forested habitat per year and 2.3% of the available habitat through 2022 (Table 4.2). The majority of the expected forest conversion will occur in the Southern range (53%), followed by the Eastern range (26%), Midwest (19%). Only about 2% of the total conversion will occur in the Western range.

Similar to timber harvest, we lack a breakdown of forest conversion during the active and non-volant seasons, and we assume that it will occur with equal frequency throughout the year. Therefore, the average annual acres of forest conversion during the active season are 58.6% of the total average annual acres, and 16.7% of the total is estimated to occur in the non-volant season.

We use the same methods described for timber harvest (see Section 4.1.2.2) to estimate individual-level effects corresponding to the stressor-exposure-response pathways for prescribed burning. Our calculations for each pathway that we quantify are presented in tabular form in Section 4.3.

4.5.3 QUANTIFYING EFFECTS OF FOREST CONVERSION

We quantify the two pathways expected to disturb or harm the NLEB: disturbance from fleeing human activity (Table 4.10), and harm from removing occupied roost trees (Table 4.11 for pups and Table 4.12 for adults). Human disturbance from forest conversion during the active season (April – October) within maternity roosting areas may disturb up to 21,004 volant NLEB annually (Table 4.10). Forest conversion activities that remove occupied roost trees during the non-volant season may harm up to 317 pups annually (Table 4.11). Removal of occupied roost trees during the active season may harm up to 83 adults annually (Table 4.12).

In addition to these two pathways, forest conversion could alter the flow of air and water through unknown hibernacula and also harm NLEBs. We do not have enough information to quantify the effects of this pathway because we do not know where projects will occur relative to the unknown hibernacula that are likely on the landscape. Although the alteration of unknown hibernacula is reasonably certain to occur, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of forest conversion activities. In addition, the hibernacula often selected by NLEB are “large, with large passages” (Raesly and Gates 1987), and may be less affected by relatively minor surficial micro-climatic changes that might result from forest conversion around unknown roosts. Raesly and Gates (1987) evaluated external habitat characteristics of hibernacula and reported that for the NLEB the percentage of cultivated fields within 0.6 miles (1 km) the hibernacula was greater (52.6 percent) for those caves used by the species, than for those caves not used by the species (37.7 percent), suggesting that the removal of some forest around a hibernacula can be consistent with the species needs.

We also do not quantify the potential reductions in fitness that may result as indirect effects from loss of habitat. We anticipate that 0.3% (914,237 acres) of available habitat will be converted annually through 2022. We anticipate that habitat losses from forest conversion will be permanent. However, the NLEB does not appear to be limited by habitat, as demonstrated by a great deal of plasticity within its environment (e.g., living in highly fragmented forest habitats to contiguous forest blocks from the southern United States to Canada’s Yukon Territory) in the absence of WNS. Therefore, reductions in fitness from habitat loss are anticipated to be small.

4.6 WIND TURBINE OPERATION

Wind energy development is rapidly increasing throughout the NLEB’s range. Iowa, Illinois, Oklahoma, Minnesota, Kansas, and New York are within the top 10 States for wind energy capacity (installed megawatts) in the United States (AWEA 2013). There is a national movement towards a 20 percent wind energy sector in the U.S. market by 2030 (United States Department of Energy (US DOE) 2008). Through 2012, wind energy has achieved its goals in installation towards the targeted 20 percent by 2030 (AWEA 2015a). If the target is achieved, it would represent nearly a five-fold increase in wind energy capacity during the next 15 years (Loss et al. 2013). While locations of future wind energy projects are largely influenced by ever-changing economic factors and are difficult to predict, sufficient wind regimes exist to support wind power development throughout the range of the NLEB (USDOE 2015a), and wind development can be expected to increase throughout the range in future years. Wind energy facilities have been constructed in areas within a large portion of the range of the NLEB.

4.6.1 EFFECTS OF WIND TURBINE OPERATION

Significant bat mortality has been witnessed associated with utility-scale (greater than or equal to 0.66 megawatt (MW)) wind turbines along forested ridge tops in the eastern and northeastern United States and in agricultural areas of the Midwest (Johnson 2005; Arnett et al. 2008; Cryan 2011; Arnett and Baerwald 2013; Hayes 2013; Smallwood 2013). Recent estimates of bat mortality from wind energy facilities vary considerably depending on the methodology used and species of bat. Arnett and Baerwald (2013) estimated that 650,104 to 1,308,378 bats had been killed at wind energy facilities in the United States and Canada as of 2011, and expected another 196,190 to 395,886 would be lost in 2012. Other bat mortality estimates range from "well over 600,000… in 2012" (Hayes 2013; [but see Huso and Dalthorp 2014]) to 888,000 bats per year (Smallwood 2013), and mortality can be expected to increase as more turbines are installed on the landscape. The majority of bats killed include migratory foliage-roosting species the hoary bat (*Lasiurus cinereus*) and eastern red bat, and the migratory, tree- and cavity-roosting silver-haired bat (Arnett et al. 2008; Cryan 2011; Arnett and Baerwald 2013). NLEBs are rarely detected as mortalities, even in areas where they are known to be common on the landscape.

The Service reviewed post-construction mortality monitoring studies at 62 unique operating wind energy facilities in the range of the NLEB in the United States and Canada. In these studies, 41 NLEB mortalities were documented, comprising less than 1 percent of all bat mortalities. Northern long-eared bat mortalities were detected throughout the study range at 29 percent of the facilities, including: Illinois, Indiana, Maryland, Michigan, Missouri, New York, Pennsylvania, West Virginia, and Ontario. There is a great deal of uncertainty related to extrapolating these numbers to generate an estimate of total NLEB mortality at wind energy facilities due to variability in post-construction survey effort and methodology (Huso and Dalthorp 2014). Bat mortality can vary between years and between sites, and detected carcasses are only a small percentage of total bat mortalities. Despite these limitations, Arnett and Baerwald (2013) estimated that wind energy facilities in the United States and Canada killed between 1,175 and 2,433 NLEBs from 2000 to 2011.

There are three impacts of wind turbines that may explain proximate causes of bat fatalities, which include: (1) bats collide with turbine towers; (2) bats collide with moving blades; or (3) bats suffer internal injuries (barotrauma) after being exposed to rapid pressure changes near the trailing edges and tips of moving blades (Cryan and Barclay 2009). Researchers have recently indicated that traumatic injury, including bone fractures and soft tissue trauma caused by collision with moving blades, is the major cause of bat mortality at wind energy facilities

(Rollins et al. 2012; Grodsky et al. 2011). Grodsky et al. (2011) suggested that these injuries can lead to an underestimation of bat mortality at wind energy facilities due to delayed lethal effects. However, the authors also noted that the surface and core pressure drops behind the spinning turbine blades are high enough (equivalent to sound levels that are 10,000 times higher in energy density than the threshold of pain in humans) to cause significant ear damage to bats flying near wind turbines (Grodsky et al. 2011). Bats suffering from ear damage would have a difficult time navigating and foraging, as both of these functions depend on the bats' ability to echolocate (Grodsky et al. 2011). While earlier papers indicated that barotrauma may also be responsible for a considerable portion of bat mortality at wind energy facilities (Baerwald et al. 2008), in a more recent study, researchers found only 6 percent of wind turbine killed bats at one site were possibly killed by barotrauma (Rollins et al. 2012). In a separate study, Grodsky et al. (2011) found that 74 percent of carcasses had bone fractures and more than half had mild to severe hemorrhaging in the middle or inner ears; thus it is difficult to attribute individual fatalities exclusively to either direct collision or barotrauma.

Table 4.1 shows the two pathways we identified for NLEB responses to wind turbine operation and the range of individual responses expected. The primary impact to bats from operation of wind facilities is death resulting from collision with operating turbines. It is also possible that NLEBs could be disturbed by sound from turbine operation; however, studies have found no evidence to suggest that bats are likely to be affected (Szewczak and Arnett 2006; Horn et al. 2008). We do not address sound from turbine operation further in this BO. We include the potential impacts from construction under forest conversion.

4.6.2 QUANTIFYING EFFECTS OF WIND TURBINE OPERATION

This section describes the approach for determining the current and future wind energy development conditions and the estimation of potential fatalities from wind energy through the duration of this consultation in 2022.

We compiled the installed wind power capacity (megawatts [MW]) as identified by the American Wind Energy Association (AWEA) for each state within the NLEB's range through 2014 (AWEA 2014). Similar to the population estimation methods in Section 2.4.2, we excluded a state from our analyses if less than 50% of it is within the NLEB range. There is currently no installed wind power capacity in the excluded states of Louisiana, Alabama, Georgia, and South Carolina, but there was 5,857 MW of installed capacity in Montana, Wyoming, and Oklahoma as of 2014. To determine if excluding these states was reasonable, we also examined a wind development pressure map (Figure 4.1) developed using the Federal Aviation Administration's wind turbine data (Service 2015a, unpublished data). We concluded that a small amount of potential wind energy development was within the species' range in Montana, Wyoming, and Oklahoma; however, the inclusion of the full states of Nebraska and Kansas should compensate for any impacts not included in the excluded states. The total amount of installed wind capacity for the remaining states within the range of the NLEB was 28,294 MW at the end of 2014 (Table 4.13).

To estimate the potential impacts of future wind energy development through 2022, we used the Department of Energy's 2020 and 2030 build-out projections from the interactive map developed using data from with their 2015 Wind Vision Report (http://energy.gov/maps/map-projected-growth-wind-industry-now-until-2050; USDOE 2015b). The total amount of installed wind capacity by 2020 for states with more than 50% of their area within the NLEB range is projected to be 44,100 MW (Table 4.13). Lacking annual projections, we assumed that the annual build-out from 2014 to 2020 would be the mean of the total build-out over the six year period. We estimated build-out in 2021 and 2022 by taking the difference between the 2030 and 2020 projections and assuming the annual build-out in 2021 and 2022 would be the mean of the total build-out through 2030. The total amount of installed wind capacity by 2022 for states with more than 50% of their area within the NLEB range is projected to be 55,006 MW. The total capacity of wind energy is anticipated to nearly double in the next seven years.

The best source of information available to estimate anticipated future impacts to bats from collision with wind turbines is data from post-construction monitoring studies of existing wind facilities. Species composition data from these studies can be used to estimate the level of NLEB mortality by assuming the proportion of documented fatalities of NLEB, relative to the fatalities of all other bat species, represents the proportion of NLEB fatalities expected in other projects situated in similar geographic areas. It is important to use data that are as representative as possible of the conditions in the area for which mortality is being estimated because multiple variables are likely to influence mortality rates at wind energy facilities, including location relative to bat areas of activity, turbine height, rotor-swept area, turbine cut-in speed (i.e., the minimum speed required to produce energy), geographic location, elevation, topographic location, surrounding habitat types, time of year, and weather conditions. Uncertainty regarding variations in the relative densities of different species of bats across the landscape and over time are an additional source of error in this estimation. However, we used the data from the draft Midwest Wind Energy Habitat Conservation Plan (MWE HCP) as a surrogate for the full range of the species because the post construction mortality studies have not been compiled at the range-wide scale of the NLEB. The estimates from the MWE HCP represent the best available data for this consultation, but we acknowledge the uncertainty of these estimates for the Eastern, Southern, and Western portions of the species' range.

The number of NLEBs that may be impacted by wind development in each state was calculated following these steps[3]: (1) determine the anticipated bat fatality rate for the geographic area of

[3] The MWE HCP is currently in development with the Service, a coalition of eight Midwestern states, and representatives of the wind energy industry. Much of the following information in this section comes from the draft

interest based on the results of post-construction monitoring studies; (2) determine the proportion of the NLEB among fatalities in post-construction monitoring studies in the applicable range of the NLEB; and (3) multiply the proportion of the NLEB by the expected fatality rate to derive the expected number of total fatalities of the NLEB. For example, if the total estimated bat mortality from regional data is 12 bats/MW/year (or 1,200 bats/year for a 100 MW facility), and the number of NLEB fatalities among all bat fatalities was 1 out of 100 (or 1%), the total estimated mortality of the NLEB would be 12 fatalities/year.

1. *determine the anticipated bat fatality rate for the geographic area of interest based on the results of post-construction monitoring studies*

   The studies used to estimate all bat fatality rates for the MWE HCP were limited to those that were conducted in the eight Midwestern states within the range of the covered bat species in the MWE HCP (i.e., Indiana bat, NLEB, little brown bat). The following additional criteria were used to select post-construction monitoring studies: (1) the search interval had to be weekly or more frequent; (2) studies had to correct for carcass persistence and searcher efficiency using site-specific data; (3) the search interval had to be shorter than the mean carcass persistence rate; (4) only include the mortality rate for the most robust study method for studies that reported more than one mortality rate; and (5) only include the bat fatality estimates from control turbines for curtailment study projects. These studies were further modified to account for unsearched areas where bats were expected to fall by applying a correction factor (sensu Hull and Muir 2013) if the study included search areas smaller than 100 m search radii. Fatality rates must also be representative of the period over which future mortality is being estimated; therefore, rates were adjusted to account for bat mortality that occurred during from April 1 to October 31, which is inclusive of the time frame within which all NLEB mortalities have been documented.

   Based on these criteria, 17 fatality monitoring studies were selected to estimate fatality of all bats within the MWE HCP states. Of these 17 studies, two were conducted in Minnesota, three in Wisconsin, three in Iowa, four in Illinois, two in Indiana, and three in Ohio. Reported bat fatality rates (adjusted as described above) were variable across projects and ranged from a low of 1.42 bats/MW/study period at the Big Blue project in Minnesota (Fagen Engineering, LLC 2014), to 38.25 bats/MW/study period at the Cedar Ridge project in Wisconsin (BHE Environmental 2010). The mean bat fatality rate was 17.55 bats/MW/year. This estimate is similar to pre-WNS values surveys in Maryland (15.61 bats/MW; Young et al. 2011) and Pennsylvania (14.4 bats/MW; Taucher et al.

MWE HCP being written by Leidos, Inc. The analytical process used here was developed and approved by the Service; therefore, the data derived from this study currently represents the best available information to inform this analysis.

2012), which addresses some of the uncertainty of using Midwest estimates for the entire range.

2. *determine the proportion of the NLEB among fatalities in post-construction monitoring studies in the applicable range of the NLEB*

   The MWE HCP used 71 studies to estimate species composition for NLEBs. This was a larger pool than the more restrictive studies used to determine the all bat fatality rate because the purpose was to capture all available data on NLEB mortality in the Midwest. Of these 71 studies, three species of long-distance migrants made up the highest percentage of fatalities, totaling 88% of the 8,934 bat carcasses documented across all studies. Eastern red bats had the highest number of fatalities (3,893 bat carcasses or 44%), followed by hoary bats (2,328 bat carcasses or 26%), and silver-haired bats (1,621 bat carcasses or 18%). The next most common species found among fatalities were big brown bats (519 bat carcasses or 6%), followed by little brown bats (339 bat carcasses or 4%). NLEBs made up 0.09% (8 bat carcasses out of 8,934) of the fatality pool.

3. *multiply the proportion of the NLEB by the expected fatality rate to derive the expected number of total fatalities of the NLEB*

   Based on the estimated percentage of NLEBs (0.09%) among the mean bat fatality rate (17.55/MW/year), the mean estimated NLEB fatalities/MW/year was 0.0158. This NLEB fatality rate was then applied to the current installed wind capacity and projected build-out through 2022 to determine an estimated number of NLEB fatalities that would occur during each year over the term of this consultation assuming no avoidance and minimization measures would be in place. Based on these assumptions, we estimated that 5,654 NLEB fatalities could result from the projected wind capacity of 55,006 MW through 2022 (3,575 NLEBs from current facilities and 2,078 NLEBs from projected build-out; Table 4.13). There was an estimated 447 mortalities in 2014, and annual estimates increase every year by 42 individuals from 2015-2020 and 86 individuals in 2021 and 2022 for a total of 869 individuals in 2022. These are over-estimates because they do not account for avoidance and minimization measures that are currently applied at wind facilities, especially within the range of the endangered Indiana bat and it does not account for declines from WNS, especially in the Eastern range.

   Operational adjustments can be made to minimize mortality of bat species at wind facilities through two primary methods: (1) turbines are "feathered," or rendered near motionless below the normal manufacturer's cut-in speed, and (2) the cut-in speed is raised to a wind speed higher than the normal manufacturer's cut-in speed during periods and in areas of greatest risk for bats. These adjustments have been found to significantly reduce bat mortality because bat activity and mortality have been shown to have an inverse relationship with wind speed (Arnett et al. 2013). Some facilities within the range of the NLEB have already instituted these operational adjustments to avoid take of Indiana bats or as required by Indiana bat Habitat Conservation Plans. In addition, the wind industry has recently announced new best management practices establishing voluntary operating protocols, which they expect "to reduce impacts to bats from operating wind turbines by as much as 30 percent" (AWEA 2015b). According to AWEA, the agreement "involves wind operators' voluntarily limiting the operations of turbines in low-wind speed conditions during the fall bat migration season, when research has shown bats are most at risk of collision" (AWEA 2015b). Given the large numbers of other bat species impacted by wind energy (Hein et al 2013) and the economic importance of bats in controlling agricultural or forest pest species (Boyles et al 2011), we anticipate that these new standards will be adopted by most wind energy facilities and ultimately required by wind-energy-siting regulators at state and local levels. It is possible that total fatalities will be reduced by as much as 50% if we include the effects of additional curtailment that is ongoing at many projects and the effects of WNS on the overall population.

4.7 OTHER ACTIVITIES THAT MAY AFFECT THE NLEB

The NLEB is likely to be affected by a variety of other activities which are excepted from incidental take prohibitions in the final 4(d) rule that are not covered by the general categories for removal from human structures, forest management, forest conversion, and wind turbine operation. These activities include, but may not be limited to:

- Disturbance/noise from with human activities not associated with timber harvest or forest conversion
- Lighting
- Use of pesticides for pest and vegetation control
- Spills/chemical contamination
- Water quality alteration
- Collision
- Noise from munitions, detonations, and training vehicles/aircraft
- Use of military training smoke and obscurants
- Bridge maintenance, repair, or replacement
- Subsurface drilling or blasting for utility line and road installation
- Use of waste pits to store contaminated fluids

4.7.1 EFFECTS OF OTHER ACTIVITIES

Disturbance/Noise

Noise and vibration and general human disturbance are stressors that may disrupt normal feeding, sheltering, and breeding activities of the NLEB. Many activities may result in increased noise/vibration/disturbance that may result in effects to bats. Significant changes in noise levels in an area may result in temporary to permanent alteration of bat behaviors. The novelty of these noises and their relative volume levels will likely dictate the range of responses from individuals or colonies of bats. At low noise levels (or farther distances), bats initially may be startled, but they would likely habituate to the low background noise levels. At closer range and louder noise levels (particularly if accompanied by physical vibrations from heavy machinery and the crashing of falling trees) many bats would probably be startled to the point of fleeing from their day-time roosts and in a few cases may experience increased predation risk. For projects with noise levels greater than usually experienced by bats, and that continue for multiple days, the bats roosting within or close to these areas are likely to shift their focal roosting areas further away or may temporarily abandon these roosting areas completely.

There is limited literature available regarding impacts from noise (outside of road/traffic) on bats. Gardner et al. (1991) had evidence that an NLEB conspecific, Indiana bat, continued to roost and forage in an area with active timber harvest (see the timber harvest Section above regarding other similar studies for NLEB). They suggested that noise and exhaust emissions from machinery could possibly disturb colonies of roosting bats, but such disturbances would have to be severe to cause roost abandonment. Callahan (1993) noted that the likely cause of the bats in his study area abandoning a primary roost tree was disturbance from a bulldozer clearing brush adjacent to the tree.

Indiana bats have also been documented roosting within approximately 300 meters of a busy state route adjacent to Fort Drum Military Installation (Fort Drum) and immediately adjacent to housing areas and construction activities on Fort Drum (US Army 2014). Bats roosting or foraging in all of the examples above have likely become habituated to the noise/vibration/disturbance.

Table 4.1 shows the pathway we identified for NLEB responses to noise/disturbance, and it is possible that NLEBs will be disturbed by noise/disturbance. A small subset of disturbed individuals may be harmed. Although some adverse effects to NLEBs are reasonably certain to occur from noise or disturbance, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%.

Lighting

Bat behavior may be affected by lights when traveling between roosting and foraging areas. Foraging in lighted areas may increase risk of predation or it may deter bats from flying in those areas. Bats that significantly alter their foraging patterns may increase their energy expenditures resulting in reduced reproductive rates. This depends on the context (e.g., duration, location, extent, type) of the lighting.

Some bats seem to benefit from artificial lighting, taking advantage of high densities of insects attracted to light. For example, 18 species of bats in Panama frequently foraged around streetlights, including slow-flying edge foragers (Jung and Kalko 2010). However, seven species in the same study were not recorded foraging near streetlights. Bat activity differed among color of lights with higher activity at bluish-white and yellow-white lights than orange. Bat activity at streetlights varied for some species with season and moonlight (Jung and Kalko 2010). In summary, this study suggests highly variable responses among species to artificial lighting.

Some species appear to be adverse to lights. Downs et al. (2003) found that lighting of *Pipistrellus pygmaeus* roosts reduced the number of bats that emerged. In Canada and Sweden, *Myotis* spp. and *Plecotus auritus* were only recorded foraging away from street lights (Furlonger et al. 1987, Rydell 1992). Stone et al. (2009) found that commuting activity of lesser horseshoe bats (*Rhinolophus hipposideros*) in Britain and was reduced dramatically and the onset of commuting was delayed in the presence of high pressure sodium (HPS) lighting. Stone et al. (2012) also found that light-emitting diodes (LED) caused a reduction in *Rhinolophus hipposideros* and *Myotis* spp. activity. In contrast, there was no effect of lighting on *Pipistrellus pipistrellus*, *Pipistrellus pygmaeus*, or *Nyctalus/Eptesicus* spp.

Although there is limited information regarding potential neutral, positive, or negative impacts to NLEB from increased light levels, slow-flying bats such as *Rhinolophus*, *Myotis*, and *Plecotus* species have echolocation and wing-morphology adapted for cluttered environments (Norberg and Rayner 1987), and emerge from roosts when light levels are low, probably to avoid predation by diurnal birds of prey (Jones and Rydell 1994). Therefore, we would generally expect that NLEB would avoid lit areas. In Indiana, Indiana bats avoided foraging in urban areas and Sparks et al. (2005) suggested that it may have been in part due to high light levels. Using captive bats, Alsheimer (2012) also found that the little brown bat (*M. lucifugus*), was more active in the dark than light.

Table 4.1 shows the pathway we identified for NLEB responses to lighting, and it is possible that NLEBs will experience reduced fitness from lighting. Although some adverse effects to NLEBs are reasonably certain to occur from lighting, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%.

Pesticides

Herbicides and other pesticides may be used to control pests and weed species including noxious or invasive plants. Treatments typically occur in spring, early summer, or fall. Treatments can be applied either by hand, from a truck mounted boom sprayer withspray heads designed to minimize drift, or aerially. Herbicide and other pesticide applications typically occur during the day when bats are roosting, and often in the morning to avoid and minimize wind-induced drift.

Long-term sublethal effects of environmental contaminants, such as herbicides and other pesticides, on bats are largely unknown; however, environmentally relevant exposure levels of various contaminants have been shown to impair nervous system, endocrine, and reproductive functioning in other wildlife (Yates et al. 2014, Köhler and Triebskorn 2013, Colborn et al. 1993). Moreover, bats' high metabolic rates, longevity, insectivorous diet, migration-hibernation patterns of fat deposition and depletion, and immune impairment during hibernation, along with potentially exacerbating effects of WNS, likely increase their risk of exposure to and accumulation of environmental toxins (Secord et al. 2015, Yates et al. 2014, Geluso et al. 1976, Quarles 2013, O'Shea and Clark 2002).

Table 4.1 shows the pathway we identified for NLEB responses to the use of herbicides and other pesticides, and it is possible that NLEBs will experience reduced fitness and harm depending on the specific circumstances. Bats may drink contaminated water or forage in affected or treated areas and thus may eat insects exposed to chemicals. Bats may also be directly exposed to herbicides or other pesticides sprayed in roosting areas. Although some adverse effects to NLEBs are reasonably certain to occur from herbicides and other pesticide use, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%. In addition, all herbicides and other pesticides must be used in accordance to their label instructions, which are designed to minimize water contamination and adverse effects to wildlife.

Spills/Chemical Contamination

Accidents during project operation could result in the leakage of hazardous chemicals into the environment which could affect water quality resulting in reduced densities of aquatic insects that bats consume. If an accident occurred and hazardous chemicals leaked into the environment, a rapid response from state and/or federal agencies would limit the size of the spill area. However, if chemicals did reach surface waters (streams and wetlands), a short-term reduction in both aquatic and terrestrial insects could occur, thus reducing the spring, summer, or autumn prey base for foraging NLEB. If this occurred, it would be localized, thus allowing foraging NLEBs to move nearby and continue foraging.

Table 4.1 shows the pathway we identified for NLEB responses to spills and chemical contamination, and it is possible that NLEBs will experience reduced fitness and harm depending on the specific circumstances. Bats may drink contaminated water or forage in affected areas with the potential to eat insects exposed to chemicals. Although some adverse effects to NLEBs are reasonably certain to occur from spills and chemical contamination, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%. In addition, all projects are typically required to follow state and/or federal wetland permitting, stormwater management, and water quality standards.

Water Quality Alteration

Some projects may result in permanent loss from wetland and/or stream fill or temporarily reduce water quality from dust and sedimentation. Table 4.1 shows the pathway we identified for NLEB responses to water quality alteration. Activities that reduce quantity or quality of water sources and foraging habitat may impact bats, even if conducted while individuals are not present. Standard construction BMPs (e.g., silt fencing) will minimize erosion and subsequent sedimentation, thus reducing potential impacts on aquatic ecosystems. Since potential impacts from sedimentation are expected to be localized, foraging bats should have alternative drinking water and foraging locations. The surrounding landscape will continue to provide an abundant prey base of both terrestrial and aquatic insects during project construction, operation, and maintenance. Therefore, any potential direct effects to bats from a reduction in water quality are anticipated to be insignificant.

Collision

Collision has been documented for Indiana bats and other myotids. The Indiana bat recovery plan indicates that bats do not seem particularly susceptible to vehicle collisions, but it may threaten local populations in certain situations (Service 2007). Russell et al. (2009) assessed the level of mortality from road kills on a bat colony in Pennsylvania and collected 27 road-killed little brown bats and 1 Indiana bat. This study also cited unpublished data from the Penssylvania Game Commission documenting NLEB collision mortality. Curtis et al. (2014) indicates that a dead NLEB was found along a road in Kansas and was thought to have collided with a vehicle. Collision has been documented for other *Myotis* in Europe (Lesinski et al. 2011). Collision risk of bats varies depending on time of year, location of road in relation to roosting/foraging areas), the characteristics of their flight, traffic volume, and whether young bats are dispersing (Lesinski 2007, Lesinski 2008, Russell et al. 2009, Bennett et al. 2011).

It can be difficult to determine whether roads pose greater risk for bats colliding with vehicles or greater likelihood of deterring bat activity in the area (thus decreasing risk of collision). Many studies suggest that roads may serve as a barrier to bats (Bennett and Zurcher 2013, Bennett et al. 2013, Berthinussen and Altringham 2011, Wray et al. 2006). In most cases, we expect there will be a decreased likelihood of bats crossing roads (and therefore, reduced risk of collision) of increasing size (lanes).

Table 4.1 shows the pathway we identified for NLEB responses to collision, and we anticipated that NLEBs will be killed from collision with vehicles. Although some mortality is reasonably certain to occur, we anticipate that relatively small numbers of bats will be impacted per year in each state because of the decreased likelihood of bats crossing major roads. Also, we anticipate the likelihood of mortality will be reduced by the widely dispersed of new road construction and occupancy rates that are typically less than 50%.

Noise from Munitions, Detonations, and Training Vehicles, Aircraft

Recent studies have indicated that anthropogenic noise can alter foraging behavior and success of bats, including some gleaning species like the NLEB (Bunkley et al. 2015; Schaub et al. 2008; Siemers and Schaub 2011). Table 4.1 shows the pathway we identified for NLEB responses to noise from military training operations, and it is possible that NLEBs will be disturbed. A small subset of disturbed individuals may be harmed. However, studies indicate that indicate bats do not avoid active ranges or alter foraging behavior during night-time maneuvers, and NLEBs are expected to become habituated to noise disturbance (Whitaker & Gummer 2002; Service 2010; USFWS 2009). Although some adverse effects to NLEBs may occur from noise from military operations, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%.

Use of Military Training Smoke and Obscurants

Smoke/obscurants are used to conceal military movements and help protect troops and equipment in combat conditions. Although they would be primarily used during the day, smoke/obscurants may be deployed at night. Training on military installations may include, but is not limited to, smokes and obscurants such as fog oil, colored smoke grenades, white phosphorous, and graphite smoke. Research indicates that prolonged dermal and respiratory exposures to these items, except for the graphite smoke, could have adverse effects on roosting and foraging Indiana bats (Service 1998; Service 2012; Driver et al. 2002; USWFS 2009; NRC 1999). Given the similar roosting behavior and foraging locations of the NLEB, it is likely they will also be adversely affected by these smokes and obscurants.

Table 4.1 shows the pathway we identified for NLEB responses to the use of smokes and obscurants, and it is possible that NLEBs will be harmed depending on the specific circumstances. Although some adverse effects to NLEBs are reasonably certain to occur, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the limited use of these chemicals and occupancy rates that are typically less than 50%. In addition, many military installations already limit the use of smokes and obscurants in areas that may affect the Indiana bat, further reducing the impact to NLEBs.

Bridge Maintenance, Repair, or Replacement

NLEBs have been found using bridges for day and night roosts in Illinois, Louisiana, Iowa, and Missouri (Feldhamer et al. 2003; Ferrara and Leberg 2009; Kiser et al. 2002; Benedict and Howell 2008; Droppelman 2014). Altering or removing bridges when occupied by NLEBs is expected to result in adverse effects. Bridge alteration refers to any bridge repair, retrofit, maintenance, and/or rehabilitation work activities that modifies the bridge to the point that it is no longer suitable for roosting.

Table 4.1 shows the two pathways we identified for NLEB responses to bridge work and it is possible that NLEBs will experience reduced fitness and harm depending on the specific circumstances. We expect that NLEBs will be killed or injured bats during activities conducted while bats are present, and the removal of roosts can reduce fitness. Although some adverse effects to NLEBs are reasonably certain to occur from bridge maintenance, repair, or replacement, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%.

Subsurface Drilling or Blasting

Surface-disturbing activities (such as drilling or blasting) in the vicinity of hibernacula may affect bat populations if those activities result in changes to the microclimate (temperature, humidity, and air flow) of the cave or mine (Ellison et al. 2003).

Table 4.1 shows the two pathways we identified for NLEB responses to drilling and blasting, and it is possible that NLEBs will be harmed. These activities can alter the flow of air and water through unknown hibernacula. Although the alteration of unknown hibernacula is reasonably certain to occur, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of timber harvest activities.

Use of Waste Pits to Store Contaminated Fluids

The oil and gas industry (and possibly other industries) occasionally use of temporary waste pits to store materials removed from drilling, including sand used during hydraulic fracturing treatments, wellbore cuttings, bentonite drilling muds, and fluids. These waste pits have been documented to attract and entrap wildlife. Bats may drink contaminated water or become trapped in waste pits and die. Table 4.1 shows the pathway we identified for NLEB responses to waste pits, and it is possible that NLEBs will be harmed. Although some adverse effects to NLEBs are reasonably certain to occur from the use of waste pits, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%.

4.8 CONSERVATION MEASURES IN THE 4(D) RULE

In BOs, we consider how conservation measures included in the proposed action may reduce the severity of effects or the probability of exposure. Prohibitions adopted under the final 4(d) will reduce the severity of effects or the probability of exposure of NLEB to the full scope of activities that may affect the species through regulatory processes under section 7 and section 10 the Act. Under the final 4(d) rule, incidental take involving tree removal in the WNS zone is not prohibited if two conservation measures are followed. The first measure is the year-round application of a 0.25-mile radius buffer (which is equivalent to 125.7 acres) around known NLEB hibernacula. The second conservation measure involves the temporary protection of known, occupied maternity roost trees. Incidental take is prohibited if the activity cuts or destroys a known, occupied maternity roost tree and other trees within a 150-foot radius around the maternity roost tree (which is equivalent to 1.6 acres) during the pup season (June 1-July 31). The 150 ft buffer covers 1.6 acres around a known maternity roost tree. In addition, incidental take is prohibited in hibernacula within the WNS zone; therefore, regardless of the buffer size, NLEBs are protected from take while in known hibernacula when they are most vulnerable.

To determine how these conservation measures reduce the severity of effects or probability of exposure, we compared the acreages affected by the conservation measures to the total forested habitat within the range of the NLEB (Table 4.14). As described in section 2.2, there are currently 1,508 known hibernacula and 1,412 known maternity roost trees. The year-round protection of forested habitat around hibernacula results in a total of 189,556 acres (0.05% of the total forested habitat) in 31 of 37 states (84% of the range) where activities that may affect the NLEB are subject to regulatory processes under sections 7 and 10 of the Act. The temporary protection of known, occupied maternity roosts results in a total of 2,259 acres (<0.001% of the total forested habitat) in 17 of 37 states (46% of the range) where activities that may affect the NLEB are subject to the same regulatory processes.

These two conservation measures are beneficial in that they protect known hibernating populations from take and help protect known maternity colonies from direct harm by temporarily protecting known maternity roost trees during the pup season. However, because known maternity roost trees likely represent a small fraction of the total, the beneficial effect of this conservation measure, which reduces the severity of effects, does not significantly reduce the probability of exposure. Additionally, known roost trees may be cut either before June 1st or after July 31st in compliance with the 4(d) rule, or during that time period with either an incidental take permit under section 10, or an incidental take statement under section 7. The hibernacula conservation measure is more protective in scope (i.e., timing, location, and severity). The severity of the effects and probability of exposure are somewhat reduced, but this beneficial effect extends only to known hibernacula. Like known maternity roost trees, known hibernacula likely represent a small fraction of the total.

4.9 SUMMARY OF IMPACTS OF INDIVIDUALS

Table 4.15 combines the total annual estimated effects of the activities quantified for timber harvest, prescribed fire, forest conversion, and wind turbine operation. Because fatalities from wind turbine operation increase every year between 2015 and 2022, we report the average annual wind fatalities over the time-frame of this consultation. Based on these estimations, we anticipate that up to 117,267 NLEB will be disturbed and 3,285 pups and 980 adults will be harmed annually from timber harvest, prescribed fire, forest conversion, and wind turbine operation.

The disturbance associated with timber harvest, prescribed burning, and forest conversion within maternity roosting areas during the active season (April – October) can cause volant bats to flee their roosts and expend additional energy while exposed to day-time predators. Our methodology computes the number of NLEB affected annually as 117,267 bats (or 1.2% of the population) (Table 4.16). We recognize that not all of the NLEB roosting in an activity area will necessarily respond to disturbance by fleeing their roosts, likely depending on the disturbance intensity and proximity; therefore, we consider this to be an overestimate. Table 4.16 shows that 66 percent of the potential disturbance in maternity roosting areas is due to timber harvest, 18 percent to forest conversion, and 17% to prescribed burning. Disturbance that disrupts normal behavior patterns and creates the likelihood of injury to listed species (e.g., causing a nocturnal species to travel during daylight hours) may result in harm.

Timber harvest, prescribed burning, and forest conversion may also occur in maternity roosting areas during the non-volant season (June 1 – July 31). Heat and smoke from prescribed burning, and tree removal from the other activities, may kill or injure a non-volant pup, who cannot flee the threat unless carried by its mother, which we do not presume precludes this potential harm. We estimate that up to 3,285 NLEB pups (0.1 percent of the total pup population) are exposed to potentially lethal habitat modification annually (Table 4.17). Prescribed burning may affect 56.6

percent of the total pup population (Table 4.17). The potential for death or injury resulting from prescribed burning depends largely on site-specific circumstances, e.g., fire intensity near the maternity roost tree and the height above ground of pups in the maternity roost tree. Not all fires through maternity roosting areas will kill or injure all pups present, but our methodology in this BO estimates that all potentially vulnerable individuals within the expected area of activity/occupancy overlap are affected. We therefore consider this to be an overestimate. Timber harvest and forest conversion account for 33.8 and 9.6 percent of the estimated harm to non-volant pups, respectively (Table 4.17). Unlike prescribed burning, we did not assume that all potentially vulnerable individuals within the expected area of activity/occupancy overlap are affected. We assumed that 15 percent of pups would be injured or killed when their roost tree was felled.

Wind turbine operation and tree removal from timber harvest and forest conversion may also kill or injure adults when they are struck by turbines or when occupied roost trees are felled. We estimate that up to 980 NLEB adults (less than 0.02 percent of the total adult population) are exposed to potentially lethal wind turbines and habitat modification annually (Table 4.18). Wind turbine operation accounts for 66.3% of the adult mortality, followed by timber harvest (25.2%) and forest conversion (8.5%) (Table 4.18). As discussed in Section 4.1.5.2, we believe the wind fatalities may be overestimated by as much as 50% after accounting for population reductions from WNS and current and future curtailment. The adult mortality from tree removal is not as likely to be overestimated because we did not assume that all potentially vulnerable individuals within the expected area of activity/occupancy are affected.

Additional harm is anticipated for unquantified effects from removal from human structures and “other” activities that may affect the NLEB; however, we do not expect the additional impacts to substantially change the total numbers reported in Table 4.15 for reasons discussed above (see section 4.1). In addition, we consider some of the numbers for harm and disturbance in this section to be overestimates as discussed, and we also expect that the numbers affected over time will be reduced as WNS continues to affect the range-wide population. As populations decline as a result of WNS, the chances of any particular activity affecting northern long-eared bats becomes more remote.

4.10 IMPACTS TO POPULATIONS

As described above, individual NLEBs may experience decreased reproductive success and survival as a result of implementation of the final 4(d) rule. Of importance here though, is how these potential adverse effects to individual bats affect the overall health and viability of populations present within the action area. This is best done by looking at the maternity colony and hibernacula populations; however, we do not have enough information about local populations or when and where projects will occur relative to the species’ occurrence.

The finest-scale of analysis we have to examine effects on local populations is at the state level. States vary greatly in the number of maternity colonies estimated per state (Table 2.5). States in the Eastern range generally have the lowest estimated number of maternity colonies, ranging from 16 maternity colonies in Delaware to 6,984 colonies in West Virginia. States with small numbers of maternity colonies are likely at greater risk of extirpation from impacts to individuals. For example, Delaware has 16 maternity colonies estimated to be comprised of 20 females each, for a total adult population size of 640 individuals. Activities implemented according to the final 4(d) rule could disturb 9 individuals in Delaware per year, along with harm to 3 pups and 2 adults per year. If all the annual impacts occurred within one maternity colony, it is possible that the colony would be reduced by at least 10% in one year (2 adults killed from a colony with 20 females = 10%), and potentially more if the 3 pups were also killed. Losses to very small populations may not be sustainable at the local-level. It is possible that the loss of 10% of the maternity colony could result in the loss of that colony, but it is unlikely that that level of impact would occur within a single maternity colony every year. However, areas hardest hit by WNS are likely at greatest risk (i.e., currently much of the Eastern range).

Although local populations could be affected by the implementation of the final 4(d) rule, most of the states have larger populations and more maternity colonies. In addition, less than 2.3% of NLEBs will be disturbed in all states (Table 4.16), less than 1% of pups will be harmed in all states (Table 4.17), and less than 1% of adults will be harmed in all states (Table 4.18). Therefore, the vast majority of individuals and populations that survive WNS will be unaffected by these activities.

Where the species has substantially declined as a result of WNS, the surviving members of the population may be resilient or resistant to WNS. These surviving populations are particularly important to the persistence of the populations. The individual effects analysis indicates that some additional impacts will occur as a result this action. We do not know at this time if the impacts from this action are additive; however, even if the potential mortality from these activities is additive to the impacts from WNS, it is likely that the species will persist in these states based on the number of maternity colonies and widely-dispersed nature of the activities.

Based on the relatively small numbers affected annually compared to the state population sizes, we do not anticipate population-level effects to the NLEB. We conclude that adverse effects from timber harvest, prescribed fire, forest conversion, wind energy, and other activities will not lead to population-level declines in this species. Because we do not anticipate population-level impacts from our action, our analysis of effects to the NLEB is complete.

4.11 INTERRELATED AND INTERDEPENDENT ACTIONS

An interrelated activity is an activity that is part of the proposed action and depends on the proposed action for its justification. An interdependent activity is an activity that has no independent utility apart from the action under consultation. At this time, we are unaware of actions that are interrelated and interdependent with the final 4(d) rule that have not already been considered in this BO.

4.12 TABLES AND FIGURES FOR EFFECTS OF THE ACTION

Table 4.1. Exposure-response analysis for activities conducted in accordance with the final 4(d) rule that may affect the NLEB.

Activity	Subactivity	Stressor	Exposure (time)	Exposure (space)	Resource Affected	Individual Response	Interpretation
Removal from Human Structures	Exclusion	Using exclusion to make a known roost unsuitable	Year-round; indirect effect	All occupied areas except hibernacula	Adults	Reduced fitness	Loss of structures where bat colonies have demonstrated repeated could reduce fitness through additional energy expenditure while searching for a new roost site.
Removal from Human Structures	Rodenticides and sticky traps	Using rodenticides and sticky traps to remove bats	Active season, daytime; direct effect	Roosting areas (maternity and non-maternity)	Individuals	Injury, mortality; harm	Activities conducted while bats are present are likely to kill or injure individuals. We expect this threat to be reduced through the implementation of BMPs for bat removal.
Removal from Human Structures	Eviction Devices	Using eviction or exclusionary devices to remove bats	Active season, daytime; direct effect	Roosting areas (maternity and non-maternity)	Pups	Injury, mortality; harm	Use of exclusionary devices during the non-volant period is likely to result in the death of pups because females cannot return to take care of their young. However, many states require that exclusions be conducted outside of the non-volant period to minimize impacts.
Removal from Human Structures	Rabies testing	Euthanizing bats for rabies testing during removal	Active season, daytime; direct effect	Roosting areas (maternity and non-maternity)	Individuals	Injury, mortality; harm	Rabies testing will kill adults and volant juveniles. Data from MO and NY indicate that an average of 7 bats were killed bats per year during the most recent three years.
Forest Management	Timber Harvest	Reducing mid-story clutter adjacent to roost trees	Year-round; indirect effect	Maternity roosting areas	Vegetation near roost trees	Beneficial through maintenance or improvement of habitat	Beneficial through increased solar radiation on roosts; improved access to roosts; travel corridors to foraging areas; however, we are unable to quantify the degree of benefit in terms of increased survival or reproductive success.
Forest Management, Forest Conversion	Timber Harvest, Construction Activities	Removing unoccupied roost trees	Winter; indirect effect	Maternity roosting areas	Trees	Reduced fitness	Removal of roost trees where bat colonies have demonstrated repeated could reduce fitness through additional energy expenditure while searching for a new roost site.
Forest Management, Forest Conversion	Timber Harvest, Construction Activities	Removing trees that provide habitat used for foraging, swarming, or staging	Year-round; indirect effect	All occupied areas except hibernacula	Insect prey, forest cover that supports (shelters) bat activity	Reduced fitness; energy expenditure for relocating from traditional use areas to alternative habitat	Loss of forest habitat decreases opportunities for growth and successful reproduction. Depending on location and size of the harvest, forest cover removal in the summer home range may cause a shift in home range or relocation. Loss of habitat in staging/swarming areas near hibernacula may cause a similar shift in habitat use for larger numbers of individuals, due to their seasonal concentration in these areas, and may reduce fall mating success and/or reduced fitness in preparation for spring migration
Forest Management, Forest Conversion, Other	Timber Harvest, Construction Activities, Most other subactivities	Disturbance (noise, machinery exhaust, activity) associated with human activities	Active season, daytime; direct effect	Roosting areas (maternity and non-maternity)	Individuals	Disturbance (fleeing); harass	Fleeing disturbance during daylight hours increases the likelihood of predation
Forest Management, Forest Conversion, Other	Timber Harvest, Construction Activities	Altering the flow of air and water through hibernacula.	Winter (direct effect) and active season (indirect effect)	Near hibernacula	Individuals	Arousal from hibernation; reduced fitness, mortality; take in the form of harm.	Response depends on proximity of tree removal to hibernacula entrances, airflow patterns, and local hydrology. Sufficient modification may cause injury or mortality (take in the form of harm).
Forest Management, Forest Conversion	Timber Harvest, Construction Activities	Removing occupied roost trees	Active seasos; direct effect	Maternity roosting areas	Individuals	Injury, mortality; harm	Removing occupied trees is likely to kill or injure pups and adults. For the purposes of this consultation, we assume that 15% of non-volant bats and 3% of adults may be injured or killed.
Forest Conversion	Construction Activities	Removal of forested habitat	Year-round; indirect effect	All occupied areas except hibernacula	Trees	Reduced fitness	Fragmentation of forests patches and travel corridors may result in longer flights to find alternative suitable habitat and colonial disruption.
Forest Management	Prescribed Burning	Creating snags, creating roost features in live trees	Year-round; indirect effect	All occupied areas except hibernacula	Trees	Beneficial through maintenance or improvement of habitat	Beneficial through greater availability of suitable roosts increasing opportunities for successful reproduction, more efficient use of forest habitat however, we are unable to quantify the degree of benefit in terms of increased survival or reproductive success

Table 4.1. Continued.

Activity	Subactivity	Stressor	Exposure (time)	Exposure (space)	Resource Affected	Individual Response	Interpretation
Forest Management	Prescribed Burning	Stimulating growth of ground cover and insect populations	Growing-season following the burn; indirect effect	Foraging areas	Insect prey	Beneficial through maintenance or improvement of habitat	Beneficial through greater availability of insect prey increasing foraging efficiency; however, we are unable to quantify the degree of benefit in terms of increased survival or reproductive success
Forest Management	Prescribed Burning	Thinning mid-story clutter adjacent to roost trees	Growing-season following the burn; indirect effect	Maternity roosting areas	Vegetation near roost trees	Beneficial through maintenance or improvement of habitat	Beneficial through increased solar radiation on roosts; improved access to roosts however, we are unable to quantify the degree of benefit in terms of increased survival or reproductive success.
Forest Management	Prescribed Burning	Destroying existing snags and other trees suitable for roosting	Year-round; indirect effect	All occupied areas except hibernacula	Trees	Reduced fitness	Loss of suitable roosts decreases opportunities for successful reproduction, more efficient use of forest habitat
Forest Management	Prescribed Burning	Heat and smoke	Active season, day time; direct effect	Roosting areas (maternity and non-maternity)	Individuals; adults and volant juveniles	Disturbance (fleeing); harass	Fleeing the line of fire of a prescribed burn during daylight hours increases the likelihood of predation
Forest Management	Prescribed Burning	Heat and smoke	Active season, night time; direct effect	Foraging areas	Individuals; adults and volant juveniles	Disturbance (fleeing)	Fleeing the line of fire of a prescribed burn during night-time foraging is unlikely to cause injury
Forest Management	Prescribed Burning	Heat and smoke	Winter; direct effect	Near hibernacula	Individuals	Arousal from hibernation; reduced fitness, mortality; take in the form of harm	Response depends on proximity of fire to hibernacula entrances and airflow patterns. Sufficient smoke entering hibernacula may cause injury or mortality.
Forest Management	Prescribed Burning	Heat and smoke	Non-volant season; direct effect	Maternity roosting areas	Individuals; non-volant juveniles	Injury, mortality; harm	Response varies with fire intensity and roost height; a combination of high-intensity burns and/or low roosts is likely to cause injury or mortality
Wind Energy	Operation	Sound from Operating Turbines	Active season, day and night; direct effect	Active season; direct effect	Individuals	Disturbance (fleeing)	Studies (Szewczak and Arnett 2006, Horn et al. 2008) have found evidence to suggest that bats are not likely to be negatively affected by sound from operating turbines.
Wind Energy	Operation	Collision with Operating Turbines	Active season, direct effect	All occupied areas except hibernacula	Individuals	Mortality; harm	Collision with wind wind turbines is likely to kill bats
Other	Most subactivities	Lighting	Active season, night; direct effect	All occupied areas except hibernacula	Individuals	Disturbance (fleeing), increased risk of predation; increase energy expenditure; harass	Foraging in lighted areas may increase risk of predation (leading to death) or it may deter bats from flying in those areas. Bats that significantly alter their foraging patterns may increase their energy expenditures resulting in reduced reproductive rates. This depends on the context (e.g., duration, location, extent, type) of the lighting. Some studies also show a beneficial effect of concentrating prey.
Other	Most subactivities	Use of pesticides and herbicides for pest and vegetation control	Active season, direct and indirect effect	All occupied areas except hibernacula	Individuals; insect prey	lethal or sublethal exposure to toxins; reduction in prey availability; harm/harass	Bats may drink contaminated water or forage in affected areas with the potential to eat insects exposed to chemicals. Bats may also be directly exposed to herbicides sprayed in roosting areas. Effects are reduced because all herbidices and pesticides must be used in accordance with their label.
Other	Most subactivities	Chemical contamination from use or spills in/around bat habitat	Active season, direct and indirect effect	All occupied areas except hibernacula	Individuals; insect prey	lethal or sublethal exposure to toxins; reduction in prey availability; harm/harass	Bats may drink contaminated water or forage in affected areas with the potential to eat insects exposed to chemicals.
Other	Most subactivities	Water Quality Alteration; sedimentation	Active season, indirect effect	All occupied areas except hibernacula	Insect prey	Reduced fitness	Temporary effects on water quality could occur during construction, which could reduce local insect populations. Standard construction BMPs (e.g., silt fencing) will minimize erosion and subsequent sedimentation, thus reducing potential impacts on aquatic ecosystems.

Table 4.1. Continued.

Activity	Subactivity	Stressor	Exposure (time)	Exposure (space)	Resource Affected	Individual Response	Interpretation
Other	Military Operations	Noise from munitions, detonations, and training vehicles, including aircraft	Active season, direct effect	All occupied areas except hibernacula	Individuals	Disturbance (fleeing)	Fleeing disturbance increases the likelihood of predation. However, studies indicate bats do not avoid active ranges or alter foraging behavior during night-time maneuvers, and NLEBs are expected to become habituated to noise disturbance.
Other	Military Operations	Use of Military Training Smoke and Obscurants	Active season, direct effect	All occupied areas except hibernacula	Individuals	Injury, mortality; harm	Research indicates that prolonged dermal and respiratory exposures smokes and obsurants could have adverse effects on roosting and foraging bats.
Other	Bridge maintenance, repair, or replacement	Bridge work activities affect roosting bats	Active season, direct effect	Roosting areas (maternity and non-maternity)	Individuals	injury, mortality; harm	Bats may be injured or killed if they do not exit the bridge before it is either removed or the action results in effects to portion of the bridge where the bats are roosting.
Other	Bridge maintenance, repair, or replacement	Bridge work makes it unsuitable for roosting.	Inactive season, indirect effect	Roosting areas (maternity and non-maternity)	Individuals	Increased energy exposure; reduced fitness	Removal of bridges where bat colonies have demonstrated repeated could reduce fitness through additional energy expenditure while searching for a new roost site.
Other	Drilling	Subsurface drilling utility line and road installation	Winter (direct effect) and active season (indirect effect)	Near hibernacula	Individuals	Arousal from hibernation; reduced fitness, mortality; take in the form of harm.	Response depends on proximity of harvest to hibernacula entrances, airflow patterns, and local hydrology. Sufficient modification may cause injury or mortality (take in the form of harm).
Other	Blasting	Use of explosives to remove rocks for utility line and road installation	Winter (direct effect) and active season (indirect effect)	Near hibernacula	Individuals	Arousal from hibernation; reduced fitness, mortality; take in the form of harm.	Response depends on proximity of harvest to hibernacula entrances, airflow patterns, and local hydrology. Sufficient modification may cause injury or mortality (take in the form of harm).
Other	Storage Pits for oil and gas waste	Bats can become trapped in waste pits or drink contaminated water	Active season, direct effect	All occupied areas except hibernacula	Individuals	Injury, mortality; harm	Bats may drink contaminated water or become trapped in waste pits and die.

Table 4.2. Mean annual harvest (acres) for each state included in the analysis (Source: U.S. Forest Service's Forest Inventory EVALIDator web-application Version 1.6.0.03; Available only on internet: http://apps.fs.fed.us/Evalidator/evalidator.jsp).

Region	State	Acres of Forested Land	Years	N (years)	Harvest (acres) National Forest	Other Federal	State & Local	Private	Total	Average (acre/year)	Percent of Annual Average Acres Harvested
Midwest	Iowa	3,013,759	2009-2014	6	0	0	6,290	118,105	124,395	20,733	0.7%
Midwest	Illinois	4,847,480	2009-2014	6	0	7,392	0	220,038	227,430	37,905	0.8%
Midwest	Indiana	4,830,395	2009-2014	6	2,924	3,500	12,114	292,650	311,189	51,865	1.1%
Midwest	Michigan	20,127,048	2009-2014	6	79,571	0	340,950	1,189,042	1,609,563	268,261	1.3%
Midwest	Minnesota	17,370,394	2010-2014	5	43,708	2,977	391,433	360,229	798,346	159,669	0.9%
Midwest	Missouri	15,471,982	2009-2014	6	66,135	0	45,879	933,470	1,045,484	174,247	1.1%
Midwest	Ohio	8,088,277	2009-2014	6	1,945	0	15,572	467,607	485,124	80,854	1.0%
Midwest	Wisconsin	16,980,084	2009-2014	6	75,449	4,738	390,366	1,144,172	1,614,726	269,121	1.6%
Eastern	Connecticut	1,711,749	2009-2014	6	0	0	14,622	44,924	59,546	9,924	0.6%
Eastern	Delaware	339,520	2009-2014	6	0	0	2,540	13,625	16,164	2,694	0.8%
Eastern	Maine	17,660,246	2010-2014	5	0	0	86,952	2,285,161	2,372,113	474,423	2.7%
Eastern	Maryland	2,460,652	2009-2014	6	0	0	11,192	76,740	87,931	14,655	0.6%
Eastern	Massachusetts	3,024,092	2009-2014	6	0	0	16,196	66,640	82,837	13,806	0.5%
Eastern	New Hampshire	4,832,408	2009-2014	6	14,502	7,118	35,153	355,549	412,332	68,722	1.4%
Eastern	New Jersey	1,963,561	2009-2014	6	0	0	0	21,442	21,442	3,574	0.2%
Eastern	New York	18,966,416	2009-2014	6	0	0	62,807	1,002,449	1,065,256	177,543	0.9%
Eastern	Pennsylvania	16,781,960	2009-2014	6	10,966	8,625	128,668	1,026,196	1,174,456	195,743	1.2%
Eastern	Rhode Island	359,519	2009-2014	6	0	0	0	0	0	0	0.0%
Eastern	Vermont	4,591,280	2010-2014	5	4,858	0	5,596	245,487	259,941	51,988	1.1%
Eastern	Virginia	15,907,041	2008-2013	6	2,606	9,518	20,195	1,125,092	1,157,410	192,902	1.2%
Eastern	West Virginia	12,154,471	2009-2014	6	0	0	0	463,133	463,133	77,189	0.6%
Southern	Arkansas	18,754,916	2009-2014	6	193,868	11,975	43,919	2,411,963	2,661,725	443,621	2.4%
Southern	Kentucky	12,471,762	2006-2013	8	17,706	8,644	4,873	847,274	878,496	109,812	0.9%
Southern	Mississippi	19,541,284	2006-2014	9	68,994	21,053	60,562	3,273,286	3,423,895	380,433	1.9%
Southern	North Carolina	18,587,540	2003-2014	12	0	29,351	60,638	2,276,778	2,366,767	197,231	1.1%
Southern	Tennessee	13,941,333	2005-2013	9	0	12,837	3,028	1,151,325	1,167,190	129,688	0.9%
Western	Kansas	2,502,434	2009-2014	6	0	6,205	0	57,781	63,985	10,664	0.4%
Western	Nebraska	1,576,174	2009-2014	6	0	0	1,221	91,823	93,044	15,507	1.0%
Western	North Dakota	759,998	2009-2014	6	0	0	0	0	0	0	0.0%
Western	South Dakota	1,910,934	2009-2014	6	163,971	0	1,489	52,375	217,834	36,306	1.9%
	Total	281,528,709			747,203	133,933	1,762,255	21,614,356	24,261,754	3,669,077	1.3%

Table 4.3. Estimated numbers of NLEB affected (disturbed) annually by human activity from active-season harvest in maternity roosting areas.

Region	State	A. Harvest, Bat Active Season (acres)[1]	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Bats Affected (FxE)
Midwest	Iowa	12,149	3,013,759	0.403%	6.3%	765	0.808	619
Midwest	Illinois	22,212	4,847,480	0.458%	9.4%	2,097	0.701	1,469
Midwest	Indiana	30,393	4,830,395	0.629%	5.7%	1,722	0.701	1,207
Midwest	Michigan	157,201	20,127,048	0.781%	4.8%	7,479	0.701	5,240
Midwest	Minnesota	93,566	17,370,394	0.539%	8.9%	8,295	0.808	6,706
Midwest	Missouri	102,109	15,471,982	0.660%	4.0%	4,040	0.701	2,831
Midwest	Ohio	47,380	8,088,277	0.586%	6.4%	3,013	0.701	2,111
Midwest	Wisconsin	157,705	16,980,084	0.929%	6.8%	10,694	0.701	7,493
Eastern	Connecticut	5,816	1,711,749	0.340%	1.4%	83	0.359	30
Eastern	Delaware	1,579	339,520	0.465%	0.8%	12	0.359	5
Eastern	Maine	278,012	17,660,246	1.574%	1.4%	3,949	0.701	2,767
Eastern	Maryland	8,588	2,460,652	0.349%	0.8%	65	0.359	24
Eastern	Massachusetts	8,090	3,024,092	0.268%	1.0%	83	0.359	30
Eastern	New Hampshire	40,271	4,832,408	0.833%	1.5%	597	0.359	215
Eastern	New Jersey	2,094	1,963,561	0.107%	4.8%	101	0.359	37
Eastern	New York	104,040	18,966,416	0.549%	5.0%	5,233	0.359	1,880
Eastern	Pennsylvania	114,705	16,781,960	0.684%	5.1%	5,856	0.359	2,104
Eastern	Rhode Island	0	359,519	0.000%	1.4%	0	0.359	0
Eastern	Vermont	30,465	4,591,280	0.664%	1.5%	451	0.359	163
Eastern	Virginia	113,040	15,907,041	0.711%	7.3%	8,246	0.359	2,963
Eastern	West Virginia	45,233	12,154,471	0.372%	8.1%	3,662	0.359	1,316
Southern	Arkansas	259,962	18,754,916	1.386%	9.9%	25,636	0.701	17,961
Southern	Kentucky	64,350	12,471,762	0.516%	6.1%	3,956	0.701	2,772
Southern	Mississippi	222,934	19,541,284	1.141%	5.2%	11,515	0.808	9,309
Southern	North Carolina	115,577	18,587,540	0.622%	6.0%	6,982	0.701	4,892
Southern	Tennessee	75,997	13,941,333	0.545%	6.2%	4,717	0.359	1,695
Western	Kansas	6,249	2,502,434	0.250%	3.4%	213	0.808	172
Western	Nebraska	9,087	1,576,174	0.577%	3.4%	309	0.808	250
Western	North Dakota	0	759,998	0.000%	3.4%	0	0.808	0
Western	South Dakota	21,275	1,910,934	1.113%	3.4%	723	0.808	585
	Total	2,150,079	281,528,709	0.764%		120,495		76,846

[1] We prorated the total annual harvest for activities occuring during the active season by using the annual percent of the active season (58.6%).

[2] From Table 2.5

Table 4.4. Estimated numbers of NLEB pups affected (harmed) annually by non-volant season harvest in maternity roosting areas.

Region	State	A. Havest, Non-Volant Season[1] (acres)	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Maternity Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Pups Affected (FxE)
Midwest	Iowa	3,462	3,013,759	0.115%	6.3%	218	0.269	9
Midwest	Illinois	6,330	4,847,480	0.131%	9.4%	598	0.234	21
Midwest	Indiana	8,661	4,830,395	0.179%	5.7%	491	0.234	18
Midwest	Michigan	44,800	20,127,048	0.223%	4.8%	2,131	0.234	75
Midwest	Minnesota	26,665	17,370,394	0.154%	8.9%	2,364	0.269	96
Midwest	Missouri	29,099	15,471,982	0.188%	4.0%	1,151	0.234	41
Midwest	Ohio	13,503	8,088,277	0.167%	6.4%	859	0.234	31
Midwest	Wisconsin	44,943	16,980,084	0.265%	6.8%	3,048	0.234	107
Eastern	Connecticut	1,657	1,711,749	0.097%	1.4%	24	0.120	1
Eastern	Delaware	450	339,520	0.133%	0.8%	4	0.120	1
Eastern	Maine	79,229	17,660,246	0.449%	1.4%	1,125	0.234	40
Eastern	Maryland	2,447	2,460,652	0.099%	0.8%	19	0.120	1
Eastern	Massachusetts	2,306	3,024,092	0.076%	1.0%	24	0.120	1
Eastern	New Hampshire	11,477	4,832,408	0.237%	1.5%	170	0.120	4
Eastern	New Jersey	597	1,963,561	0.030%	4.8%	29	0.120	1
Eastern	New York	29,650	18,966,416	0.156%	5.0%	1,491	0.120	27
Eastern	Pennsylvania	32,689	16,781,960	0.195%	5.1%	1,669	0.120	30
Eastern	Rhode Island	0	359,519	0.000%	1.4%	0	0.120	0
Eastern	Vermont	8,682	4,591,280	0.189%	1.5%	129	0.120	3
Eastern	Virginia	32,215	15,907,041	0.203%	7.3%	2,350	0.120	43
Eastern	West Virginia	12,891	12,154,471	0.106%	8.1%	1,044	0.120	19
Southern	Arkansas	74,085	18,754,916	0.395%	9.9%	7,306	0.234	256
Southern	Kentucky	18,339	12,471,762	0.147%	6.1%	1,127	0.234	40
Southern	Mississippi	63,532	19,541,284	0.325%	5.2%	3,282	0.269	133
Southern	North Carolina	32,938	18,587,540	0.177%	6.0%	1,990	0.234	70
Southern	Tennessee	21,658	13,941,333	0.155%	6.2%	1,344	0.120	25
Western	Kansas	1,781	2,502,434	0.071%	3.4%	61	0.269	3
Western	Nebraska	2,590	1,576,174	0.164%	3.4%	88	0.269	4
Western	North Dakota	0	759,998	0.000%	3.4%	0	0.269	0
Western	South Dakota	6,063	1,910,934	0.317%	3.4%	206	0.269	9
	Total	612,736	281,528,709	0.218%		34,339		1,109

[1] We prorated the total annual harvest for activities occuring during the non-volant season by using the annual percent of the non-volant season (16.7%).

[2] From Table 2.5

Table 4.5. Estimated numbers of NLEB adults affected (harmed) annually by active season harvest in maternity roosting areas.

Region	State	A. Havest, Active Season[1] (acres)	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Maternity Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Adults Affected (FxE)
Midwest	Iowa	12,149	3,013,759	0.403%	6.3%	765	0.081	2
Midwest	Illinois	22,212	4,847,480	0.458%	9.4%	2,097	0.071	5
Midwest	Indiana	30,393	4,830,395	0.629%	5.7%	1,722	0.071	4
Midwest	Michigan	157,201	20,127,048	0.781%	4.8%	7,479	0.071	16
Midwest	Minnesota	93,566	17,370,394	0.539%	8.9%	8,295	0.081	21
Midwest	Missouri	102,109	15,471,982	0.660%	4.0%	4,040	0.071	9
Midwest	Ohio	47,380	8,088,277	0.586%	6.4%	3,013	0.071	7
Midwest	Wisconsin	157,705	16,980,084	0.929%	6.8%	10,694	0.071	23
Eastern	Connecticut	5,816	1,711,749	0.340%	1.4%	83	0.036	1
Eastern	Delaware	1,579	339,520	0.465%	0.8%	12	0.036	1
Eastern	Maine	278,012	17,660,246	1.574%	1.4%	3,949	0.071	9
Eastern	Maryland	8,588	2,460,652	0.349%	0.8%	65	0.036	1
Eastern	Massachusetts	8,090	3,024,092	0.268%	1.0%	83	0.036	1
Eastern	New Hampshire	40,271	4,832,408	0.833%	1.5%	597	0.036	1
Eastern	New Jersey	2,094	1,963,561	0.107%	4.8%	101	0.036	1
Eastern	New York	104,040	18,966,416	0.549%	5.0%	5,233	0.036	6
Eastern	Pennsylvania	114,705	16,781,960	0.684%	5.1%	5,856	0.036	7
Eastern	Rhode Island	0	359,519	0.000%	1.4%	0	0.036	0
Eastern	Vermont	30,465	4,591,280	0.664%	1.5%	451	0.036	1
Eastern	Virginia	113,040	15,907,041	0.711%	7.3%	8,246	0.036	9
Eastern	West Virginia	45,233	12,154,471	0.372%	8.1%	3,662	0.036	4
Southern	Arkansas	259,962	18,754,916	1.386%	9.9%	25,636	0.071	55
Southern	Kentucky	64,350	12,471,762	0.516%	6.1%	3,956	0.071	9
Southern	Mississippi	222,934	19,541,284	1.141%	5.2%	11,515	0.081	29
Southern	North Carolina	115,577	18,587,540	0.622%	6.0%	6,982	0.071	15
Southern	Tennessee	75,997	13,941,333	0.545%	6.2%	4,717	0.036	6
Western	Kansas	6,249	2,502,434	0.250%	3.4%	213	0.081	1
Western	Nebraska	9,087	1,576,174	0.577%	3.4%	309	0.081	1
Western	North Dakota	0	759,998	0.000%	3.4%	0	0.081	0
Western	South Dakota	21,275	1,910,934	1.113%	3.4%	723	0.081	2
	Total	2,150,079	281,528,709	0.764%		120,495		247

[1] We prorated the total annual harvest for activities occuring during the active season by using the annual percent of the active season (58.6%).

[2] From Table 2.5

Table 4.6. Prescribed fire (acres) within forested lands from 2002-2014 for each state included in the analysis (Source: National Interagency Fire Center, modified using the percent of prescribed fire within forested lands in each state from the 2012 National Prescribed Fire Use Survey Report).

Region	State	Acres of Forested Land	Average Annual Acres of Forest Land Burned	Minimum Annual Acres of Forest Land Burned	Maximum Annual Acres of Forest Land Burned	Percent of Average Available Habitat Burned
Midwest	Iowa	3,013,759	10,365	251	26,741	0.3%
Midwest	Illinois	4,847,480	8,102	626	21,890	0.2%
Midwest	Indiana	4,830,395	6,385	1,962	12,600	0.1%
Midwest	Michigan	20,127,048	9,325	1,669	16,652	0.0%
Midwest	Minnesota	17,370,394	102,512	48,837	158,160	0.6%
Midwest	Missouri	15,471,982	35,419	-	95,268	0.2%
Midwest	Ohio	8,088,277	2,781	259	6,767	0.0%
Midwest	Wisconsin	16,980,084	15,831	2,836	25,495	0.1%
Eastern	Connecticut	1,711,749	53	-	113	0.0%
Eastern	Delaware	339,520	50	-	161	0.0%
Eastern	Maine	17,660,246	3	2	5	0.0%
Eastern	Maryland	2,460,652	2,631	524	11,823	0.1%
Eastern	Massachusetts	3,024,092	272	2	815	0.0%
Eastern	New Hampshire	4,832,408	103	35	209	0.0%
Eastern	New Jersey	1,963,561	7,115	-	14,549	0.4%
Eastern	New York	18,966,416	189	39	918	0.0%
Eastern	Pennsylvania	16,781,960	1,795	-	7,013	0.0%
Eastern	Rhode Island	359,519	19	-	97	0.0%
Eastern	Vermont	4,591,280	323	46	902	0.0%
Eastern	Virginia	15,907,041	13,570	5,768	20,546	0.1%
Eastern	West Virginia	12,154,471	718	87	2,950	0.0%
Southern	Arkansas	18,754,916	153,639	100,108	200,998	0.8%
Southern	Kentucky	12,471,762	8,207	3,495	12,097	0.1%
Southern	Mississippi	19,541,284	126,297	1,818	253,860	0.6%
Southern	North Carolina	18,587,540	109,273	38,869	170,668	0.6%
Southern	Tennessee	13,941,333	14,959	1,856	23,085	0.1%
Western	Kansas	2,502,434	77	7	134	0.0%
Western	Nebraska	1,576,174	7,432	2,883	17,339	0.5%
Western	North Dakota	759,998	6,291	1,413	8,464	0.8%
Western	South Dakota	1,910,934	5,171	383	9,291	0.3%
		281,528,709	648,908	213,775	1,119,611	0.2%

Table 4.7. Estimated numbers of NLEB affected (disturbed) annually by heat and smoke from active-season prescribed burning in maternity roosting areas.

Region	State	A. Active Season Burning (acres)[1]	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Bats Affected (FxE)
Midwest	Iowa	6,074	3,013,759	0.2%	6.3%	383	0.808	310
Midwest	Illinois	4,748	4,847,480	0.1%	9.4%	448	0.701	314
Midwest	Indiana	3,742	4,830,395	0.1%	5.7%	212	0.701	149
Midwest	Michigan	5,464	20,127,048	0.0%	4.8%	260	0.701	183
Midwest	Minnesota	60,072	17,370,394	0.3%	8.9%	5,325	0.808	4,306
Midwest	Missouri	20,755	15,471,982	0.1%	4.0%	821	0.701	576
Midwest	Ohio	1,630	8,088,277	0.0%	6.4%	104	0.701	73
Midwest	Wisconsin	9,277	16,980,084	0.1%	6.8%	629	0.701	441
Eastern	Connecticut	31	1,711,749	0.0%	1.4%	0	0.359	1
Eastern	Delaware	29	339,520	0.0%	0.8%	0	0.359	1
Eastern	Maine	2	17,660,246	0.0%	1.4%	0	0.701	1
Eastern	Maryland	1,542	2,460,652	0.1%	0.8%	12	0.359	5
Eastern	Massachusetts	159	3,024,092	0.0%	1.0%	2	0.359	1
Eastern	New Hampshire	60	4,832,408	0.0%	1.5%	1	0.359	1
Eastern	New Jersey	4,170	1,963,561	0.2%	4.8%	202	0.359	73
Eastern	New York	111	18,966,416	0.0%	5.0%	6	0.359	2
Eastern	Pennsylvania	1,052	16,781,960	0.0%	5.1%	54	0.359	20
Eastern	Rhode Island	11	359,519	0.0%	1.4%	0	0.359	1
Eastern	Vermont	189	4,591,280	0.0%	1.5%	3	0.359	2
Eastern	Virginia	7,952	15,907,041	0.0%	7.3%	580	0.359	209
Eastern	West Virginia	421	12,154,471	0.0%	8.1%	34	0.359	13
Southern	Arkansas	90,032	18,754,916	0.5%	9.9%	8,879	0.701	6,221
Southern	Kentucky	4,809	12,471,762	0.0%	6.1%	296	0.701	208
Southern	Mississippi	74,010	19,541,284	0.4%	5.2%	3,823	0.808	3,091
Southern	North Carolina	64,034	18,587,540	0.3%	6.0%	3,868	0.701	2,711
Southern	Tennessee	8,766	13,941,333	0.1%	6.2%	544	0.359	196
Western	Kansas	45	2,502,434	0.0%	3.4%	2	0.808	2
Western	Nebraska	4,355	1,576,174	0.3%	3.4%	148	0.808	120
Western	North Dakota	3,687	759,998	0.5%	3.4%	126	0.808	102
Western	South Dakota	3,030	1,910,934	0.2%	3.4%	103	0.808	84
	Total	380,260	281,528,709	0.1%		26,863		19,417

[1] We prorated the total annual burning for activities occuring during the active season by using the annual percent of the active season (58.6%).

[2] From Table 2.5

Table 4.8. Estimated numbers of NLEB pups affected (harmed) annually by heat and smoke from non-volant season prescribed burning in maternity roosting areas.

Region	State	A. Non-Volant Season[1] Burning (acres)	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Pups Affected (FxE)
Midwest	Iowa	1,731	3,013,759	0.1%	6.3%	109	0.269	30
Midwest	Illinois	1,353	4,847,480	0.0%	9.4%	128	0.234	30
Midwest	Indiana	1,066	4,830,395	0.0%	5.7%	60	0.234	15
Midwest	Michigan	1,557	20,127,048	0.0%	4.8%	74	0.234	18
Midwest	Minnesota	17,119	17,370,394	0.1%	8.9%	1,518	0.269	409
Midwest	Missouri	5,915	15,471,982	0.0%	4.0%	234	0.234	55
Midwest	Ohio	464	8,088,277	0.0%	6.4%	30	0.234	7
Midwest	Wisconsin	2,644	16,980,084	0.0%	6.8%	179	0.234	42
Eastern	Connecticut	9	1,711,749	0.0%	1.4%	0	0.120	1
Eastern	Delaware	8	339,520	0.0%	0.8%	0	0.120	1
Eastern	Maine	1	17,660,246	0.0%	1.4%	0	0.234	1
Eastern	Maryland	439	2,460,652	0.0%	0.8%	3	0.120	1
Eastern	Massachusetts	45	3,024,092	0.0%	1.0%	0	0.120	1
Eastern	New Hampshire	17	4,832,408	0.0%	1.5%	0	0.120	1
Eastern	New Jersey	1,188	1,963,561	0.1%	4.8%	58	0.120	7
Eastern	New York	32	18,966,416	0.0%	5.0%	2	0.120	1
Eastern	Pennsylvania	300	16,781,960	0.0%	5.1%	15	0.120	2
Eastern	Rhode Island	3	359,519	0.0%	1.4%	0	0.120	1
Eastern	Vermont	54	4,591,280	0.0%	1.5%	1	0.120	1
Eastern	Virginia	2,266	15,907,041	0.0%	7.3%	165	0.120	20
Eastern	West Virginia	120	12,154,471	0.0%	8.1%	10	0.120	2
Southern	Arkansas	25,658	18,754,916	0.1%	9.9%	2,530	0.234	591
Southern	Kentucky	1,371	12,471,762	0.0%	6.1%	84	0.234	20
Southern	Mississippi	21,092	19,541,284	0.1%	5.2%	1,089	0.269	294
Southern	North Carolina	18,249	18,587,540	0.1%	6.0%	1,102	0.234	258
Southern	Tennessee	2,498	13,941,333	0.0%	6.2%	155	0.120	19
Western	Kansas	13	2,502,434	0.0%	3.4%	0	0.269	1
Western	Nebraska	1,241	1,576,174	0.1%	3.4%	42	0.269	12
Western	North Dakota	1,051	759,998	0.1%	3.4%	36	0.269	10
Western	South Dakota	864	1,910,934	0.0%	3.4%	29	0.269	8
	Total	108,368	281,528,709	0.038%		7,656		1,859

[1] We prorated the total annual burning for activities occuring during the non-volant season by using the annual percent of the non-volant season (16.7%).

[2] From Table 2.5

Table 4.9. Mean annual acres of forest conversion harvest for each state included in the analysis.

REGION	STATE	Acres of Forested Land	Approximate Acres of Forest Lost per Year (NLCD change 2001 to 2011)	Percent of Habitat Lost Annually	Approximate Acres of Forest Lost by 2022	Percent of Habitat Lost by 2022
Midwest	Iowa	3,013,759	2,520	0.1%	17,641	0.6%
Midwest	Illinois	4,847,480	6,156	0.1%	43,092	0.9%
Midwest	Indiana	4,830,395	4,002	0.1%	28,011	0.6%
Midwest	Michigan	20,127,048	44,704	0.2%	312,930	1.6%
Midwest	Minnesota	17,370,394	52,135	0.3%	364,942	2.1%
Midwest	Missouri	15,471,982	16,968	0.1%	118,775	0.8%
Midwest	Ohio	8,088,277	13,522	0.2%	94,655	1.2%
Midwest	Wisconsin	16,980,084	30,191	0.2%	211,334	1.2%
Eastern	Connecticut	1,711,749	2,940	0.2%	20,577	1.2%
Eastern	Delaware	339,520	1,492	0.4%	10,444	3.1%
Eastern	Maine	17,660,246	52,154	0.3%	365,076	2.1%
Eastern	Maryland	2,460,652	6,286	0.3%	43,999	1.8%
Eastern	Massachusetts	3,024,092	7,075	0.2%	49,526	1.6%
Eastern	New Hampshire	4,832,408	12,002	0.2%	84,016	1.7%
Eastern	New Jersey	1,963,561	6,045	0.3%	42,318	2.2%
Eastern	New York	18,966,416	14,117	0.1%	98,822	0.5%
Eastern	Pennsylvania	16,781,960	22,638	0.1%	158,468	0.9%
Eastern	Rhode Island	359,519	715	0.2%	5,003	1.4%
Eastern	Vermont	4,591,280	3,858	0.1%	27,008	0.6%
Eastern	Virginia	15,907,041	95,261	0.6%	666,824	4.2%
Eastern	West Virginia	12,154,471	12,700	0.1%	88,899	0.7%
Southern	Arkansas	18,754,916	115,372	0.6%	807,604	4.3%
Southern	Kentucky	12,471,762	23,167	0.2%	162,169	1.3%
Southern	Mississippi	19,541,284	162,759	0.8%	1,139,312	5.8%
Southern	North Carolina	18,587,540	130,835	0.7%	915,845	4.9%
Southern	Tennessee	13,941,333	54,006	0.4%	378,039	2.7%
Western	Kansas	2,502,434	4,224	0.2%	29,567	1.2%
Western	Nebraska	1,576,174	4,036	0.3%	28,252	1.8%
Western	North Dakota	759,998	1,826	0.2%	12,785	1.7%
Western	South Dakota	1,910,934	10,532	0.6%	73,725	3.9%
	TOTALS	281,528,709	914,237	0.3%	6,399,657	2.3%

Table 4.10. Estimated numbers of NLEB affected (disturbed) annually by human activity from active-season forest conversion in maternity roosting areas.

Region	State	A. Forest Conversion, Bat Active Season (acres)[1]	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Bats Affected (FxE)
Midwest	Iowa	1,477	3,013,759	0.049%	6.3%	93	0.808	76
Midwest	Illinois	3,607	4,847,480	0.074%	9.4%	341	0.701	239
Midwest	Indiana	2,345	4,830,395	0.049%	5.7%	133	0.701	94
Midwest	Michigan	26,197	20,127,048	0.130%	4.8%	1,246	0.701	874
Midwest	Minnesota	30,551	17,370,394	0.176%	8.9%	2,708	0.808	2,190
Midwest	Missouri	9,943	15,471,982	0.064%	4.0%	393	0.701	276
Midwest	Ohio	7,924	8,088,277	0.098%	6.4%	504	0.701	354
Midwest	Wisconsin	17,692	16,980,084	0.104%	6.8%	1,200	0.701	841
Eastern	Connecticut	1,723	1,711,749	0.101%	1.4%	25	0.359	9
Eastern	Delaware	874	339,520	0.258%	0.8%	7	0.359	3
Eastern	Maine	30,562	17,660,246	0.173%	1.4%	434	0.701	305
Eastern	Maryland	3,683	2,460,652	0.150%	0.8%	28	0.359	11
Eastern	Massachusetts	4,146	3,024,092	0.137%	1.0%	43	0.359	16
Eastern	New Hampshire	7,033	4,832,408	0.146%	1.5%	104	0.359	38
Eastern	New Jersey	3,543	1,963,561	0.180%	4.8%	171	0.359	62
Eastern	New York	8,273	18,966,416	0.044%	5.0%	416	0.359	150
Eastern	Pennsylvania	13,266	16,781,960	0.079%	5.1%	677	0.359	244
Eastern	Rhode Island	419	359,519	0.116%	1.4%	6	0.359	3
Eastern	Vermont	2,261	4,591,280	0.049%	1.5%	33	0.359	13
Eastern	Virginia	55,823	15,907,041	0.351%	7.3%	4,072	0.359	1,463
Eastern	West Virginia	7,442	12,154,471	0.061%	8.1%	602	0.359	217
Southern	Arkansas	67,608	18,754,916	0.360%	9.9%	6,667	0.701	4,672
Southern	Kentucky	13,576	12,471,762	0.109%	6.1%	835	0.701	585
Southern	Mississippi	95,377	19,541,284	0.488%	5.2%	4,926	0.808	3,983
Southern	North Carolina	76,669	18,587,540	0.412%	6.0%	4,632	0.701	3,245
Southern	Tennessee	31,647	13,941,333	0.227%	6.2%	1,964	0.359	706
Western	Kansas	2,475	2,502,434	0.099%	3.4%	84	0.808	69
Western	Nebraska	2,365	1,576,174	0.150%	3.4%	80	0.808	66
Western	North Dakota	1,070	759,998	0.141%	3.4%	36	0.808	30
Western	South Dakota	6,172	1,910,934	0.323%	3.4%	210	0.808	170
	Total	535,743	281,528,709	0.190%		32,673		21,004

[1] We prorated the total annual conversion for activities occuring during the active season by using the annual percent of the active season (58.6%).

[2] From Table 2.5

Table 4.11. Estimated numbers of NLEB pups affected (harmed) annually by non-volant-season forest conversion in maternity roosting areas.

Region	State	A. Forest Conversion, Non-Volant Season[1] (acres)	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Maternity Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Pups Affected (FxE)
Midwest	Iowa	421	3,013,759	0.014%	6.3%	27	0.269	2
Midwest	Illinois	1,028	4,847,480	0.021%	9.4%	97	0.234	4
Midwest	Indiana	668	4,830,395	0.014%	5.7%	38	0.234	2
Midwest	Michigan	7,466	20,127,048	0.037%	4.8%	355	0.234	13
Midwest	Minnesota	8,706	17,370,394	0.050%	8.9%	772	0.269	32
Midwest	Missouri	2,834	15,471,982	0.018%	4.0%	112	0.234	4
Midwest	Ohio	2,258	8,088,277	0.028%	6.4%	144	0.234	6
Midwest	Wisconsin	5,042	16,980,084	0.030%	6.8%	342	0.234	12
Eastern	Connecticut	491	1,711,749	0.029%	1.4%	7	0.120	1
Eastern	Delaware	249	339,520	0.073%	0.8%	2	0.120	1
Eastern	Maine	8,710	17,660,246	0.049%	1.4%	124	0.234	5
Eastern	Maryland	1,050	2,460,652	0.043%	0.8%	8	0.120	1
Eastern	Massachusetts	1,182	3,024,092	0.039%	1.0%	12	0.120	1
Eastern	New Hampshire	2,004	4,832,408	0.041%	1.5%	30	0.120	1
Eastern	New Jersey	1,010	1,963,561	0.051%	4.8%	49	0.120	1
Eastern	New York	2,358	18,966,416	0.012%	5.0%	119	0.120	3
Eastern	Pennsylvania	3,781	16,781,960	0.023%	5.1%	193	0.120	4
Eastern	Rhode Island	119	359,519	0.033%	1.4%	2	0.120	1
Eastern	Vermont	644	4,591,280	0.014%	1.5%	10	0.120	1
Eastern	Virginia	15,909	15,907,041	0.100%	7.3%	1,160	0.120	21
Eastern	West Virginia	2,121	12,154,471	0.017%	8.1%	172	0.120	4
Southern	Arkansas	19,267	18,754,916	0.103%	9.9%	1,900	0.234	67
Southern	Kentucky	3,869	12,471,762	0.031%	6.1%	238	0.234	9
Southern	Mississippi	27,181	19,541,284	0.139%	5.2%	1,404	0.269	57
Southern	North Carolina	21,849	18,587,540	0.118%	6.0%	1,320	0.234	47
Southern	Tennessee	9,019	13,941,333	0.065%	6.2%	560	0.120	11
Western	Kansas	705	2,502,434	0.028%	3.4%	24	0.269	1
Western	Nebraska	674	1,576,174	0.043%	3.4%	23	0.269	1
Western	North Dakota	305	759,998	0.040%	3.4%	10	0.269	1
Western	South Dakota	1,759	1,910,934	0.092%	3.4%	60	0.269	3
	Total	152,678	281,528,709	0.054%		9,311		317

[1] We prorated the total annual conversion for activities occuring during the non-volant season by using the annual percent of the non-volant season (16.7%).

[2] From Table 2.5

Table 4.12. Estimated numbers of NLEB adults affected (harmed) annually by active-season forest conversion in maternity roosting areas.

Region	State	A. Forest Conversion, Active Season[1] (acres)	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Maternity Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Adults Affected (FxE)
Midwest	Iowa	1,477	3,013,759	0.049%	6.3%	93	0.081	1
Midwest	Illinois	3,607	4,847,480	0.074%	9.4%	341	0.071	1
Midwest	Indiana	2,345	4,830,395	0.049%	5.7%	133	0.071	1
Midwest	Michigan	26,197	20,127,048	0.130%	4.8%	1,246	0.071	3
Midwest	Minnesota	30,551	17,370,394	0.176%	8.9%	2,708	0.081	7
Midwest	Missouri	9,943	15,471,982	0.064%	4.0%	393	0.071	1
Midwest	Ohio	7,924	8,088,277	0.098%	6.4%	504	0.071	2
Midwest	Wisconsin	17,692	16,980,084	0.104%	6.8%	1,200	0.071	3
Eastern	Connecticut	1,723	1,711,749	0.101%	1.4%	25	0.036	1
Eastern	Delaware	874	339,520	0.258%	0.8%	7	0.036	1
Eastern	Maine	30,562	17,660,246	0.173%	1.4%	434	0.071	1
Eastern	Maryland	3,683	2,460,652	0.150%	0.8%	28	0.036	1
Eastern	Massachusetts	4,146	3,024,092	0.137%	1.0%	43	0.036	1
Eastern	New Hampshire	7,033	4,832,408	0.146%	1.5%	104	0.036	1
Eastern	New Jersey	3,543	1,963,561	0.180%	4.8%	171	0.036	1
Eastern	New York	8,273	18,966,416	0.044%	5.0%	416	0.036	1
Eastern	Pennsylvania	13,266	16,781,960	0.079%	5.1%	677	0.036	1
Eastern	Rhode Island	419	359,519	0.116%	1.4%	6	0.036	1
Eastern	Vermont	2,261	4,591,280	0.049%	1.5%	33	0.036	1
Eastern	Virginia	55,823	15,907,041	0.351%	7.3%	4,072	0.036	5
Eastern	West Virginia	7,442	12,154,471	0.061%	8.1%	602	0.036	1
Southern	Arkansas	67,608	18,754,916	0.360%	9.9%	6,667	0.071	15
Southern	Kentucky	13,576	12,471,762	0.109%	6.1%	835	0.071	2
Southern	Mississippi	95,377	19,541,284	0.488%	5.2%	4,926	0.081	13
Southern	North Carolina	76,669	18,587,540	0.412%	6.0%	4,632	0.071	10
Southern	Tennessee	31,647	13,941,333	0.227%	6.2%	1,964	0.036	3
Western	Kansas	2,475	2,502,434	0.099%	3.4%	84	0.081	1
Western	Nebraska	2,365	1,576,174	0.150%	3.4%	80	0.081	1
Western	North Dakota	1,070	759,998	0.141%	3.4%	36	0.081	1
Western	South Dakota	6,172	1,910,934	0.323%	3.4%	210	0.081	1
	Total	535,743	281,528,709	0.190%		32,673		83

[1] We prorated the total annual harvest for activities occuring during the active season by using the annual percent of the active season (58.6%).

[2] From Table 2.5

Table 4.13. Estimated NLEB fatalities from wind energy operation created using current and projected wind capacity through 2022.

REGION	STATE	Installed Wind Capacity in 2014 (MW)	Projected Wind Capacity in 2020 (MW)	Projected Wind Capacity in 2030 (MW)	Mean Annual Build-out 2014-2020 (MW)	Mean Annual Build-out 2021-2022 (MW)	Current Fatality through 2014	Annual Fatality 2015	Annual Fatality 2016	Annual Fatality 2017	Annual Fatality 2018	Annual Fatality 2019	Annual Fatality 2020	Annual Fatality 2021	Annual Fatality 2022	Total Fatality All Years
Midwest	Iowa	5688	6200	17300	85	1110	90	91	93	94	95	97	98	115	133	906
Midwest	Illinois	3568	3980	19490	69	1551	56	57	59	60	61	62	63	87	112	616
Midwest	Indiana	1745	2610	13500	144	1089	28	30	32	34	37	39	41	58	76	375
Midwest	Michigan[1]	1531	1531	1850	0	32	24	24	24	24	24	24	24	25	25	219
Midwest	Minnesota	3035	3470	3990	73	52	48	49	50	51	53	54	55	56	56	472
Midwest	Missouri	459	1280	4350	137	307	7	9	12	14	16	18	20	25	30	151
Midwest	Ohio	435	2990	5320	426	233	7	14	20	27	34	41	47	51	55	295
Midwest	Wisconsin	648	1320	1640	112	32	10	12	14	16	17	19	21	21	22	152
Eastern	Connecticut	0	130	130	22	0	0	0	1	1	1	2	2	2	2	11
Eastern	Delaware[2]	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Eastern	Maine	440	950	950	85	0	7	8	10	11	12	14	15	15	15	107
Eastern	Maryland	160	820	820	110	0	3	4	6	8	9	11	13	13	13	80
Eastern	Massachusetts	107	270	270	27	0	2	2	3	3	3	4	4	4	4	29
Eastern	New Hampshire	171	470	470	50	0	3	3	4	5	6	7	7	7	7	50
Eastern	New Jersey[2]	9	9	0	0	0	0	0	0	0	0	0	0	0	0	1
Eastern	New York	1748	1750	3860	0	0	28	28	28	28	28	28	28	28	28	249
Eastern	Pennsylvania[2]	1340	5580	5400	707	0	21	32	43	55	66	77	88	88	88	559
Eastern	Rhode Island[2]	9	9	0	0	0	0	0	0	0	0	0	0	0	0	1
Eastern	Vermont[2]	119	440	430	54	0	2	3	4	4	5	6	7	7	7	45
Eastern	Virginia	0	100	830	17	73	0	0	1	1	1	1	2	3	4	12
Eastern	West Virginia	583	600	2030	3	143	9	9	9	9	9	9	9	12	14	91
Southern	Arkansas	0	0	2550	0	255	0	0	0	0	0	0	0	4	8	12
Southern	Kentucky	0	0	950	0	95	0	0	0	0	0	0	0	2	3	5
Southern	Mississippi	0	0	450	0	45	0	0	0	0	0	0	0	1	1	2
Southern	North Carolina	0	750	750	125	0	0	2	4	6	8	10	12	12	12	65
Southern	Tennessee	29	29	1310	0	128	0	0	0	0	0	0	0	2	5	10
Western	Kansas[2]	2967	3420	3270	76	0	47	48	49	50	52	53	54	54	54	461
Western	Nebraska	812	1260	1360	75	10	13	14	15	16	18	19	20	20	20	155
Western	North Dakota	1886	2870	4710	164	184	30	32	35	38	40	43	45	48	51	362
Western	South Dakota	803	1260	2400	76	114	13	14	15	16	17	19	20	22	24	159
Totals		**28294**	**44100**	**100380**	**2634**	**5453**	**447**	**489**	**530**	**572**	**613**	**655**	**697**	**783**	**869**	**5654**

[1]Projections were held constant for Michigan between 2014 and 2020 because 2020 projections were already exceeded.

[2]Projections are expected to decline slightly between 2020-2030; however, we did not reduce capacity because we assume constructed facilities will continue to operate.

Table 4.14. Influence of conservation measures for tree removal activities included in the final 4(d) rule for the NLEB.

Range	State	Known Hibernacula	Known Occupied Maternity Roost Trees	Acres Covered by Hibernacula Conservation Measure[1]	Acres Covered by Maternity Roost Tree Conservation Measure[2]	Acres of Forested Land	Percent of Total Available Habitat Covered by Measures
Midwest	Iowa	2	14	251	22	3,013,759	0.01%
Midwest	Illinois	44	39	5,531	62	4,847,480	0.12%
Midwest	Indiana	69	193	8,673	309	4,830,395	0.19%
Midwest	Michigan	77	25	9,679	40	20,127,048	0.05%
Midwest	Minnesota	15	102	1,886	163	17,370,394	0.01%
Midwest	Missouri	269	58	33,813	93	15,471,982	0.22%
Midwest	Ohio	32	4	4,022	6	8,088,277	0.05%
Midwest	Wisconsin	67	84	8,422	134	16,980,084	0.05%
Eastern	Connecticut	8	0	1,006	0	1,711,749	0.06%
Eastern	Delaware	2	0	251	0	339,520	0.07%
Eastern	Maine	3	0	377	0	17,660,246	0.00%
Eastern	Maryland	8	0	1,006	0	2,460,652	0.04%
Eastern	Massachusetts	7	16	880	26	3,024,092	0.03%
Eastern	New Hampshire	11	0	1,383	0	4,832,408	0.03%
Eastern	New Jersey	9	47	1,131	75	1,963,561	0.06%
Eastern	New York	90	27	11,313	43	18,966,416	0.06%
Eastern	Pennsylvania	322	157	40,475	251	16,781,960	0.24%
Eastern	Rhode Island	0	0	0	0	359,519	0.00%
Eastern	Vermont	16	0	2,011	0	4,591,280	0.04%
Eastern	Virginia	11	12	1,383	19	15,907,041	0.01%
Eastern	West Virginia	104	231	13,073	370	12,154,471	0.11%
Southern	Alabama	11	0	1,383	0	22,876,792	0.01%
Southern	Arkansas	77	310	9,679	496	18,754,916	0.05%
Southern	Georgia	6	20	754	32	24,768,236	0.00%
Southern	Kentucky	122	254	15,335	406	12,471,762	0.13%
Southern	Louisiana	0	0	0	0	14,540,135	0.00%
Southern	Mississippi	0	0	0	0	19,541,284	0.00%
Southern	North Carolina	29	101	3,645	162	18,587,540	0.02%
Southern	Oklahoma	9	0	1,131	0	12,646,138	0.01%
Southern	South Carolina	3	0	377	0	13,120,509	0.00%
Southern	Tennessee	61	50	7,668	80	13,941,333	0.06%
Western	Kansas	1	0	126	0	2,502,434	0.01%
Western	Montana	0	0	0	0	25,573,200	0.00%
Western	Nebraska	2	0	251	0	759,998	0.03%
Western	North Dakota	0	0	0	0	1,576,174	0.00%
Western	South Dakota	21	0	2,640	0	1,910,934	0.14%
Western	Wyoming	0	0	0	0	11,448,541	0.00%
	Total	1,508	1,744	189,556	2,790	406,502,260	0.05%

[1]Hibernacula buffer circles have a radius of 0.25 mi, which is 125.7 acres

[2]Maternity roost trees have a temporary buffer circle with a 150 ft radius, which is 1.6 acres

Table 4.15. Summary of annual disturbance and harm estimates from timber harvest, prescribed fire, forest conversion, and wind[4].

Region	State	Harass Timber Harvest	Harass Prescribed Fire	Harass Forest Conversion	Harm (pups) Timber Harvest	Harm (pups) Prescribed Fire	Harm (pups) Forest Conversion	Harm (adults) Timber Harvest	Harm (adults) Forest Conversion	Harm (adults) Average Wind	Total Annual Harassment	Total Annual Harm (pups)	Total Annual Harm (adults)
Midwest	Iowa	619	310	76	9	30	2	2	1	102	1,005	41	105
Midwest	Illinois	1,469	314	239	21	30	4	5	1	70	2,022	55	76
Midwest	Indiana	1,207	149	94	18	15	2	4	1	43	1,450	35	48
Midwest	Michigan	5,240	183	874	75	18	13	16	3	24	6,297	106	43
Midwest	Minnesota	6,706	4,306	2,190	96	409	32	21	7	53	13,202	537	81
Midwest	Missouri	2,831	576	276	41	55	4	9	1	18	3,683	100	28
Midwest	Ohio	2,111	73	354	31	7	6	7	2	36	2,538	44	45
Midwest	Wisconsin	7,493	441	841	107	42	12	23	3	18	8,775	161	44
Eastern	Connecticut	30	1	9	1	1	1	1	1	1	40	3	3
Eastern	Delaware	5	1	3	1	1	1	1	1	0	9	3	2
Eastern	Maine	2,767	1	305	40	1	5	9	1	13	3,073	46	23
Eastern	Maryland	24	5	11	1	1	1	1	1	10	40	3	12
Eastern	Massachusetts	30	1	16	1	1	1	1	1	3	47	3	5
Eastern	New Hampshire	215	1	38	4	1	1	1	1	6	254	6	8
Eastern	New Jersey	37	73	62	1	7	1	1	1	0	172	9	2
Eastern	New York	1,880	2	150	27	1	3	6	1	28	2,032	31	35
Eastern	Pennsylvania	2,104	20	244	30	2	4	7	1	67	2,368	36	75
Eastern	Rhode Island	0	1	3	0	1	1	0	1	0	4	2	1
Eastern	Vermont	163	2	13	3	1	1	1	1	5	178	5	7
Eastern	Virginia	2,963	209	1,463	43	20	21	9	5	2	4,635	84	16
Eastern	West Virginia	1,316	13	217	19	2	4	4	1	10	1,546	25	15
Southern	Arkansas	17,961	6,221	4,672	256	591	67	55	15	2	28,854	914	72
Southern	Kentucky	2,772	208	585	40	20	9	9	2	1	3,565	69	12
Southern	Mississippi	9,309	3,091	3,983	133	294	57	29	13	0	16,383	484	42
Southern	North Carolina	4,892	2,711	3,245	70	258	47	15	10	8	10,848	375	33
Southern	Tennessee	1,695	196	706	25	19	11	6	3	1	2,597	55	10
Western	Kansas	172	2	69	3	1	1	1	1	52	243	5	54
Western	Nebraska	250	120	66	4	12	1	1	1	18	436	17	20
Western	North Dakota	0	102	30	0	10	1	0	1	42	132	11	43
Western	South Dakota	585	84	170	9	8	3	2	1	18	839	20	21
	Total	76,846	19,417	21,004	1,109	1,859	317	247	83	650	117,267	3,285	980

[4] Wind is the mean annual estimate from 2015 to 2022 reported in Table 4.13.

Table 4.16. Summary of the activities expected to disturb NLEB annually. The total number of bats per state includes adults and pups.

Region	State	Total # Bats Harassed per year	Percent Harass from Burning	Percent Harass from Harvest	Percent Harass from Conversion	Total # Bats per State	Percent Total Bats Affected
Midwest	Iowa	1,005	30.8%	61.6%	7.6%	153,495	0.7%
Midwest	Illinois	2,022	15.5%	72.7%	11.8%	320,580	0.6%
Midwest	Indiana	1,450	10.3%	83.2%	6.5%	191,763	0.8%
Midwest	Michigan	6,297	2.9%	83.2%	13.9%	670,878	0.9%
Midwest	Minnesota	13,202	32.6%	50.8%	16.6%	1,244,835	1.1%
Midwest	Missouri	3,683	15.6%	76.9%	7.5%	428,922	0.9%
Midwest	Ohio	2,538	2.9%	83.2%	13.9%	360,360	0.7%
Midwest	Wisconsin	8,775	5.0%	85.4%	9.6%	806,715	1.1%
Eastern	Connecticut	40	2.5%	75.0%	22.5%	8,760	0.5%
Eastern	Delaware	9	11.1%	55.6%	33.3%	960	0.9%
Eastern	Maine	3,073	0.0%	90.0%	9.9%	175,734	1.7%
Eastern	Maryland	40	12.5%	60.0%	27.5%	6,720	0.6%
Eastern	Massachusetts	47	2.1%	63.8%	34.0%	11,160	0.4%
Eastern	New Hampshire	254	0.4%	84.6%	15.0%	25,740	1.0%
Eastern	New Jersey	172	42.4%	21.5%	36.0%	34,140	0.5%
Eastern	New York	2,032	0.1%	92.5%	7.4%	342,720	0.6%
Eastern	Pennsylvania	2,368	0.8%	88.9%	10.3%	307,800	0.8%
Eastern	Rhode Island	4	25.0%	0.0%	75.0%	1,860	0.2%
Eastern	Vermont	178	1.1%	91.6%	7.3%	24,420	0.7%
Eastern	Virginia	4,635	4.5%	63.9%	31.6%	416,880	1.1%
Eastern	West Virginia	1,546	0.8%	85.1%	14.0%	353,520	0.4%
Southern	Arkansas	28,854	21.6%	62.2%	16.2%	1,295,775	2.2%
Southern	Kentucky	3,565	5.8%	77.8%	16.4%	537,147	0.7%
Southern	Mississippi	16,383	18.9%	56.8%	24.3%	815,940	2.0%
Southern	North Carolina	10,848	25.0%	45.1%	29.9%	786,708	1.4%
Southern	Tennessee	2,597	7.5%	65.3%	27.2%	310,920	0.8%
Western	Kansas	243	0.8%	70.8%	28.4%	68,850	0.4%
Western	Nebraska	436	27.5%	57.3%	15.1%	43,335	1.0%
Western	North Dakota	132	77.3%	0.0%	22.7%	20,925	0.6%
Western	South Dakota	839	10.0%	69.7%	20.3%	52,515	1.6%
	Total	117,267	16.6%	65.5%	17.9%	9,820,077	1.2%

Table 4.17. Summary of the activities expected to harm NLEB pups annually.

Region	State	Total # Pups Harmed per year	Percent Harm from Burning	Percent Harm from Harvest	Percent Harm from Conversion	Total # Pups per State	Percent Total Pups Affected
Midwest	Iowa	41	73.2%	22.0%	4.9%	51,165	0.1%
Midwest	Illinois	55	54.5%	38.2%	7.3%	106,860	0.1%
Midwest	Indiana	35	42.9%	51.4%	5.7%	63,921	0.1%
Midwest	Michigan	106	17.0%	70.8%	12.3%	223,626	0.0%
Midwest	Minnesota	537	76.2%	17.9%	6.0%	414,945	0.1%
Midwest	Missouri	100	55.0%	41.0%	4.0%	142,974	0.1%
Midwest	Ohio	44	15.9%	70.5%	13.6%	120,120	0.0%
Midwest	Wisconsin	161	26.1%	66.5%	7.5%	268,905	0.1%
Eastern	Connecticut	3	33.3%	33.3%	33.3%	2,920	0.1%
Eastern	Delaware	3	33.3%	33.3%	33.3%	320	0.9%
Eastern	Maine	46	2.2%	87.0%	10.9%	58,578	0.1%
Eastern	Maryland	3	33.3%	33.3%	33.3%	2,240	0.1%
Eastern	Massachusetts	3	33.3%	33.3%	33.3%	3,720	0.1%
Eastern	New Hampshire	6	16.7%	66.7%	16.7%	8,580	0.1%
Eastern	New Jersey	9	77.8%	11.1%	11.1%	11,380	0.1%
Eastern	New York	31	3.2%	87.1%	9.7%	114,240	0.0%
Eastern	Pennsylvania	36	5.6%	83.3%	11.1%	102,600	0.0%
Eastern	Rhode Island	2	50.0%	0.0%	50.0%	620	0.3%
Eastern	Vermont	5	20.0%	60.0%	20.0%	8,140	0.1%
Eastern	Virginia	84	23.8%	51.2%	25.0%	138,960	0.1%
Eastern	West Virginia	25	8.0%	76.0%	16.0%	117,840	0.0%
Southern	Arkansas	914	64.7%	28.0%	7.3%	431,925	0.2%
Southern	Kentucky	69	29.0%	58.0%	13.0%	179,049	0.0%
Southern	Mississippi	484	60.7%	27.5%	11.8%	271,980	0.2%
Southern	North Carolina	375	68.8%	18.7%	12.5%	262,236	0.1%
Southern	Tennessee	55	34.5%	45.5%	20.0%	103,640	0.1%
Western	Kansas	5	20.0%	60.0%	20.0%	22,950	0.0%
Western	Nebraska	17	70.6%	23.5%	5.9%	14,445	0.1%
Western	North Dakota	11	90.9%	0.0%	9.1%	6,975	0.2%
Western	South Dakota	20	40.0%	45.0%	15.0%	17,505	0.1%
	Total	3,285	56.6%	33.8%	9.6%	3,273,359	0.1%

Table 4.18. Summary of the activities expected to harm NLEB adults annually.

Region	State	Total # Adults Harmed per year	Percent Harm from Harvest	Percent Harm from Conversion	Percent Harm from Wind	Total # Adults per State	Percent Total Adults Affected
Midwest	Iowa	105	1.9%	1.0%	97.1%	102,330	0.10%
Midwest	Illinois	76	6.6%	1.3%	92.1%	213,720	0.04%
Midwest	Indiana	48	8.3%	2.1%	89.7%	127,842	0.04%
Midwest	Michigan	43	37.0%	6.9%	56.1%	447,252	0.01%
Midwest	Minnesota	81	25.9%	8.6%	65.4%	829,890	0.01%
Midwest	Missouri	28	32.1%	3.6%	64.3%	285,948	0.01%
Midwest	Ohio	45	15.5%	4.4%	80.1%	240,240	0.02%
Midwest	Wisconsin	44	52.6%	6.9%	40.6%	537,810	0.01%
Eastern	Connecticut	3	29.6%	29.6%	40.7%	5,840	0.06%
Eastern	Delaware	2	50.0%	50.0%	0.0%	640	0.31%
Eastern	Maine	23	40.0%	4.4%	55.6%	117,156	0.02%
Eastern	Maryland	12	8.6%	8.6%	82.8%	4,480	0.26%
Eastern	Massachusetts	5	18.6%	18.6%	62.8%	7,440	0.07%
Eastern	New Hampshire	8	12.9%	12.9%	74.2%	17,160	0.05%
Eastern	New Jersey	2	50.0%	50.0%	0.0%	22,760	0.01%
Eastern	New York	35	17.1%	2.9%	80.0%	228,480	0.02%
Eastern	Pennsylvania	75	9.3%	1.3%	89.4%	205,200	0.04%
Eastern	Rhode Island	1	0.0%	100.0%	0.0%	1,240	0.08%
Eastern	Vermont	7	13.6%	13.6%	72.9%	16,280	0.05%
Eastern	Virginia	16	57.6%	32.0%	10.4%	277,920	0.01%
Eastern	West Virginia	15	26.7%	6.7%	66.7%	235,680	0.01%
Southern	Arkansas	72	76.9%	21.0%	2.1%	863,850	0.01%
Southern	Kentucky	12	77.4%	17.2%	5.4%	358,098	0.00%
Southern	Mississippi	42	68.6%	30.8%	0.6%	543,960	0.01%
Southern	North Carolina	33	45.1%	30.1%	24.8%	524,472	0.01%
Southern	Tennessee	10	60.8%	30.4%	8.9%	207,280	0.00%
Western	Kansas	54	1.9%	1.9%	96.3%	45,900	0.12%
Western	Nebraska	20	5.1%	5.1%	89.9%	28,890	0.07%
Western	North Dakota	43	0.0%	2.4%	97.6%	13,950	0.30%
Western	South Dakota	21	9.4%	4.7%	86.0%	35,010	0.06%
	Total	980	25.2%	8.5%	66.3%	6,546,718	0.01%

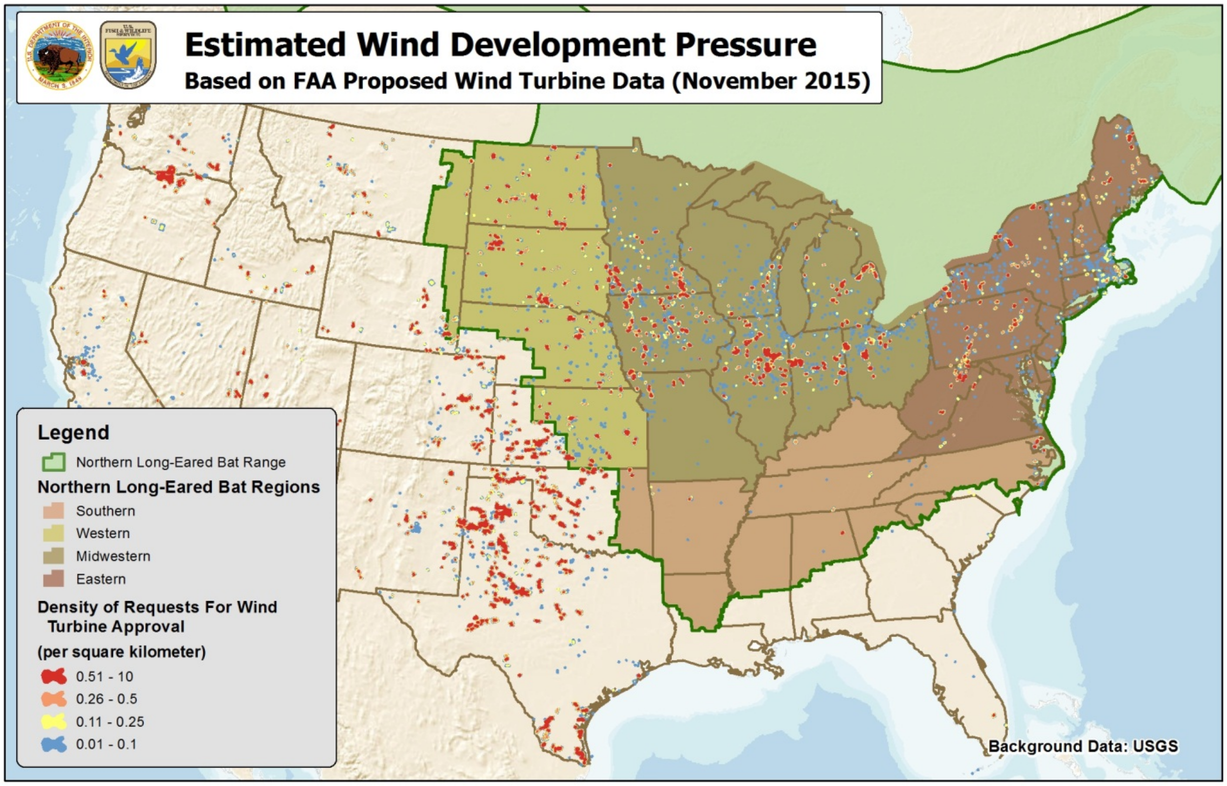

Figure 4.1. Estimated wind development pressure based on the Federal Aviation Administration's proposed wind turbine data.

5 CUMULATIVE EFFECTS

In the context of a consultation, cumulative effects are the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the Action Area. Future federal actions that are unrelated to the proposed action are not considered, because they require separate consultation under section 7 of the ESA.

Section 4 of this BO discusses all actions that may affect the NLEB associated with the implementation of the final 4(d) rule. These include effects of state, tribal, local and private actions. These actions are typically included in this section; however, the action evaluated in this BO is the finalization and implementation of the final 4(d) rule, which includes state, tribal, local, and private actions. We acknowledge that some of the activities included in the effects of the action are cumulative effects, but we do not separate them in this BO.

6 CONCLUSION

WNS is the primary factor affecting the status of the NLEB, which has caused dramatic and rapid declines in abundance, resulting in the local extirpation of the species in some areas. Although other factors, individually or in combination, are likely insignificant at the range-wide scale, they may exacerbate the effects of WNS at the local population scale, thereby accelerating declines and the likelihood of local extirpation due to the disease or reducing the population's ability to survive and potentially rebound. Our analysis of the effects of activities that may affect the NLEB, but do not cause prohibited take, indicates that the additional loss of individual NLEB resulting from these activities would not exacerbate the effects of WNS at the scale of states within its range. Even if all anthropogenic activities that might adversely affect NLEB ceased, we do not believe that the resulting reduction in adverse effects would materially change the devastating impact WNS has had, and will continue to have, on NLEB at the local population level or at larger scales.

The species' foremost conservation need is to reduce or eliminate the threat of WNS. In areas impacted by WNS, the next priorities are to protect NLEB in hibernacula and maternity roost trees, and to continue to monitor populations in summer habitats (e.g., identify where the species continues to survive after the detection of Pd or WNS and determine the factors influencing its resilience).

From our assessment of the species' status/environmental baseline, we have observed NLEB population declines within a few years following the arrival of WNS, and can expect further declines as the disease moves through the Action Area. Based on post-WNS occupancy rates inferred from summer survey data and assumptions about colony size and distribution in forested habitats, we estimate that the population of NLEB is currently about 6,546,700 adult NLEB.

Activities that may affect the NLEB, but will not cause prohibited take under the final 4(d) rule, primarily include timber harvest, prescribed fire, forest conversion, and wind turbine operation. We estimate that these activities will disturb up to 117,267 volant NLEB (both adults and juveniles) each year, all within roosting areas (both maternity and non-maternity), and mostly (65.5 percent) resulting from timber harvest. The Action is expected to harm up to 3,285 non-volant juvenile NLEB annually, all within maternity roosting areas, and mostly resulting from prescribed burning and tree clearing activities conducted during the active season. The Action is also expected to harm up to 980 adults annually, mostly from wind turbine operation and removal of undocumented occupied roosts.

The disturbance estimate amounts to 1.2 percent of the total NLEB population, including young-of-the-year (1 per adult female following parturition), and less than 2.3% of the total number of NLEBs in each individual state. We do not expect disturbance of less than 2.3% of a state's population to significantly affect the numbers or reproduction of the species in the states, as only a small fraction of those fleeing roosts due to disturbance are likely to suffer injury from day-time predators or other hazards encountered before roosting elsewhere. Further, we do not expect disturbance to significantly affect the distribution of the species on the Forests, as the disturbances causing it are temporary, ceasing when project-level activity ceases.

The harm estimate of 3,285 NLEB pups amounts to less than 0.1 percent of the total population of non-volant pups. Less than 1% of the total number of NLEB pups may be harmed in individual states. However, these numbers are overestimates. As noted above, most of this harm is caused by prescribed burning and tree clearing activities, where the potential for death or injury depends largely on site-specific circumstances, e.g., the likelihood of felling a tree containing a maternity colony. Not all tree clearing activities through maternity roosting areas will kill or injure all pups present, but our methodology in this BO estimates that all potentially vulnerable individuals within the expected area of activity/occupancy overlap are affected. The same is true for prescribed fire. We also estimated that 980 adults (less than 0.02% of the total population) may be affected by wind turbine operation and tree clearing activities. Less than 1% of the total number of NLEB adults may be affected in all individual states. These numbers are more realistic estimations because we did not assume that all potentially vulnerable individuals would be affected – we assumed that only 3% of adults would be impacted.

There are no additional interrelated and interdependent actions to the proposed Action or cumulative effects that are not included in the analysis of the proposed Action.

The final 4(d) rule determined that the conservation of the NLEB as a threatened species is best served by limiting the full suite of prohibitions applicable to endangered species under section 9 of the Act to its most vulnerable life stages, i.e., while in hibernacula or in maternity roost trees within the WNS zone, and to activities, tree removal in particular, that are most likely to affect the species. Activities excepted from the requirements to obtain incidental take statements or incidental take permits will affect relatively small numbers of individuals, which is not anticipated to impair conservation efforts or the recovery potential of the species. The vast majority of individuals and populations that survive WNS are unaffected by these activities. It is likely that the species will persist in the individual states based on the number of maternity colonies and widely-dispersed nature of the activities. Based on the relatively small numbers affected annually compared to the state population sizes, we conclude that adverse effects from timber harvest, prescribed fire, forest conversion, wind energy, and other activities will not cause population-level declines in this species.

The Service defines "to jeopardize the continued existence of a listed species" as to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of the species. After reviewing the current status of the NLEB, environmental baseline, effects of the Action, and cumulative effects, it is the Service's biological opinion that the Action, as proposed, is not likely to jeopardize the continued existence of the NLEB. The Service has not proposed or designated critical habitat for this species; therefore, none is affected.

Incidental take that is not expressly prohibited under the final 4(d) rule does not require exception in an Incidental Take Statement. This BO has evaluated major categories of actions that may affect the NLEB, but for which incidental take is not prohibited. Accordingly, there are no reasonable and prudent measures or terms and conditions that are necessary and appropriate for these actions. Federal agencies may rely on this BO to fulfill their project-specific section 7(a)(2) responsibilities under the framework specified in section 1.3 of this BO, which provides a process by which agencies may verify that their proposed actions do not include activities that would cause prohibited incidental take. Prohibited incidental take requires either a separate consultation (federal actions) or an incidental take permit (non-federal actions).

7 REINITIATION NOTICE

Reinitiation of formal consultation is required and shall be requested by the Service, where discretionary federal involvement or control over the action has been retained or is authorized by law and: (a) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (b) If the identified action is subsequently modified in a manner that has an effect to the listed species or critical habitat that was not considered in the biological opinion; or (c) If a new species is listed or critical habitat designated that may be affected by the identified action. The section 7 regulations also require that consultation be reinitiated if the amount or extent of taking specified in the incidental take statement is exceeded (50 CFR 402.16); however, this condition does not apply to this consultation because all incidental take resulting from actions carried out in compliance with the final 4(d) rule is not prohibited.

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VIRGINIA DEPARTMENT OF GAME AND INLAND FISHERIES
GUIDANCE DOCUMENT ON
BEST MANAGEMENT PRACTICES FOR
CONSERVATION OF LITTLE BROWN BATS AND TRI-COLORED BATS

(Approved February 16, 2016)

Summary: This guidance document specifies the best management practices and processes to be utilized in conserving little brown and tri-colored bats and in determining whether a specific practice is eligible for incidental take of either of these species.

Electronic Copy: An electronic copy of this guidance in PDF format is available online on the Virginia Department of Game and Inland Fisheries (VDGIF) Web site at http://www.dgif.virginia.gov/wildlife/LBBA_TCBA_Guidance.pdf.

Contact Information: Please contact the Department of Game and Inland Fisheries at Rick.Reynolds@dgif.virignia.gov or by calling 540-248-9360 with any questions regarding the application of this guidance.

Disclaimer: This document is provided as guidance and, as such, sets forth standard operating procedures of the Board of Game and Inland Fisheries and the Department of Game and Inland Fisheries that administers the program on behalf of the Board. This guidance provides a general interpretation of the applicable Code and Regulations, but is not meant to be exhaustive in nature. Each situation may differ and may require additional interpretation of the Virginia Endangered Species Act and attendant regulations.

I. Background:

The Virginia Endangered Species Act, Article 6 of Title 29.1 of the Code of Virginia, specifies that the Board of Game and Inland Fisheries may allow the incidental take of state-designated endangered or threatened species under certain provisions. State endangered and threatened species are designated as such by regulation of the Board (4VAC15-20-130.B); the updated list may be found online at http://leg1.state.va.us/cgi-bin/legp504.exe?000+reg+4VAC15-20-130. The Act also clearly indicates that the taking of state endangered or threatened species is illegal unless specifically allowed by Code or regulation. The Code of Virginia specifies that any regulation adopted by the Board that allows the incidental take of state endangered or threatened species must describe the circumstances that must exist to allow for incidental take, include appropriate conservation actions that must be taken that enhance the survival of the species, and require the actual taking to be at a minimum.

This guidance document shall provide additional details on the circumstances under which the Board will allow the incidental take of little brown bats and tri-colored bats, consistent with the designation of these species as state endangered.

II. Definitions (pursuant to Article 6, Title 29.1, Code of Virginia and 4VAC15-20-140):

"Species" are defined as any subspecies of fish or wildlife and any distinct population segment of any species or vertebrate fish or wildlife which interbreed when mature.
"Take" is defined as harassing, harming, pursuing, hunting, shooting, wounding, killing, trapping, capturing, possessing, or collecting, or attempting to do any of these activities.

"Incidental take" is defined as any taking of an endangered or threatened species of fish and wildlife, excluding those species appearing on the federal list of endangered and threatened species, that otherwise would be prohibited by law or regulation, if the taking is incidental to, but not the purpose of, an otherwise lawful activity.

III. Authority:

The Endangered Species Act in the Code of Virginia contains the following authorities applicable to this guidance:

> **§ 29.1-564. Taking, transportation, sale, etc., of endangered species prohibited.**
> The taking, transportation, possession, sale, or offer for sale within the Commonwealth of any fish or wildlife appearing on any list of threatened or endangered species published by the United States Secretary of the Interior pursuant to the provisions of the federal Endangered Species Act of 1973 (P.L. 93-205), or any modifications or amendments thereto, is prohibited except as provided in § 29.1-568.
>
> **§29.1-566. Regulations.**
> The Board is authorized to adopt the federal list, as well as modifications and amendments thereto by regulations; to declare by regulation, after consideration of recommendations from the Director of the Department of Conservation and Recreation and from other reliable data sources, that species not appearing on the federal lists are endangered or threatened species in Virginia; and to prohibit by regulation the taking, transportation, processing, sale, or offer for sale within the Commonwealth of any threatened or endangered species of fish or wildlife.
>
> **§ 29.1-568. When Board may permit taking of endangered or threatened species; designated experimental populations.**
>
> > A. The Board may permit the taking, exportation, transportation, or possession of any fish or wildlife which is listed by the provisions of this article, for zoological, educational, or scientific purposes and for propagation of such fish or wildlife in captivity for preservation purposes. Any person may, in accordance with all applicable federal and state laws, possess, breed, sell, and transport any nonnative wildlife included on any list of threatened or endangered species published by the United States Secretary of the Interior pursuant to provisions of the federal Endangered Species Act of 1973 (P.L. 93-205), as amended, when (i) the federal designation does not specifically prohibit such possession, breeding, selling, or transporting and (ii) the nonnative wildlife is not included on the list of predatory or undesirable animals specified by regulations of the Board adopted pursuant to § 29.1-542.

B. The Board may adopt regulations that:

1. Allow the taking, possession, exportation, transportation, or release of fish or wildlife within or among designated experimental populations of a specific species, within the context of an approved conservation plan for the species. Any regulation designating an experimental population shall (i) specify the circumstances under which taking of an individual member of an experimental population will be exempt from the prohibitions and penalties authorized under this article and (ii) describe the geographic extent of the experimental population, which shall be distinct from naturally occurring populations continuing to be subject to the prohibitions and penalties authorized under this article.

2. Allow incidental take provided such regulations shall (i) describe the allowable circumstances; (ii) include provisions that ensure offsets through the implementation of conservation actions specified by the Department to enhance the long-term survival of the species or population; and (iii) require any actual taking to be at a minimum.

IV. Discussion and Interpretation:

Little brown bats and tri-colored bats have experienced substantial declines across the Commonwealth since the discovery of white-nose syndrome (WNS) in2009. Recent monitoring surveys document that populations of both species have declined more than 95% across the state since then. The following best management practices are provided as guidance for maintaining and improving habitats for these species, minimizing purposeful or accidental take of these animals, and enhancing the long-term survival of these species in Virginia.

<u>Hibernacula: Current Knowledge of Hibernacula and Conservation Measures</u>

The VDGIF knows about 132 hibernacula (places where these animals hibernate during the winter) with little brown and or tri-colored bats present. These hibernacula typically are located in western Virginia and are typically caves. Of the 132 hibernacula, 50 have combined little brown and tri-colored counts of 50 or more individuals and supported over 95% of the hibernating populations pre white-nose syndrome. Of the 50, 10 are on public lands, and an additional four have private landowner protections (e.g., easements). Our goal is to protect and manage these 50 hibernacula and surrounding fall swarm habitat (roost trees, open areas, riparian, and other habitats within a 0.25-mile radius of a hibernaculum used by bats for roosting or foraging before hibernating) that historically supported 97.5% of the hibernating populations of these two species.

While there is no literature guiding the decision to protect a specific number of hibernacula or percentage of a population to maintain these species in Virginia during hibernation, the VDGIF thinks that protecting and managing approximately one-third of the known hibernacula, that supported a majority of known pre-WNS hibernating populations, is appropriate. As new information is gathered through surveys, monitoring and modeling, sites may be added or removed from the list.

- *Conservation Measures:* For hibernacula containing over 50 individuals of little brown and/or tri-colored bats (documented between 1995 to present), a two tiered buffer zone is recommended:
  - Between December 1 and April 30, implement a 250-foot radius buffer zone with the following restrictions: no tree removal, prescribed fire, or land disturbance impacting the entrance(s) to the hibernacula. This action will protect the immediate area around the hibernacula by reducing disturbance during fall swarm, hibernation, and spring emergence. Tree removal and prescribed fire are permitted outside of these dates.
    - *Incidental Take Protocol:* If tree removal needs to occur due to public safety or property damage concerns, and there are no known roost trees, then no further action is necessary. If there are known tree roosts, follow the guidance under Roost Trees below.
  - Between September 1 and November 30, increase the buffer to a 0.25-mile radius, with the following conditions: for timber harvests greater than 20 acres, retain snags (dead, broken-off trees), "wolf" trees (large trees with wide spreading crowns that may have broken branches, cavities or sloughing bark) (if not presenting public safety or property risk) and small tree groups (1 per 20 acres harvested) of up to 15 trees of 3 inches diameter at breast height (dbh) or greater. Because of the significant decline (greater than 90%) documented for little brown and tri-colored bats, the VDGIF does not anticipate that fall swarm roost trees will be a limiting factor in the protection and conservation of these species. These timber harvest actions will retain and provide fall roost trees for these species near their winter hibernating areas. Tree removal and prescribed fire are permitted outside these dates.
    - *Incidental Take Protocol:* If there are known tree roosts that need to be removed due to public safety or property damage concerns, follow the guidance under Roost Trees below.

Under these circumstances and conditions, we anticipate little to no lethal take of little brown bats or tri-colored bats.

Roost Trees: Current Knowledge of Roost Trees and Conservation Measures

The VDGIF has not tracked and is not aware of any little brown or tri-colored bat roost trees (places where the animals live when not hibernating) in Virginia. The VDGIF is in the process of surveying for roost trees and will provide updated guidance as new information becomes available. Typically, both species utilize human dwellings (barns, sheds, attics, buildings, etc.) as well as trees for maternity roosts. Our goal is to identify and protect as many of the remaining maternity colonies as possible

- *Conservation Measures:*
    - Between June 1 and July 31, implement a 150-foot radius buffer zone with the following restrictions: no tree removal, prescribed fire, or land disturbance within the buffer zone. This will protect the known roost tree(s) and foraging habitat close to the roost tree during the maternity season. Tree removal and prescribed fire are permitted outside these dates.

- If a little brown or tri-colored maternity roost needs to be excluded due to public safety or property damage concerns, then the following *Incidental Take Protocol* will apply:
  - ♦ The exclusion will be performed by a Nuisance Wildlife Control Operator (NWCO) or individual that is certified in bat exclusion techniques through a program recognized by the VDGIF and is permitted by the VDGIF.
  - ♦ Exclusion devices will be used to allow volant (capable of flight) individuals to escape.
  - ♦ Individual animals incapable of sustaining themselves will be collected and transport to a willing and appropriate VDGIF-permitted wildlife rehabilitation facility.

  Under these circumstances and conditions, we anticipate little to no lethal take of little brown bats or tri-colored bats.

<u>Human Structures: Current Knowledge of Human Structure Use and Conservation Measures</u>

Little brown and big brown bats are the two species most commonly found in human-occupied dwellings and the ones most likely to cause human conflicts. The VDGIF is currently aware of three structures that serve as roosts for little brown bats. Tri-colored bats utilize human structures as well, but are more commonly found in barns, sheds, and abandoned structures and less so in occupied dwellings. Currently, the VDGIF is not aware of any tri-colored bat roosts in Virginia. The VDGIF is in the process of surveying for roost trees and artificial roost structures and will provide updated guidance as new information becomes available.

- *Conservation Measures*: Between May 15 and August 31, no exclusion of bats from maternity colonies, except for human health concerns or property damage, as determined by the landowner.
  - If a little brown or tri-colored maternity roost needs to be excluded due to human health or property damage concerns, then the following *Incidental Take Protocol* will apply:
    - ♦ The exclusion will be performed by a Nuisance Wildlife Control Operator (NWCO) or individual that is certified in bat exclusion techniques through a program recognized by the VDGIF and is permitted by the VDGIF.
    - ♦ Exclusion devices will be used to allow volant (capable of flight) individuals to escape.
    - ♦ Individual animals incapable of sustaining themselves will be collected and transport to a willing and appropriate VDGIF-permitted wildlife rehabilitation facility.

  Under these circumstances and conditions, we anticipate little to no lethal take of little brown bats or tri-colored bats.

Facility or Project Operations: Operation under a VDGIF-approved plan

The VDGIF understands and recognizes that white-nose syndrome is the primary cause for the rapid and significant decline of little brown and tri-colored bats in Virginia. However, additional losses that result from other activities may exacerbate these losses. Under certain approved circumstances, the VDGIF can allow facility operations that might otherwise result in taking of bats when those operations are conducted in a manner than implements measures to specifically minimize impacts to these species.

- *Conservation Measures*: Project or facility operations that might incidentally take little brown or tri-colored bats can be allowed when conducted in accordance with a plan developed by the project or facility operator and approved by the VDGIF. The plan must include, but is not limited to, the following information:
    - the specific circumstance/operational activity or condition that may result in taking:
    - the specific measures to be implemented that avoid, minimize and/or mitigate incidental take associated with an otherwise lawful activity;
    - the expected incidental take;
    - the implementation schedule; and
    - an explicit point of contact for communications to and from the VDGIF.

  The operator must acknowledge and implement practices to report bats taken, even in circumstances where specific measures have been approved and implemented. If project operations occur within areas described in other parts of this document (e.g., Hibernacula; Known Roosts), the operator is expected to abide by the conservation measures described in those sections.

  Under these circumstances and conditions, we anticipate little to no lethal take of little brown bats or tri-colored bats.

In any instance of allowable incidental take, it is the landowner's responsibility to document the circumstance, actions taken, and number of animals taken (if any), in making a determination that these species should be removed to address human health, public safety or property damage issues. The landowner is responsible for retaining this documentation.

V. Adoption, Amendments, and Repeal:

This document will remain in effect until rescinded or superseded.

02/16/2016

Robert W. Duncan
Executive Director, Department of Game and Inland Fisheries

Date

Programmatic Biological Opinion on Final 4(d) Rule for the Northern Long-Eared Bat and Activities Excepted from Take Prohibitions

U.S. Fish and Wildlife Service
Regions 2, 3, 4, 5, and 6

Prepared by:
U.S. Fish and Wildlife Service
Midwest Regional Office
Bloomington, Minnesota
January 5, 2016

U.S. FISH & WILDLIFE SERVICE
DEPARTMENT OF THE INTERIOR

Lynn Lewis
Lynn Lewis, Assistant Regional Director, R3

1/5/16
Date

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EXECUTIVE SUMMARY

This Endangered Species Act (Act) Biological Opinion (BO) addresses the effects to the northern long-eared bat (NLEB) resulting from the Service's finalization of a special rule under the authority of section 4(d) of the Act. It also evaluates activities that the Service proposes to prohibit and except from take prohibitions under the final 4(d) rule. In the request for intra-Service consultation, the Service proposes a framework for streamlined section 7 consultation for other federal actions that may affect the NLEB and are consistent with the provisions of the 4(d) rule. This is a programmatic intra-Service consultation, because it addresses multiple actions on a program basis conducted under the umbrella of the final 4(d) rule. The Service has not designated or proposed critical habitat for the NLEB; therefore, this BO does not address effects to critical habitat. Because we anticipate continued NLEB declines as white-nose syndrome (WNS) spreads, this BO will cover the next 7 years that the disease is minimally expected to spread and impact the NLEB throughout its entire range. The Service will reinitiate consultation by the end of 2022 or earlier if the standard reinitiation criteria are triggered.

The final rule addresses both purposeful take and incidental taking of the NLEB, with certain differences distinguished based on the occurrence of WNS as follows:

- The final 4(d) rule prohibits purposeful take of NLEBs throughout the species' range, except when (1) necessary to protect human health; (2) in instances of removal of NLEBs from human structures; or (3) the authorized capture and handling of NLEBs by individuals permitted to conduct these same activities for other bat species until May 3, 2016.
- The final 4(d) rule does not prohibit incidental take resulting from otherwise lawful activities in areas not yet affected by WNS (i.e., areas outside of the WNS zone).
- Within the WNS zone, the final 4(d) rule prohibits incidental take of NLEBs in their hibernacula, which may be caused by activities that disturb or disrupt hibernating individuals when they are present as well as the physical or other alteration of the hibernaculum's entrance or environment when bats are not present.
- Incidental take of NLEBs outside of hibernacula resulting from activities other than tree removal is not prohibited provided they do not result in the incidental take of NLEBs inside hibernacula.
- Incidental take resulting from tree removal is prohibited if it: (1) occurs within 0.25 miles (0.4 km) of known NLEB hibernacula; or (2) cuts or destroys known, occupied maternity roost trees or any other trees within a 150-foot (45-meter) radius around the known, occupied maternity tree during the pup season (June 1 to July 31).
- Removal of hazardous trees for the protection of human life and property is not prohibited.

Federal agencies can rely upon the finding of this BO to fulfill their project-specific section 7(a)(2) responsibilities if they utilize the optional framework as described. The framework requires prior notification of activities that may affect the NLEB, along with a determination that the action would not cause prohibited incidental take. Service concurrence with the action agency determination is not required, but the Service may advise the action agency whether additional information indicates project-level consultation for the NLEB is required. If the Service does not respond within 30 days, the action agency may consider its project responsibilities under section 7(a)(2) with respect to the NLEB fulfilled through this programmatic BO. Action agencies must also report if actions deviate from the determination, along with the surveys of any surveys.

The Action Area addressed in this BO includes the entire range of the NLEB within the United States, which includes all or portions of 37 States and the District of Columbia from Maine west to Montana, south to eastern Kansas, eastern Oklahoma, Arkansas, and east to South Carolina. Within the Action Area, the WNS zone currently includes all or most of the states within the species' range except North Dakota, Montana, South Dakota, and Wyoming.

Status of the NLEB

The disease WNS is the primary factor affecting the status of the NLEB, which has caused dramatic and rapid declines in abundance. Data support substantial declines in the Eastern range and portions of the Midwest range. We expect further declines as the disease continues to spread across the species' range. NLEBs continue to be distributed across much of the historical range, but there are many gaps where bats are no longer detected or captured, and in other areas, their occurrence is sparse given local declines and extirpations. Although significant NLEB population declines have only been documented due to the spread of WNS, other sources of mortality could further diminish the species' ability to persist as it experiences ongoing dramatic declines.

We estimate that the range-wide population of NLEBs is comprised of about 6.5 million adults. This population estimate was calculated for the purposes of assessing the potential relative impact of activities contemplated in this BO, and it has limitations and a substantial amount of uncertainty.

Effects of the Action

The NLEB is likely to be affected by many activities which are not prohibited in the final 4(d) rule. We address the general effects of different activities, which we categorized into 7 general groups: (1) capture and handling of NLEBs by individuals with section 10(a)(1)(A) permits for other listed bats or State permits until May 3, 2016; (2) removal from human structures; (3)

timber harvest; (4) prescribed fire; (5) forest conversion; (6) wind turbine operation; and (7) other activities that may affect the NLEB. The effects of category #1 are not addressed in this consultation.

Based on the available scientific literature, we identified various pathways by which environmental changes (stressors) caused by the Action may affect individual NLEB and the expected responses of individuals exposed to the stressors. General response categories include potentially increased fitness, reduced fitness, disturbance, and harm. We do not have enough information to quantify the effects of removal from human structures and the "other" category of activities that may affect the NLEB. For pathways associated with timber harvest, prescribed fire, and forest conversion, we estimate the number of NLEB individuals exposed by computing the expected overlap between the activities and NLEB-occupied habitats in each state. For wind turbine operation, we estimate the number of bats that could be killed using the current and projected amount of wind energy development and information on bat mortality rates.

Based on these estimations, we anticipate that up to 117,267 NLEB (1.2% of the total population) will be disturbed and 3,285 pups (0.1% of the total pup population) and 980 adults (less than 0.02% of the total adult population) will be harmed annually from timber harvest, prescribed fire, forest conversion, and wind turbine operation. We consider these numbers to be overestimates based on our methodology. Additional harm is anticipated for the unquantified effects from removal from human structures and "other" activities that may affect the NLEB; however, we do not expect the additional impacts to substantially change the total numbers estimated. In addition, we also expect that the numbers affected over time will be reduced as WNS continues to affect the range-wide population.

Although local populations could be affected by the implementation of the final 4(d) rule, most of the states have larger populations and more maternity colonies. In addition, less than 2.3% of NLEBs will be disturbed in all states, less than 1% of pups will be harmed in all states, and less than 1% of adults will be harmed in all states. Therefore, the vast majority of individuals and populations that survive WNS will be unaffected by these activities. Based on the relatively small numbers affected annually compared to the state population sizes, we conclude that adverse effects from timber harvest, prescribed fire, forest conversion, wind energy, and other activities will not lead to population-level declines in this species.

Conclusion

WNS is the primary factor affecting the status of the NLEB, which has caused dramatic and rapid declines in abundance, resulting in the local extirpation of the species in some areas. Our analysis of the effects of activities that may affect the NLEB, but do not cause prohibited take, indicates that the additional loss of individual NLEB resulting from these activities would not exacerbate the effects of WNS at the scale of states within its range. Even if all anthropogenic activities that might adversely affect NLEB ceased, we do not believe that the resulting reduction in adverse effects would materially change the devastating impact WNS has had, and will continue to have, on NLEB at the local population level or at larger scales.

After reviewing the current status of the NLEB, environmental baseline, effects of the Action, and cumulative effects, it is the Service's biological opinion that the Action, as proposed, is not likely to jeopardize the continued existence of the NLEB.

This BO has evaluated major categories of actions that may affect the NLEB, but for which incidental take is not prohibited. Accordingly, there are no reasonable and prudent measures or terms and conditions that are necessary and appropriate for these actions. Federal agencies may rely on this BO to fulfill their project-specific section 7(a)(2) responsibilities under the framework specified in this BO. Prohibited incidental take requires either a separate consultation (federal actions) or an incidental take permit (non-federal actions).

BIOLOGICAL OPINION

A Biological Opinion (BO) is the document required under the Endangered Species Act of 1973 (Act), as amended, that states the opinion of the U.S. Fish and Wildlife Service (Service) as to whether a proposed federal action is likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of designated critical habitat.

The action evaluated in this BO is the Service's finalization of a special rule under the authority of section 4(d) of the Act for the northern long-eared bat (*Myotis septentrionalis*) (NLEB). Section 9 of the Act generally prohibits the "take" of a species listed as endangered. The Act and its implementing regulations (50 CFR 17) define take as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. The Act does not specify particular prohibitions for threatened species. Instead, under section 4(d), the Secretary of the Interior has the discretion to issue such regulations to provide for the conservation of threatened species, which may include prohibitions under section 9. This BO also evaluates activities that the Service proposes to prohibit and except from take prohibitions under the final 4(d) rule. In the request for intra-Service consultation, the Service proposes a framework for streamlined section 7 consultation for other federal actions that may affect the NLEB and are consistent with the provisions of the 4(d) rule. This is a programmatic intra-Service consultation, because it addresses multiple actions on a program basis under the umbrella of activities excepted from take prohibitions in the Service's final 4(d) rule.

"To jeopardize the continued existence of a listed species" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of the species (50 CFR §402.02). This BO examines whether projects and activities implemented that are likely to adversely affect the NLEB, but would not cause take prohibited under the final 4(d) rule , are likely to jeopardize the continued existence of the NLEB.

The Service anticipates that white-nose syndrome (WNS), the disease causing the decline of the species, will spread throughout the range of the NLEB by 2023-2028 (Federal Register [FR]80[63]:17974). In listing rule, we determined that the NLEB is not currently in danger of extinction throughout all of its range, but if similar declines occur after WNS spreads throughout its entire range, the NLEB may be in danger of extinction. We expect that the status of the species will continue to decline as WNS reaches new areas; therefore, this BO will cover the next 7 years that the disease is minimally expected to spread and impact the NLEB throughout its entire range. The Service will reinitiate consultation by the end of 2022 or earlier if the reinitiation criteria described in Section 7 (Reinitiation Notice) of this BO are triggered. We believe this is a reasonable approach given that the range-wide decline of the NLEB due to WNS may reveal that the action may affect the NLEB in a manner or to an extent not previously considered.

1 DESCRIPTION OF THE PROPOSED ACTION

1.1 BACKGROUND

The proposed action is the finalization of the interim 4(d) rule for the NLEB and evaluation of activities excepted from take prohibitions. This rule replaces an interim 4(d) rule established concurrently with the listing of the NLEB as a threatened species on April 2, 2015 (FR 80[63]:17974), under the Act. The interim 4(d) rule:

(1) prohibits purposeful take of NLEBs throughout the species' range, except in instances of removal of NLEBs from human structures;
(2) authorized capture and handling of NLEB by individuals permitted to conduct these same activities for other bats (for a period of 1 year after the effective date of the interim 4(d) rule);
(3) in areas not yet affected by white-nose syndrome (WNS), all incidental take resulting from any otherwise lawful activity is excepted from prohibition;
(4) in areas currently known to be affected by WNS, all incidental take prohibitions apply, except take attributable to forest management practices, maintenance and limited expansion of transportation and utility rights-of-way, prairie habitat management, and limited tree removal projects, provided these activities protect known maternity roosts and hibernacula; and
(5) removal of hazardous trees for the protection of human life or property is excepted from the take prohibition.

The listing and interim 4(d) rule went into effect on May 4, 2015, and the interim 4(d) rule remains in effect until a final 4(d) rule is published in the Federal Register.

1.2 U.S. FISH AND WILDLIFE SERVICE ACTION

The Service is finalizing the interim 4(d) rule for the NLEB. The final rule will address both purposeful take and incidental taking of the NLEB, with certain differences distinguished based on the occurrence of WNS. The final 4(d) rule prohibits purposeful take of NLEBs throughout the species' range, except when:

- necessary to protect human health;
- in instances of removal of NLEBs from human structures; or

- the authorized capture and handling of NLEBs by individuals permitted to conduct these same activities for other bat species until May 3, 2016.

After May 3, 2016, a permit pursuant to Section 10(a)(1)(A)[1] of the Act is required for the capture and handling of NLEBs outside of human structures. We define human structures as houses, garages, barns, sheds, and other buildings designed for human entry.

"Incidental taking" is defined at 50 CFR 17.3 as "any taking otherwise prohibited, if such taking is incidental to, and not the purpose of, an otherwise lawful activity." Incidental take within the context of the final 4(d) rule is regulated in distinct and separate manners relative to the geographic location of the proposed activity and the occurrence of WNS. The WNS zone provides the boundary for implementation of the final rule. It is defined as the set of counties with confirmed evidence of the fungus causing the disease (*Pseudogymnoascus destructans*, or Pd) or WNS, plus a 150-mile (241 km) buffer from the Pd-positive county line to account for the spread of the fungus from one year to the next. In instances where the 150-mile (241 km) buffer line bisects a county, the entire county is included in the WNS zone. The final 4(d) rule does not prohibit incidental take resulting from otherwise lawful activities in areas not yet affected by WNS (i.e., areas outside of the WNS zone).

Within the WNS zone, the final 4(d) rule prohibits incidental take of NLEBs in their hibernacula (which includes caves, mines, and other locations where bats hibernate in winter). Take of NLEBs inside of hibernacula may be caused by activities that disturb or disrupt hibernating individuals when they are present as well as the physical or other alteration of the hibernaculum's entrance or environment when bats are not present, if the activity will impair essential behavioral patterns (e.g., sheltering) and cause harm. Known hibernacula are defined as locations where one or more NLEBs have been detected during hibernation or detected at the entrance during fall swarming or spring emergence. Any hibernaculum with NLEBs observed at least once is considered a known hibernaculum as long as it remains suitable for NLEB use. A hibernaculum remains suitable for NLEBs even when Pd or WNS has been detected.

For NLEBs outside of hibernacula within the WNS zone, the final 4(d) rule establishes separate incidental take prohibitions for activities involving tree removal and those that do not involve tree removal. Incidental take of NLEBs outside of hibernacula resulting from activities other than tree removal is not prohibited provided they do not result in the incidental take of NLEBs inside hibernacula or otherwise impair essential behavioral patterns at known hibernacula. Incidental take resulting from tree removal is prohibited if it: (1) occurs within 0.25 miles (0.4 km) of known NLEB hibernacula; or (2) cuts or destroys known, occupied maternity roost trees or any other trees within a 150-foot (45-meter) radius around the known, occupied maternity tree during the pup season (June 1 to July 31). Removal of hazardous trees for the protection of human life

[1] Section 10(a)(1)(A) describes recovery/scientific permits issued for the enhancement of the survival of the species.

and property is not prohibited. Known, occupied maternity roost trees are defined as trees that have had female NLEBs or juvenile bats tracked to them or the presence of female or juvenile bats is known as a result of other methods. Known, occupied maternity roost trees are considered known roosts as long as the tree and surrounding habitat remain suitable for the NLEB.

The final 4(d) rule individually sets forth prohibitions on possession and other acts with unlawfully taken NLEBs, and on import and export of NLEBs. Under this rule, take of the NLEB is also not prohibited for the following: removal of hazardous trees for protection of human life and property; take in defense of life; and take by an employee or agent of the Service, of the National Marine Fisheries Service, or of a State conservation agency that is operating a conservation program pursuant to the terms of a cooperative agreement with the Service.

Section 4(d) of the Act states that the Secretary shall issue such regulations as she deems "necessary and advisable to provide for the conservation" of species listed as threatened species. The Service determined that the final 4(d) rule is necessary and advisable to provide for the conservation of the NLEB, because it provides for temporary protection of known maternity roost trees during the pup season and to known hibernacula within the WNS zone, and it prohibits most forms of purposeful take throughout the species range. The final rule describes how prohibiting certain types of take is not necessary for the long-term survival of the species, and it acknowledges the importance of addressing the threat of WNS as the primary measure to arrest and reverse the decline of the species.

1.3 OTHER FEDERAL AGENCY ACTIONS

Federal agency actions that involve activities that involve activities not prohibited under the final 4(d) rule may result in effects to the NLEB if the species is exposed to action-caused stressors. Incidental take resulting from these activities is not prohibited; however, the final 4(d) rule does not alter the requirements for consultation under section 7 of the Act, which apply to all federal actions that may affect listed species and designated critical habitat. Section 7(a)(2) of the Act, directs federal agencies, in consultation with the Secretary, to insure that their actions are not likely to jeopardize the continued existence of any listed species, or result in the destruction or adverse modification of designated critical habitat. Therefore, the purpose of section 7(a)(2) is broader than an evaluation of anticipated take and issuance of an Incidental Take Statement.

To address the broader purpose of 7(a)(2) for federal actions that may affect the NLEB but would not cause take prohibited under the final 4(d) rule, the Service's Headquarters Office has requested intra-agency formal consultation with the Service's Midwest Regional Office on the effects of all such federal actions. Because the Service has determined with the final 4(d) rule that regulating incidental take associated with the excepted activities is not necessary or advisable for the conservation of the NLEB, Service Headquarters proposes an optional framework for subsequent federal agency reliance on the findings of an intra-Service consultation that would streamline section 7(a)(2) compliance for such activities. The primary objective of the framework is to provide an efficient means for Service verification of federal agency determinations that their proposed actions are consistent with those evaluated in the intra-Service consultation and do not require an incidental take statement for the NLEB. Such verification is necessary because incidental take is prohibited in the vicinity of known hibernacula and known roosts, and these locations are continuously updated. We do not include specific action agencies or their specific actions in this BO; rather, we focus on the types of activities that may affect the NLEB and conduct our jeopardy analysis on these activities. Federal agencies may rely on this BO to fulfill their project-specific section 7(a)(2) responsibilities under the following framework:

1. For all federal activities that may affect the NLEB, the action agency will provide project-level documentation describing the activities that are excepted from incidental take prohibitions and addressed in this consultation. The federal agency must provide written documentation to the appropriate Service Field Office when it is determined their action may affect (i.e., not likely to adversely affect or likely to adversely affect) the NLEB, but would not cause prohibited incidental take. This documentation must follow these procedures:

    a. In coordination with the appropriate Service Field Office, each action agency must make a determination as to whether their activity is excepted from incidental taking prohibitions in the final 4(d) rule. Activities that will occur within 0.25 mile of a known hibernacula or within 150 feet of known, occupied maternity roost trees during the pup season (June 1 to July 31) are not excepted pursuant to the final 4(d) rule. This determination must be updated annually for multi-year activities.
    b. At least 30 days in advance of funding, authorizing, or carrying out an action, the federal agency must provide written notification of their determination to the appropriate Service Field Office.
    c. For this determination, the action agency will rely on the definitions of prohibited activities provided in the final 4(d) rule and the activities considered in this consultation.
    d. The determination must include a description of the proposed project and the action area (the area affected by all direct and indirect project effects) with sufficient detail to support the determination.
    e. The action agency must provide its determination as part of a request for coordination or consultation for other listed species or separately if no other species may be affected.
    f. Service concurrence with the action agency determination is not required, but the Service may advise the action agency whether additional information indicates consultation for the NLEB is required; i.e., where the proposed project includes an activity not covered by the 4(d) rule and thus not addressed in the Biological Opinion and is subject to additional consultation.
    g. If the Service does not respond within 30 days under (f) above, the action agency

may presume its determination is informed by best available information and consider its project responsibilities under section 7(a)(2) with respect to the NLEB fulfilled through this programmatic Biological Opinion.

2. Reporting
    a. For monitoring purposes, the Service will assume all activities are conducted as described. If an agency does not conduct an activity as described, it must promptly report and describe such departures to the appropriate Service Field Office.
    b. The action agency must provide the results of any surveys for the NLEB to the appropriate Service Field Office within their jurisdiction.
    c. Parties finding a dead, injured, or sick NLEB must promptly notify the appropriate Service Field Office.

If a Federal action agency chooses not to follow this framework, standard section 7 consultation procedures will apply.

Section 7(a)(1) of the Act directs Federal agencies, in consultation with and with the assistance of the Secretary (a function delegated to the Service), to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Service Headquarters provides to federal action agencies who choose to implement the framework described above several conservation recommendations for exercising their 7(a)(1) responsibility in this context. Conservation recommendations are discretionary federal agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. Service Headquarters recommends that the following conservation measures to all Federal agencies whose actions may affect the NLEB:

1. Perform NLEB surveys according to the most recent Range-wide Indiana Bat/NLEB Summer Survey Guidelines. Benefits from agencies voluntarily performing NLEB surveys include:
    a. Surveys will help federal agencies meet their responsibilities under section 7(a)(1) of the Act. The Service and partners will use the survey data to better understand habitat use and distribution of NLEB, track the status of the species, evaluate threats and impacts, and develop effective conservation and recovery actions. Active participation of federal agencies in survey efforts will lead to a more effective conservation strategy for the NLEB.
    b. Should the Service reclassify the species as endangered in the future, an agency with a good understanding of how the species uses habitat based on surveys within its action areas could inform greater flexibility under section 7(a)(2) of the Act. Such information could facilitate an expedited consultation and incidental take statement that may, for example, exempt taking associated with tree removal during the active season, but outside of the pup season, in known occupied habitat.
2. Apply additional voluntary conservation measures, where appropriate, to reduce the

impacts of activities on NLEBs. Conservation measures include:

a. Conduct tree removal activities outside of the NLEB pup season (June 1 to July 31) and/or the active season (April 1 to October 31). This will minimize impacts to pups at roosts not yet identified.
b. Avoid clearing suitable spring staging and fall swarming habitat within a 5-mile radius of known or assumed NLEB hibernacula during the staging and swarming seasons (April 1 to May 15 and August 15 to November 14, respectively).
c. Manage forests to ensure a continual supply of snags and other suitable maternity roost trees.
d. Conduct prescribed burns outside of the pup season (June 1 to July 31) and/or the active season (April 1 to October 31). Avoid high-intensity burns (causing tree scorch higher than NLEB roosting heights) during the summer maternity season to minimize direct impacts to NLEB.
e. Perform any bridge repair, retrofit, maintenance, and/or rehabilitation work outside of the NLEB active season (April 1 to October 31) in areas where NLEB are known to roost on bridges or where such use is likely.
f. Do not use military smoke and obscurants within forested suitable NLEB habitat during the pup season (June 1 to July 31) and/or the active season (April 1 to October 31).
g. Minimize use of herbicides and pesticides. If necessary, spot treatment is preferred over aerial application.
h. Evaluate the use of outdoor lighting during the active season and seek to minimize light pollution by angling lights downward or via other light minimization measures.
i. Participate in actions to manage and reduce the impacts of white-nose syndrome on NLEB. Actions needed to investigate and manage white-nose syndrome are described in a national plan the Service developed in coordination with other state and federal agencies (Service 2011).

1.4 ACTION AREA

The action area is defined as all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). In delineating the action area, we evaluated the farthest reaching physical, chemical, and biotic effects of the action on the environment.

The "Action Area" for this consultation includes the entire range of the NLEB within the United States, which includes all or portions of the following 37 States and the District of Columbia: Alabama, Arkansas, Connecticut, Delaware, Georgia, Illinois, Indiana, Iowa, Kansas, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Mississippi, Missouri, Montana, Nebraska, New Hampshire, New Jersey, New York, North Carolina, North Dakota, Ohio, Oklahoma, Pennsylvania, Rhode Island, South Carolina, South Dakota, Tennessee, Vermont, Virginia, West Virginia, Wisconsin, and Wyoming. Within the Action Area, the WNS zone currently includes all or most of the states within the species' range except North Dakota, Montana, South Dakota, and Wyoming (Figure 1.1) (note: tables and figures for each major section of this BO appear at the end of the section). The WNS zone map is updated on the first of every month (http://www.fws.gov/midwest/endangered/mammals/nleb/pdf/WNSZone.pdf).

1.5 ACTIVITIES NOT EVALUATED IN THIS BIOLOGICAL OPINION

The following general categories of activities are prohibited under the final 4(d) rule within the WNS zone:

1. Activities resulting in the disruption or disturbance of NLEBs in their hibernacula.
2. Activities resulting in the physical or other alteration of a hibernaculum's entrance or its environment at any time of year.
3. Tree clearing activities within 0.25 miles of a known NLEB hibernaculum.
4. Tree clearing activities that result in cutting or destroying known, occupied maternity roost trees or any other trees within a 150 ft radius around the roost tree during the pup season (June 1 – July 31).

Separate project-specific section 7 consultation is required for these activities; therefore, they are not addressed further in this consultation.

1.6 TABLES AND FIGURES FOR DESCRIPTION OF THE ACTION

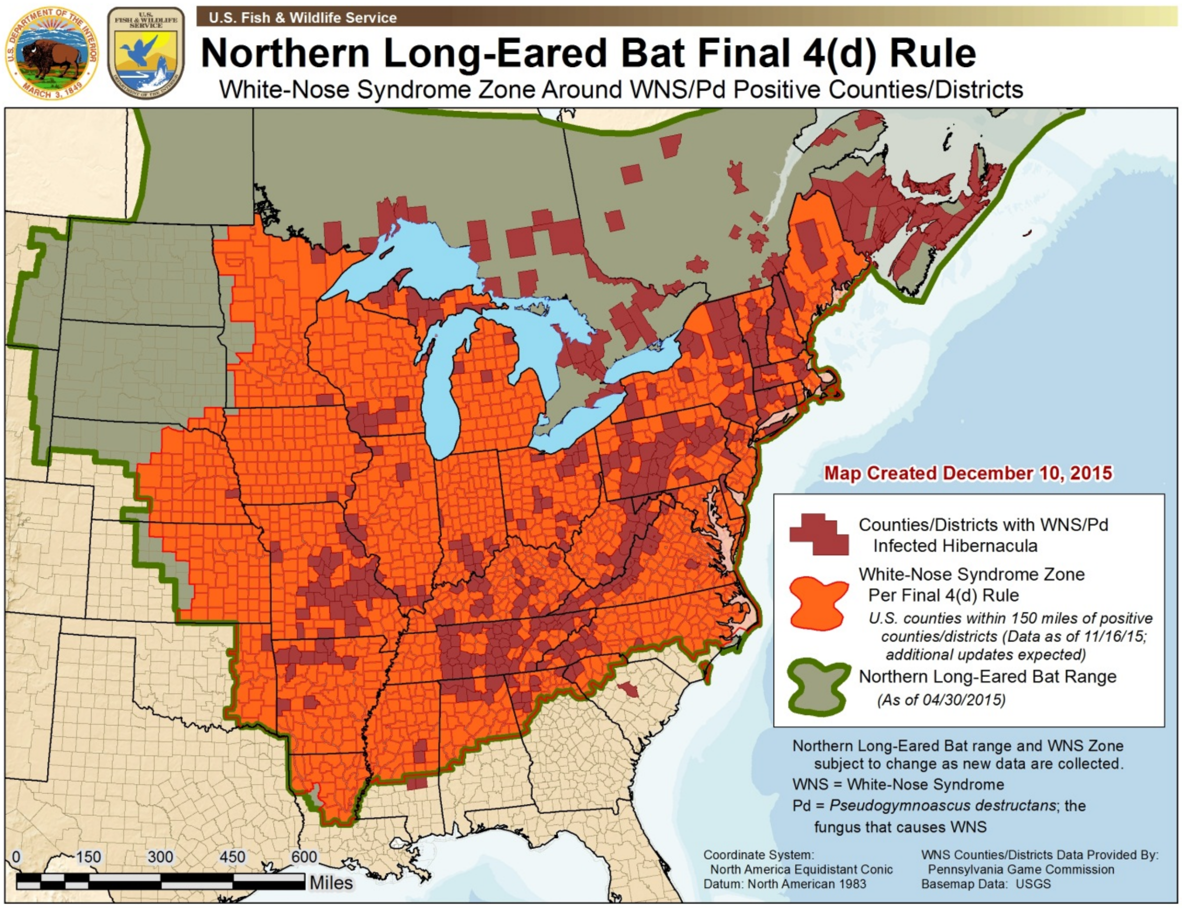

Figure 1.1. The NLEB WNS Zone around WNS/Pd positive counties or districts.

2 STATUS OF THE SPECIES/CRITICAL HABITAT

As described in Section 1, the Service listed the NLEB as a threatened species on April 2, 2015. The final rule determined that critical habitat designation for the NLEB was prudent, but not determinable at the time. The final listing rule describes the status of the species in detail and is hereby incorporated by reference. We summarize and paraphrase portions of the final rule in this section that are most relevant to an evaluation of the proposed Action. Additional information and citations can be found in the final listing rule.

2.1 SPECIES BACKGROUND & HABITAT

The NLEB is a temperate, insectivorous, migratory bat that hibernates in mines and caves in the winter and spends summers in wooded areas. The key stages in its annual cycle are: hibernation, spring staging and migration, pregnancy, lactation, volancy/weaning, fall migration and swarming. NLEB generally hibernate between mid-fall through mid-spring each year. The spring migration period likely runs from mid-March to mid-May each year, as females depart shortly after emerging from hibernation and are pregnant when they reach their summer area. Young are born between June and early July, with nursing continuing until weaning, which is shortly after young become volant (able to fly) in mid- to late-July. Fall migration likely occurs between mid-August and mid-October.

2.1.1 SUMMER HABITAT AND ECOLOGY

Suitable summer habitat for NLEB consists of a wide variety of forested/wooded habitats where they roost, forage, and travel and may also include some adjacent and interspersed non-forested habitats. This includes forests and woodlots containing potential roosts, as well as linear features such as fencerows, riparian forests, and other wooded corridors. These wooded areas may be dense or loose aggregates of trees with variable amounts of canopy closure.

After hibernation ends in late March or early April (as late as May in some northern areas), most NLEB migrate to summer roosts. For purposes of this BO, we define the NLEB active season as the period between emergence and hibernation from April 1 – October 31. We recognize that the active season is variable across the action area depending on latitude, elevation, and weather conditions; however, we believe this range captures most of the period throughout the range in most years. The spring migration period typically runs from mid-March to mid-May (Caire et al. 1979; Easterla 1968; Whitaker and Mumford 2009). The NLEB is not considered to be a long distance migrant (typically 40-50 miles). Males and non-reproductive females may summer near hibernacula, or migrate to summer habitat some distance from their hibernaculum.

After emergence, female NLEBs actively form colonies in the summer (Foster and Kurta 1999) and exhibit fission-fusion behavior (Garroway and Broders 2007), where members frequently coalesce to form a group, but composition of the group is in flux (Barclay and Kurta 2007). As part of this behavior, NLEBs switch tree roosts often (Sasse and Pekins 1996), typically every 2 to 3 days (Foster and Kurta 1999; Owen et al. 2002; Carter and Feldhamer 2005; Timpone et al. 2010). NLEB maternity colonies range widely in size (reported range of 7 to 100; Owen et al. 2002; Whitaker and Mumford 2009), although about 30-60 may be most common (Whitaker and Mumford 2009; Caceres and Barclay 2000; Service 2014).

NLEBs show interannual fidelity to roost trees and/or maternity areas. They use networks of roost trees often centered around one or more central-node roost trees (Johnson et al. 2012) with multiple alternate roost trees. NLEB roost in cavities, underneath bark, crevices, or hollows of both live and dead trees and/or snags (typically ≥3 inches dbh). NLEB are known to use a wide variety of roost types, using tree species based on presence of cavities or crevices or presence of peeling bark. NLEBs have also been occasionally found roosting in structures like buildings, barns, sheds, houses, and bridges (Benedict and Howell 2008; Krochmal and Sparks 2007; Timpone et al. 2010; Service 2014).

Summer home range includes both roosting and foraging areas, and range size may vary by sex. Maternity roosting areas have been reported to vary from mean of 21 to 179 acres (Owen et al. 2003; Broders et al. 2006; Lacki et al. 2009) to a high of 425 acres (Lacki et al. 2009). Foraging areas are six or more times larger (Broders et al. 2006; Henderson and Broders 2008). The distance traveled between consecutive roosts varies widely from 20 ft (Foster and Kurta 1999) to 2.4 miles (Timpone et al. 2010). Likewise, the distance traveled between roost trees and foraging areas in telemetry studies varies widely, e.g., a mean of 1,975 ft (Sasse and Perkins 1996) and a mean of 3,609 ft (Henderson and Broders 2008). Circles with a radius of these distances have an area of 281 and 939 acres. Based on reported maximum individual home range (425 acres) and travel distances between roosts and foraging areas described above (939 acres), we use 1,000 acres for purposes of this BO as the area a colony uses. An analysis of mist net survey data in Kentucky (Service 2014, unpublished data cited in the final listing rule) shows that most males and non-reproductive females are captured in the same locations as reproductively active females, suggesting substantial overlap in the summer home range of reproductive females and other individuals (94%).

NLEBs are typically born in late-May or early June, with females giving birth to a single offspring. Lactation then lasts 3 to 5 weeks, with pups becoming volant between early July and early August. For purposes of this BO and the final 4(d) rule, we define the pup season (i.e., the period of non-volancy) as June 1 – July 31.

2.1.2 WINTER HABITAT AND ECOLOGY

Suitable winter habitat (hibernacula) includes underground caves and cave-like structures (e.g. abandoned or active mines, railroad tunnels). There may be other landscape features being used by NLEB during the winter that have yet to be documented. Generally, NLEB hibernate from October to April depending on local climate (November-December through March in southern areas with emergence as late as mid-May in some northern areas).

Hibernacula for NLEB typically have significant cracks and crevices for roosting; relatively constant, cool temperatures (0-9 degrees Celsius) and with high humidity and minimal air currents. Specific areas where they hibernate have very high humidity, so much so that droplets of water are often seen on their fur. Within hibernacula, surveyors find them in small crevices or cracks, often with only the nose and ears visible.

NLEB tend to roost singly or in small groups (Service 2014), with hibernating population sizes ranging from just a few individuals to around 1,000 (Service unpublished data). NLEB display more winter activity than other cave species, with individuals often moving between hibernacula throughout the winter (Griffin 1940; Whitaker and Rissler 1992; Caceres and Barclay 2000). NLEB have shown a high degree of philopatry (i.e., using the same site multiple years) to the hibernacula used, returning to the same hibernacula annually.

2.1.3 SPRING STAGING AND FALL SWARMING HABITAT AND ECOLOGY

Upon arrival at hibernacula in mid-August to mid-November, NLEB “swarm,” a behavior in which large numbers of bats fly in and out of cave entrances from dusk to dawn, while relatively few roost in caves during the day. Swarming continues for several weeks and mating occurs during the latter part of the period. After mating, females enter directly into hibernation but not necessarily at the same hibernaculum at which they had been mating. A majority of bats of both sexes hibernate by the end of November (by mid-October in northern areas).

Reproductively active females store sperm through the winter from autumn copulations. Ovulation takes place after the bats emerge from hibernation in spring. The period after hibernation and just before spring migration is typically referred to as “staging,” a time when bats forage and a limited amount of mating occurs. This period can be as short as a day for an individual, but not all bats emerge on the same day.

In general, NLEB use roosts in the spring and fall similar to those selected during the summer. Suitable spring staging/fall swarming habitat consists of the variety of forested/wooded habitats where they roost, forage, and travel, which is most typically within 5 miles of a hibernaculum.

2.2 DISTRIBUTION AND RANGE

The NLEB ranges across much of the eastern and north central United States, and all Canadian provinces west to the southern Yukon Territory and eastern British Columbia (Figure 2.1) (Nagorsen and Brigham 1993; Caceres and Pybus 1997; Environment Yukon 2011). In the United States, the species' range reaches 37 states from Maine west to Montana, south to eastern Kansas, eastern Oklahoma, Arkansas, and east to South Carolina (Whitaker and Hamilton 1998; Caceres and Barclay 2000; Amelon and Burhans 2006). Historically, the species has been most frequently observed in the northeastern United States and in Canadian Provinces, Quebec and Ontario. However, throughout the majority of the species' range it is patchily distributed, and historically was less common in the southern and western portions of the range than in the northern portion of the range (Amelon and Burhans 2006).

The U.S. portion of the NLEB's range is discussed in this BO in four parts: Eastern, Midwest, Southern, and Western. This is done solely for purposes of analysis and discussion; there is currently no indication that these are distinct populations. The Eastern range comprises Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and West Virginia. The Midwest range includes Illinois, Indiana, Iowa, Michigan, Minnesota, Missouri, Ohio, and Wisconsin. The Southern range comprises Alabama, Arkansas, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, and Tennessee, and the Western range includes Kansas, Montana, Nebraska, North Dakota, South Dakota, and Wyoming.

Although NLEBs are typically found in low numbers in inconspicuous roosts, most records of NLEB are from winter hibernacula surveys (Caceres and Pybus 1997). There are currently 1,508 hibernacula known throughout the species' range in the United States (Table 2.1). The majority of the known hibernacula occur within the Eastern (39%) and the Midwest range (38), followed by 21 percent in the Southern range, and 2 percent in the Western range. Even prior to WNS, many hibernacula contained only a few (1 to 3) individuals (Whitaker and Hamilton 1998). There are likely many more unknown hibernacula.

There have also been many summer mist-net and acoustic surveys conducted within the range of the NLEB, but the surveys have not been complied into a central database across the species' range. The data is housed with the state natural resources programs, state natural heritage programs, or the local Service field offices. We are unable to report the total number of locations with NLEBs; however, we have compiled the total number of known maternity roost trees in each state (Table 2.1). There are 1,744 known maternity roost trees in 19 of 37 states, with 42% occurring in the Southern range, 30% in the Midwest, and 28% in the Eastern range. There are no known maternity roost trees in the Western range. There are limitations to these data because most states and natural heritage programs have not been tracking NLEB occurrences or individual roosts.

The current range and distribution of NLEB must be described and understood within the context of the impacts of WNS. Prior to the onset of WNS, the best available information on NLEB came primarily from surveys (primarily focused on Indiana bat or other bat species) and some targeted research projects. In these efforts, NLEB was very frequently encountered and was considered the most common myotid bat in many areas. Overall, the species was considered to be widespread and abundant throughout its historic range (Caceres and Barclay 2000). NLEBs continue to be distributed across much of the historical range, but there are many gaps within the range where bats are no longer detected or captured, and in other areas, their occurrence is sparse given local declines and extirpations.

2.3 STATUS AND THREATS

2.3.1 WHITE-NOSE SYNDROME

WNS is an emerging infectious wildlife disease caused by a fungus of European origin, Pd, which poses a considerable threat to hibernating bat species throughout North America, including the NLEB (Service 2011). WNS is responsible for unprecedented mortality of insectivorous bats in eastern North America (Blehert et al. 2009; Turner et al. 2011). No other threat is as severe and immediate for the NLEB as the disease WNS. There is no doubt that NLEB populations would be declining so dramatically without the impact of WNS. Since the disease was first observed in New York in 2007 (later biologists found evidence from 2006 photographs), WNS has spread rapidly in bat populations from the East to the Midwest and the South. As of November 2015, WNS or Pd was confirmed in 30 of the 37 states within the species' range (Figure 1.1; Table 2.2). Data support substantial declines in the Eastern range and portions of the Midwest range. In addition, there are apparent population declines at most hibernacula with WNS in the Southern range. We expect further declines as the disease continues to spread across the species' range.

Post-WNS hibernacula counts available from the northeast U.S. show the most substantial population declines for the NLEB. Turner et al. (2011) compared the most recent pre-WNS count to the most recent post-WNS count for six cave bat species and reported a 98 percent total decline in the number of hibernating NLEB at 30 hibernacula in New York, Pennsylvania, Vermont, Virginia, and West Virginia through 2011. For the final listing rule, the Service conducted an analysis of additional survey information at 103 sites across 12 U.S. States and Canadian provinces (New York, Pennsylvania, Vermont, West Virginia, Virginia, New Hampshire, Maryland, Connecticut, Massachusetts, North Carolina, New Jersey, and Quebec) and found comparable declines in winter colony size. At these sites, total NLEB counts declined by an average of 96 percent after the arrival of WNS; 68 percent of the sites declined to zero NLEB, and 92 percent of sites declined by more than 50 percent. Frick et al. (2015) consider the NLEB now extirpated from 69 percent of the hibernacula in Vermont, New York, Pennsylvania, Maryland, Virginia, and West Virginia that had colonies of NLEB prior to WNS. Langwig et al. (2012) reported that 14 populations of NLEB in New York, Vermont, and Connecticut became locally extinct within 2 years due to disease.

Long-term summer survey data (including pre- and post-WNS) for the NLEB, where available, corroborate the population decline evident in hibernacula survey data. For example, summer surveys from 2005 – 2011 near Surry Mountain Lake in New Hampshire showed a 98 percent decline in capture success of NLEB post-WNS, which is similar to the hibernacula data for the State (a 95 percent decline) (Moosman et al. 2013). Mist-netting data from Pennsylvania indicate that NLEB captures declined by 46 percent in 2011, 63 percent in 2012, 76 percent in 2013, and 94 percent in 2014, compared to the average pre-WNS capture rate between 2001 to 2007 (Butchkoski 2014; Pennsylvania Game Commission, unpublished data). The NLEB is more commonly encountered in summer mist-net surveys in the Midwest; however, similar rates of population decline are already occurring in Ohio and Illinois. Early reports also indicate declines in Missouri and Indiana (80 FR 17979-17980). Other data, much of it received as comments on the proposed listing rule from State wildlife agencies, demonstrate that various measures of summer NLEB abundance and relative abundance (mist net surveys, acoustic surveys) have declined following detection of WNS in the state.

Although the dispersal rate of Pd across the landscape and the onset of WNS after the fungus arrives at a new site are variable, it appears unlikely that any site within the range of the NLEB is not susceptible to WNS. Some evidence suggests that certain microclimatic conditions may hinder disease progression at some sites, but given sufficient exposure time, WNS has had similar impacts on NLEB everywhere the disease is documented. Absent direct evidence that some NLEB exposed to the fungus do not contract WNS, available information suggests that the disease will eventually spread throughout the species' range. As described in Section 1 of this BO, we anticipate that WNS will spread throughout the range of the NLEB by 2023-2028.

2.3.2 OTHER THREATS

Although significant NLEB population declines have only been documented due to the spread of WNS, other sources of mortality could further diminish the species' ability to persist as it experiences ongoing dramatic declines. The final listing rule for the NLEB describes known threats to the species under each of the five statutory factors for listing decisions, of which disease/predation, discussed above, is the dominant factor. We summarize here the findings of the final listing rule regarding the other four factors that are relevant to this consultation.

Human and non-human modification of hibernacula, particularly altering or closing hibernacula entrances, is considered the next greatest threat after WNS to the NLEB. Some modifications, e.g., closure of a cave entrance with structures/materials besides a bat-friendly gate, can cause a partial or complete loss of the utility of a site to serve as hibernaculum. Humans can also disturb hibernating bats, either directly or indirectly, resulting in an increase in energy-consuming arousal bouts during hibernation (Thomas 1995; Johnson et al. 1998).

During the summer, NLEB habitat loss is primarily due to forest conversion and forest management. Throughout the range of NLEB, forest conversion is expected to increase due to commercial and urban development, energy production and transmission, and natural changes. The 2010 Resources Planning Act Assessment projects forest losses of 16–34 million acres (or 4–8 percent of 2007 forest area) across the conterminous United States, and forest loss is expected to be concentrated in the southern United States, with losses of 9–21 million acres (USFS 2012). Forest conversion causes loss of potential habitat, fragmentation of remaining habitat, and if occupied at the time of the conversion, direct injury or mortality to individuals. Forest management activities, unlike forest conversion, typically result in temporary impacts to the habitat of NLEB, but like forest conversion, may also cause direct injury or mortality to individuals. The net effect of forest management may be positive, neutral, or negative, depending on the type, scale, and timing of various practices. The primary potential benefit of forest management to the species is perpetuating forests on the landscape that provide suitable roosting and foraging habitat.

Wind energy facilities are known to cause mortality of NLEB. While mortality estimates vary between sites and years, sustained mortality at particular facilities could cause declines in local populations. Wind energy development within portions of the species' range is projected to continue.

Climate change may also affect this species, as NLEB are particularly sensitive to changes in temperature, humidity, and precipitation. Climate change may indirectly affect the NLEB through changes in food availability and the timing of hibernation and reproductive cycles.

Environmental contaminants, in particular insecticides, other pesticides, and inorganic contaminants, such as mercury and lead, may also have detrimental effects on NLEB. Contaminants may bio-accumulate (become concentrated) in the tissues of bats, potentially leading to a myriad of sub-lethal and lethal effects. NLEBs may also be indirectly affected through a reduction in available insect prey.

Fire is one of the environmental stressors that contribute to the creation of snags and damaged trees on the landscape, which NLEB frequently use as summer roosts. Fire may also kill or injure bats, especially flightless pups. Prescribed burning is a common tool for forest management in many parts of the species' range.

There is currently no evidence that the natural or manmade factors discussed above (hibernacula modification, forest conversion, forest management, wind energy, climate change, contaminants, fire) have separately or cumulatively contributed to significant range-wide population effects on the NLEB prior to the onset of WNS. However, declines due to WNS have significantly reduced the number and size of NLEB populations in some areas of its range. This has reduced these populations to the extent that they may be increasingly vulnerable to other stressors that they may have previously had the ability to withstand. These impacts could potentially be seen on two levels. First, individual NLEB sickened or struggling with infection by WNS may be less able to survive other stressors. Second, NLEB populations impacted by WNS, with smaller numbers and reduced fitness among individuals, may be less able to recover making them more prone to extirpation. The status and potential for these impacts will vary across the range of the species.

2.4 POPULATION DYNAMICS

Hibernacula counts are generally the best census method for most bats that hibernate, because individuals are concentrated and relatively stationary. However, because the NLEB is difficult to detect in hibernacula, moves between hibernacula during the winter, and many hibernacula are likely not known, a range-wide population estimate for the species is not available. The NLEB is most widely dispersed on the landscape during the summer where it is most likely exposed, directly or indirectly (i.e., later in time), to the widely dispersed (i.e., not concentrated in a given area) activities that are excepted from take prohibitions under the 4(d) rule.

For purposes of this BO, we estimate NLEB numbers based on total forested acres in each state and assumptions about:

- state-specific occupancy rates;
- forested acres in each state;
- maternity colony home-range size;
- number of adult females per colony;
- overlap between adult male home range and maternity colony home range;
- overlap between maternity colonies; and
- landscape-scale adult sex ratio (we assume 1:1).

We explain these data and assumptions in the following sub-sections.

2.4.1 OCCUPANCY RATES

We requested summer survey results from the three most recent years available from our field offices to provide an estimate of recent occupancy rates. Field offices provided the total number of survey sites (typically mist-net surveys), by state and by year, and the number of sites that captured at least one NLEB. Occupancy rates were calculated using the proportion of sites occupied with NLEB from the total number of sites sampled (Table 2.3). Where no data were available, we used the post-WNS survey data provided by the Forest Service for National Forests within the respective state (Table 2.3). Some states have only 1 or 2 years of data, and others have 8 or more consecutive years of data. In most cases, the numbers and locations of these survey sites do not constitute a representative sample of the available forest habitat in each state. Regardless, the alternative to using these data is to consider the NLEB ubiquitous within forested habitat in each state, which would greatly overestimate occupancy. Instead, we use these data as the best available information from which to make inferences about the extent of NLEB occupancy in each state[2].

Table 2.2 identifies the years in which WNS was detected in the state. We compute pre- and post-WNS occupancy rates as the number of net sites with NLEB divided by the total number of bat capture sites in each state. We applied the occupancy rate listed in Table 2.3 to each state.

2.4.2 TOTAL FORESTED ACRES IN EACH STATE

We compiled the total forested acres for each state from the U.S. Forest Service's 2015 State and Private Forestry Fact sheets (available at http://stateforesters.org/regional-state). We assumed that all forested acres within each state are suitable for the NLEB, which probably overestimates habitat availability but it is not unreasonable given the NLEB's ability to use very small trees (≥ 3 in dbh). We could have estimated the amount of forest in each state in more detail, but our analysis of other factors unrelated to forest cover was limited to statewide data, so we used statewide data throughout the analysis for all factors.

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[2] The occupancy data used in this analysis has many limitations and a substantial amount of uncertainty. Occupancy as used here is the proportion of suitable habitat that is likely to have NLEB present. This is sensitive to the accuracy of the suitable habitat data, the accuracy of the survey data used to estimate the occupancy, and biases in the survey data collection methodology. The definition of suitable habitat used for this analysis is necessarily very general (forested areas) to be applicable across the entire species range. The surveys used to generate the occupancy data were often very sparse and not designed for this purpose. Repurposing of the data may increase the effects of bias in distribution of sample points (in relation to both suitable habitat and bat distributions), sampling methodologies, and sampling timing. We believe that because much of the sampling was not targeted specifically at NLEB and often involves surveys for development or construction projects, survey locations are unlikely to be closely correlated to NLEB distributions, which may minimize the influence of some biases. However, the limitations of the available data and its biases are potentially significant to the occupancy estimates, and this creates uncertainty that we acknowledge. Given these factors, our estimates of population are meant as tool for assessing potential relative impact by providing a scale for comparison, not as a precise estimate of the northern long-eared bat populations.

Not every state is wholly within the range of the NLEB (Figure 2.1), and including the total forested acreage from states not fully within the species' range could greatly overestimate the population size. Therefore, we excluded states with less than 50% of its area within the species range, which eliminated Montana, Wyoming, Oklahoma, Louisiana, Alabama, Georgia, and South Carolina. The inclusion of the full states of Nebraska, Kansas, Mississippi, and North Carolina should compensate for any individuals not included in the excluded states. The list of states included, along with the total forested acres are reported in Table 2.4.

2.4.3 COLONY SIZE (NUMBERS OF BATS AND OCCUPIED AREA)

In addition to the occupancy rates described above, we rely in this BO primarily on colony characteristics reported in the literature to estimate state-wide bat numbers. NLEB colonies are comprised of variable numbers of adult females. Two important studies give a range of 30–60 adult females per colony (see Section 2.1.1). Given the number of colonies that a state likely supports (see Section 2.4.4) (see Section 2.4.4), we then estimate total NLEB numbers in the occupied available habitat using the number of females per colony and assuming a 1:1 adult female/adult male ratio and a maximum of 1 pup per female.

While colony sizes of 30-60 bats may be typical in areas unaffected by WNS, in areas with clear declines in bat populations, these estimates may no longer be appropriate. Declines in total population appear to exceed what could be explained by declines in occupancy rates alone. The total reproductive female population can be described as the product of the average colony size in females and the number of colonies:

[Total female reproductive population = Number of colonies * Mean females per colony] OR
N=C*F

If the rate of total population decline exceeds the rate of decline in number of colonies (as described by declines in occupancy) there must also be an additional reduction in the average colony size as well.

Information about total population sizes or average colony sizes is not available on a wide scale. However, there are a few instances where we have obtained data that could be used to approximate rates of population decline without knowing the actual sizes of populations. In Pennsylvania, captures of bats per unit effort have been tracked for several years. Changes in this number of bats per unit effort captured across a wide area could be assumed to mirror changes in the total population for that area. So if the total population declined by 50%, we would expect to see a 50% decline in captures of bats per unit effort as well. The number of bats per unit effort in Pennsylvania declined to 22.3% of pre-WNS levels (averaging capture rates across 2012-2014). Over the same time period, occupancy declined 49.8%. Pre-WNS occupancy was 67.9% of suitable habitat, while the last three years of data indicate an occupancy rate of 33.8% of suitable habitat (0.338/0.679=0.498).

The change over time of the total female population is going to be a function of the change in the number of colonies and the change in the mean number of females per colony. Or, put another way, the change in females per colony over time can be described by the change in the number of colonies in relation to the change in total female population. So:

$N_t/N_0 = (C_t*F_t)/(C_0*F_0)$ OR $C_t = (N_t/N_0)*(C_0*F_0)/ F_t$ OR $C_t = (N_t/N_0)*C_0/(F_t/ F_0)$

Assuming changes in captures per unit effort is a good approximation for changes in the proportion of remaining bats, and using the decline in occupancy to represent the decline in the number of colonies, with a decline in occupancy of 49.8%, the average colony size is likely to have declined by 55% to approximately 20 bats per colony. (((0.223/1)*45)/(0.498)=20.2)

Similarly, Ohio has seen declines in captures per mist net site to 91.2% of pre-WNS levels, using the average of 2012-2014 rates. While likely to be less accurate to represent population declines than captures per unit effort, captures per mist net site may be a reasonable approximation for total population changes as well. Occupancy rates have been relatively stable in Ohio, increasing slightly from 39.6% over 2007-2010 to 42.1% over 2012-2014 (although with a large drop in 2014). Assuming the captures per mist net site is also a reasonable estimate of the rate of total population decline, a slightly increasing occupancy indicates that declines must be occurring within colonies. The average colony is likely to have declined 14%, to about 39 bats. (((0.912/1)*45)/(1.06) = 38.7)

WNS was first documented in Pennsylvania in 2008-2009 and in Ohio in 2010-2011 (Table 2.2). For the purposes of this BO, we assume that colonies are comprised of 20 females in all states where WNS was documented prior to the winter of 2010-2011 (Table 2.4). Rhode Island does not have any hibernacula; therefore, WNS has not been confirmed in the state. We assume that bats in summer habitat in Rhode Island have been affected by WNS in the surrounding states, and colonies are comprised of 20 females. For all states with WNS documented during or after the winter of 2010-2011, we assume colonies are comprised of 39 females. For states that do not have WNS (including states that have only documented Pd), we use 45 females per colony (the mid-point of the 30–60 range) as the basis for estimating bat numbers. For each colony present in a state, we assume a NLEB population is comprised of 20, 39, or 45 adult females and the same number of sympatric adult males and juveniles following parturition, depending on the status of WNS (Table 2.4).

As described in Section 2.1.1, we use 1,000 acres for purposes of this BO as the area a colony uses. Within this area, one or more members of a colony and sympatric adult males would likely appear in mist net or acoustic surveys. Such appearance is the basis for the occupancy rates we use to estimate the acreage of available forested habitat that NLEB may use during the active season in the states, which are given in Table 2.4.

Maternity roosting areas are a subset of the 1,000-acre colony size we use in this BO. As described above, Broders et al. (2006) and Henderson and Broders (2008) found that foraging areas were six or more times larger than maternity roosting areas. One sixth of our 1,000-acre colony size is 167 acres, which is within the range of other maternity roosting areas reported (Carter and Feldhamer 2005; Silvis et al. 2015). For purposes of this BO, we use a maternity roosting area of 167 acres. Table 2.5 shows our estimates of the percentage of each state that is used as maternity roost areas based on the number of expected colonies (Table 2.4) and 167 acres per colony.

2.4.4 OVERLAP

Lacking information about the degree of spatial overlap between NLEB maternity colonies, for this BO we assume that colonies do not overlap, e.g., we assume that 1,000 acres of occupied habitat supports one colony. Estimated or assumed occupancy rates in all of the states are all less than 70 percent (Table 2.3); therefore, it is unlikely that limited habitat availability would contribute to substantial colony-range overlap. If incorrect, the possible effect of this assumption is to underestimate the population size in each state (i.e., 1,000 acres supports more than 1 colony).

As described in Section 2.1.1, mist net survey data in Kentucky indicate substantial overlap in the summer home range of reproductive females and males and non-reproductive females (1,712 of 1,825 capture records, or 94 percent). The Service further analyzed this data to determine the percentage of capture locations for males and non-reproductive females that were not capture locations for reproductive female captures or within 3 miles of a reproductive female capture location (Service 2015b). Of 909 capture locations, 87 (9.57 percent) did not have reproductively active females and were more than 3 miles away from captures of reproductive females, suggesting a 100 – 9.57 = 90.43 percent overlap between the home range of individuals belonging to maternity colonies and other individuals. We lack state-specific information about the overlap between reproductively active females and other bats; therefore, for this BO, we assume the 90.43 percent overlap suggested by the Kentucky data. We multiply occupied forest acres by 0.9043 to compute the number of probable maternity colonies; e.g., 100,000 occupied acres × 0.9043 = 90,430 acres supporting 90,430 ÷ 1000 = 91 maternity colonies, rounding up any fractional remainder.

2.4.5 POPULATION ESTIMATES

Table 2.4 provides our estimates of the summer adult population size of NLEB in the 30 states included in the analysis. It relies on the total forested acres and the other assumptions described above; i.e., occupancy rates for each state in Table 2.3, 90.43 percent overlap between the range of males and maternity colonies, 1,000 acres per colony, no overlap between colonies, the number of adult females per colony (20, 39, or 45 depending on WNS), and a 1:1 male/female sex ratio. Here are example calculations for Iowa as reported in Table 2.4:

- 3,013,759 forested acres × 0.417 occupancy rate = 1,256,738 occupied acres;
- 1,256,738 occupied acres × 0.9043 overlap with males = 1,136,467 colony-occupied acres;
- 1,136,467 acres ÷ 1,000 acres per colony = 1,137 colonies;
- 1,137 colonies × 45 adult females per colony = 51,165 adult females; and
- 51,165 adult females + 1 adult male per female (or 51,165 adult males) = 102,330 total adults.

We estimate that the range-wide population of NLEBs is comprised of 6,546,718 adults based on these calculations and the assumption that the 30 states included in the analysis represent the range-wide population. Arkansas supports the largest population (863,850 adults; 13%), followed by Minnesota with 829,890 (13%). Delaware and Rhode Island support the smallest populations with 640 and 1,240 adults, respectively. Based on these estimates, the Midwest supports 43% of the total population followed by the Southern range (38%), the Eastern range (17%), and the Western range (2%).

It is likely that the state populations are overestimates in areas affected by WNS. We used the occupancy data from the last 3 years, but in nearly all WNS areas there is a clear downward trend and most data are at least a year old. Therefore, the occupation rates and resulting population estimates are likely lower in many areas.

2.5 ANALYSIS OF THE SPECIES/CRITICAL HABITAT LIKELY TO BE AFFECTED

As described in Section 1, the NLEB is likely to be adversely affected by the activities which are excepted from incidental take prohibitions in the final 4(d) rule. Many federally listed, proposed, and candidate species, and their designated or proposed critical habitats, occur within the Action Area for this consultation. However, the Service Headquarters has determined that the proposed action will have no effect on any other listed, proposed, or candidate species or designated or proposed critical habitats. The action is the Service’s finalization the 4(d) rule for the NLEB. It sets forth the prohibitions for take under section 9(a)(1) of the Act and the exceptions to those prohibitions. It does not alter in any way the consultation requirements under section 7(a)(2) of the Act. Although this BO provides a framework for streamlined section 7 consultation for federal actions that are consistent with the provisions of the 4(d) rule, the framework only applies to the NLEB. Federal agencies will still be required to consult on activities that may affect other listed species within the Action Area. Therefore, only the NLEB will be considered further in this BO.

2.6 TABLES AND FIGURES FOR STATUS OF THE SPECIES

Table 2.1. Known NLEB hibernacula and known maternity roosts trees by state.

Range	State	Known Hibernacula	Known Occupied Maternity Roost Trees
Midwest	Iowa	2	14
Midwest	Illinois	44	39
Midwest	Indiana	69	193
Midwest	Michigan	77	25
Midwest	Minnesota	15	102
Midwest	Missouri	269	58
Midwest	Ohio	32	4
Midwest	Wisconsin	67	84
Eastern	Connecticut	8	0
Eastern	Delaware	2	0
Eastern	Maine	3	0
Eastern	Maryland	8	0
Eastern	Massachusetts	7	16
Eastern	New Hampshire	11	0
Eastern	New Jersey	9	47
Eastern	New York	90	27
Eastern	Pennsylvania	322	157
Eastern	Rhode Island	0	0
Eastern	Vermont	16	0
Eastern	Virginia	11	12
Eastern	West Virginia	104	231
Southern	Alabama	11	0
Southern	Arkansas	77	310
Southern	Georgia	6	20
Southern	Kentucky	122	254
Southern	Louisiana	0	0
Southern	Mississippi	0	0
Southern	North Carolina	29	101
Southern	Oklahoma	9	0
Southern	South Carolina	3	0
Southern	Tennessee	61	50
Western	Kansas	1	0
Western	Montana	0	0
Western	Nebraska	2	0
Western	North Dakota	0	0
Western	South Dakota	21	0
Western	Wyoming	0	0
	Total	1,508	1,744

Table 2.2. White-nose syndrome (WNS) and *Pseudogymnoascus destructans* (Pd) occurrence in the 37 States.

REGION	STATE	WNS or Pd Present?	First Winter WNS Confirmed	Documented WNS Mortality in Bats?
Midwest	Iowa	Pd	Pd only (2011-2012)	No
Midwest	Illinois	WNS	2012-2013	Yes
Midwest	Indiana	WNS	2010-2011	Yes
Midwest	Michigan	WNS	2014-2015	Yes
Midwest	Minnesota	Pd	Pd only (2011-2012)	No
Midwest	Missouri	WNS	2011-2012	Yes
Midwest	Ohio	WNS	2010-2011	Yes
Midwest	Wisconsin	WNS	2013-2014	Yes
Eastern	Connecticut	WNS	2008-2009	Yes
Eastern	Delaware	WNS	2009-2010	Yes
Eastern	Maine	WNS	2010-2011	Yes
Eastern	Maryland	WNS	2009-2010	Yes
Eastern	Massachusetts	WNS	2007-2008	Yes
Eastern	New Hampshire	WNS	2008-2009	Yes
Eastern	New Jersey	WNS	2008-2009	Yes
Eastern	New York	WNS	2006-2007	Yes
Eastern	Pennsylvania	WNS	2008-2009	Yes
Eastern	Rhode Island	No	NA	NA
Eastern	Vermont	WNS	2007-2008	Yes
Eastern	Virginia	WNS	2008-2009	Yes
Eastern	West Virginia	WNS	2008-2009	Yes
Southern	Alabama	WNS	2011-2012	Yes
Southern	Arkansas	WNS	2013-2014	Yes
Southern	Georgia	WNS	2012-2013	Yes
Southern	Kentucky	WNS	2010-2011	Yes
Southern	Louisiana	No	NA	NA
Southern	Mississippi	Pd	Pd only (2013-2014)	No
Southern	North Carolina	WNS	2010-2011	Yes
Southern	Oklahoma	Pd	Pd only (2014-2015)	No
Southern	South Carolina	WNS	2012-2013	Yes
Southern	Tennessee	WNS	2009-2010	Yes
Western	Kansas	No	NA	NA
Western	Montana	No	NA	NA
Western	Nebraska	Pd	Pd only (2014-2015)	No
Western	North Dakota	No	NA	NA
Western	South Dakota	No	NA	NA
Western	Wyoming	No	NA	NA

Table 2.3. NLEB summer state-wide occupancy estimates, based on summer survey results.

Range	State	Description	Pre-WNS Years (Combined)		Pre-WNS Occupancy Rate	Sum of 3 Most Recent WNS Years	WNS Impacted Occupancy Rate	Occupancy Rate Used
Midwest	IA	Total Mist Net Sites	2009-2011	24		0		
		Sites with NLEB Captures		10	41.7%	0	N/A	41.7%
	IL	Total Mist Net Sites	2009-2011	40		0		
		Sites with NLEB Captures		25	62.5%	0	N/A	62.5%
	IN	Total Mist Net Sites				283		
		Sites with NLEB Captures			N/A	106	37.5%	37.5%
	MI	Total Mist Net Sites	2004-2014	149		0		
		Sites with NLEB Captures		47	31.5%	0	N/A	31.5%
	MN	Total Mist Net Sites	2013-2014	121		0		
		Sites with NLEB Captures		71	58.7%	0	N/A	58.7%
	MO	Total Mist Net Sites				42		
		Sites with NLEB Captures			N/A	11	26.2%	26.2%
	OH	Total Mist Net Sites	2007-2010	733		2485		
		Sites with NLEB Captures		290	39.6%	1046	42.1%	42.1%
	WI	Total Mist Net Sites				78		
		Sites with NLEB Captures			N/A	35	44.9%	44.9%
Eastern	CT$	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	9.4%
	DE^	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	5.0%	5.0%
	ME*	Total Acoustic Sites				180		
		Sites with NLEB Captures			N/A	17	9.4%	9.4%
	MD^	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	5.0%	5.0%
	MA*	Total Acoustic Sites				132		
		Sites with NLEB Captures			N/A	9	6.8%	6.8%
	NH#	Total Mist Net Sites	2002-2004	13		173		
		Sites with NLEB Captures		12	92.3%	17	9.8%	9.8%
	NJ	Total Mist Net Sites	1995-2008	132		25		
		Sites with NLEB Captures		89	67.4%	8	32.0%	32.0%
	NY+#	Total Mist Net Sites	2000-2005	56		45		
		Sites with NLEB Captures		39	69.6%	15	33.3%	33.3%
	PA	Total Mist Net Sites	2001-2007	1069		1469		
		Sites with NLEB Captures		726	67.9%	497	33.8%	33.8%
	RI$	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	9.4%
	VT+#	Total Mist Net Sites	2000-2005			12		
		Sites with NLEB Captures			See NY	3	25.0%	9.8%
	VA#	Total Mist Net Sites	2010	27		60		
		Sites with NLEB Captures		27	100.0%	29	48.3%	48.3%
	WV	Total Mist Net Sites	1997-2008	508		97		
		Sites with NLEB Captures		401	78.9%	52	53.6%	53.6%

Table 3.1. Continued.

Range	State	Description	Pre-WNS Years (Combined)		Pre-WNS Occupancy Rate	Sum of 3 Most Recent WNS Years	WNS Impacted Occupancy Rate	Occupancy Rate Used
Southern	AL[#]	Total Mist Net Sites	2001-2011	179		38		
		Sites with NLEB Captures		48	26.8%	13	34.2%	34.2%
	AR[#]	Total Mist Net Sites	2009-2013	568		95		
		Sites with NLEB Captures		399	70.2%	62	65.3%	65.3%
	GA[#]	Total Mist Net Sites	2001-2011	62		18		
		Sites with NLEB Captures		37	59.7%	10	55.6%	55.6%
	KY	Total Mist Net Sites	2005-2010	503		305		
		Sites with NLEB Captures		263	52.3%	124	40.7%	40.7%
	LA[$]	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	34.2%
	MS[$]	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	34.2%
	NC[#]	Total Mist Net Sites	2000-2012	244		35		
		Sites with NLEB Captures		199	81.6%	14	40.0%	40.0%
	OK	Total Mist Net Sites	2013-2015	28		0		
		Sites with NLEB Captures		13	46.4%	0	N/A	46.4%
	SC[$]	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	34.2%
	TN[#]	Total Mist Net Sites	2000-2008	221		90		
		Sites with NLEB Captures		153	69.2%	37	41.1%	41.1%
Western	KS[+]	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	22.5%
	MT[+]	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	22.5%
	NE[+]	Total Mist Net Sites				0		
		Sites with NLEB Captures			N/A	0	N/A	22.5%
	ND[+]	Total Mist Net Sites	2009-2014	42		0		
		Sites with NLEB Captures		3	7.1%	0	N/A	22.5%
	SD[+]	Total Mist Net Sites	2003-2006	13		0		
		Sites with NLEB Captures		10	76.9%	0	N/A	22.5%
	WY[+]	Total Mist Net Sites	2010-2014	56		0		
		Sites with NLEB Captures		12	21.4%	0	N/A	22.5%

* Acoustic data used due to limited amount of mist net data

^ Statewide occupancy estimates from a more in-depth analysis used

[#] Based on data from National Forests in the state

[$] Data from nearby states used because statewide data was inadequate or unavailable

[+] Data from multiple states were aggregated due to small datasets

Table 2.4. NLEB adult summer population estimates for the 30 states included in analysis.

Region	State	Forested Acres	Percent Occupancy	Occupied Acres	Maternity Colonies	Maternity Colony Size	Adult Females	Total Adults	Total Pups
Midwest	Iowa	3,013,759	41.7%	1,256,738	1,137	45	51,165	102,330	51,165
Midwest	Illinois	4,847,480	62.5%	3,029,675	2,740	39	106,860	213,720	106,860
Midwest	Indiana	4,830,395	37.5%	1,811,398	1,639	39	63,921	127,842	63,921
Midwest	Michigan	20,127,048	31.5%	6,340,020	5,734	39	223,626	447,252	223,626
Midwest	Minnesota	17,370,394	58.7%	10,196,421	9,221	45	414,945	829,890	414,945
Midwest	Missouri	15,471,982	26.2%	4,053,659	3,666	39	142,974	285,948	142,974
Midwest	Ohio	8,088,277	42.1%	3,405,165	3,080	39	120,120	240,240	120,120
Midwest	Wisconsin	16,980,084	44.9%	7,624,058	6,895	39	268,905	537,810	268,905
Eastern	Connecticut	1,711,749	9.4%	160,904	146	20	2,920	5,840	2,920
Eastern	Delaware	339,520	5.0%	16,976	16	20	320	640	320
Eastern	Maine	17,660,246	9.4%	1,660,063	1,502	39	58,578	117,156	58,578
Eastern	Maryland	2,460,652	5.0%	123,033	112	20	2,240	4,480	2,240
Eastern	Massachusetts	3,024,092	6.8%	205,638	186	20	3,720	7,440	3,720
Eastern	New Hampshire	4,832,408	9.8%	473,576	429	20	8,580	17,160	8,580
Eastern	New Jersey	1,963,561	32.0%	628,340	569	20	11,380	22,760	11,380
Eastern	New York	18,966,416	33.3%	6,315,817	5,712	20	114,240	228,480	114,240
Eastern	Pennsylvania	16,781,960	33.8%	5,672,302	5,130	20	102,600	205,200	102,600
Eastern	Rhode Island	359,519	9.4%	33,795	31	20	620	1,240	620
Eastern	Vermont	4,591,280	9.8%	449,945	407	20	8,140	16,280	8,140
Eastern	Virginia	15,907,041	48.3%	7,683,101	6,948	20	138,960	277,920	138,960
Eastern	West Virginia	12,154,471	53.6%	6,514,796	5,892	20	117,840	235,680	117,840
Southern	Arkansas	18,754,916	65.3%	12,246,960	11,075	39	431,925	863,850	431,925
Southern	Kentucky	12,471,762	40.7%	5,076,007	4,591	39	179,049	358,098	179,049
Southern	Mississippi	19,541,284	34.2%	6,683,119	6,044	45	271,980	543,960	271,980
Southern	North Carolina	18,587,540	40.0%	7,435,016	6,724	39	262,236	524,472	262,236
Southern	Tennessee	13,941,333	41.1%	5,729,888	5,182	20	103,640	207,280	103,640
Western	Kansas	2,502,434	22.5%	563,048	510	45	22,950	45,900	22,950
Western	Nebraska	1,576,174	22.5%	354,639	321	45	14,445	28,890	14,445
Western	North Dakota	759,998	22.5%	171,000	155	45	6,975	13,950	6,975
Western	South Dakota	1,910,934	22.5%	429,960	389	45	17,505	35,010	17,505
	Total	281,528,709	37.8%	106,345,057	96,183		3,273,359	6,546,718	3,273,359

Table 2.5. Estimated acreage of NLEB maternity roosting areas for the 30 states included in analysis.

Region	State	Forested Acres	Maternity Colonies[1]	Maternity Roost Area Acres (167 acres per Colony)	Percent of Forest Habitat Used as Maternity Roost Areas
Midwest	Iowa	3,013,759	1,137	189,879	6.30%
Midwest	Illinois	4,847,480	2,740	457,580	9.44%
Midwest	Indiana	4,830,395	1,639	273,713	5.67%
Midwest	Michigan	20,127,048	5,734	957,578	4.76%
Midwest	Minnesota	17,370,394	9,221	1,539,907	8.87%
Midwest	Missouri	15,471,982	3,666	612,222	3.96%
Midwest	Ohio	8,088,277	3,080	514,360	6.36%
Midwest	Wisconsin	16,980,084	6,895	1,151,465	6.78%
Eastern	Connecticut	1,711,749	146	24,382	1.42%
Eastern	Delaware	339,520	16	2,672	0.79%
Eastern	Maine	17,660,246	1,502	250,834	1.42%
Eastern	Maryland	2,460,652	112	18,704	0.76%
Eastern	Massachusetts	3,024,092	186	31,062	1.03%
Eastern	New Hampshire	4,832,408	429	71,643	1.48%
Eastern	New Jersey	1,963,561	569	95,023	4.84%
Eastern	New York	18,966,416	5,712	953,904	5.03%
Eastern	Pennsylvania	16,781,960	5,130	856,710	5.10%
Eastern	Rhode Island	359,519	31	5,177	1.44%
Eastern	Vermont	4,591,280	407	67,969	1.48%
Eastern	Virginia	15,907,041	6,948	1,160,316	7.29%
Eastern	West Virginia	12,154,471	5,892	983,964	8.10%
Southern	Arkansas	18,754,916	11,075	1,849,525	9.86%
Southern	Kentucky	12,471,762	4,591	766,697	6.15%
Southern	Mississippi	19,541,284	6,044	1,009,348	5.17%
Southern	North Carolina	18,587,540	6,724	1,122,908	6.04%
Southern	Tennessee	13,941,333	5,182	865,394	6.21%
Western	Kansas	2,502,434	510	85,170	3.40%
Western	Nebraska	1,576,174	321	53,607	3.40%
Western	North Dakota	759,998	155	25,885	3.41%
Western	South Dakota	1,910,934	389	64,963	3.40%
	Total	281,528,709	96,183	16,062,561	5.71%

[1] From Table 2.4

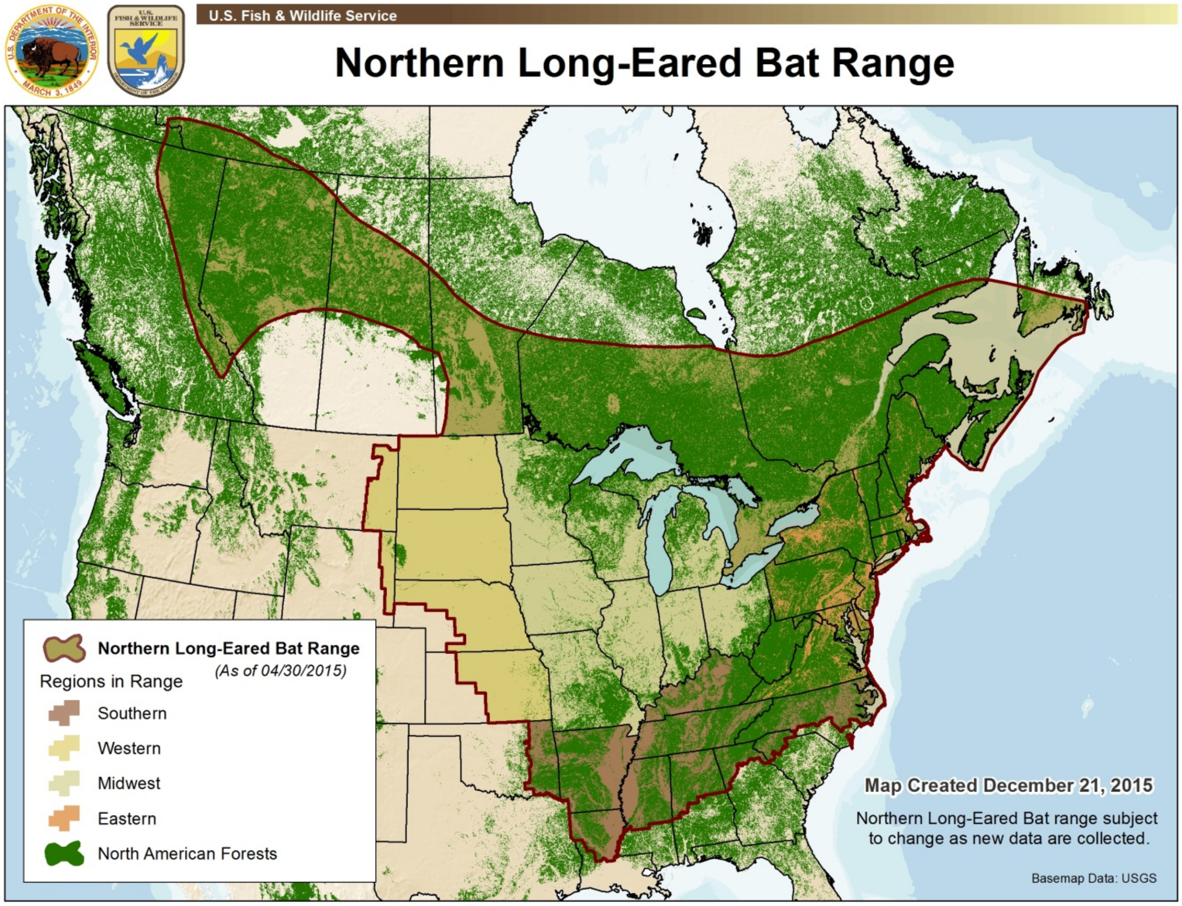

Figure 2.1. Range of the NLEB.

3 ENVIRONMENTAL BASELINE

Regulations implementing the Act (50 CFR 402.02) define the environmental baseline as the past and present impacts of all Federal, State, or private actions and other human activities in the Action Area. Also included in the environmental baseline are the anticipated impacts of all proposed Federal projects in the Action Area that have undergone section 7 consultation, and the impacts of State and private actions which are contemporaneous with the consultation in progress. The environmental baseline is a “snapshot” of the species’ health in the Action Area at the time of the consultation, and does not include the effects of the action under review.

Because the Action Area covers the entire range of the species within the United States, the environmental baseline is the same as the status of the species discussed in detail in Section 2. No further discussion is needed in this section.

4 EFFECTS OF THE ACTION

This section addresses the direct and indirect effects of the Action on the NLEB, including the effects of interrelated and interdependent activities. Direct effects are caused by the action and occur at the same time and place. Indirect effects are caused by the proposed action and are later in time but still are reasonably certain to occur.

The NLEB is likely to be affected by many activities which are excepted from incidental take prohibitions in the final 4(d) rule. Instead of describing all of the activities, we address the general effects of different activities, which we categorized into 7 general groups:

1. Capture and handling of NLEBs by individuals with section 10(a)(1)(A) permits for other listed bats or State permits until May 3, 2016
2. Removal from human structures
3. Timber harvest
4. Prescribed fire
5. Forest conversion
6. Wind turbine operation
7. Other activities that may affect the NLEB

The effects of category #1 are not addressed in this consultation because a separate section 10(a)(1)(A) permit and section 7 consultation will be required for those activities after May 3, 2016, as required by the final 4(d) rule. Until that time, we expect limited effects because NLEBs are currently hibernating and most surveys are conducted during the summer. Winter hibernacula surveys could affect the NLEB until May 3, 2016; however, researchers conducting winter surveys must have a section 10(a)(1)(A) permit for other listed bat species. The Service completed three BOs for the effects of existing bat section 10(a)(1)(A) permits on the NLEB in the Midwest, Mountain/Prairie and Southeast Regions. The adverse effects from winter hibernacula surveys are addressed in those BOs, which were non-jeopardy opinions.

The final 4(d) rule does not prohibit incidental take outside of the WNS zone. This effects analysis does not address the differences in prohibitions outside of the WNS zone because current actions that may affect the NLEB have not been shown to have significant impacts on NLEBs before WNS was detected. We expect that the impacts will be further reduced in the areas outside of the WNS zone because less than 2% of the total estimated population of NLEB occurs in the areas outside of the WNS zone (Section 2.4.5), and the habitat is more sparse (Figure 2.1). In addition, we anticipate that the WNS zone will expand further into the western states fairly quickly. Therefore, we did not attempt to analyze the different prohibitions between the zones.

4.1 EFFECTS ANALYSIS METHODOLOGY

For each of the remaining six categories of activities described above, we apply the following steps to analyze effects at the programmatic level:

- **Effects of the Activity –** We review best available science and commercial information about how the activity may affect the NLEB. Based on the literature review, we identify the stressor(s) (alteration of the environment that is relevant to the species) that may result from the proposed activity. For each stressor, we identify the circumstances for an individual bat's exposure to the stressor (overlap in time and space between the stressor and a NLEB). Given exposure, we identify the likely individual response(s), both positive and negative. For this consultation, we group responses into one of four categories: (1) potentially increased fitness (e.g., increased access to, or availability of, prey organisms); (2) reduced fitness (e.g., reduced food resources, reduced suitable roosting sites); (3) disturbance (e.g., day-time disturbance in a maternity roosting area, causing bats to flee and increasing the likelihood of injury or predation); and (4) harm (e.g., harvesting a tree occupied by adults and flightless bat pups resulting in death or injury; predation resulting from disturbance). This analysis is captured in the Exposure-Response Table (Table 4.1). This table provides the complete record of the effects analysis for this species and is intended to be read in concert with and support this effects analysis section.
- **Quantifying Effects to Individuals –** Estimating the numbers of individuals of a species exposed to stressors in a programmatic consultation is difficult because programs do not usually specify with sufficient detail when and where projects will occur relative to the species' occurrence. For this consultation, we have very little site-specific data about NLEB distribution and abundance in the Action Area; however, we do not assume that the species is ubiquitous, which would grossly overestimate effects. We do not have

enough information to quantify the effects of the pathways associated with removal from human structures and the "other" category of activities that may affect the NLEB. These effects are discussed in general in the sections below. For pathways associated with timber harvest, prescribed fire, and forest conversion, we apply the annual average acreage of the activity, NLEB occupancy rates, and NLEB density within occupied areas to estimate individual-level effects (numbers of individual bats included in the pathway), which we describe in Section 4.1.2.2 below. For wind turbine operation, we estimate the number of bats that could be killed using the current and projected amount of wind energy development and information on bat mortality rates, which we describe in Section 4.1.5.2 below.

We then aggregate all of the effects to individuals and examine:

- **Population-level Effects –** We evaluate the aggregated consequences of the effects to individuals/habitat on the fitness of the population(s) to which those individuals belong. This step closes with our conclusions on the likely fate or ultimate response of the population(s) and is couched in terms of population fitness (i.e., persistence and reproductive potential, long and short-term).
- **Species Range-wide** - This step determines whether the anticipated reductions in population fitness will reduce the likelihood of survival and recovery of the species by reducing its range-wide reproduction, numbers, or distribution (RND). If the Service and other action agencies have insured that the population-level risks do not noticeably, detectably, or perceivably reduce the likelihood of progressing towards or maintaining the RND needs, then the action is not likely to appreciably reduce the likelihood of both survival and recovery of the species.

4.2 REMOVAL FROM HUMAN STRUCTURES

4.2.1 EFFECTS OF REMOVAL FROM HUMAN STRUCTURES

As described in Section 2.1.1., NLEBs have occasionally been found roosting in human structures such as barns, houses, and sheds. Humans and bats often conflict when bats roost in human structures. Public misconception and health concerns from rabies, bat droppings, and urine often result in the need to remove bats from human structures. Many techniques used to remove bats are harmful and may result in mortality, including poisoning, trapping (e.g., cages, sticky traps), exterminating, and translocating (WNS Conservation and Recovery Working Group 2015). Bats can also be removed through humane methods (if used during the proper time of year) such as eviction/venting and exclusion. Eviction/venting refers to the use of one-way doors and exits to remove bats from a structure by utilizing their natural tendency to leave the roost at night. Exclusion refers to closing gaps and sealing holes to prevent bats from entering or re-entering a structure (WNS Conservation and Recovery Working Group 2015). Eviction and exclusion are widely-used, popular methods because poisons and traps are messy and might result in dead bats rotting in walls and attics.

Table 4.1 shows the four pathways we identified for NLEB responses to removal from human structures and the range of individual responses expected. The use of rodenticides and sticky traps to remove bats is likely to result in mortality. NLEBs may also be euthanized for rabies testing. Roost closure during the maternity season has been documented to result in lower reproductive success (Brigham and Fenton 1986). Attempts to evict or exclude bats at this time can result in the death of flightless young, as well as an increase in the number of adult bats and orphaned pups that enter the living space, potentially heightening the risk of human/bat contact (WNS Conservation and Recovery Working Group 2015). In addition, NLEBs can be indirectly affected through the loss of the roost by exclusion if additional energy is required during their search for a new roost site when NLEBs return to the site after hibernation.

The WNS Conservation and Recovery Group, in coordination with states and wildlife control operators, recently developed Best Management Practices (BMPs) for bat control activities in human structures (WNS Conservation and Recovery Working Group 2015) to ensure that adverse effects are minimized. The National Wildlife Control Operators Association recently released a new training on bat standards, affecting at least 48 wildlife control operators in 20 States within the NLEB range that are Certified Wildlife Control Professionals. This certification requires training, seminars, and continued education, and we anticipate that these professionals (and probably others) will follow the bat standards.

States within the range of the NLEB vary in requirements for removal of bats from human structures. States with state- or federally-listed bat species may require permits for bat removal or may require wildlife control operators to use BMPs when removing or excluding bats from houses or structures. Within the range of the NLEB, only Maine, Montana, and the Dakotas do not have another state- or federally-listed bat species, so it is likely that many of these states already have a program to recommend or require BMPs for bat removal prior to the NLEB listing in 2014. We surveyed states to determine if: (1) wildlife control operators are required to obtain authorization for bat removal or exclusions; (2) BMPs are required or recommended; and (3) exclusions and evictions are conducted outside of the NLEB maternity season.

We were able to speak with representatives from state natural resource programs in Illinois, Wisconsin, Michigan, Missouri, Minnesota, Ohio, Vermont, and South Carolina. Five of the eight states require authorization for wildlife control operators to remove or exclude bats from buildings. Of these five states, all but Michigan require that evictions and exclusion occur after NLEB pups are capable of flight, unless in the unusual case of a severe health hazard. Even though three states do not require authorization for wildlife control operators, only two states

(Missouri and Michigan) do not communicate or recommend BMPs for bat exclusion or removals.

We also obtained rabies testing data from the state health departments in New York and Missouri. If a single or pair of bats enter a household, wildlife control operators generally trap the bats and euthanize them for rabies testing. These data indicate that an average of 7 NLEBs were killed per year for rabies testing during the most recent three years. In both New York and Missouri, NLEB make up a small fraction (typically less than 2%) of the bats in houses.

Although removal from human structures can result in NLEB mortality, we anticipate that few bats are impacted per year in each state based on the relatively rare use of human structures, the implementation of bat removal BMPs (either required or recommended) throughout most of the range of the NLEB, and the relatively small amount of NLEBs killed for rabies testing.

4.3 TIMBER HARVEST

Timber harvest is one of two categories of forest management described in this BO. Unlike forest conversion, forest management maintains forest habitat on the landscape, and the impacts from management activities are for the most part considered temporary in nature. Impacts from forest management are expected to range from positive (e.g., maintaining or increasing suitable roosting and foraging habitat within NLEB home ranges) to neutral (e.g., minor amounts forest removal, areas outside NLEB summer home ranges or away from hibernacula) to negative (e.g., death of adult females or pups or both).

Timber harvest is the removal of trees associated with forest management. It includes a wide variety of practices from selected harvest of individual trees to clearcutting. Timber harvest is often partitioned according to the forest management treatment type used to accomplish the harvest: even-aged management; uneven-aged management; thinning; and salvage/sanitation. It is conducted for a variety of purposes including, but not limited to, harvests (commercial and non-commercial) for timber production and for ecosystem restoration, endangered/threatened/sensitive species conservation, stand regeneration for forest health, wildlife habitat improvement, insect and disease control, and fuel reduction. All of these activities are categorized under the general category of timber harvest for the purposes of this BO.

4.3.1 EFFECTS OF TIMBER HARVEST

Literature Review

The best available data indicate that the NLEB shows a varied degree of sensitivity to timber-harvesting practices. Menzel et al. (2002) found NLEB roosting in intensively managed stands in West Virginia. At the same study site, Owen et al. (2002) concluded that NLEB roosted in areas with abundant snags, and that in intensively managed forests of the central Appalachians, roost availability was not a limiting factor. Perry and Thill (2007) tracked NLEB in central Arkansas and found roosts in eight different forest classes, of which 89 percent were in three classes of mixed pine-hardwood forest. The mixed pine-hardwood forest stands that supported most of the roosts were partially harvested or thinned, unharvested (50–99 years old), or harvested by group selection.

Timber harvest accomplished through thinning, group selection, and individual selection may create canopy openings in an otherwise densely-forested setting, which may promote more rapid development of bat pups. In central Arkansas, Perry and Thill (2007) found female NLEB bat roosts were more often located in areas with partial harvesting than males, with more male roosts (42 percent) in un-harvested stands than female roosts (24 percent). They postulated that females roosted in relatively more open forest conditions because they may receive greater solar radiation, which may increase developmental rates of young or permit young bats a greater opportunity to conduct successful initial flights (Perry and Thill 2007). Cryan et al. (2001) found several reproductive and non-reproductive female NLEB roosts in recently harvested (less than 5 years) stands in the Black Hills of South Dakota where snags and small stems (dbh of 5 to 15 cm (2 to 6 inches)) were the only trees left standing. In this study, however, the largest colony (n=41) was found in a mature forest stand that had not been harvested in more than 50 years. Lacki and Schwierjohann (2001) stated that silvicultural practices could meet both male and female roosting requirements by maintaining large-diameter snags, while allowing for regeneration of forests.

Forest patch size and contiguity are factors that appear to influence habitat use by NLEB. Henderson et al. (2008) observed gender-based differences in mist-net capture rates of NLEB on Prince Edward Island related to forest patch size. The area of deciduous stands had a consistent positive relationship with the probability of presence of both males and females, but males were found more often in smaller stands than females. In southeastern Missouri, Yates and Muzika (2006) reported that NLEB showed a preference for contiguous tracts of forest cover (rather than fragmented or open landscapes) for foraging or traveling, and that different forest types interspersed on the landscape increased the likelihood of occupancy.

In West Virginia, Owen et al. (2003) radio-tracked nine female NLEB that spent their foraging and travelling time in the following habitat types (in descending order of use):

- 70–90-year-old stands without harvests in more than 10–15 years (“intact forest”) (mean use 52.4 percent);

- 70–90 year-old stands with 30–40 percent of basal area removed in the past 10 years (“diameter-limit harvests”) (mean use 42.9 percent);
- open areas (clearcuts and roads) (clear cut = all trees > 2.5 cm (1.0 inch) dbh removed) (mean use 4.6 percent); and
- clearcuts with approximately 4.5 m^2/ha (19.6 ft^2/acre) tree basal area remaining (“deferment harvests”) (mean use 0.03 percent).

Habitat selection differed significantly relative to habitat availability, with diameter-limit harvests ranking as the strongest habitat preference, where percent use exceeded percent availability for 7 of the 9 bats.

In Alberta, Canada, NLEB avoided the center of clearcuts and foraged more in intact forest than expected (Patriquin and Barclay 2003). On Prince Edward Island, Canada, female NLEB preferred to forage in areas centered along creeks running through forests (Henderson and Broders 2008). In mature forests on the Sumter National Forest in northwestern South Carolina, 10 of the 11 stands in which NLEB were detected were mature stands (Loeb and O’Keefe 2006). Within those mature stands, NLEB were recorded more often at points with sparse or medium-density vegetation than at points with dense vegetation, suggesting that small openings within forest stands facilitate commuting and/or provide suitable foraging habitat. However, in southwestern North Carolina, Loeb and O’Keefe (2011) found that NLEB rarely used forest openings, but often used roads.

At Fort Knox in Kentucky, Silvis et al. (2014) tracked three maternity colonies of NLEB to evaluate their social and resource networks, i.e., roost trees. Roost and social network structure differed between maternity colonies, and roost availability was not strongly related to network characteristics or space use. In model simulations based on the tracking data, removal of more than 20 percent of roosts initiated social network fragmentation, with greater loss causing more fragmentation. The authors suggested that flexible social dynamics and tolerance of roost loss are adaptive strategies for coping with ephemeral conditions in dynamic forest habitats. Sociality among bats may contribute to reproductive success, and fragmented colonies may experience reduced success.

In the same Fort Knox study area with the same three maternity colonies, Silvis et al. (2015) removed during winter a primary maternity roost tree from one colony, 24 percent of the secondary roosts from another colony, and none from the third. Neither removal treatment altered the number of roosts used by individual bats, but secondary roost removal doubled the distances moved between sequentially used roosts. Overall location and spatial size of colonies was similar pre- and post-treatment. Patterns of roost use before and after removal treatments also were similar. Roost height, diameter at breast height, percent canopy openness, and roost species composition were similar pre- and post-treatment. NLEB use a wide range of tree species and sizes as roosts, and potential roosts were not limited in the treatment areas.

Although the literature we reviewed contains no reports of NLEB mortality resulting from tree harvest, there have been three documented instances of Indiana bat adults and pups killed or injured when an occupied roost tree was felled. Indiana bats and NLEB are closely related and have similar behavior (i.e., forest-dwelling, forming maternity colonies, roosting in trees in the summer). Cope et al. (1974) reported the first felling of an occupied Indiana bat maternity roost tree in Wayne County, Indiana. The landowner observed bats exiting the tree when it was bulldozed down. The original account stated that eight bats (2 adult females and 6 juveniles) were "captured and identified as Indiana bats," and that about 50 bats flew from the tree. Although the original account did not specify how the eight bats were captured, J. Whitaker (Indiana State University, pers. comm., 2005) recounted that those bats were killed or disabled, retrieved by the landowner, and subsequently identified by a biologist. In another case, Belwood (2002) reported on the felling of a dead maple in a residential lawn in Ohio. One dead adult female and 33 non-volant young were retrieved by the researcher. Three of the young bats were already dead when they were picked up, and two more died subsequently. The rest were apparently retrieved by adult bats that had survived. In a third case, 11 dead adult female Indiana bats were retrieved (by people) when their roost was felled in Knox County, Indiana (J. Whitaker, pers. comm., 2005).

These accounts suggest that some individuals, including non-volant pups, can survive the felling of a maternity roost tree. It is not possible to infer injury rates from these studies. It is only possible to crudely estimate mortality rates from the Belwood case. If we assume that there were 66 individuals in the tree (the 33 pups observed plus 1 dead adult female and 32 presumed additional adult females who retrieved their pups), the overall survival rate was high at 91%. Only 1 adult bat was observed dead (about 3% of adults), and the juvenile mortality rate was about 15%. We acknowledge that timber harvest operations in a forest bear little resemblance to these three instances, but available evidence indicates that both adults and pups can be killed when an occupied roost tree is felled. For the purposes of this consultation, we assume that 15% of non-volant bats have the potential to be harmed, and 3% of adult bats could be killed or injured in a felled tree. Adults may be at greater risk during the spring during colder temperatures and increased use of torpor. It is also possible that trees felled adjacent to roost trees could strike roosting bats and result in injury or death.

Disturbance associated with harvest activity could cause NLEB to flee or abandon day-time roosts, which increases the likelihood of predation. This may also result in females aborting or not being impregnated depending on the time of year. Gardner et al. (1991) reported that Indiana bats continued to roost and forage in an area with active timber harvest, but this will depend on the scale of harvest and whether there is any remaining suitable habitat. Callahan (1993) attributed the abandonment of a primary maternity roost tree to disturbance from a bulldozer clearing brush adjacent to the tree.

Surface-disturbing activities in the vicinity of hibernacula may affect bat populations if those activities result in changes to the microclimate (temperature, humidity, and air flow) of the cave or mine (Ellison et al. 2003). Tree removal in karst areas can alter soil characteristics, water quality, local hydrology to the extent that it alters cave microclimates and affects bats (Bilecki 2003, Hamilton-Smith 2001). Bats in hibernation are susceptible to dehydration due to high evaporative loss from their naked wings and large lungs (Perry 2013). Richter et al. (1993) documented temperature increases resulting from structural modifications to a cave entrance that substantially reduced its suitability for bats. The creation of new openings or filling in existing openings could also result from obstructing cave entrances with dirt or logging slash.

Summary of Exposure-Response Table

Table 4.1 shows the five pathways we identified for NLEB responses to timber harvest and the range of individual responses expected. The primary alteration of the environment associated with timber harvest that is relevant to the NLEB is the removal of trees that provide roosts or serve as foraging, spring staging, or fall swarming habitat. Removing occupied trees is likely to kill or injure pups and adults. Loss of forest habitat decreases opportunities for growth and successful reproduction. Alteration of hibernacula can harm NLEBs. The disturbance (noise, exhaust from machinery, etc.) that accompanies harvest activities may result in disturbance because fleeing during daylight increases the likelihood of predation. A small subset of disturbed individuals may be harmed. Thinning mid-story clutter may have a beneficial effect on the suitability of adjacent maternity roost trees when done when bats are not present. The species' responses to these stressors depends on the type of harvest (e.g., thinning, salvage, even-aged management, clear cut, etc.) and the context of exposure, i.e., when and where it occurs.

4.3.2 METHODOLOGY FOR QUANTIFYING EFFECTS OF TIMBER HARVEST

To estimate the potential impacts of timber harvest through 2022, we calculated the average annual amount of timber harvest in states within the NLEB's range using data available through the USDA Forest Service's Forest Inventory Analysis (available only on internet: http://apps.fs.fed.us/Evalidator/evalidator.jsp; accessed November 2015). This database reports the total harvest (acres) of federal, state and local, and private entities by state for various combinations of years. We used the most recent combination of years available and calculated the mean annual harvest (Table 4.2). We assumed that the mean annual harvest from recent years will be consistent through the period of this consultation and recognize that many types of harvest leave a remaining forest that is available for NLEB use. The information in this database may be overestimated for certain states and underestimated for others. For instance, we estimated that 163,971 acres would be harvested on average in National Forests in South Dakota; however, the U.S. Forest Service is currently projecting up 35,000 acres of harvest annually. In Illinois, the database reports 0 acres of harvest, but the Forest Service projects 1,300 acres of average annual harvest.

Similar to the population estimation methods in Section 2.4.2, we excluded a state from our analyses if less than 50% of it is within the NLEB range. These estimates are likely conservative and underestimate the number of acres harvested; however, some harvest reports may reflect a few tree removals and not necessarily a clear cut or selected harvest. We anticipate that 3,669,077 acres will be harvested annually through 2022, which is 1.3% of the available forested habitat, or 9.1% over seven years (Table 4.2). Timber harvest is expected to occur in similar proportions in the Midwest, Eastern, and Southern ranges (29, 35, and 34%, respectively), but only about 2% of the total harvest will occur in the Western range. We anticipate that habitat losses from timber harvest will be temporary.

We further analyzed these data by partitioning the average annual acreage expected during the NLEB active season and the pup season. Lacking a breakdown of the acres harvested during the active and non-volant seasons, we assume that timber harvest will occur with equal frequency throughout the year. The NLEB active season (April 1 – October 31) is 214 days, or 58.6% of the year. The NLEB non-volant season (June 1 – July 31) is 61 days, or 16.7% of the year. Therefore, the average annual acres of timber harvest during the active season is 58.6% of the total average annual acres, and 16.7% of the total timber harvest is estimated to occur in the non-volant season.

For spatial exposure to stressors, we must consider that timber harvest and NLEB-occupied areas may occur anywhere within the forested acreage of each state, but we recognize there are some forests in National or State Parks or Wilderness areas that may not be subject to harvest. NLEB occupancy estimates vary by state from about 9 to 60 percent (see section 2.4.1). It is possible for timber harvest, which annually affects about 1.3 percent of the available forested habitat, to occur entirely on the 5 to 65 percent of the habitat in each state that we consider occupied, or not at all, because we have no information indicating whether certain activities are more or less likely to occur in occupied areas. Therefore, our effects analyses compute the expected (probable) degree of spatial overlap between activities and occupied areas as the product of two independent probabilities, namely, the percentage of the forested habitat that is proposed for timber harvest multiplied by the percentage of the forested habitat that the NLEB occupies in a particular manner, e.g., for roosting or foraging.

The following example demonstrates our methodology for estimating individual-level direct effects corresponding to the stressor-exposure-response pathway for timber harvest during the non-volant season (June 1–July 31) within a maternity roost, which may kill or injure non-volant pups.

a. State A, with 500,000 acres of forested habitat, will annually harvest 2,500 acres (0.5 percent of the total habitat) during the non-volant season.
b. State A has a 30 percent occupancy rate for NLEB, i.e., 150,000 acres of State A are within the active-season home range of individuals of this species.
c. We assume that individuals belonging to maternity colonies collectively occupy 90 percent (co-capture rate of reproductive females with males and non-reproductive females; see section 2.4 for the basis of this and other NLEB distribution and abundance assumptions) of these 150,000 acres, or 0.90 × 150,000 = 135,000 acres.
d. We assume maternity colonies do not overlap and occupy 1,000 acres each; therefore State A supports 135,000 ÷ 1,000 = 135 colonies.
e. We assume that individuals in a maternity colony roost in trees within an area of 167 acres; therefore, the colonies of State A occupy 135 × 167 acres = 22,545 acres for roosting, which is 4.5 percent of State A.
f. State A has not yet been affected by WNS; therefore, each colony supports 45 non-volant pups during the harvest time frame (1 pup per adult female, section 2.4).

In this example, 2,500 acres (0.5 percent) of the forested acres in the state are proposed for harvest during the non-volant season, and 22,545 acres (4.5 percent) harbors non-volant pups. The mathematically expected (probable) degree of spatial overlap is the product of the two percentages, or 0.5 percent × 4.5 percent = 0.0225 percent, which is 112.7 acres of the 500,000 acres in State A. To estimate the number of bat pups affected, we multiply the density of bat pups in maternity roosting areas (45 pups per 167 acres) by the expected acreage of overlap: (45 ÷ 167) × 112.7 = 30.3, which we round up to 31 pups. We aggregate the results of this type of analysis for all timber harvest actions within a state and across all 30 states included in the analysis, which provides a basis for estimating the total expected effects of multiple project-level actions at a scale not exceeding the total amount of timber harvest estimated per year.

Consistent with the example above, our calculations for estimating the effects corresponding to each stressor-exposure-response pathway that we quantify are presented in tabular form in section 4.3. Each table lists the 30 states with the following six columns of data:

a. annual, active-season, or non-volant-season extent (acres) of timber harvest (or the proposed activity causing the stressor), depending on the pathway;
b. total forest habitat acres;
c. percent of the forest habitat receiving the activity (a ÷ b);
d. percent of the forest habitat that NLEB use at a time and in a manner (from section 2.4) that the stressor could affect causing a specific type of individual response;
e. expected overlap (acres) of the activity and the bat-occupied area (b × c × d); and
f. expected number of individuals affected (e × bat density in the occupied area).

In the final step of the calculations described above, the density we multiply by the expected area of overlap depends on the manner in which NLEB use the habitat exposed to the stressor. In the preceding example, non-volant pups in maternity roosting areas are the individuals responding to the stressor, and the density is 45 pups per 167 acres (0.2695). Based on the data and assumptions identified in section 2.4 about NLEB populations in the Action Area, we use the following NLEB densities in computing column "e" of each effects estimation table:

Habitat	NLEB individuals	Density for 45 females per Maternity Colony	Density for 39 females per Maternity Colony	Density for 20 females per Maternity Colony
Summer home range	Adult females and sympatric adult males	0.0814	0.0362	0.0705
Maternity roosting areas	Non-volant pups	0.2695	0.1198	0.2335
Roosting areas	Adult females, volant juveniles, and sympatric adult males	0.8084	0.3593	0.7006

This methodology generates results in terms of numbers of individual NLEB affected, but we must acknowledge its inherent imprecision. It relies on assumptions about state-specific occupancy rates and applies values for colony size, sex ratios, etc., that we believe are reasonable and based on best available information, but which are either uncertain or variable across the Action Area. Although it is coarse, this methodology provides a transparent basis for quantifying effects for interpretation relative to the status of the species, which is the purpose of an effects analysis in a BO.

4.3.3 QUANTIFYING EFFECTS OF TIMBER HARVEST

We quantify the two pathways expected to result in direct effects to the NLEB: disturbance from fleeing human activity (Table 4.3), and harm from removing occupied roost trees (Table 4.4 for pups and Table 4.5 for adults). Human disturbance from timber harvest during the active season (April – October) within maternity roosting areas may disturb up to 76,846 volant NLEB annually (Table 4.3). A small subset of these disturbed individuals may be harmed. Timber harvests that remove occupied roost trees during the non-volant season may harm up to 1,109 pups annually (Table 4.4). Removal of occupied roost trees during the active season may harm up to 247 adults annually (Table 4.5).

In addition to these two pathways, timber harvest activities could alter the flow of air and water through unknown hibernacula which could also harm NLEBs. We do not have enough information to quantify the effects of this pathway because we do not know where projects will occur relative to the unknown hibernacula that are likely on the landscape. Although the alteration of unknown hibernacula is reasonably certain to occur, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed (i.e., not concentrated in a given area) nature of timber harvest activities. In addition, the hibernacula often selected by NLEB are "large, with large passages" (Raesly and Gates 1987), and may be less affected by relatively minor surficial micro-climatic changes that might result from timber harvest around unknown roosts. Further, bats rarely hibernate near the entrances of structures (Grieneisen 2011). Davis et al (1999) reported that partial clearcutting “appears not to affect winter temperatures deep in caves.”

We also do not quantify the potential reductions in fitness that may result as indirect effects from loss of habitat. We anticipate that 1.3% (3,669,077 acres) of available habitat will be harvested annually through 2022; however, we anticipate that habitat losses from timber harvest will be temporary. In addition, the NLEB does not appear to be limited by habitat, as demonstrated by a great deal of plasticity within its environment (e.g., living in highly fragmented forest habitats to contiguous forest blocks from the southern United States to Canada’s Yukon Territory) in the absence of WNS. Therefore, reductions in fitness from habitat loss are anticipated to be small. Further, timber harvest practices that reduce mid-story clutter likely also benefit NLEB habitat and may increase fitness of local NLEB populations. We do not quantify the potential increases in fitness because we lack the scientific support to interpret the degree to which survival or reproductive success rates of local populations may be influenced; however, management of existing forests is likely to maintain roosting or foraging habitat.

4.4 PRESCRIBED FIRE

Prescribed fire is the other category of forest management described in this BO. Prescribed burning is deliberately burning wild-land fuels under specified environmental conditions in a predetermined area with a predetermined fire-line intensity and rate of movement in order to attain resource management objectives. It is typically classified as dormant-season and growing-season burning. The seasonality varies by latitude and elevation, but the dormant season is generally October –April and the growing season is April 15 – August 15. Dormant-season burning is primarily used to reduce the buildup of hazardous fuels and thereby reduce the likelihood of catastrophic wildfires or to achieve ecological stand objectives. Growing-season burning is used for site preparation, control of undesirable species, and restoration and maintenance of fire-dependent plant communities and associated wildlife. Most growing season burning takes place in the spring and fall; however, growing season burning occurs through the active and pup seasons in the rest of the range. For example, we recently completed programmatic consultations for the NLEB with the U.S. Forest Service on Forest Plans in their Southern and Eastern regions, which includes the Midwest, Southern, and Eastern ranges of the NLEB. Twenty-one and 16 percent of prescribed burning was projected to occur during the pup season (defined by the Forest Service as May 1 to July 30) in the Southern and Eastern regions, respectively.

4.4.1 EFFECTS OF PRESCRIBED FIRE

Literature Review

Perry (2012) provides a review of fire effects on bats in the eastern oak region of the U.S., and Carter et al. (2002) provides a similar review for bats in the southeastern and mid-Atlantic states. Forest-dwelling bats, including the wide-ranging NLEB, were presumably adapted to the fire-driven disturbance regime that preceded European settlement and fire suppression in many parts of the eastern U.S. Concurrent changes in habitat conditions preclude any reasonable inferences about the overall impact of fire suppression on populations of forest-dwelling bats. It is apparent that fire may affect individual bats directly (negatively) through exposure to heat, smoke, and carbon monoxide, and indirectly (both positively and negatively) through habitat modifications and resulting changes in their food base (Dickinson et al. 2009).

Direct Effects – Summer Roosting

Little is known about the direct effects of fire on cavity and bark roosting bats, such as the NLEB, and few studies have examined escape behaviors, direct mortality, or potential reductions in survival associated with effects of fire. Dickinson et al. (2009) monitored two NLEB (one male and one female) in roosts during a controlled summer burn. Within 10 minutes of ignition near their roosts, both bats flew to areas that were not burning. Among four bats they tracked before and after burning, all switched roosts during the fire, with no observed mortality. Rodrigue et al. (2001) reported flushing a *Myotis* bat from an ignited snag during an April controlled burn in West Virginia.

Carter et al. (2002) suggested that the risk of direct injury and mortality to southeastern forest-dwelling bats resulting from summer prescribed fire is generally low. During warm temperatures, bats are able to arouse from short-term torpor quickly. Most adult bats are quick, flying at speeds > 30 km/hour (Patterson and Hardin 1969), enabling escape to unburned areas. NLEB use multiple roosts, switching roost trees often (see *Summer Roosting Behavior* in Section 2.4.3), and could likely use alternative roosts in unburned areas, should fire destroy the current roost. Non-volant pups are likely the most vulnerable to death and injury from prescribed fire. Although most eastern bat species are able to carry their young for some time after they are born (Davis 1970), the degree to which this behavior would allow females to relocate their young if fire threatens the nursery roost is unknown.

Dickinson et al. (2010) used a fire plume model, field measurements, and models of carbon monoxide and heat effects on mammals to explore the risk to the Indiana bat and other tree-roosting bats during prescribed fires in mixed-oak forests of southeastern Ohio and eastern Kentucky. Carbon monoxide levels did not reach critical thresholds that could harm bats in low-intensity burns at typical roosting heights for the Indiana bat (8.6 m) (28.2 ft). NLEB roost height selection is more variable, but on average lower (6.9 m) (22.8 ft) than the Indiana bat (Lacki et al. 2009b). In this range of heights, direct heat could cause injury to the thin tissue of bat ears. Such injury would occur at roughly the same height as tree foliage necrosis (death) or where temperatures reach 60 °C (140 °F). Most prescribed fires for forest management are planned to avoid significant tree scorch.

Direct and Indirect Effects – Winter Roosting

Little is known about the direct effects of fire on bats in adjacent caves and mines. Smoke and noxious gases could enter caves and mines, depending on airflow characteristics and weather conditions (Carter et al. 2002; Perry 2011). Although smoke from winter fires may not reach toxic levels in caves and mine, introduced gases could arouse bats from hibernation, causing energy expenditure and reduced fitness (Dickinson et al. 2009). Caviness (2003) observed smoke intrusion into hibernacula during winter burning in Missouri, but did not observe any bat arousal. Fire could alter vegetation surrounding the entrances to caves and mines, which could indirectly affect temperature and humidity regimes of hibernacula by modifying airflow (Carter et al. 2002, Richter et al. 1993).

Indirect Effects – Roost Availability/Suitability

Fire can affect the availability of roosting substrate (cavities, crevices, loose bark) by creating or consuming snags, which typically provide these features, or by creating these features in live trees. Although stand-replacing or intense wildfires may create large areas of snags, the effects of multiple, low-intensity prescribed burning on snag dynamics are less obvious, especially for forests consisting mostly of fire-adapted species. Low-intensity, ground-level fire may injure larger hardwood trees, creating avenues for pathogens such as fungi to enter and eventually form hollow cavities in otherwise healthy trees (Smith and Sutherland 2006). Fire may scar the base of trees, promoting the growth of basal cavities or hollowing of the bole in hardwoods (Nelson et al. 1933, Van Lear and Harlow 2002). Repeated burning could potentially create forest stands with abundant hollow trees. Trees located near down logs, snags, or slash may be more susceptible to damage or death, and aggregations of these fuels can create clusters of damaged trees or snags (Brose and Van Lear 1999, Smith and Sutherland 2006).

Bats are known to take advantage of fire-killed snags and continue roosting in burned areas. Boyles and Aubrey (2006) found that, after years of fire suppression, initial burning created abundant snags, which evening bats (*Nycticeius humeralis*) used extensively for roosting. Johnson et al. (2010) found that after burning, male Indiana bats roosted primarily in fire-killed maples. In the Daniel Boone National Forest, Lacki et al. (2009a) radio-tracked adult female NLEB before and after prescribed fire, finding more roosts (74.3 percent) in burned habitats than in unburned habitats. Burning may create more suitable snags for roosting through exfoliation of bark (Johnson et al. 2009a), mimicking trees in the appropriate decay stage for roosting bats.

In addition to creating snags and live trees with roost features, prescribed fire may enhance the suitability of trees as roosts by reducing adjacent forest clutter (see *Canopy Cover/Closure* in Section 2.4.3). Perry et al. (2007) found that five of six species, including NLEB, roosted disproportionally in stands that were thinned and burned 1-4 years prior but that still retained large overstory trees. Boyles and Aubrey (2006) found evening bats used burned forest exclusively for roosting.

Indirect Effects – Summer Foraging

Adult insects are the predominant prey of NLEB (see Section 2.2.4 Foraging Behavior). On the Daniel Boone National Forest, Lacki et al. (2009a) found that abundance of coleopterans (beetles), dipterans (flies), and all insects combined captured in black-light traps increased following prescribed fires. The mechanism of this increase is presumably the new growth of ground vegetation that a burn stimulates. In fecal samples of NLEB, lepidopterans (moths), coleopterans, and dipterans were the three most important groups of insect prey, with dipteran consumption increasing after burning. NLEB appeared to track the observed changes in insect availability, i.e., home ranges were closer to burned habitats following fires than to unburned habitats, but home range size did not vary before and after fires.

<u>Summary of Exposure-Response Table</u>

Table 4.1 shows the eight pathways we identified for NLEB responses to prescribed fire and the range of individual responses expected. In general, exposure to prescribed burning can cause direct adverse responses (disturbance, injury, death) and indirect adverse and beneficial responses via changes to roosting and foraging resources and forest health maintenance. Stressors caused by burning include heat and smoke during the actual movement of a fire through forested areas and fire-induced changes in vegetation structure and composition. Bat exposure to these direct and indirect stressors depends on timing of the burn and how bats may use the burned area, e.g., for roosting, foraging, spring staging, fall swarming, or hibernation in a cave/mine where the entrance is within or near the burned area.

4.4.2 METHODOLOGY FOR QUANTIFYING EFFECTS OF PRESCRIBED FIRE

To estimate the potential impacts of prescribed fire through 2022, we compiled the mean, minimum, and maximum acres of prescribed burns in each state from 2002 to 2014 (Table 4.6) using data available through the National Interagency Fire Center (available on internet: https://www.nifc.gov/fireInfo/fireInfo_stats_prescribed.html; accessed November 2015). We assumed the mean annual use of prescribed fire from 2002-2014 will be consistent through the period of this consultation. Similar to the population estimation methods in Section 2.4.2, we excluded a state from our analyses if less than 50% of it is within the NLEB range.

These data represent the total amount of prescribed burning in each state without regard to habitat type. We further parsed these data using information from the 2012 National Prescribed Fire Use Survey Report (Melvin 2012) to exclude burned grassland habitats as these are not relevant to the NLEB. The burn report estimated the percent of prescribed fire used to manage grassland or agriculture habitat and forested land in 2012. We recognize that this percentage likely varies to some degree every year, but we assume that the proportion of prescribed fire in forested habitat is similar. We use the mean annual acres of prescribed fire in forested habitat reported in Table 4.6 for the purposes of this BO. We anticipate that 648,908 acres will be burned annually through 2022, which is 0.2% of the available forested habitat (Table 4.2). The majority of prescribed burning is expected to occur in the Southern range (64%), followed by 29% in the Midwest, 4% and 3% in the Eastern and Western ranges, respectively.

Similar to timber harvest, we lack a breakdown of the acres burned during the active and non-volant seasons, and we assume that prescribed burning will occur with equal frequency throughout the year. Therefore, the average annual acres of prescribed burning during the active season are 58.6% of the total average annual acres, and 16.7% of the total is estimated to occur in the non-volant season. This estimate is similar to the recent estimates from programmatic consultations for the NLEB on U.S. Forest Service lands, where 21 and 16 percent of prescribed burning was projected to occur during the pup season (defined by the Forest Service as May 1 to July 30) in the Southern and Eastern regions, respectively. This may be an overestimate for the western range.

We use the same methods described for timber harvest (see Section 4.1.2.2) to estimate individual-level effects corresponding to the stressor-exposure-response pathways for prescribed burning. Our calculations for each pathway that we quantify are presented in tabular form in Section 4.3.

4.4.3 QUANTIFYING EFFECTS OF PRESCRIBED FIRE

We quantify the two pathways expected to disturb or harm the NLEB: disturbance from fleeing the fire (Table 4.7), and harm to pups from heat and smoke during the non-volant season (Table 4.8). Prescribed fires during the active season within maternity roosting areas may disturb up to 19,417 volant NLEB annually through fleeing and increased predation (Table 4.7). A small subset of disturbed individuals may be harmed. Prescribed burning during the non-volant season may harm up to 1,859 pups annually (Table 4.8).

In addition to these two pathways, prescribed burning could alter the flow of air and water through unknown hibernacula and also harm NLEBs. We do not have enough information to quantify the effects of this pathway because we do not know where projects will occur relative to the unknown hibernacula that are likely on the landscape. Although the alteration of unknown hibernacula may occur, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of prescribed burning. In addition, Caviness (2003) reported that prescribed burns were found to have no notable influence on bats hibernating in various caves in the Ozark National Forest. All bats present in caves at the beginning of the burn were still present and in "full hibernation" when the burn was completed, and bat numbers increased in the caves several days after the burn. There were minute changes in relative humidity and temperature during the burn and elevated short-term levels of some contaminants from smoke were noted.

We also do not quantify the potential reductions or increases in fitness that may result as indirect effects from the loss of roost trees (adverse) or the creation of roost trees, increased prey availability, or reduction of mid-story clutter (beneficial). We anticipate that only 0.2% of available habitat will be burned annually, and any habitat losses from prescribed fire will be temporary. In addition, the NLEB does not appear to be limited by roost trees, as demonstrated through a great deal of plasticity within its environment (e.g., roosting in a wide variety of trees and sizes). Therefore, reductions in fitness from habitat loss are anticipated to be small. Further, prescribed fire likely also benefits NLEB habitat and may increase fitness of local populations as described above. We do not quantify the potential increases in fitness because we lack the scientific support to interpret the degree to which survival or reproductive success rates of local populations may be influenced; however, management of existing forests is likely to maintain roosting or foraging habitat.

4.5 FOREST CONVERSION

Forest conversion is the loss of forest to another land cover type (e.g., grassland, cropland, development). For the purposes of this BO, we define forest conversion as any activity that removes forested habitat that is suitable for the NLEB. This includes, but is not limited to, tree removal from commercial or residential development, energy production and transmission (oil, gas, solar, wind), mining, agriculture, transportation, military training, and other ecosystem management. Unlike forest management, forest conversion permanently removes forested habitat on the landscape, or in some cases, there is no forest for decades as in the case of mining.

4.5.1 EFFECTS OF FOREST CONVERSION

In the final listing rule for the NLEB, we note that forest conversion could result in the following impacts: (1) loss of suitable roosting or foraging habitat; (2) fragmentation of remaining forest patches, leading to longer flights between suitable roosting and foraging habitat; (3) removal of (fragmenting colonies/networks) travel corridors; and (4) direct injury or mortality from the removal of occupied roosts during active season clearing. Forest conversion could also alter the flow of air and water through unknown hibernacula and impact NLEBs.

The literature review for timber harvest describes the loss of suitable roosting or foraging habitat, direct injury or mortality from removal of occupied roost, and alteration of hibernacula (see section 4.1.2.1). Fragmentation of forests patches and travel corridors may result in longer flights to find alternative suitable habitat and colonial disruption. NLEBs emerge from hibernation with their lowest annual fat reserves and return to their summer home ranges. Because NLEBs have summer home range fidelity (Foster and Kurta 1999; Patriquin et al. 2010; Broders et al. 2013), loss or alteration of forest habitat may put additional stress on females when returning to summer roost or foraging areas after hibernation. Females (often pregnant) have limited energy reserves available for use if forced to seek out new roosts or foraging areas. Hibernation and reproduction are the most energetically demanding periods for temperate-zone bats, including the NLEB (Broders et al. 2013). Bats may reduce metabolic costs of foraging by concentrating efforts in areas of known high prey profitability, a benefit that could result from the bat's local roosting and home range knowledge and site fidelity (Broders et al. 2013). Cool spring temperatures provide an additional energetic demand, as bats need to stay sufficiently warm or enter torpor. Entering torpor comes at a cost of delayed parturition; bats born earlier in the year have a greater chance of surviving their first winter and breeding in their first year of life (Frick et al. 2010). Delayed parturition may also be costly because young of the year and adult females would have less time to prepare for hibernation (Broders et al. 2013). Female NLEBs typically roost colonially, with their largest population counts occurring in the spring (Foster and Kurta 1999), presumably as one way to reduce thermal costs for individual bats (Foster and Kurta 1999). Therefore, similar to other temperate bats, NLEBs have multiple high metabolic demands (particularly in spring) and must have sufficient suitable roosting and foraging habitat available in relatively close proximity to allow for successful reproduction.

Table 4.1 shows the six pathways we identified for NLEB responses to forest conversion and the range of individual responses expected. The primary alteration of the environment associated with forest conversion that is relevant to the NLEB is the removal of trees that provide roosts or serve as foraging, spring staging, or fall swarming habitat. Removing occupied trees is likely to kill or injure pups and adults. Fragmentation and loss of forest habitat decreases opportunities for growth and successful reproduction. Alteration of hibernacula can harm NLEBs. The disturbance (noise, exhaust from machinery, etc.) that accompanies conversion activities may result in disturbance because fleeing during daylight increases the likelihood of predation. A small subset of disturbed individuals may be harmed. The species' responses to these stressors depend on the timing, location, and extent of the removal. In areas with little forest or highly fragmented forests (e.g., western U.S. edge of the range, central Midwestern states; see Figure 1.1, above), impact of forest loss would be disproportionately greater than similar-sized losses in heavily forested areas (e.g., Appalachians and northern forests). Also, the impact of habitat loss within a NLEB's home range is expected to vary depending on the scope of removal.

4.5.2 METHODOLOGY FOR QUANTIFYING EFFECTS OF FOREST CONVERSION

To estimate the potential impacts of forest conversion through 2022, we examined the total forested acres in each state from 2001 to 2011 using the National Land Cover Datasets (Homer et al. 2015). We calculated the approximate acres of forest lost per state per year by subtracting the acres of total forest in 2011 from the forested acres in 2001 and calculating the annual loss over the 10 year period (Table 4.9). We assume that the mean annual forest conversion from 2001-2011 will be consistent through the period of this consultation. Similar to the population estimation methods in Section 2.4.2, we excluded a state from our analyses if less than 50% of it is within the NLEB range. We anticipate that 914,237 acres will be converted from forested habitat annually through 2022, which is 0.3% of the available forested habitat per year and 2.3% of the available habitat through 2022 (Table 4.2). The majority of the expected forest conversion will occur in the Southern range (53%), followed by the Eastern range (26%), Midwest (19%). Only about 2% of the total conversion will occur in the Western range.

Similar to timber harvest, we lack a breakdown of forest conversion during the active and non-volant seasons, and we assume that it will occur with equal frequency throughout the year. Therefore, the average annual acres of forest conversion during the active season are 58.6% of the total average annual acres, and 16.7% of the total is estimated to occur in the non-volant season.

We use the same methods described for timber harvest (see Section 4.1.2.2) to estimate individual-level effects corresponding to the stressor-exposure-response pathways for prescribed burning. Our calculations for each pathway that we quantify are presented in tabular form in Section 4.3.

4.5.3 QUANTIFYING EFFECTS OF FOREST CONVERSION

We quantify the two pathways expected to disturb or harm the NLEB: disturbance from fleeing human activity (Table 4.10), and harm from removing occupied roost trees (Table 4.11 for pups and Table 4.12 for adults). Human disturbance from forest conversion during the active season (April – October) within maternity roosting areas may disturb up to 21,004 volant NLEB annually (Table 4.10). Forest conversion activities that remove occupied roost trees during the non-volant season may harm up to 317 pups annually (Table 4.11). Removal of occupied roost trees during the active season may harm up to 83 adults annually (Table 4.12).

In addition to these two pathways, forest conversion could alter the flow of air and water through unknown hibernacula and also harm NLEBs. We do not have enough information to quantify the effects of this pathway because we do not know where projects will occur relative to the unknown hibernacula that are likely on the landscape. Although the alteration of unknown hibernacula is reasonably certain to occur, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of forest conversion activities. In addition, the hibernacula often selected by NLEB are “large, with large passages” (Raesly and Gates 1987), and may be less affected by relatively minor surficial micro-climatic changes that might result from forest conversion around unknown roosts. Raesly and Gates (1987) evaluated external habitat characteristics of hibernacula and reported that for the NLEB the percentage of cultivated fields within 0.6 miles (1 km) the hibernacula was greater (52.6 percent) for those caves used by the species, than for those caves not used by the species (37.7 percent), suggesting that the removal of some forest around a hibernacula can be consistent with the species needs.

We also do not quantify the potential reductions in fitness that may result as indirect effects from loss of habitat. We anticipate that 0.3% (914,237 acres) of available habitat will be converted annually through 2022. We anticipate that habitat losses from forest conversion will be permanent. However, the NLEB does not appear to be limited by habitat, as demonstrated by a great deal of plasticity within its environment (e.g., living in highly fragmented forest habitats to contiguous forest blocks from the southern United States to Canada’s Yukon Territory) in the absence of WNS. Therefore, reductions in fitness from habitat loss are anticipated to be small.

4.6 WIND TURBINE OPERATION

Wind energy development is rapidly increasing throughout the NLEB’s range. Iowa, Illinois, Oklahoma, Minnesota, Kansas, and New York are within the top 10 States for wind energy capacity (installed megawatts) in the United States (AWEA 2013). There is a national movement towards a 20 percent wind energy sector in the U.S. market by 2030 (United States Department of Energy (US DOE) 2008). Through 2012, wind energy has achieved its goals in installation towards the targeted 20 percent by 2030 (AWEA 2015a). If the target is achieved, it would represent nearly a five-fold increase in wind energy capacity during the next 15 years (Loss et al. 2013). While locations of future wind energy projects are largely influenced by ever-changing economic factors and are difficult to predict, sufficient wind regimes exist to support wind power development throughout the range of the NLEB (USDOE 2015a), and wind development can be expected to increase throughout the range in future years. Wind energy facilities have been constructed in areas within a large portion of the range of the NLEB.

4.6.1 EFFECTS OF WIND TURBINE OPERATION

Significant bat mortality has been witnessed associated with utility-scale (greater than or equal to 0.66 megawatt (MW)) wind turbines along forested ridge tops in the eastern and northeastern United States and in agricultural areas of the Midwest (Johnson 2005; Arnett et al. 2008; Cryan 2011; Arnett and Baerwald 2013; Hayes 2013; Smallwood 2013). Recent estimates of bat mortality from wind energy facilities vary considerably depending on the methodology used and species of bat. Arnett and Baerwald (2013) estimated that 650,104 to 1,308,378 bats had been killed at wind energy facilities in the United States and Canada as of 2011, and expected another 196,190 to 395,886 would be lost in 2012. Other bat mortality estimates range from "well over 600,000… in 2012" (Hayes 2013; [but see Huso and Dalthorp 2014]) to 888,000 bats per year (Smallwood 2013), and mortality can be expected to increase as more turbines are installed on the landscape. The majority of bats killed include migratory foliage-roosting species the hoary bat (*Lasiurus cinereus*) and eastern red bat, and the migratory, tree- and cavity-roosting silver-haired bat (Arnett et al. 2008; Cryan 2011; Arnett and Baerwald 2013). NLEBs are rarely detected as mortalities, even in areas where they are known to be common on the landscape.

The Service reviewed post-construction mortality monitoring studies at 62 unique operating wind energy facilities in the range of the NLEB in the United States and Canada. In these studies, 41 NLEB mortalities were documented, comprising less than 1 percent of all bat mortalities. Northern long-eared bat mortalities were detected throughout the study range at 29 percent of the facilities, including: Illinois, Indiana, Maryland, Michigan, Missouri, New York, Pennsylvania, West Virginia, and Ontario. There is a great deal of uncertainty related to extrapolating these numbers to generate an estimate of total NLEB mortality at wind energy facilities due to variability in post-construction survey effort and methodology (Huso and Dalthorp 2014). Bat mortality can vary between years and between sites, and detected carcasses are only a small percentage of total bat mortalities. Despite these limitations, Arnett and Baerwald (2013) estimated that wind energy facilities in the United States and Canada killed between 1,175 and 2,433 NLEBs from 2000 to 2011.

There are three impacts of wind turbines that may explain proximate causes of bat fatalities, which include: (1) bats collide with turbine towers; (2) bats collide with moving blades; or (3) bats suffer internal injuries (barotrauma) after being exposed to rapid pressure changes near the trailing edges and tips of moving blades (Cryan and Barclay 2009). Researchers have recently indicated that traumatic injury, including bone fractures and soft tissue trauma caused by collision with moving blades, is the major cause of bat mortality at wind energy facilities

(Rollins et al. 2012; Grodsky et al. 2011). Grodsky et al. (2011) suggested that these injuries can lead to an underestimation of bat mortality at wind energy facilities due to delayed lethal effects. However, the authors also noted that the surface and core pressure drops behind the spinning turbine blades are high enough (equivalent to sound levels that are 10,000 times higher in energy density than the threshold of pain in humans) to cause significant ear damage to bats flying near wind turbines (Grodsky et al. 2011). Bats suffering from ear damage would have a difficult time navigating and foraging, as both of these functions depend on the bats' ability to echolocate (Grodsky et al. 2011). While earlier papers indicated that barotrauma may also be responsible for a considerable portion of bat mortality at wind energy facilities (Baerwald et al. 2008), in a more recent study, researchers found only 6 percent of wind turbine killed bats at one site were possibly killed by barotrauma (Rollins et al. 2012). In a separate study, Grodsky et al. (2011) found that 74 percent of carcasses had bone fractures and more than half had mild to severe hemorrhaging in the middle or inner ears; thus it is difficult to attribute individual fatalities exclusively to either direct collision or barotrauma.

Table 4.1 shows the two pathways we identified for NLEB responses to wind turbine operation and the range of individual responses expected. The primary impact to bats from operation of wind facilities is death resulting from collision with operating turbines. It is also possible that NLEBs could be disturbed by sound from turbine operation; however, studies have found no evidence to suggest that bats are likely to be affected (Szewczak and Arnett 2006; Horn et al. 2008). We do not address sound from turbine operation further in this BO. We include the potential impacts from construction under forest conversion.

4.6.2 QUANTIFYING EFFECTS OF WIND TURBINE OPERATION

This section describes the approach for determining the current and future wind energy development conditions and the estimation of potential fatalities from wind energy through the duration of this consultation in 2022.

We compiled the installed wind power capacity (megawatts [MW]) as identified by the American Wind Energy Association (AWEA) for each state within the NLEB's range through 2014 (AWEA 2014). Similar to the population estimation methods in Section 2.4.2, we excluded a state from our analyses if less than 50% of it is within the NLEB range. There is currently no installed wind power capacity in the excluded states of Louisiana, Alabama, Georgia, and South Carolina, but there was 5,857 MW of installed capacity in Montana, Wyoming, and Oklahoma as of 2014. To determine if excluding these states was reasonable, we also examined a wind development pressure map (Figure 4.1) developed using the Federal Aviation Administration's wind turbine data (Service 2015a, unpublished data). We concluded that a small amount of potential wind energy development was within the species' range in Montana, Wyoming, and Oklahoma; however, the inclusion of the full states of Nebraska and Kansas should compensate for any impacts not included in the excluded states. The total amount of installed wind capacity for the remaining states within the range of the NLEB was 28,294 MW at the end of 2014 (Table 4.13).

To estimate the potential impacts of future wind energy development through 2022, we used the Department of Energy's 2020 and 2030 build-out projections from the interactive map developed using data from with their 2015 Wind Vision Report (http://energy.gov/maps/map-projected-growth-wind-industry-now-until-2050; USDOE 2015b). The total amount of installed wind capacity by 2020 for states with more than 50% of their area within the NLEB range is projected to be 44,100 MW (Table 4.13). Lacking annual projections, we assumed that the annual build-out from 2014 to 2020 would be the mean of the total build-out over the six year period. We estimated build-out in 2021 and 2022 by taking the difference between the 2030 and 2020 projections and assuming the annual build-out in 2021 and 2022 would be the mean of the total build-out through 2030. The total amount of installed wind capacity by 2022 for states with more than 50% of their area within the NLEB range is projected to be 55,006 MW. The total capacity of wind energy is anticipated to nearly double in the next seven years.

The best source of information available to estimate anticipated future impacts to bats from collision with wind turbines is data from post-construction monitoring studies of existing wind facilities. Species composition data from these studies can be used to estimate the level of NLEB mortality by assuming the proportion of documented fatalities of NLEB, relative to the fatalities of all other bat species, represents the proportion of NLEB fatalities expected in other projects situated in similar geographic areas. It is important to use data that are as representative as possible of the conditions in the area for which mortality is being estimated because multiple variables are likely to influence mortality rates at wind energy facilities, including location relative to bat areas of activity, turbine height, rotor-swept area, turbine cut-in speed (i.e., the minimum speed required to produce energy), geographic location, elevation, topographic location, surrounding habitat types, time of year, and weather conditions. Uncertainty regarding variations in the relative densities of different species of bats across the landscape and over time are an additional source of error in this estimation. However, we used the data from the draft Midwest Wind Energy Habitat Conservation Plan (MWE HCP) as a surrogate for the full range of the species because the post construction mortality studies have not been compiled at the range-wide scale of the NLEB. The estimates from the MWE HCP represent the best available data for this consultation, but we acknowledge the uncertainty of these estimates for the Eastern, Southern, and Western portions of the species' range.

The number of NLEBs that may be impacted by wind development in each state was calculated following these steps[3]: (1) determine the anticipated bat fatality rate for the geographic area of

[3] The MWE HCP is currently in development with the Service, a coalition of eight Midwestern states, and representatives of the wind energy industry. Much of the following information in this section comes from the draft

interest based on the results of post-construction monitoring studies; (2) determine the proportion of the NLEB among fatalities in post-construction monitoring studies in the applicable range of the NLEB; and (3) multiply the proportion of the NLEB by the expected fatality rate to derive the expected number of total fatalities of the NLEB. For example, if the total estimated bat mortality from regional data is 12 bats/MW/year (or 1,200 bats/year for a 100 MW facility), and the number of NLEB fatalities among all bat fatalities was 1 out of 100 (or 1%), the total estimated mortality of the NLEB would be 12 fatalities/year.

1. *determine the anticipated bat fatality rate for the geographic area of interest based on the results of post-construction monitoring studies*

   The studies used to estimate all bat fatality rates for the MWE HCP were limited to those that were conducted in the eight Midwestern states within the range of the covered bat species in the MWE HCP (i.e., Indiana bat, NLEB, little brown bat). The following additional criteria were used to select post-construction monitoring studies: (1) the search interval had to be weekly or more frequent; (2) studies had to correct for carcass persistence and searcher efficiency using site-specific data; (3) the search interval had to be shorter than the mean carcass persistence rate; (4) only include the mortality rate for the most robust study method for studies that reported more than one mortality rate; and (5) only include the bat fatality estimates from control turbines for curtailment study projects. These studies were further modified to account for unsearched areas where bats were expected to fall by applying a correction factor (sensu Hull and Muir 2013) if the study included search areas smaller than 100 m search radii. Fatality rates must also be representative of the period over which future mortality is being estimated; therefore, rates were adjusted to account for bat mortality that occurred during from April 1 to October 31, which is inclusive of the time frame within which all NLEB mortalities have been documented.

   Based on these criteria, 17 fatality monitoring studies were selected to estimate fatality of all bats within the MWE HCP states. Of these 17 studies, two were conducted in Minnesota, three in Wisconsin, three in Iowa, four in Illinois, two in Indiana, and three in Ohio. Reported bat fatality rates (adjusted as described above) were variable across projects and ranged from a low of 1.42 bats/MW/study period at the Big Blue project in Minnesota (Fagen Engineering, LLC 2014), to 38.25 bats/MW/study period at the Cedar Ridge project in Wisconsin (BHE Environmental 2010). The mean bat fatality rate was 17.55 bats/MW/year. This estimate is similar to pre-WNS values surveys in Maryland (15.61 bats/MW; Young et al. 2011) and Pennsylvania (14.4 bats/MW; Taucher et al.

MWE HCP being written by Leidos, Inc. The analytical process used here was developed and approved by the Service; therefore, the data derived from this study currently represents the best available information to inform this analysis.

2012), which addresses some of the uncertainty of using Midwest estimates for the entire range.

2. *determine the proportion of the NLEB among fatalities in post-construction monitoring studies in the applicable range of the NLEB*

   The MWE HCP used 71 studies to estimate species composition for NLEBs. This was a larger pool than the more restrictive studies used to determine the all bat fatality rate because the purpose was to capture all available data on NLEB mortality in the Midwest. Of these 71 studies, three species of long-distance migrants made up the highest percentage of fatalities, totaling 88% of the 8,934 bat carcasses documented across all studies. Eastern red bats had the highest number of fatalities (3,893 bat carcasses or 44%), followed by hoary bats (2,328 bat carcasses or 26%), and silver-haired bats (1,621 bat carcasses or 18%). The next most common species found among fatalities were big brown bats (519 bat carcasses or 6%), followed by little brown bats (339 bat carcasses or 4%). NLEBs made up 0.09% (8 bat carcasses out of 8,934) of the fatality pool.

3. *multiply the proportion of the NLEB by the expected fatality rate to derive the expected number of total fatalities of the NLEB*

   Based on the estimated percentage of NLEBs (0.09%) among the mean bat fatality rate (17.55/MW/year), the mean estimated NLEB fatalities/MW/year was 0.0158. This NLEB fatality rate was then applied to the current installed wind capacity and projected build-out through 2022 to determine an estimated number of NLEB fatalities that would occur during each year over the term of this consultation assuming no avoidance and minimization measures would be in place. Based on these assumptions, we estimated that 5,654 NLEB fatalities could result from the projected wind capacity of 55,006 MW through 2022 (3,575 NLEBs from current facilities and 2,078 NLEBs from projected build-out; Table 4.13). There was an estimated 447 mortalities in 2014, and annual estimates increase every year by 42 individuals from 2015-2020 and 86 individuals in 2021 and 2022 for a total of 869 individuals in 2022. These are over-estimates because they do not account for avoidance and minimization measures that are currently applied at wind facilities, especially within the range of the endangered Indiana bat and it does not account for declines from WNS, especially in the Eastern range.

   Operational adjustments can be made to minimize mortality of bat species at wind facilities through two primary methods: (1) turbines are “feathered,” or rendered near motionless below the normal manufacturer’s cut-in speed, and (2) the cut-in speed is raised to a wind speed higher than the normal manufacturer’s cut-in speed during periods and in areas of greatest risk for bats. These adjustments have been found to significantly reduce bat mortality because bat activity and mortality have been shown to have an inverse relationship with wind speed (Arnett et al. 2013). Some facilities within the range of the NLEB have already instituted these operational adjustments to avoid take of Indiana bats or as required by Indiana bat Habitat Conservation Plans. In addition, the wind industry has recently announced new best management practices establishing voluntary operating protocols, which they expect "to reduce impacts to bats from operating wind turbines by as much as 30 percent" (AWEA 2015b). According to AWEA, the agreement "involves wind operators' voluntarily limiting the operations of turbines in low-wind speed conditions during the fall bat migration season, when research has shown bats are most at risk of collision" (AWEA 2015b). Given the large numbers of other bat species impacted by wind energy (Hein et al 2013) and the economic importance of bats in controlling agricultural or forest pest species (Boyles et al 2011), we anticipate that these new standards will be adopted by most wind energy facilities and ultimately required by wind-energy-siting regulators at state and local levels. It is possible that total fatalities will be reduced by as much as 50% if we include the effects of additional curtailment that is ongoing at many projects and the effects of WNS on the overall population.

4.7 OTHER ACTIVITIES THAT MAY AFFECT THE NLEB

The NLEB is likely to be affected by a variety of other activities which are excepted from incidental take prohibitions in the final 4(d) rule that are not covered by the general categories for removal from human structures, forest management, forest conversion, and wind turbine operation. These activities include, but may not be limited to:

- Disturbance/noise from with human activities not associated with timber harvest or forest conversion
- Lighting
- Use of pesticides for pest and vegetation control
- Spills/chemical contamination
- Water quality alteration
- Collision
- Noise from munitions, detonations, and training vehicles/aircraft
- Use of military training smoke and obscurants
- Bridge maintenance, repair, or replacement
- Subsurface drilling or blasting for utility line and road installation
- Use of waste pits to store contaminated fluids

4.7.1 EFFECTS OF OTHER ACTIVITIES

Disturbance/Noise

Noise and vibration and general human disturbance are stressors that may disrupt normal feeding, sheltering, and breeding activities of the NLEB. Many activities may result in increased noise/vibration/disturbance that may result in effects to bats. Significant changes in noise levels in an area may result in temporary to permanent alteration of bat behaviors. The novelty of these noises and their relative volume levels will likely dictate the range of responses from individuals or colonies of bats. At low noise levels (or farther distances), bats initially may be startled, but they would likely habituate to the low background noise levels. At closer range and louder noise levels (particularly if accompanied by physical vibrations from heavy machinery and the crashing of falling trees) many bats would probably be startled to the point of fleeing from their day-time roosts and in a few cases may experience increased predation risk. For projects with noise levels greater than usually experienced by bats, and that continue for multiple days, the bats roosting within or close to these areas are likely to shift their focal roosting areas further away or may temporarily abandon these roosting areas completely.

There is limited literature available regarding impacts from noise (outside of road/traffic) on bats. Gardner et al. (1991) had evidence that an NLEB conspecific, Indiana bat, continued to roost and forage in an area with active timber harvest (see the timber harvest Section above regarding other similar studies for NLEB). They suggested that noise and exhaust emissions from machinery could possibly disturb colonies of roosting bats, but such disturbances would have to be severe to cause roost abandonment. Callahan (1993) noted that the likely cause of the bats in his study area abandoning a primary roost tree was disturbance from a bulldozer clearing brush adjacent to the tree.

Indiana bats have also been documented roosting within approximately 300 meters of a busy state route adjacent to Fort Drum Military Installation (Fort Drum) and immediately adjacent to housing areas and construction activities on Fort Drum (US Army 2014). Bats roosting or foraging in all of the examples above have likely become habituated to the noise/vibration/disturbance.

Table 4.1 shows the pathway we identified for NLEB responses to noise/disturbance, and it is possible that NLEBs will be disturbed by noise/disturbance. A small subset of disturbed individuals may be harmed. Although some adverse effects to NLEBs are reasonably certain to occur from noise or disturbance, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%.

Lighting

Bat behavior may be affected by lights when traveling between roosting and foraging areas. Foraging in lighted areas may increase risk of predation or it may deter bats from flying in those areas. Bats that significantly alter their foraging patterns may increase their energy expenditures resulting in reduced reproductive rates. This depends on the context (e.g., duration, location, extent, type) of the lighting.

Some bats seem to benefit from artificial lighting, taking advantage of high densities of insects attracted to light. For example, 18 species of bats in Panama frequently foraged around streetlights, including slow-flying edge foragers (Jung and Kalko 2010). However, seven species in the same study were not recorded foraging near streetlights. Bat activity differed among color of lights with higher activity at bluish-white and yellow-white lights than orange. Bat activity at streetlights varied for some species with season and moonlight (Jung and Kalko 2010). In summary, this study suggests highly variable responses among species to artificial lighting.

Some species appear to be adverse to lights. Downs et al. (2003) found that lighting of *Pipistrellus pygmaeus* roosts reduced the number of bats that emerged. In Canada and Sweden, *Myotis* spp. and *Plecotus auritus* were only recorded foraging away from street lights (Furlonger et al. 1987, Rydell 1992). Stone et al. (2009) found that commuting activity of lesser horseshoe bats (*Rhinolophus hipposideros*) in Britain and was reduced dramatically and the onset of commuting was delayed in the presence of high pressure sodium (HPS) lighting. Stone et al. (2012) also found that light-emitting diodes (LED) caused a reduction in *Rhinolophus hipposideros* and *Myotis* spp. activity. In contrast, there was no effect of lighting on *Pipistrellus pipistrellus*, *Pipistrellus pygmaeus*, or *Nyctalus/Eptesicus* spp.

Although there is limited information regarding potential neutral, positive, or negative impacts to NLEB from increased light levels, slow-flying bats such as *Rhinolophus*, *Myotis*, and *Plecotus* species have echolocation and wing-morphology adapted for cluttered environments (Norberg and Rayner 1987), and emerge from roosts when light levels are low, probably to avoid predation by diurnal birds of prey (Jones and Rydell 1994). Therefore, we would generally expect that NLEB would avoid lit areas. In Indiana, Indiana bats avoided foraging in urban areas and Sparks et al. (2005) suggested that it may have been in part due to high light levels. Using captive bats, Alsheimer (2012) also found that the little brown bat (*M. lucifugus*), was more active in the dark than light.

Table 4.1 shows the pathway we identified for NLEB responses to lighting, and it is possible that NLEBs will experience reduced fitness from lighting. Although some adverse effects to NLEBs are reasonably certain to occur from lighting, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%.

Pesticides

Herbicides and other pesticides may be used to control pests and weed species including noxious or invasive plants. Treatments typically occur in spring, early summer, or fall. Treatments can be applied either by hand, from a truck mounted boom sprayer withspray heads designed to minimize drift, or aerially. Herbicide and other pesticide applications typically occur during the day when bats are roosting, and often in the morning to avoid and minimize wind-induced drift.

Long-term sublethal effects of environmental contaminants, such as herbicides and other pesticides, on bats are largely unknown; however, environmentally relevant exposure levels of various contaminants have been shown to impair nervous system, endocrine, and reproductive functioning in other wildlife (Yates et al. 2014, Köhler and Triebskorn 2013, Colborn et al. 1993). Moreover, bats' high metabolic rates, longevity, insectivorous diet, migration-hibernation patterns of fat deposition and depletion, and immune impairment during hibernation, along with potentially exacerbating effects of WNS, likely increase their risk of exposure to and accumulation of environmental toxins (Secord et al. 2015, Yates et al. 2014, Geluso et al. 1976, Quarles 2013, O'Shea and Clark 2002).

Table 4.1 shows the pathway we identified for NLEB responses to the use of herbicides and other pesticides, and it is possible that NLEBs will experience reduced fitness and harm depending on the specific circumstances. Bats may drink contaminated water or forage in affected or treated areas and thus may eat insects exposed to chemicals. Bats may also be directly exposed to herbicides or other pesticides sprayed in roosting areas. Although some adverse effects to NLEBs are reasonably certain to occur from herbicides and other pesticide use, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%. In addition, all herbicides and other pesticides must be used in accordance to their label instructions, which are designed to minimize water contamination and adverse effects to wildlife.

Spills/Chemical Contamination

Accidents during project operation could result in the leakage of hazardous chemicals into the environment which could affect water quality resulting in reduced densities of aquatic insects that bats consume. If an accident occurred and hazardous chemicals leaked into the environment, a rapid response from state and/or federal agencies would limit the size of the spill area. However, if chemicals did reach surface waters (streams and wetlands), a short-term reduction in both aquatic and terrestrial insects could occur, thus reducing the spring, summer, or autumn prey base for foraging NLEB. If this occurred, it would be localized, thus allowing foraging NLEBs to move nearby and continue foraging.

Table 4.1 shows the pathway we identified for NLEB responses to spills and chemical contamination, and it is possible that NLEBs will experience reduced fitness and harm depending on the specific circumstances. Bats may drink contaminated water or forage in affected areas with the potential to eat insects exposed to chemicals. Although some adverse effects to NLEBs are reasonably certain to occur from spills and chemical contamination, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%. In addition, all projects are typically required to follow state and/or federal wetland permitting, stormwater management, and water quality standards.

Water Quality Alteration

Some projects may result in permanent loss from wetland and/or stream fill or temporarily reduce water quality from dust and sedimentation. Table 4.1 shows the pathway we identified for NLEB responses to water quality alteration. Activities that reduce quantity or quality of water sources and foraging habitat may impact bats, even if conducted while individuals are not present. Standard construction BMPs (e.g., silt fencing) will minimize erosion and subsequent sedimentation, thus reducing potential impacts on aquatic ecosystems. Since potential impacts from sedimentation are expected to be localized, foraging bats should have alternative drinking water and foraging locations. The surrounding landscape will continue to provide an abundant prey base of both terrestrial and aquatic insects during project construction, operation, and maintenance. Therefore, any potential direct effects to bats from a reduction in water quality are anticipated to be insignificant.

Collision

Collision has been documented for Indiana bats and other myotids. The Indiana bat recovery plan indicates that bats do not seem particularly susceptible to vehicle collisions, but it may threaten local populations in certain situations (Service 2007). Russell et al. (2009) assessed the level of mortality from road kills on a bat colony in Pennsylvania and collected 27 road-killed little brown bats and 1 Indiana bat. This study also cited unpublished data from the Penssylvania Game Commission documenting NLEB collision mortality. Curtis et al. (2014) indicates that a dead NLEB was found along a road in Kansas and was thought to have collided with a vehicle. Collision has been documented for other *Myotis* in Europe (Lesinski et al. 2011). Collision risk of bats varies depending on time of year, location of road in relation to roosting/foraging areas), the characteristics of their flight, traffic volume, and whether young bats are dispersing (Lesinski 2007, Lesinski 2008, Russell et al. 2009, Bennett et al. 2011).

It can be difficult to determine whether roads pose greater risk for bats colliding with vehicles or greater likelihood of deterring bat activity in the area (thus decreasing risk of collision). Many studies suggest that roads may serve as a barrier to bats (Bennett and Zurcher 2013, Bennett et al. 2013, Berthinussen and Altringham 2011, Wray et al. 2006). In most cases, we expect there will be a decreased likelihood of bats crossing roads (and therefore, reduced risk of collision) of increasing size (lanes).

Table 4.1 shows the pathway we identified for NLEB responses to collision, and we anticipated that NLEBs will be killed from collision with vehicles. Although some mortality is reasonably certain to occur, we anticipate that relatively small numbers of bats will be impacted per year in each state because of the decreased likelihood of bats crossing major roads. Also, we anticipate the likelihood of mortality will be reduced by the widely dispersed of new road construction and occupancy rates that are typically less than 50%.

Noise from Munitions, Detonations, and Training Vehicles, Aircraft

Recent studies have indicated that anthropogenic noise can alter foraging behavior and success of bats, including some gleaning species like the NLEB (Bunkley et al. 2015; Schaub et al. 2008; Siemers and Schaub 2011). Table 4.1 shows the pathway we identified for NLEB responses to noise from military training operations, and it is possible that NLEBs will be disturbed. A small subset of disturbed individuals may be harmed. However, studies indicate that indicate bats do not avoid active ranges or alter foraging behavior during night-time maneuvers, and NLEBs are expected to become habituated to noise disturbance (Whitaker & Gummer 2002; Service 2010; USFWS 2009). Although some adverse effects to NLEBs may occur from noise from military operations, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%.

Use of Military Training Smoke and Obscurants

Smoke/obscurants are used to conceal military movements and help protect troops and equipment in combat conditions. Although they would be primarily used during the day, smoke/obscurants may be deployed at night. Training on military installations may include, but is not limited to, smokes and obscurants such as fog oil, colored smoke grenades, white phosphorous, and graphite smoke. Research indicates that prolonged dermal and respiratory exposures to these items, except for the graphite smoke, could have adverse effects on roosting and foraging Indiana bats (Service 1998; Service 2012; Driver et al. 2002; USWFS 2009; NRC 1999). Given the similar roosting behavior and foraging locations of the NLEB, it is likely they will also be adversely affected by these smokes and obscurants.

Table 4.1 shows the pathway we identified for NLEB responses to the use of smokes and obscurants, and it is possible that NLEBs will be harmed depending on the specific circumstances. Although some adverse effects to NLEBs are reasonably certain to occur, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the limited use of these chemicals and occupancy rates that are typically less than 50%. In addition, many military installations already limit the use of smokes and obscurants in areas that may affect the Indiana bat, further reducing the impact to NLEBs.

<u>Bridge Maintenance, Repair, or Replacement</u>

NLEBs have been found using bridges for day and night roosts in Illinois, Louisiana, Iowa, and Missouri (Feldhamer et al. 2003; Ferrara and Leberg 2009; Kiser et al. 2002; Benedict and Howell 2008; Droppelman 2014). Altering or removing bridges when occupied by NLEBs is expected to result in adverse effects. Bridge alteration refers to any bridge repair, retrofit, maintenance, and/or rehabilitation work activities that modifies the bridge to the point that it is no longer suitable for roosting.

Table 4.1 shows the two pathways we identified for NLEB responses to bridge work and it is possible that NLEBs will experience reduced fitness and harm depending on the specific circumstances. We expect that NLEBs will be killed or injured bats during activities conducted while bats are present, and the removal of roosts can reduce fitness. Although some adverse effects to NLEBs are reasonably certain to occur from bridge maintenance, repair, or replacement, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%.

<u>Subsurface Drilling or Blasting</u>

Surface-disturbing activities (such as drilling or blasting) in the vicinity of hibernacula may affect bat populations if those activities result in changes to the microclimate (temperature, humidity, and air flow) of the cave or mine (Ellison et al. 2003).

Table 4.1 shows the two pathways we identified for NLEB responses to drilling and blasting, and it is possible that NLEBs will be harmed. These activities can alter the flow of air and water through unknown hibernacula. Although the alteration of unknown hibernacula is reasonably certain to occur, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of timber harvest activities.

Use of Waste Pits to Store Contaminated Fluids

The oil and gas industry (and possibly other industries) occasionally use of temporary waste pits to store materials removed from drilling, including sand used during hydraulic fracturing treatments, wellbore cuttings, bentonite drilling muds, and fluids. These waste pits have been documented to attract and entrap wildlife. Bats may drink contaminated water or become trapped in waste pits and die. Table 4.1 shows the pathway we identified for NLEB responses to waste pits, and it is possible that NLEBs will be harmed. Although some adverse effects to NLEBs are reasonably certain to occur from the use of waste pits, we anticipate that relatively small numbers of bats will be impacted per year in each state based on the widely dispersed nature of activities and occupancy rates that are typically less than 50%.

4.8 CONSERVATION MEASURES IN THE 4(D) RULE

In BOs, we consider how conservation measures included in the proposed action may reduce the severity of effects or the probability of exposure. Prohibitions adopted under the final 4(d) will reduce the severity of effects or the probability of exposure of NLEB to the full scope of activities that may affect the species through regulatory processes under section 7 and section 10 the Act. Under the final 4(d) rule, incidental take involving tree removal in the WNS zone is not prohibited if two conservation measures are followed. The first measure is the year-round application of a 0.25-mile radius buffer (which is equivalent to 125.7 acres) around known NLEB hibernacula. The second conservation measure involves the temporary protection of known, occupied maternity roost trees. Incidental take is prohibited if the activity cuts or destroys a known, occupied maternity roost tree and other trees within a 150-foot radius around the maternity roost tree (which is equivalent to 1.6 acres) during the pup season (June 1-July 31). The 150 ft buffer covers 1.6 acres around a known maternity roost tree. In addition, incidental take is prohibited in hibernacula within the WNS zone; therefore, regardless of the buffer size, NLEBs are protected from take while in known hibernacula when they are most vulnerable.

To determine how these conservation measures reduce the severity of effects or probability of exposure, we compared the acreages affected by the conservation measures to the total forested habitat within the range of the NLEB (Table 4.14). As described in section 2.2, there are currently 1,508 known hibernacula and 1,412 known maternity roost trees. The year-round protection of forested habitat around hibernacula results in a total of 189,556 acres (0.05% of the total forested habitat) in 31 of 37 states (84% of the range) where activities that may affect the NLEB are subject to regulatory processes under sections 7 and 10 of the Act. The temporary protection of known, occupied maternity roosts results in a total of 2,259 acres (<0.001% of the total forested habitat) in 17 of 37 states (46% of the range) where activities that may affect the NLEB are subject to the same regulatory processes.

These two conservation measures are beneficial in that they protect known hibernating populations from take and help protect known maternity colonies from direct harm by temporarily protecting known maternity roost trees during the pup season. However, because known maternity roost trees likely represent a small fraction of the total, the beneficial effect of this conservation measure, which reduces the severity of effects, does not significantly reduce the probability of exposure. Additionally, known roost trees may be cut either before June 1st or after July 31st in compliance with the 4(d) rule, or during that time period with either an incidental take permit under section 10, or an incidental take statement under section 7. The hibernacula conservation measure is more protective in scope (i.e., timing, location, and severity). The severity of the effects and probability of exposure are somewhat reduced, but this beneficial effect extends only to known hibernacula. Like known maternity roost trees, known hibernacula likely represent a small fraction of the total.

4.9 SUMMARY OF IMPACTS OF INDIVIDUALS

Table 4.15 combines the total annual estimated effects of the activities quantified for timber harvest, prescribed fire, forest conversion, and wind turbine operation. Because fatalities from wind turbine operation increase every year between 2015 and 2022, we report the average annual wind fatalities over the time-frame of this consultation. Based on these estimations, we anticipate that up to 117,267 NLEB will be disturbed and 3,285 pups and 980 adults will be harmed annually from timber harvest, prescribed fire, forest conversion, and wind turbine operation.

The disturbance associated with timber harvest, prescribed burning, and forest conversion within maternity roosting areas during the active season (April – October) can cause volant bats to flee their roosts and expend additional energy while exposed to day-time predators. Our methodology computes the number of NLEB affected annually as 117,267 bats (or 1.2% of the population) (Table 4.16). We recognize that not all of the NLEB roosting in an activity area will necessarily respond to disturbance by fleeing their roosts, likely depending on the disturbance intensity and proximity; therefore, we consider this to be an overestimate. Table 4.16 shows that 66 percent of the potential disturbance in maternity roosting areas is due to timber harvest, 18 percent to forest conversion, and 17% to prescribed burning. Disturbance that disrupts normal behavior patterns and creates the likelihood of injury to listed species (e.g., causing a nocturnal species to travel during daylight hours) may result in harm.

Timber harvest, prescribed burning, and forest conversion may also occur in maternity roosting areas during the non-volant season (June 1 – July 31). Heat and smoke from prescribed burning, and tree removal from the other activities, may kill or injure a non-volant pup, who cannot flee the threat unless carried by its mother, which we do not presume precludes this potential harm. We estimate that up to 3,285 NLEB pups (0.1 percent of the total pup population) are exposed to potentially lethal habitat modification annually (Table 4.17). Prescribed burning may affect 56.6

percent of the total pup population (Table 4.17). The potential for death or injury resulting from prescribed burning depends largely on site-specific circumstances, e.g., fire intensity near the maternity roost tree and the height above ground of pups in the maternity roost tree. Not all fires through maternity roosting areas will kill or injure all pups present, but our methodology in this BO estimates that all potentially vulnerable individuals within the expected area of activity/occupancy overlap are affected. We therefore consider this to be an overestimate. Timber harvest and forest conversion account for 33.8 and 9.6 percent of the estimated harm to non-volant pups, respectively (Table 4.17). Unlike prescribed burning, we did not assume that all potentially vulnerable individuals within the expected area of activity/occupancy overlap are affected. We assumed that 15 percent of pups would be injured or killed when their roost tree was felled.

Wind turbine operation and tree removal from timber harvest and forest conversion may also kill or injure adults when they are struck by turbines or when occupied roost trees are felled. We estimate that up to 980 NLEB adults (less than 0.02 percent of the total adult population) are exposed to potentially lethal wind turbines and habitat modification annually (Table 4.18). Wind turbine operation accounts for 66.3% of the adult mortality, followed by timber harvest (25.2%) and forest conversion (8.5%) (Table 4.18). As discussed in Section 4.1.5.2, we believe the wind fatalities may be overestimated by as much as 50% after accounting for population reductions from WNS and current and future curtailment. The adult mortality from tree removal is not as likely to be overestimated because we did not assume that all potentially vulnerable individuals within the expected area of activity/occupancy are affected.

Additional harm is anticipated for unquantified effects from removal from human structures and "other" activities that may affect the NLEB; however, we do not expect the additional impacts to substantially change the total numbers reported in Table 4.15 for reasons discussed above (see section 4.1). In addition, we consider some of the numbers for harm and disturbance in this section to be overestimates as discussed, and we also expect that the numbers affected over time will be reduced as WNS continues to affect the range-wide population. As populations decline as a result of WNS, the chances of any particular activity affecting northern long-eared bats becomes more remote.

4.10 IMPACTS TO POPULATIONS

As described above, individual NLEBs may experience decreased reproductive success and survival as a result of implementation of the final 4(d) rule. Of importance here though, is how these potential adverse effects to individual bats affect the overall health and viability of populations present within the action area. This is best done by looking at the maternity colony and hibernacula populations; however, we do not have enough information about local populations or when and where projects will occur relative to the species' occurrence.

The finest-scale of analysis we have to examine effects on local populations is at the state level. States vary greatly in the number of maternity colonies estimated per state (Table 2.5). States in the Eastern range generally have the lowest estimated number of maternity colonies, ranging from 16 maternity colonies in Delaware to 6,984 colonies in West Virginia. States with small numbers of maternity colonies are likely at greater risk of extirpation from impacts to individuals. For example, Delaware has 16 maternity colonies estimated to be comprised of 20 females each, for a total adult population size of 640 individuals. Activities implemented according to the final 4(d) rule could disturb 9 individuals in Delaware per year, along with harm to 3 pups and 2 adults per year. If all the annual impacts occurred within one maternity colony, it is possible that the colony would be reduced by at least 10% in one year (2 adults killed from a colony with 20 females = 10%), and potentially more if the 3 pups were also killed. Losses to very small populations may not be sustainable at the local-level. It is possible that the loss of 10% of the maternity colony could result in the loss of that colony, but it is unlikely that that level of impact would occur within a single maternity colony every year. However, areas hardest hit by WNS are likely at greatest risk (i.e., currently much of the Eastern range).

Although local populations could be affected by the implementation of the final 4(d) rule, most of the states have larger populations and more maternity colonies. In addition, less than 2.3% of NLEBs will be disturbed in all states (Table 4.16), less than 1% of pups will be harmed in all states (Table 4.17), and less than 1% of adults will be harmed in all states (Table 4.18). Therefore, the vast majority of individuals and populations that survive WNS will be unaffected by these activities.

Where the species has substantially declined as a result of WNS, the surviving members of the population may be resilient or resistant to WNS. These surviving populations are particularly important to the persistence of the populations. The individual effects analysis indicates that some additional impacts will occur as a result this action. We do not know at this time if the impacts from this action are additive; however, even if the potential mortality from these activities is additive to the impacts from WNS, it is likely that the species will persist in these states based on the number of maternity colonies and widely-dispersed nature of the activities.

Based on the relatively small numbers affected annually compared to the state population sizes, we do not anticipate population-level effects to the NLEB. We conclude that adverse effects from timber harvest, prescribed fire, forest conversion, wind energy, and other activities will not lead to population-level declines in this species. Because we do not anticipate population-level impacts from our action, our analysis of effects to the NLEB is complete.

4.11 INTERRELATED AND INTERDEPENDENT ACTIONS

An interrelated activity is an activity that is part of the proposed action and depends on the proposed action for its justification. An interdependent activity is an activity that has no independent utility apart from the action under consultation. At this time, we are unaware of actions that are interrelated and interdependent with the final 4(d) rule that have not already been considered in this BO.

4.12 TABLES AND FIGURES FOR EFFECTS OF THE ACTION

Table 4.1. Exposure-response analysis for activities conducted in accordance with the final 4(d) rule that may affect the NLEB.

Activity	Subactivity	Stressor	Exposure (time)	Exposure (space)	Resource Affected	Individual Response	Interpretation
Removal from Human Structures	Exclusion	Using exclusion to make a known roost unsuitable	Year-round; indirect effect	All occupied areas except hibernacula	Adults	Reduced fitness	Loss of structures where bat colonies have demonstrated repeated could reduce fitness through additional energy expenditure while searching for a new roost site.
Removal from Human Structures	Rodenticides and sticky traps	Using rodenticides and sticky traps to remove bats	Active season, daytime; direct effect	Roosting areas (maternity and non-maternity)	Individuals	Injury, mortality; harm	Activities conducted while bats are present are likely to kill or injure individuals. We expect this threat to be reduced through the implementation of BMPs for bat removal.
Removal from Human Structures	Eviction Devices	Using eviction or exclusionary devices to remove bats	Active season, daytime; direct effect	Roosting areas (maternity and non-maternity)	Pups	Injury, mortality; harm	Use of exclusionary devices during the non-volant period is likely to result in the death of pups because females cannot return to take care of their young. However, many states require that exclusions be conducted outside of the non-volant period to minimize impacts.
Removal from Human Structures	Rabies testing	Euthanizing bats for rabies testing during removal	Active season, daytime; direct effect	Roosting areas (maternity and non-maternity)	Individuals	Injury, mortality; harm	Rabies testing will kill adults and volant juveniles. Data from MO and NY indicate that an average of 7 bats were killed bats per year during the most recent three years.
Forest Management	Timber Harvest	Reducing mid-story clutter adjacent to roost trees	Year-round; indirect effect	Maternity roosting areas	Vegetation near roost trees	Beneficial through maintenance or improvement of habitat	Beneficial through increased solar radiation on roosts; improved access to roosts; travel corridors to foraging areas; however, we are unable to quantify the degree of benefit in terms of increased survival or reproductive success.
Forest Management, Forest Conversion	Timber Harvest, Construction Activities	Removing unoccupied roost trees	Winter; indirect effect	Maternity roosting areas	Trees	Reduced fitness	Removal of roost trees where bat colonies have demonstrated repeated could reduce fitness through additional energy expenditure while searching for a new roost site.
Forest Management, Forest Conversion	Timber Harvest, Construction Activities	Removing trees that provide habitat used for foraging, swarming, or staging	Year-round; indirect effect	All occupied areas except hibernacula	Insect prey, forest cover that supports (shelters) bat activity	Reduced fitness; energy expenditure for relocating from traditional use areas to alternative habitat	Loss of forest habitat decreases opportunities for growth and successful reproduction. Depending on location and size of the harvest, forest cover removal in the summer home range may cause a shift in home range or relocation. Loss of habitat in staging/swarming areas near hibernacula may cause a similar shift in habitat use for larger numbers of individuals, due to their seasonal concentration in these areas, and may reduce fall mating success and/or reduced fitness in preparation for spring migration
Forest Management, Forest Conversion, Other	Timber Harvest, Construction Activities, Most other subactivities	Disturbance (noise, machinery exhaust, activity) associated with human activities	Active season, daytime; direct effect	Roosting areas (maternity and non-maternity)	Individuals	Disturbance (fleeing); harass	Fleeing disturbance during daylight hours increases the likelihood of predation
Forest Management, Forest Conversion, Other	Timber Harvest, Construction Activities	Altering the flow of air and water through hibernacula.	Winter (direct effect) and active season (indirect effect)	Near hibernacula	Individuals	Arousal from hibernation; reduced fitness, mortality; take in the form of harm.	Response depends on proximity of tree removal to hibernacula entrances, airflow patterns, and local hydrology. Sufficient modification may cause injury or mortality (take in the form of harm).
Forest Management, Forest Conversion	Timber Harvest, Construction Activities	Removing occupied roost trees	Active seasos; direct effect	Maternity roosting areas	Individuals	Injury, mortality; harm	Removing occupied trees is likely to kill or injure pups and adults. For the purposes of this consultation, we assume that 15% of non-volant bats and 3% of adults may be injured or killed.
Forest Conversion	Construction Activities	Removal of forested habitat	Year-round; indirect effect	All occupied areas except hibernacula	Trees	Reduced fitness	Fragmentation of forests patches and travel corridors may result in longer flights to find alternative suitable habitat and colonial disruption.
Forest Management	Prescribed Burning	Creating snags, creating roost features in live trees	Year-round; indirect effect	All occupied areas except hibernacula	Trees	Beneficial through maintenance or improvement of habitat	Beneficial through greater availability of suitable roosts increasing opportunities for successful reproduction, more efficient use of forest habitat however, we are unable to quantify the degree of benefit in terms of increased survival or reproductive success

Table 4.1. Continued.

Activity	Subactivity	Stressor	Exposure (time)	Exposure (space)	Resource Affected	Individual Response	Interpretation
Forest Management	Prescribed Burning	Stimulating growth of ground cover and insect populations	Growing-season following the burn; indirect effect	Foraging areas	Insect prey	Beneficial through maintenance or improvement of habitat	Beneficial through greater availability of insect prey increasing foraging efficiency; however, we are unable to quantify the degree of benefit in terms of increased survival or reproductive success
Forest Management	Prescribed Burning	Thinning mid-story clutter adjacent to roost trees	Growing-season following the burn; indirect effect	Maternity roosting areas	Vegetation near roost trees	Beneficial through maintenance or improvement of habitat	Beneficial through increased solar radiation on roosts; improved access to roosts however, we are unable to quantify the degree of benefit in terms of increased survival or reproductive success.
Forest Management	Prescribed Burning	Destroying existing snags and other trees suitable for roosting	Year-round; indirect effect	All occupied areas except hibernacula	Trees	Reduced fitness	Loss of suitable roosts decreases opportunities for successful reproduction, more efficient use of forest habitat
Forest Management	Prescribed Burning	Heat and smoke	Active season, day time; direct effect	Roosting areas (maternity and non-maternity)	Individuals; adults and volant juveniles	Disturbance (fleeing); harass	Fleeing the line of fire of a prescribed burn during daylight hours increases the likelihood of predation
Forest Management	Prescribed Burning	Heat and smoke	Active season, night time; direct effect	Foraging areas	Individuals; adults and volant juveniles	Disturbance (fleeing)	Fleeing the line of fire of a prescribed burn during night-time foraging is unlikely to cause injury
Forest Management	Prescribed Burning	Heat and smoke	Winter; direct effect	Near hibernacula	Individuals	Arousal from hibernation; reduced fitness, mortality; take in the form of harm	Response depends on proximity of fire to hibernacula entrances and airflow patterns. Sufficient smoke entering hibernacula may cause injury or mortality.
Forest Management	Prescribed Burning	Heat and smoke	Non-volant season; direct effect	Maternity roosting areas	Individuals; non-volant juveniles	Injury, mortality; harm	Response varies with fire intensity and roost height; a combination of high-intensity burns and/or low roosts is likely to cause injury or mortality
Wind Energy	Operation	Sound from Operating Turbines	Active season, day and night; direct effect	Active season; direct effect	Individuals	Disturbance (fleeing)	Studies (Szewczak and Arnett 2006, Horn et al. 2008) have found evidence to suggest that bats are not likely to be negatively affected by sound from operating turbines.
Wind Energy	Operation	Collision with Operating Turbines	Active season, direct effect	All occupied areas except hibernacula	Individuals	Mortality; harm	Collision with wind wind turbines is likely to kill bats
Other	Most subactivities	Lighting	Active season, night; direct effect	All occupied areas except hibernacula	Individuals	Disturbance (fleeing), increased risk of predation; increase energy expenditure; harass	Foraging in lighted areas may increase risk of predation (leading to death) or it may deter bats from flying in those areas. Bats that significantly alter their foraging patterns may increase their energy expenditures resulting in reduced reproductive rates. This depends on the context (e.g., duration, location, extent, type) of the lighting. Some studies also show a beneficial effect of concentrating prey.
Other	Most subactivities	Use of pesticides and herbicides for pest and vegetation control	Active season, direct and indirect effect	All occupied areas except hibernacula	Individuals; insect prey	lethal or sublethal exposure to toxins; reduction in prey availability; harm/harass	Bats may drink contaminated water or forage in affected areas with the potential to eat insects exposed to chemicals. Bats may also be directly exposed to herbicides sprayed in roosting areas. Effects are reduced because all herbidices and pesticides must be used in accordance with their label.
Other	Most subactivities	Chemical contamination from use or spills in/around bat habitat	Active season, direct and indirect effect	All occupied areas except hibernacula	Individuals; insect prey	lethal or sublethal exposure to toxins; reduction in prey availability; harm/harass	Bats may drink contaminated water or forage in affected areas with the potential to eat insects exposed to chemicals.
Other	Most subactivities	Water Quality Alteration; sedimentation	Active season, indirect effect	All occupied areas except hibernacula	Insect prey	Reduced fitness	Temporary effects on water quality could occur during construction, which could reduce local insect populations. Standard construction BMPs (e.g., silt fencing) will minimize erosion and subsequent sedimentation, thus reducing potential impacts on aquatic ecosystems.

Table 4.1. Continued.

Activity	Subactivity	Stressor	Exposure (time)	Exposure (space)	Resource Affected	Individual Response	Interpretation
Other	Military Operations	Noise from munitions, detonations, and training vehicles, including aircraft	Active season, direct effect	All occupied areas except hibernacula	Individuals	Disturbance (fleeing)	Fleeing disturbance increases the likelihood of predation. However, studies indicate bats do not avoid active ranges or alter foraging behavior during night-time maneuvers, and NLEBs are expected to become habituated to noise disturbance.
Other	Military Operations	Use of Military Training Smoke and Obscurants	Active season, direct effect	All occupied areas except hibernacula	Individuals	Injury, mortality; harm	Research indicates that prolonged dermal and respiratory exposures smokes and obsurants could have adverse effects on roosting and foraging bats.
Other	Bridge maintenance, repair, or replacement	Bridge work activities affect roosting bats	Active season, direct effect	Roosting areas (maternity and non-maternity)	Individuals	injury, mortality; harm	Bats may be injured or killed if they do not exit the bridge before it is either removed or the action results in effects to portion of the bridge where the bats are roosting.
Other	Bridge maintenance, repair, or replacement	Bridge work makes it unsuitable for roosting.	Inactive season, indirect effect	Roosting areas (maternity and non-maternity)	Individuals	Increased energy exposure; reduced fitness	Removal of bridges where bat colonies have demonstrated repeated could reduce fitness through additional energy expenditure while searching for a new roost site.
Other	Drilling	Subsurface drilling utility line and road installation	Winter (direct effect) and active season (indirect effect)	Near hibernacula	Individuals	Arousal from hibernation; reduced fitness, mortality; take in the form of harm.	Response depends on proximity of harvest to hibernacula entrances, airflow patterns, and local hydrology. Sufficient modification may cause injury or mortality (take in the form of harm).
Other	Blasting	Use of explosives to remove rocks for utility line and road installation	Winter (direct effect) and active season (indirect effect)	Near hibernacula	Individuals	Arousal from hibernation; reduced fitness, mortality; take in the form of harm.	Response depends on proximity of harvest to hibernacula entrances, airflow patterns, and local hydrology. Sufficient modification may cause injury or mortality (take in the form of harm).
Other	Storage Pits for oil and gas waste	Bats can become trapped in waste pits or drink contaminated water	Active season, direct effect	All occupied areas except hibernacula	Individuals	Injury, mortality; harm	Bats may drink contaminated water or become trapped in waste pits and die.

Table 4.2. Mean annual harvest (acres) for each state included in the analysis (Source: U.S. Forest Service's Forest Inventory EVALIDator web-application Version 1.6.0.03; Available only on internet: http://apps.fs.fed.us/Evalidator/evalidator.jsp).

Region	State	Acres of Forested Land	Years	N (years)	Harvest (acres) National Forest	Other Federal	State & Local	Private	Total	Average (acre/year)	Percent of Annual Average Acres Harvested
Midwest	Iowa	3,013,759	2009-2014	6	0	0	6,290	118,105	124,395	20,733	0.7%
Midwest	Illinois	4,847,480	2009-2014	6	0	7,392	0	220,038	227,430	37,905	0.8%
Midwest	Indiana	4,830,395	2009-2014	6	2,924	3,500	12,114	292,650	311,189	51,865	1.1%
Midwest	Michigan	20,127,048	2009-2014	6	79,571	0	340,950	1,189,042	1,609,563	268,261	1.3%
Midwest	Minnesota	17,370,394	2010-2014	5	43,708	2,977	391,433	360,229	798,346	159,669	0.9%
Midwest	Missouri	15,471,982	2009-2014	6	66,135	0	45,879	933,470	1,045,484	174,247	1.1%
Midwest	Ohio	8,088,277	2009-2014	6	1,945	0	15,572	467,607	485,124	80,854	1.0%
Midwest	Wisconsin	16,980,084	2009-2014	6	75,449	4,738	390,366	1,144,172	1,614,726	269,121	1.6%
Eastern	Connecticut	1,711,749	2009-2014	6	0	0	14,622	44,924	59,546	9,924	0.6%
Eastern	Delaware	339,520	2009-2014	6	0	0	2,540	13,625	16,164	2,694	0.8%
Eastern	Maine	17,660,246	2010-2014	5	0	0	86,952	2,285,161	2,372,113	474,423	2.7%
Eastern	Maryland	2,460,652	2009-2014	6	0	0	11,192	76,740	87,931	14,655	0.6%
Eastern	Massachusetts	3,024,092	2009-2014	6	0	0	16,196	66,640	82,837	13,806	0.5%
Eastern	New Hampshire	4,832,408	2009-2014	6	14,502	7,118	35,153	355,549	412,332	68,722	1.4%
Eastern	New Jersey	1,963,561	2009-2014	6	0	0	0	21,442	21,442	3,574	0.2%
Eastern	New York	18,966,416	2009-2014	6	0	0	62,807	1,002,449	1,065,256	177,543	0.9%
Eastern	Pennsylvania	16,781,960	2009-2014	6	10,966	8,625	128,668	1,026,196	1,174,456	195,743	1.2%
Eastern	Rhode Island	359,519	2009-2014	6	0	0	0	0	0	0	0.0%
Eastern	Vermont	4,591,280	2010-2014	5	4,858	0	5,596	245,487	259,941	51,988	1.1%
Eastern	Virginia	15,907,041	2008-2013	6	2,606	9,518	20,195	1,125,092	1,157,410	192,902	1.2%
Eastern	West Virginia	12,154,471	2009-2014	6	0	0	0	463,133	463,133	77,189	0.6%
Southern	Arkansas	18,754,916	2009-2014	6	193,868	11,975	43,919	2,411,963	2,661,725	443,621	2.4%
Southern	Kentucky	12,471,762	2006-2013	8	17,706	8,644	4,873	847,274	878,496	109,812	0.9%
Southern	Mississippi	19,541,284	2006-2014	9	68,994	21,053	60,562	3,273,286	3,423,895	380,433	1.9%
Southern	North Carolina	18,587,540	2003-2014	12	0	29,351	60,638	2,276,778	2,366,767	197,231	1.1%
Southern	Tennessee	13,941,333	2005-2013	9	0	12,837	3,028	1,151,325	1,167,190	129,688	0.9%
Western	Kansas	2,502,434	2009-2014	6	0	6,205	0	57,781	63,985	10,664	0.4%
Western	Nebraska	1,576,174	2009-2014	6	0	0	1,221	91,823	93,044	15,507	1.0%
Western	North Dakota	759,998	2009-2014	6	0	0	0	0	0	0	0.0%
Western	South Dakota	1,910,934	2009-2014	6	163,971	0	1,489	52,375	217,834	36,306	1.9%
	Total	281,528,709			747,203	133,933	1,762,255	21,614,356	24,261,754	3,669,077	1.3%

Table 4.3. Estimated numbers of NLEB affected (disturbed) annually by human activity from active-season harvest in maternity roosting areas.

Region	State	A. Harvest, Bat Active Season (acres)[1]	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Bats Affected (FxE)
Midwest	Iowa	12,149	3,013,759	0.403%	6.3%	765	0.808	619
Midwest	Illinois	22,212	4,847,480	0.458%	9.4%	2,097	0.701	1,469
Midwest	Indiana	30,393	4,830,395	0.629%	5.7%	1,722	0.701	1,207
Midwest	Michigan	157,201	20,127,048	0.781%	4.8%	7,479	0.701	5,240
Midwest	Minnesota	93,566	17,370,394	0.539%	8.9%	8,295	0.808	6,706
Midwest	Missouri	102,109	15,471,982	0.660%	4.0%	4,040	0.701	2,831
Midwest	Ohio	47,380	8,088,277	0.586%	6.4%	3,013	0.701	2,111
Midwest	Wisconsin	157,705	16,980,084	0.929%	6.8%	10,694	0.701	7,493
Eastern	Connecticut	5,816	1,711,749	0.340%	1.4%	83	0.359	30
Eastern	Delaware	1,579	339,520	0.465%	0.8%	12	0.359	5
Eastern	Maine	278,012	17,660,246	1.574%	1.4%	3,949	0.701	2,767
Eastern	Maryland	8,588	2,460,652	0.349%	0.8%	65	0.359	24
Eastern	Massachusetts	8,090	3,024,092	0.268%	1.0%	83	0.359	30
Eastern	New Hampshire	40,271	4,832,408	0.833%	1.5%	597	0.359	215
Eastern	New Jersey	2,094	1,963,561	0.107%	4.8%	101	0.359	37
Eastern	New York	104,040	18,966,416	0.549%	5.0%	5,233	0.359	1,880
Eastern	Pennsylvania	114,705	16,781,960	0.684%	5.1%	5,856	0.359	2,104
Eastern	Rhode Island	0	359,519	0.000%	1.4%	0	0.359	0
Eastern	Vermont	30,465	4,591,280	0.664%	1.5%	451	0.359	163
Eastern	Virginia	113,040	15,907,041	0.711%	7.3%	8,246	0.359	2,963
Eastern	West Virginia	45,233	12,154,471	0.372%	8.1%	3,662	0.359	1,316
Southern	Arkansas	259,962	18,754,916	1.386%	9.9%	25,636	0.701	17,961
Southern	Kentucky	64,350	12,471,762	0.516%	6.1%	3,956	0.701	2,772
Southern	Mississippi	222,934	19,541,284	1.141%	5.2%	11,515	0.808	9,309
Southern	North Carolina	115,577	18,587,540	0.622%	6.0%	6,982	0.701	4,892
Southern	Tennessee	75,997	13,941,333	0.545%	6.2%	4,717	0.359	1,695
Western	Kansas	6,249	2,502,434	0.250%	3.4%	213	0.808	172
Western	Nebraska	9,087	1,576,174	0.577%	3.4%	309	0.808	250
Western	North Dakota	0	759,998	0.000%	3.4%	0	0.808	0
Western	South Dakota	21,275	1,910,934	1.113%	3.4%	723	0.808	585
	Total	2,150,079	281,528,709	0.764%		120,495		76,846

[1] We prorated the total annual harvest for activities occuring during the active season by using the annual percent of the active season (58.6%).

[2] From Table 2.5

Table 4.4. Estimated numbers of NLEB pups affected (harmed) annually by non-volant season harvest in maternity roosting areas.

Region	State	A. Havest, Non-Volant Season[1] (acres)	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Maternity Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Pups Affected (FxE)
Midwest	Iowa	3,462	3,013,759	0.115%	6.3%	218	0.269	9
Midwest	Illinois	6,330	4,847,480	0.131%	9.4%	598	0.234	21
Midwest	Indiana	8,661	4,830,395	0.179%	5.7%	491	0.234	18
Midwest	Michigan	44,800	20,127,048	0.223%	4.8%	2,131	0.234	75
Midwest	Minnesota	26,665	17,370,394	0.154%	8.9%	2,364	0.269	96
Midwest	Missouri	29,099	15,471,982	0.188%	4.0%	1,151	0.234	41
Midwest	Ohio	13,503	8,088,277	0.167%	6.4%	859	0.234	31
Midwest	Wisconsin	44,943	16,980,084	0.265%	6.8%	3,048	0.234	107
Eastern	Connecticut	1,657	1,711,749	0.097%	1.4%	24	0.120	1
Eastern	Delaware	450	339,520	0.133%	0.8%	4	0.120	1
Eastern	Maine	79,229	17,660,246	0.449%	1.4%	1,125	0.234	40
Eastern	Maryland	2,447	2,460,652	0.099%	0.8%	19	0.120	1
Eastern	Massachusetts	2,306	3,024,092	0.076%	1.0%	24	0.120	1
Eastern	New Hampshire	11,477	4,832,408	0.237%	1.5%	170	0.120	4
Eastern	New Jersey	597	1,963,561	0.030%	4.8%	29	0.120	1
Eastern	New York	29,650	18,966,416	0.156%	5.0%	1,491	0.120	27
Eastern	Pennsylvania	32,689	16,781,960	0.195%	5.1%	1,669	0.120	30
Eastern	Rhode Island	0	359,519	0.000%	1.4%	0	0.120	0
Eastern	Vermont	8,682	4,591,280	0.189%	1.5%	129	0.120	3
Eastern	Virginia	32,215	15,907,041	0.203%	7.3%	2,350	0.120	43
Eastern	West Virginia	12,891	12,154,471	0.106%	8.1%	1,044	0.120	19
Southern	Arkansas	74,085	18,754,916	0.395%	9.9%	7,306	0.234	256
Southern	Kentucky	18,339	12,471,762	0.147%	6.1%	1,127	0.234	40
Southern	Mississippi	63,532	19,541,284	0.325%	5.2%	3,282	0.269	133
Southern	North Carolina	32,938	18,587,540	0.177%	6.0%	1,990	0.234	70
Southern	Tennessee	21,658	13,941,333	0.155%	6.2%	1,344	0.120	25
Western	Kansas	1,781	2,502,434	0.071%	3.4%	61	0.269	3
Western	Nebraska	2,590	1,576,174	0.164%	3.4%	88	0.269	4
Western	North Dakota	0	759,998	0.000%	3.4%	0	0.269	0
Western	South Dakota	6,063	1,910,934	0.317%	3.4%	206	0.269	9
	Total	612,736	281,528,709	0.218%		34,339		1,109

[1] We prorated the total annual harvest for activities occuring during the non-volant season by using the annual percent of the non-volant season (16.7%).

[2] From Table 2.5

Table 4.5. Estimated numbers of NLEB adults affected (harmed) annually by active season harvest in maternity roosting areas.

Region	State	A. Havest, Active Season[1] (acres)	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Maternity Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Adults Affected (FxE)
Midwest	Iowa	12,149	3,013,759	0.403%	6.3%	765	0.081	2
Midwest	Illinois	22,212	4,847,480	0.458%	9.4%	2,097	0.071	5
Midwest	Indiana	30,393	4,830,395	0.629%	5.7%	1,722	0.071	4
Midwest	Michigan	157,201	20,127,048	0.781%	4.8%	7,479	0.071	16
Midwest	Minnesota	93,566	17,370,394	0.539%	8.9%	8,295	0.081	21
Midwest	Missouri	102,109	15,471,982	0.660%	4.0%	4,040	0.071	9
Midwest	Ohio	47,380	8,088,277	0.586%	6.4%	3,013	0.071	7
Midwest	Wisconsin	157,705	16,980,084	0.929%	6.8%	10,694	0.071	23
Eastern	Connecticut	5,816	1,711,749	0.340%	1.4%	83	0.036	1
Eastern	Delaware	1,579	339,520	0.465%	0.8%	12	0.036	1
Eastern	Maine	278,012	17,660,246	1.574%	1.4%	3,949	0.071	9
Eastern	Maryland	8,588	2,460,652	0.349%	0.8%	65	0.036	1
Eastern	Massachusetts	8,090	3,024,092	0.268%	1.0%	83	0.036	1
Eastern	New Hampshire	40,271	4,832,408	0.833%	1.5%	597	0.036	1
Eastern	New Jersey	2,094	1,963,561	0.107%	4.8%	101	0.036	1
Eastern	New York	104,040	18,966,416	0.549%	5.0%	5,233	0.036	6
Eastern	Pennsylvania	114,705	16,781,960	0.684%	5.1%	5,856	0.036	7
Eastern	Rhode Island	0	359,519	0.000%	1.4%	0	0.036	0
Eastern	Vermont	30,465	4,591,280	0.664%	1.5%	451	0.036	1
Eastern	Virginia	113,040	15,907,041	0.711%	7.3%	8,246	0.036	9
Eastern	West Virginia	45,233	12,154,471	0.372%	8.1%	3,662	0.036	4
Southern	Arkansas	259,962	18,754,916	1.386%	9.9%	25,636	0.071	55
Southern	Kentucky	64,350	12,471,762	0.516%	6.1%	3,956	0.071	9
Southern	Mississippi	222,934	19,541,284	1.141%	5.2%	11,515	0.081	29
Southern	North Carolina	115,577	18,587,540	0.622%	6.0%	6,982	0.071	15
Southern	Tennessee	75,997	13,941,333	0.545%	6.2%	4,717	0.036	6
Western	Kansas	6,249	2,502,434	0.250%	3.4%	213	0.081	1
Western	Nebraska	9,087	1,576,174	0.577%	3.4%	309	0.081	1
Western	North Dakota	0	759,998	0.000%	3.4%	0	0.081	0
Western	South Dakota	21,275	1,910,934	1.113%	3.4%	723	0.081	2
	Total	2,150,079	281,528,709	0.764%		120,495		247

[1] We prorated the total annual harvest for activities occuring during the active season by using the annual percent of the active season (58.6%).

[2] From Table 2.5

Table 4.6. Prescribed fire (acres) within forested lands from 2002-2014 for each state included in the analysis (Source: National Interagency Fire Center, modified using the percent of prescribed fire within forested lands in each state from the 2012 National Prescribed Fire Use Survey Report).

Region	State	Acres of Forested Land	Average Annual Acres of Forest Land Burned	Minimum Annual Acres of Forest Land Burned	Maximum Annual Acres of Forest Land Burned	Percent of Average Available Habitat Burned
Midwest	Iowa	3,013,759	10,365	251	26,741	0.3%
Midwest	Illinois	4,847,480	8,102	626	21,890	0.2%
Midwest	Indiana	4,830,395	6,385	1,962	12,600	0.1%
Midwest	Michigan	20,127,048	9,325	1,669	16,652	0.0%
Midwest	Minnesota	17,370,394	102,512	48,837	158,160	0.6%
Midwest	Missouri	15,471,982	35,419	-	95,268	0.2%
Midwest	Ohio	8,088,277	2,781	259	6,767	0.0%
Midwest	Wisconsin	16,980,084	15,831	2,836	25,495	0.1%
Eastern	Connecticut	1,711,749	53	-	113	0.0%
Eastern	Delaware	339,520	50	-	161	0.0%
Eastern	Maine	17,660,246	3	2	5	0.0%
Eastern	Maryland	2,460,652	2,631	524	11,823	0.1%
Eastern	Massachusetts	3,024,092	272	2	815	0.0%
Eastern	New Hampshire	4,832,408	103	35	209	0.0%
Eastern	New Jersey	1,963,561	7,115	-	14,549	0.4%
Eastern	New York	18,966,416	189	39	918	0.0%
Eastern	Pennsylvania	16,781,960	1,795	-	7,013	0.0%
Eastern	Rhode Island	359,519	19	-	97	0.0%
Eastern	Vermont	4,591,280	323	46	902	0.0%
Eastern	Virginia	15,907,041	13,570	5,768	20,546	0.1%
Eastern	West Virginia	12,154,471	718	87	2,950	0.0%
Southern	Arkansas	18,754,916	153,639	100,108	200,998	0.8%
Southern	Kentucky	12,471,762	8,207	3,495	12,097	0.1%
Southern	Mississippi	19,541,284	126,297	1,818	253,860	0.6%
Southern	North Carolina	18,587,540	109,273	38,869	170,668	0.6%
Southern	Tennessee	13,941,333	14,959	1,856	23,085	0.1%
Western	Kansas	2,502,434	77	7	134	0.0%
Western	Nebraska	1,576,174	7,432	2,883	17,339	0.5%
Western	North Dakota	759,998	6,291	1,413	8,464	0.8%
Western	South Dakota	1,910,934	5,171	383	9,291	0.3%
		281,528,709	648,908	213,775	1,119,611	0.2%

Table 4.7. Estimated numbers of NLEB affected (disturbed) annually by heat and smoke from active-season prescribed burning in maternity roosting areas.

Region	State	A. Active Season Burning (acres)[1]	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Bats Affected (FxE)
Midwest	Iowa	6,074	3,013,759	0.2%	6.3%	383	0.808	310
Midwest	Illinois	4,748	4,847,480	0.1%	9.4%	448	0.701	314
Midwest	Indiana	3,742	4,830,395	0.1%	5.7%	212	0.701	149
Midwest	Michigan	5,464	20,127,048	0.0%	4.8%	260	0.701	183
Midwest	Minnesota	60,072	17,370,394	0.3%	8.9%	5,325	0.808	4,306
Midwest	Missouri	20,755	15,471,982	0.1%	4.0%	821	0.701	576
Midwest	Ohio	1,630	8,088,277	0.0%	6.4%	104	0.701	73
Midwest	Wisconsin	9,277	16,980,084	0.1%	6.8%	629	0.701	441
Eastern	Connecticut	31	1,711,749	0.0%	1.4%	0	0.359	1
Eastern	Delaware	29	339,520	0.0%	0.8%	0	0.359	1
Eastern	Maine	2	17,660,246	0.0%	1.4%	0	0.701	1
Eastern	Maryland	1,542	2,460,652	0.1%	0.8%	12	0.359	5
Eastern	Massachusetts	159	3,024,092	0.0%	1.0%	2	0.359	1
Eastern	New Hampshire	60	4,832,408	0.0%	1.5%	1	0.359	1
Eastern	New Jersey	4,170	1,963,561	0.2%	4.8%	202	0.359	73
Eastern	New York	111	18,966,416	0.0%	5.0%	6	0.359	2
Eastern	Pennsylvania	1,052	16,781,960	0.0%	5.1%	54	0.359	20
Eastern	Rhode Island	11	359,519	0.0%	1.4%	0	0.359	1
Eastern	Vermont	189	4,591,280	0.0%	1.5%	3	0.359	2
Eastern	Virginia	7,952	15,907,041	0.0%	7.3%	580	0.359	209
Eastern	West Virginia	421	12,154,471	0.0%	8.1%	34	0.359	13
Southern	Arkansas	90,032	18,754,916	0.5%	9.9%	8,879	0.701	6,221
Southern	Kentucky	4,809	12,471,762	0.0%	6.1%	296	0.701	208
Southern	Mississippi	74,010	19,541,284	0.4%	5.2%	3,823	0.808	3,091
Southern	North Carolina	64,034	18,587,540	0.3%	6.0%	3,868	0.701	2,711
Southern	Tennessee	8,766	13,941,333	0.1%	6.2%	544	0.359	196
Western	Kansas	45	2,502,434	0.0%	3.4%	2	0.808	2
Western	Nebraska	4,355	1,576,174	0.3%	3.4%	148	0.808	120
Western	North Dakota	3,687	759,998	0.5%	3.4%	126	0.808	102
Western	South Dakota	3,030	1,910,934	0.2%	3.4%	103	0.808	84
	Total	380,260	281,528,709	0.1%		26,863		19,417

[1] We prorated the total annual burning for activities occuring during the active season by using the annual percent of the active season (58.6%).

[2] From Table 2.5

Table 4.8. Estimated numbers of NLEB pups affected (harmed) annually by heat and smoke from non-volant season prescribed burning in maternity roosting areas.

Region	State	A. Non-Volant Season[1] Burning (acres)	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Pups Affected (FxE)
Midwest	Iowa	1,731	3,013,759	0.1%	6.3%	109	0.269	30
Midwest	Illinois	1,353	4,847,480	0.0%	9.4%	128	0.234	30
Midwest	Indiana	1,066	4,830,395	0.0%	5.7%	60	0.234	15
Midwest	Michigan	1,557	20,127,048	0.0%	4.8%	74	0.234	18
Midwest	Minnesota	17,119	17,370,394	0.1%	8.9%	1,518	0.269	409
Midwest	Missouri	5,915	15,471,982	0.0%	4.0%	234	0.234	55
Midwest	Ohio	464	8,088,277	0.0%	6.4%	30	0.234	7
Midwest	Wisconsin	2,644	16,980,084	0.0%	6.8%	179	0.234	42
Eastern	Connecticut	9	1,711,749	0.0%	1.4%	0	0.120	1
Eastern	Delaware	8	339,520	0.0%	0.8%	0	0.120	1
Eastern	Maine	1	17,660,246	0.0%	1.4%	0	0.234	1
Eastern	Maryland	439	2,460,652	0.0%	0.8%	3	0.120	1
Eastern	Massachusetts	45	3,024,092	0.0%	1.0%	0	0.120	1
Eastern	New Hampshire	17	4,832,408	0.0%	1.5%	0	0.120	1
Eastern	New Jersey	1,188	1,963,561	0.1%	4.8%	58	0.120	7
Eastern	New York	32	18,966,416	0.0%	5.0%	2	0.120	1
Eastern	Pennsylvania	300	16,781,960	0.0%	5.1%	15	0.120	2
Eastern	Rhode Island	3	359,519	0.0%	1.4%	0	0.120	1
Eastern	Vermont	54	4,591,280	0.0%	1.5%	1	0.120	1
Eastern	Virginia	2,266	15,907,041	0.0%	7.3%	165	0.120	20
Eastern	West Virginia	120	12,154,471	0.0%	8.1%	10	0.120	2
Southern	Arkansas	25,658	18,754,916	0.1%	9.9%	2,530	0.234	591
Southern	Kentucky	1,371	12,471,762	0.0%	6.1%	84	0.234	20
Southern	Mississippi	21,092	19,541,284	0.1%	5.2%	1,089	0.269	294
Southern	North Carolina	18,249	18,587,540	0.1%	6.0%	1,102	0.234	258
Southern	Tennessee	2,498	13,941,333	0.0%	6.2%	155	0.120	19
Western	Kansas	13	2,502,434	0.0%	3.4%	0	0.269	1
Western	Nebraska	1,241	1,576,174	0.1%	3.4%	42	0.269	12
Western	North Dakota	1,051	759,998	0.1%	3.4%	36	0.269	10
Western	South Dakota	864	1,910,934	0.0%	3.4%	29	0.269	8
	Total	108,368	281,528,709	0.038%		7,656		1,859

[1] We prorated the total annual burning for activities occuring during the non-volant season by using the annual percent of the non-volant season (16.7%).

[2] From Table 2.5

Table 4.9. Mean annual acres of forest conversion harvest for each state included in the analysis.

REGION	STATE	Acres of Forested Land	Approximate Acres of Forest Lost per Year (NLCD change 2001 to 2011)	Percent of Habitat Lost Annually	Approximate Acres of Forest Lost by 2022	Percent of Habitat Lost by 2022
Midwest	Iowa	3,013,759	2,520	0.1%	17,641	0.6%
Midwest	Illinois	4,847,480	6,156	0.1%	43,092	0.9%
Midwest	Indiana	4,830,395	4,002	0.1%	28,011	0.6%
Midwest	Michigan	20,127,048	44,704	0.2%	312,930	1.6%
Midwest	Minnesota	17,370,394	52,135	0.3%	364,942	2.1%
Midwest	Missouri	15,471,982	16,968	0.1%	118,775	0.8%
Midwest	Ohio	8,088,277	13,522	0.2%	94,655	1.2%
Midwest	Wisconsin	16,980,084	30,191	0.2%	211,334	1.2%
Eastern	Connecticut	1,711,749	2,940	0.2%	20,577	1.2%
Eastern	Delaware	339,520	1,492	0.4%	10,444	3.1%
Eastern	Maine	17,660,246	52,154	0.3%	365,076	2.1%
Eastern	Maryland	2,460,652	6,286	0.3%	43,999	1.8%
Eastern	Massachusetts	3,024,092	7,075	0.2%	49,526	1.6%
Eastern	New Hampshire	4,832,408	12,002	0.2%	84,016	1.7%
Eastern	New Jersey	1,963,561	6,045	0.3%	42,318	2.2%
Eastern	New York	18,966,416	14,117	0.1%	98,822	0.5%
Eastern	Pennsylvania	16,781,960	22,638	0.1%	158,468	0.9%
Eastern	Rhode Island	359,519	715	0.2%	5,003	1.4%
Eastern	Vermont	4,591,280	3,858	0.1%	27,008	0.6%
Eastern	Virginia	15,907,041	95,261	0.6%	666,824	4.2%
Eastern	West Virginia	12,154,471	12,700	0.1%	88,899	0.7%
Southern	Arkansas	18,754,916	115,372	0.6%	807,604	4.3%
Southern	Kentucky	12,471,762	23,167	0.2%	162,169	1.3%
Southern	Mississippi	19,541,284	162,759	0.8%	1,139,312	5.8%
Southern	North Carolina	18,587,540	130,835	0.7%	915,845	4.9%
Southern	Tennessee	13,941,333	54,006	0.4%	378,039	2.7%
Western	Kansas	2,502,434	4,224	0.2%	29,567	1.2%
Western	Nebraska	1,576,174	4,036	0.3%	28,252	1.8%
Western	North Dakota	759,998	1,826	0.2%	12,785	1.7%
Western	South Dakota	1,910,934	10,532	0.6%	73,725	3.9%
	TOTALS	281,528,709	914,237	0.3%	6,399,657	2.3%

Table 4.10. Estimated numbers of NLEB affected (disturbed) annually by human activity from active-season forest conversion in maternity roosting areas.

Region	State	A. Forest Conversion, Bat Active Season (acres)[1]	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Bats Affected (FxE)
Midwest	Iowa	1,477	3,013,759	0.049%	6.3%	93	0.808	76
Midwest	Illinois	3,607	4,847,480	0.074%	9.4%	341	0.701	239
Midwest	Indiana	2,345	4,830,395	0.049%	5.7%	133	0.701	94
Midwest	Michigan	26,197	20,127,048	0.130%	4.8%	1,246	0.701	874
Midwest	Minnesota	30,551	17,370,394	0.176%	8.9%	2,708	0.808	2,190
Midwest	Missouri	9,943	15,471,982	0.064%	4.0%	393	0.701	276
Midwest	Ohio	7,924	8,088,277	0.098%	6.4%	504	0.701	354
Midwest	Wisconsin	17,692	16,980,084	0.104%	6.8%	1,200	0.701	841
Eastern	Connecticut	1,723	1,711,749	0.101%	1.4%	25	0.359	9
Eastern	Delaware	874	339,520	0.258%	0.8%	7	0.359	3
Eastern	Maine	30,562	17,660,246	0.173%	1.4%	434	0.701	305
Eastern	Maryland	3,683	2,460,652	0.150%	0.8%	28	0.359	11
Eastern	Massachusetts	4,146	3,024,092	0.137%	1.0%	43	0.359	16
Eastern	New Hampshire	7,033	4,832,408	0.146%	1.5%	104	0.359	38
Eastern	New Jersey	3,543	1,963,561	0.180%	4.8%	171	0.359	62
Eastern	New York	8,273	18,966,416	0.044%	5.0%	416	0.359	150
Eastern	Pennsylvania	13,266	16,781,960	0.079%	5.1%	677	0.359	244
Eastern	Rhode Island	419	359,519	0.116%	1.4%	6	0.359	3
Eastern	Vermont	2,261	4,591,280	0.049%	1.5%	33	0.359	13
Eastern	Virginia	55,823	15,907,041	0.351%	7.3%	4,072	0.359	1,463
Eastern	West Virginia	7,442	12,154,471	0.061%	8.1%	602	0.359	217
Southern	Arkansas	67,608	18,754,916	0.360%	9.9%	6,667	0.701	4,672
Southern	Kentucky	13,576	12,471,762	0.109%	6.1%	835	0.701	585
Southern	Mississippi	95,377	19,541,284	0.488%	5.2%	4,926	0.808	3,983
Southern	North Carolina	76,669	18,587,540	0.412%	6.0%	4,632	0.701	3,245
Southern	Tennessee	31,647	13,941,333	0.227%	6.2%	1,964	0.359	706
Western	Kansas	2,475	2,502,434	0.099%	3.4%	84	0.808	69
Western	Nebraska	2,365	1,576,174	0.150%	3.4%	80	0.808	66
Western	North Dakota	1,070	759,998	0.141%	3.4%	36	0.808	30
Western	South Dakota	6,172	1,910,934	0.323%	3.4%	210	0.808	170
	Total	535,743	281,528,709	0.190%		32,673		21,004

[1] We prorated the total annual conversion for activities occuring during the active season by using the annual percent of the active season (58.6%).

[2] From Table 2.5

Table 4.11. Estimated numbers of NLEB pups affected (harmed) annually by non-volant-season forest conversion in maternity roosting areas.

Region	State	A. Forest Conversion, Non-Volant Season[1] (acres)	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Maternity Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Pups Affected (FxE)
Midwest	Iowa	421	3,013,759	0.014%	6.3%	27	0.269	2
Midwest	Illinois	1,028	4,847,480	0.021%	9.4%	97	0.234	4
Midwest	Indiana	668	4,830,395	0.014%	5.7%	38	0.234	2
Midwest	Michigan	7,466	20,127,048	0.037%	4.8%	355	0.234	13
Midwest	Minnesota	8,706	17,370,394	0.050%	8.9%	772	0.269	32
Midwest	Missouri	2,834	15,471,982	0.018%	4.0%	112	0.234	4
Midwest	Ohio	2,258	8,088,277	0.028%	6.4%	144	0.234	6
Midwest	Wisconsin	5,042	16,980,084	0.030%	6.8%	342	0.234	12
Eastern	Connecticut	491	1,711,749	0.029%	1.4%	7	0.120	1
Eastern	Delaware	249	339,520	0.073%	0.8%	2	0.120	1
Eastern	Maine	8,710	17,660,246	0.049%	1.4%	124	0.234	5
Eastern	Maryland	1,050	2,460,652	0.043%	0.8%	8	0.120	1
Eastern	Massachusetts	1,182	3,024,092	0.039%	1.0%	12	0.120	1
Eastern	New Hampshire	2,004	4,832,408	0.041%	1.5%	30	0.120	1
Eastern	New Jersey	1,010	1,963,561	0.051%	4.8%	49	0.120	1
Eastern	New York	2,358	18,966,416	0.012%	5.0%	119	0.120	3
Eastern	Pennsylvania	3,781	16,781,960	0.023%	5.1%	193	0.120	4
Eastern	Rhode Island	119	359,519	0.033%	1.4%	2	0.120	1
Eastern	Vermont	644	4,591,280	0.014%	1.5%	10	0.120	1
Eastern	Virginia	15,909	15,907,041	0.100%	7.3%	1,160	0.120	21
Eastern	West Virginia	2,121	12,154,471	0.017%	8.1%	172	0.120	4
Southern	Arkansas	19,267	18,754,916	0.103%	9.9%	1,900	0.234	67
Southern	Kentucky	3,869	12,471,762	0.031%	6.1%	238	0.234	9
Southern	Mississippi	27,181	19,541,284	0.139%	5.2%	1,404	0.269	57
Southern	North Carolina	21,849	18,587,540	0.118%	6.0%	1,320	0.234	47
Southern	Tennessee	9,019	13,941,333	0.065%	6.2%	560	0.120	11
Western	Kansas	705	2,502,434	0.028%	3.4%	24	0.269	1
Western	Nebraska	674	1,576,174	0.043%	3.4%	23	0.269	1
Western	North Dakota	305	759,998	0.040%	3.4%	10	0.269	1
Western	South Dakota	1,759	1,910,934	0.092%	3.4%	60	0.269	3
	Total	152,678	281,528,709	0.054%		9,311		317

[1] We prorated the total annual conversion for activities occuring during the non-volant season by using the annual percent of the non-volant season (16.7%).

[2] From Table 2.5

Table 4.12. Estimated numbers of NLEB adults affected (harmed) annually by active-season forest conversion in maternity roosting areas.

Region	State	A. Forest Conversion, Active Season[1] (acres)	B. Forest Habitat (acres)	C. Percent of Forest Affected (A/B)	D. Percent of Forest Used as Maternity Roost Areas[2]	E. Expected Overlap (acres) (BxCxD)	F. Density	G. Number of Adults Affected (FxE)
Midwest	Iowa	1,477	3,013,759	0.049%	6.3%	93	0.081	1
Midwest	Illinois	3,607	4,847,480	0.074%	9.4%	341	0.071	1
Midwest	Indiana	2,345	4,830,395	0.049%	5.7%	133	0.071	1
Midwest	Michigan	26,197	20,127,048	0.130%	4.8%	1,246	0.071	3
Midwest	Minnesota	30,551	17,370,394	0.176%	8.9%	2,708	0.081	7
Midwest	Missouri	9,943	15,471,982	0.064%	4.0%	393	0.071	1
Midwest	Ohio	7,924	8,088,277	0.098%	6.4%	504	0.071	2
Midwest	Wisconsin	17,692	16,980,084	0.104%	6.8%	1,200	0.071	3
Eastern	Connecticut	1,723	1,711,749	0.101%	1.4%	25	0.036	1
Eastern	Delaware	874	339,520	0.258%	0.8%	7	0.036	1
Eastern	Maine	30,562	17,660,246	0.173%	1.4%	434	0.071	1
Eastern	Maryland	3,683	2,460,652	0.150%	0.8%	28	0.036	1
Eastern	Massachusetts	4,146	3,024,092	0.137%	1.0%	43	0.036	1
Eastern	New Hampshire	7,033	4,832,408	0.146%	1.5%	104	0.036	1
Eastern	New Jersey	3,543	1,963,561	0.180%	4.8%	171	0.036	1
Eastern	New York	8,273	18,966,416	0.044%	5.0%	416	0.036	1
Eastern	Pennsylvania	13,266	16,781,960	0.079%	5.1%	677	0.036	1
Eastern	Rhode Island	419	359,519	0.116%	1.4%	6	0.036	1
Eastern	Vermont	2,261	4,591,280	0.049%	1.5%	33	0.036	1
Eastern	Virginia	55,823	15,907,041	0.351%	7.3%	4,072	0.036	5
Eastern	West Virginia	7,442	12,154,471	0.061%	8.1%	602	0.036	1
Southern	Arkansas	67,608	18,754,916	0.360%	9.9%	6,667	0.071	15
Southern	Kentucky	13,576	12,471,762	0.109%	6.1%	835	0.071	2
Southern	Mississippi	95,377	19,541,284	0.488%	5.2%	4,926	0.081	13
Southern	North Carolina	76,669	18,587,540	0.412%	6.0%	4,632	0.071	10
Southern	Tennessee	31,647	13,941,333	0.227%	6.2%	1,964	0.036	3
Western	Kansas	2,475	2,502,434	0.099%	3.4%	84	0.081	1
Western	Nebraska	2,365	1,576,174	0.150%	3.4%	80	0.081	1
Western	North Dakota	1,070	759,998	0.141%	3.4%	36	0.081	1
Western	South Dakota	6,172	1,910,934	0.323%	3.4%	210	0.081	1
	Total	535,743	281,528,709	0.190%		32,673		83

[1] We prorated the total annual harvest for activities occuring during the active season by using the annual percent of the active season (58.6%).

[2] From Table 2.5

Table 4.13. Estimated NLEB fatalities from wind energy operation created using current and projected wind capacity through 2022.

REGION	STATE	Installed Wind Capacity in 2014 (MW)	Projected Wind Capacity in 2020 (MW)	Projected Wind Capacity in 2030 (MW)	Mean Annual Build-out 2014-2020 (MW)	Mean Annual Build-out 2021-2022 (MW)	Current Fatality through 2014	Annual Fatality 2015	Annual Fatality 2016	Annual Fatality 2017	Annual Fatality 2018	Annual Fatality 2019	Annual Fatality 2020	Annual Fatality 2021	Annual Fatality 2022	Total Fatality All Years
Midwest	Iowa	5688	6200	17300	85	1110	90	91	93	94	95	97	98	115	133	906
Midwest	Illinois	3568	3980	19490	69	1551	56	57	59	60	61	62	63	87	112	616
Midwest	Indiana	1745	2610	13500	144	1089	28	30	32	34	37	39	41	58	76	375
Midwest	Michigan[1]	1531	1531	1850	0	32	24	24	24	24	24	24	24	25	25	219
Midwest	Minnesota	3035	3470	3990	73	52	48	49	50	51	53	54	55	56	56	472
Midwest	Missouri	459	1280	4350	137	307	7	9	12	14	16	18	20	25	30	151
Midwest	Ohio	435	2990	5320	426	233	7	14	20	27	34	41	47	51	55	295
Midwest	Wisconsin	648	1320	1640	112	32	10	12	14	16	17	19	21	21	22	152
Eastern	Connecticut	0	130	130	22	0	0	0	1	1	1	2	2	2	2	11
Eastern	Delaware[2]	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Eastern	Maine	440	950	950	85	0	7	8	10	11	12	14	15	15	15	107
Eastern	Maryland	160	820	820	110	0	3	4	6	8	9	11	13	13	13	80
Eastern	Massachusetts	107	270	270	27	0	2	2	3	3	3	4	4	4	4	29
Eastern	New Hampshire	171	470	470	50	0	3	3	4	5	6	7	7	7	7	50
Eastern	New Jersey[2]	9	9	0	0	0	0	0	0	0	0	0	0	0	0	1
Eastern	New York	1748	1750	3860	0	0	28	28	28	28	28	28	28	28	28	249
Eastern	Pennsylvania[2]	1340	5580	5400	707	0	21	32	43	55	66	77	88	88	88	559
Eastern	Rhode Island[2]	9	9	0	0	0	0	0	0	0	0	0	0	0	0	1
Eastern	Vermont[2]	119	440	430	54	0	2	3	4	4	5	6	7	7	7	45
Eastern	Virginia	0	100	830	17	73	0	0	1	1	1	1	2	3	4	12
Eastern	West Virginia	583	600	2030	3	143	9	9	9	9	9	9	9	12	14	91
Southern	Arkansas	0	0	2550	0	255	0	0	0	0	0	0	0	4	8	12
Southern	Kentucky	0	0	950	0	95	0	0	0	0	0	0	0	2	3	5
Southern	Mississippi	0	0	450	0	45	0	0	0	0	0	0	0	1	1	2
Southern	North Carolina	0	750	750	125	0	0	2	4	6	8	10	12	12	12	65
Southern	Tennessee	29	29	1310	0	128	0	0	0	0	0	0	0	2	5	10
Western	Kansas[2]	2967	3420	3270	76	0	47	48	49	50	52	53	54	54	54	461
Western	Nebraska	812	1260	1360	75	10	13	14	15	16	18	19	20	20	20	155
Western	North Dakota	1886	2870	4710	164	184	30	32	35	38	40	43	45	48	51	362
Western	South Dakota	803	1260	2400	76	114	13	14	15	16	17	19	20	22	24	159
Totals		**28294**	**44100**	**100380**	**2634**	**5453**	**447**	**489**	**530**	**572**	**613**	**655**	**697**	**783**	**869**	**5654**

[1]Projections were held constant for Michigan between 2014 and 2020 because 2020 projections were already exceeded.

[2]Projections are expected to decline slightly between 2020-2030; however, we did not reduce capacity because we assume constructed facilities will continue to operate.

Table 4.14. Influence of conservation measures for tree removal activities included in the final 4(d) rule for the NLEB.

Range	State	Known Hibernacula	Known Occupied Maternity Roost Trees	Acres Covered by Hibernacula Conservation Measure[1]	Acres Covered by Maternity Roost Tree Conservation Measure[2]	Acres of Forested Land	Percent of Total Available Habitat Covered by Measures
Midwest	Iowa	2	14	251	22	3,013,759	0.01%
Midwest	Illinois	44	39	5,531	62	4,847,480	0.12%
Midwest	Indiana	69	193	8,673	309	4,830,395	0.19%
Midwest	Michigan	77	25	9,679	40	20,127,048	0.05%
Midwest	Minnesota	15	102	1,886	163	17,370,394	0.01%
Midwest	Missouri	269	58	33,813	93	15,471,982	0.22%
Midwest	Ohio	32	4	4,022	6	8,088,277	0.05%
Midwest	Wisconsin	67	84	8,422	134	16,980,084	0.05%
Eastern	Connecticut	8	0	1,006	0	1,711,749	0.06%
Eastern	Delaware	2	0	251	0	339,520	0.07%
Eastern	Maine	3	0	377	0	17,660,246	0.00%
Eastern	Maryland	8	0	1,006	0	2,460,652	0.04%
Eastern	Massachusetts	7	16	880	26	3,024,092	0.03%
Eastern	New Hampshire	11	0	1,383	0	4,832,408	0.03%
Eastern	New Jersey	9	47	1,131	75	1,963,561	0.06%
Eastern	New York	90	27	11,313	43	18,966,416	0.06%
Eastern	Pennsylvania	322	157	40,475	251	16,781,960	0.24%
Eastern	Rhode Island	0	0	0	0	359,519	0.00%
Eastern	Vermont	16	0	2,011	0	4,591,280	0.04%
Eastern	Virginia	11	12	1,383	19	15,907,041	0.01%
Eastern	West Virginia	104	231	13,073	370	12,154,471	0.11%
Southern	Alabama	11	0	1,383	0	22,876,792	0.01%
Southern	Arkansas	77	310	9,679	496	18,754,916	0.05%
Southern	Georgia	6	20	754	32	24,768,236	0.00%
Southern	Kentucky	122	254	15,335	406	12,471,762	0.13%
Southern	Louisiana	0	0	0	0	14,540,135	0.00%
Southern	Mississippi	0	0	0	0	19,541,284	0.00%
Southern	North Carolina	29	101	3,645	162	18,587,540	0.02%
Southern	Oklahoma	9	0	1,131	0	12,646,138	0.01%
Southern	South Carolina	3	0	377	0	13,120,509	0.00%
Southern	Tennessee	61	50	7,668	80	13,941,333	0.06%
Western	Kansas	1	0	126	0	2,502,434	0.01%
Western	Montana	0	0	0	0	25,573,200	0.00%
Western	Nebraska	2	0	251	0	759,998	0.03%
Western	North Dakota	0	0	0	0	1,576,174	0.00%
Western	South Dakota	21	0	2,640	0	1,910,934	0.14%
Western	Wyoming	0	0	0	0	11,448,541	0.00%
	Total	1,508	1,744	189,556	2,790	406,502,260	0.05%

[1]Hibernacula buffer circles have a radius of 0.25 mi, which is 125.7 acres

[2]Maternity roost trees have a temporary buffer circle with a 150 ft radius, which is 1.6 acres

Table 4.15. Summary of annual disturbance and harm estimates from timber harvest, prescribed fire, forest conversion, and wind[4].

Region	State	Harass Timber Harvest	Harass Prescribed Fire	Harass Forest Conversion	Harm (pups) Timber Harvest	Harm (pups) Prescribed Fire	Harm (pups) Forest Conversion	Harm (adults) Timber Harvest	Harm (adults) Forest Conversion	Harm (adults) Average Wind	Total Annual Harassment	Total Annual Harm (pups)	Total Annual Harm (adults)
Midwest	Iowa	619	310	76	9	30	2	2	1	102	1,005	41	105
Midwest	Illinois	1,469	314	239	21	30	4	5	1	70	2,022	55	76
Midwest	Indiana	1,207	149	94	18	15	2	4	1	43	1,450	35	48
Midwest	Michigan	5,240	183	874	75	18	13	16	3	24	6,297	106	43
Midwest	Minnesota	6,706	4,306	2,190	96	409	32	21	7	53	13,202	537	81
Midwest	Missouri	2,831	576	276	41	55	4	9	1	18	3,683	100	28
Midwest	Ohio	2,111	73	354	31	7	6	7	2	36	2,538	44	45
Midwest	Wisconsin	7,493	441	841	107	42	12	23	3	18	8,775	161	44
Eastern	Connecticut	30	1	9	1	1	1	1	1	1	40	3	3
Eastern	Delaware	5	1	3	1	1	1	1	1	0	9	3	2
Eastern	Maine	2,767	1	305	40	1	5	9	1	13	3,073	46	23
Eastern	Maryland	24	5	11	1	1	1	1	1	10	40	3	12
Eastern	Massachusetts	30	1	16	1	1	1	1	1	3	47	3	5
Eastern	New Hampshire	215	1	38	4	1	1	1	1	6	254	6	8
Eastern	New Jersey	37	73	62	1	7	1	1	1	0	172	9	2
Eastern	New York	1,880	2	150	27	1	3	6	1	28	2,032	31	35
Eastern	Pennsylvania	2,104	20	244	30	2	4	7	1	67	2,368	36	75
Eastern	Rhode Island	0	1	3	0	1	1	0	1	0	4	2	1
Eastern	Vermont	163	2	13	3	1	1	1	1	5	178	5	7
Eastern	Virginia	2,963	209	1,463	43	20	21	9	5	2	4,635	84	16
Eastern	West Virginia	1,316	13	217	19	2	4	4	1	10	1,546	25	15
Southern	Arkansas	17,961	6,221	4,672	256	591	67	55	15	2	28,854	914	72
Southern	Kentucky	2,772	208	585	40	20	9	9	2	1	3,565	69	12
Southern	Mississippi	9,309	3,091	3,983	133	294	57	29	13	0	16,383	484	42
Southern	North Carolina	4,892	2,711	3,245	70	258	47	15	10	8	10,848	375	33
Southern	Tennessee	1,695	196	706	25	19	11	6	3	1	2,597	55	10
Western	Kansas	172	2	69	3	1	1	1	1	52	243	5	54
Western	Nebraska	250	120	66	4	12	1	1	1	18	436	17	20
Western	North Dakota	0	102	30	0	10	1	0	1	42	132	11	43
Western	South Dakota	585	84	170	9	8	3	2	1	18	839	20	21
	Total	76,846	19,417	21,004	1,109	1,859	317	247	83	650	117,267	3,285	980

[4] Wind is the mean annual estimate from 2015 to 2022 reported in Table 4.13.

Table 4.16. Summary of the activities expected to disturb NLEB annually. The total number of bats per state includes adults and pups.

Region	State	Total # Bats Harassed per year	Percent Harass from Burning	Percent Harass from Harvest	Percent Harass from Conversion	Total # Bats per State	Percent Total Bats Affected
Midwest	Iowa	1,005	30.8%	61.6%	7.6%	153,495	0.7%
Midwest	Illinois	2,022	15.5%	72.7%	11.8%	320,580	0.6%
Midwest	Indiana	1,450	10.3%	83.2%	6.5%	191,763	0.8%
Midwest	Michigan	6,297	2.9%	83.2%	13.9%	670,878	0.9%
Midwest	Minnesota	13,202	32.6%	50.8%	16.6%	1,244,835	1.1%
Midwest	Missouri	3,683	15.6%	76.9%	7.5%	428,922	0.9%
Midwest	Ohio	2,538	2.9%	83.2%	13.9%	360,360	0.7%
Midwest	Wisconsin	8,775	5.0%	85.4%	9.6%	806,715	1.1%
Eastern	Connecticut	40	2.5%	75.0%	22.5%	8,760	0.5%
Eastern	Delaware	9	11.1%	55.6%	33.3%	960	0.9%
Eastern	Maine	3,073	0.0%	90.0%	9.9%	175,734	1.7%
Eastern	Maryland	40	12.5%	60.0%	27.5%	6,720	0.6%
Eastern	Massachusetts	47	2.1%	63.8%	34.0%	11,160	0.4%
Eastern	New Hampshire	254	0.4%	84.6%	15.0%	25,740	1.0%
Eastern	New Jersey	172	42.4%	21.5%	36.0%	34,140	0.5%
Eastern	New York	2,032	0.1%	92.5%	7.4%	342,720	0.6%
Eastern	Pennsylvania	2,368	0.8%	88.9%	10.3%	307,800	0.8%
Eastern	Rhode Island	4	25.0%	0.0%	75.0%	1,860	0.2%
Eastern	Vermont	178	1.1%	91.6%	7.3%	24,420	0.7%
Eastern	Virginia	4,635	4.5%	63.9%	31.6%	416,880	1.1%
Eastern	West Virginia	1,546	0.8%	85.1%	14.0%	353,520	0.4%
Southern	Arkansas	28,854	21.6%	62.2%	16.2%	1,295,775	2.2%
Southern	Kentucky	3,565	5.8%	77.8%	16.4%	537,147	0.7%
Southern	Mississippi	16,383	18.9%	56.8%	24.3%	815,940	2.0%
Southern	North Carolina	10,848	25.0%	45.1%	29.9%	786,708	1.4%
Southern	Tennessee	2,597	7.5%	65.3%	27.2%	310,920	0.8%
Western	Kansas	243	0.8%	70.8%	28.4%	68,850	0.4%
Western	Nebraska	436	27.5%	57.3%	15.1%	43,335	1.0%
Western	North Dakota	132	77.3%	0.0%	22.7%	20,925	0.6%
Western	South Dakota	839	10.0%	69.7%	20.3%	52,515	1.6%
	Total	117,267	16.6%	65.5%	17.9%	9,820,077	1.2%

Table 4.17. Summary of the activities expected to harm NLEB pups annually.

Region	State	Total # Pups Harmed per year	Percent Harm from Burning	Percent Harm from Harvest	Percent Harm from Conversion	Total # Pups per State	Percent Total Pups Affected
Midwest	Iowa	41	73.2%	22.0%	4.9%	51,165	0.1%
Midwest	Illinois	55	54.5%	38.2%	7.3%	106,860	0.1%
Midwest	Indiana	35	42.9%	51.4%	5.7%	63,921	0.1%
Midwest	Michigan	106	17.0%	70.8%	12.3%	223,626	0.0%
Midwest	Minnesota	537	76.2%	17.9%	6.0%	414,945	0.1%
Midwest	Missouri	100	55.0%	41.0%	4.0%	142,974	0.1%
Midwest	Ohio	44	15.9%	70.5%	13.6%	120,120	0.0%
Midwest	Wisconsin	161	26.1%	66.5%	7.5%	268,905	0.1%
Eastern	Connecticut	3	33.3%	33.3%	33.3%	2,920	0.1%
Eastern	Delaware	3	33.3%	33.3%	33.3%	320	0.9%
Eastern	Maine	46	2.2%	87.0%	10.9%	58,578	0.1%
Eastern	Maryland	3	33.3%	33.3%	33.3%	2,240	0.1%
Eastern	Massachusetts	3	33.3%	33.3%	33.3%	3,720	0.1%
Eastern	New Hampshire	6	16.7%	66.7%	16.7%	8,580	0.1%
Eastern	New Jersey	9	77.8%	11.1%	11.1%	11,380	0.1%
Eastern	New York	31	3.2%	87.1%	9.7%	114,240	0.0%
Eastern	Pennsylvania	36	5.6%	83.3%	11.1%	102,600	0.0%
Eastern	Rhode Island	2	50.0%	0.0%	50.0%	620	0.3%
Eastern	Vermont	5	20.0%	60.0%	20.0%	8,140	0.1%
Eastern	Virginia	84	23.8%	51.2%	25.0%	138,960	0.1%
Eastern	West Virginia	25	8.0%	76.0%	16.0%	117,840	0.0%
Southern	Arkansas	914	64.7%	28.0%	7.3%	431,925	0.2%
Southern	Kentucky	69	29.0%	58.0%	13.0%	179,049	0.0%
Southern	Mississippi	484	60.7%	27.5%	11.8%	271,980	0.2%
Southern	North Carolina	375	68.8%	18.7%	12.5%	262,236	0.1%
Southern	Tennessee	55	34.5%	45.5%	20.0%	103,640	0.1%
Western	Kansas	5	20.0%	60.0%	20.0%	22,950	0.0%
Western	Nebraska	17	70.6%	23.5%	5.9%	14,445	0.1%
Western	North Dakota	11	90.9%	0.0%	9.1%	6,975	0.2%
Western	South Dakota	20	40.0%	45.0%	15.0%	17,505	0.1%
	Total	3,285	56.6%	33.8%	9.6%	3,273,359	0.1%

Table 4.18. Summary of the activities expected to harm NLEB adults annually.

Region	State	Total # Adults Harmed per year	Percent Harm from Harvest	Percent Harm from Conversion	Percent Harm from Wind	Total # Adults per State	Percent Total Adults Affected
Midwest	Iowa	105	1.9%	1.0%	97.1%	102,330	0.10%
Midwest	Illinois	76	6.6%	1.3%	92.1%	213,720	0.04%
Midwest	Indiana	48	8.3%	2.1%	89.7%	127,842	0.04%
Midwest	Michigan	43	37.0%	6.9%	56.1%	447,252	0.01%
Midwest	Minnesota	81	25.9%	8.6%	65.4%	829,890	0.01%
Midwest	Missouri	28	32.1%	3.6%	64.3%	285,948	0.01%
Midwest	Ohio	45	15.5%	4.4%	80.1%	240,240	0.02%
Midwest	Wisconsin	44	52.6%	6.9%	40.6%	537,810	0.01%
Eastern	Connecticut	3	29.6%	29.6%	40.7%	5,840	0.06%
Eastern	Delaware	2	50.0%	50.0%	0.0%	640	0.31%
Eastern	Maine	23	40.0%	4.4%	55.6%	117,156	0.02%
Eastern	Maryland	12	8.6%	8.6%	82.8%	4,480	0.26%
Eastern	Massachusetts	5	18.6%	18.6%	62.8%	7,440	0.07%
Eastern	New Hampshire	8	12.9%	12.9%	74.2%	17,160	0.05%
Eastern	New Jersey	2	50.0%	50.0%	0.0%	22,760	0.01%
Eastern	New York	35	17.1%	2.9%	80.0%	228,480	0.02%
Eastern	Pennsylvania	75	9.3%	1.3%	89.4%	205,200	0.04%
Eastern	Rhode Island	1	0.0%	100.0%	0.0%	1,240	0.08%
Eastern	Vermont	7	13.6%	13.6%	72.9%	16,280	0.05%
Eastern	Virginia	16	57.6%	32.0%	10.4%	277,920	0.01%
Eastern	West Virginia	15	26.7%	6.7%	66.7%	235,680	0.01%
Southern	Arkansas	72	76.9%	21.0%	2.1%	863,850	0.01%
Southern	Kentucky	12	77.4%	17.2%	5.4%	358,098	0.00%
Southern	Mississippi	42	68.6%	30.8%	0.6%	543,960	0.01%
Southern	North Carolina	33	45.1%	30.1%	24.8%	524,472	0.01%
Southern	Tennessee	10	60.8%	30.4%	8.9%	207,280	0.00%
Western	Kansas	54	1.9%	1.9%	96.3%	45,900	0.12%
Western	Nebraska	20	5.1%	5.1%	89.9%	28,890	0.07%
Western	North Dakota	43	0.0%	2.4%	97.6%	13,950	0.30%
Western	South Dakota	21	9.4%	4.7%	86.0%	35,010	0.06%
	Total	980	25.2%	8.5%	66.3%	6,546,718	0.01%

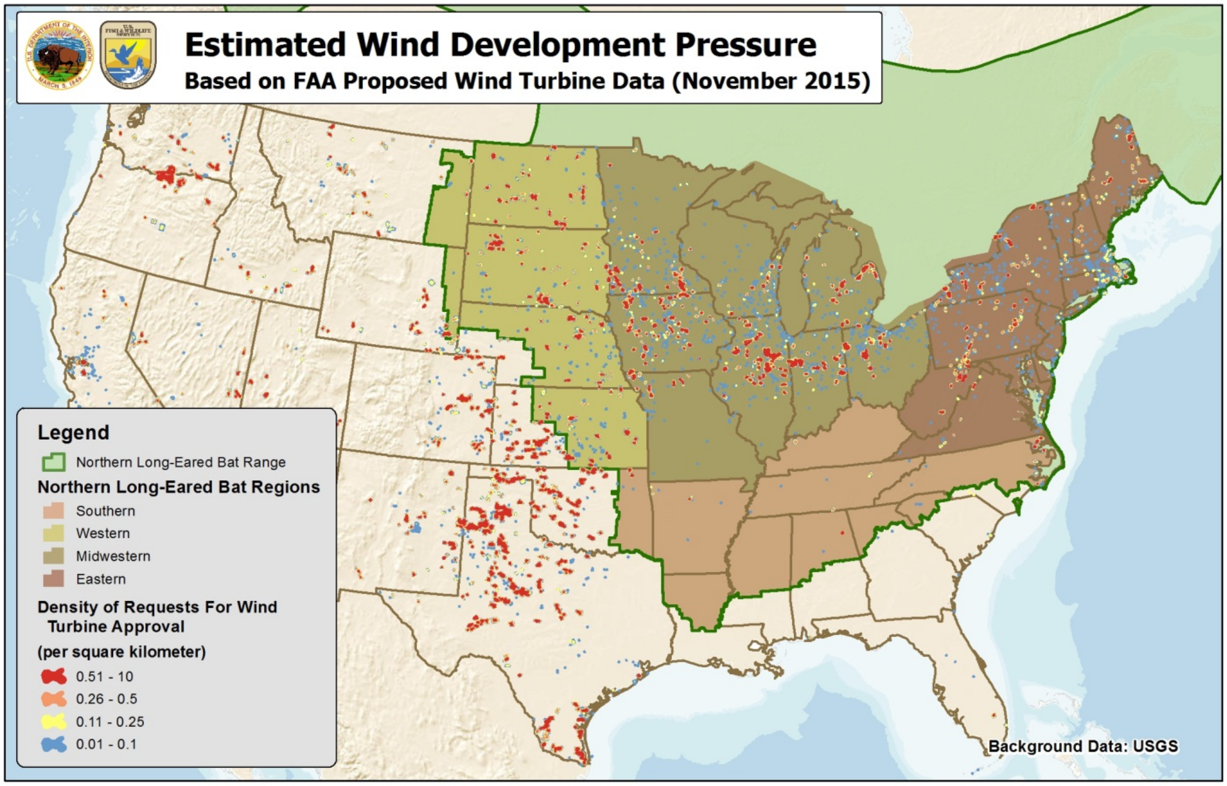

Figure 4.1. Estimated wind development pressure based on the Federal Aviation Administration's proposed wind turbine data.

5 CUMULATIVE EFFECTS

In the context of a consultation, cumulative effects are the effects of future state, tribal, local, or private actions that are reasonably certain to occur in the Action Area. Future federal actions that are unrelated to the proposed action are not considered, because they require separate consultation under section 7 of the ESA.

Section 4 of this BO discusses all actions that may affect the NLEB associated with the implementation of the final 4(d) rule. These include effects of state, tribal, local and private actions. These actions are typically included in this section; however, the action evaluated in this BO is the finalization and implementation of the final 4(d) rule, which includes state, tribal, local, and private actions. We acknowledge that some of the activities included in the effects of the action are cumulative effects, but we do not separate them in this BO.

6 CONCLUSION

WNS is the primary factor affecting the status of the NLEB, which has caused dramatic and rapid declines in abundance, resulting in the local extirpation of the species in some areas. Although other factors, individually or in combination, are likely insignificant at the range-wide scale, they may exacerbate the effects of WNS at the local population scale, thereby accelerating declines and the likelihood of local extirpation due to the disease or reducing the population's ability to survive and potentially rebound. Our analysis of the effects of activities that may affect the NLEB, but do not cause prohibited take, indicates that the additional loss of individual NLEB resulting from these activities would not exacerbate the effects of WNS at the scale of states within its range. Even if all anthropogenic activities that might adversely affect NLEB ceased, we do not believe that the resulting reduction in adverse effects would materially change the devastating impact WNS has had, and will continue to have, on NLEB at the local population level or at larger scales.

The species' foremost conservation need is to reduce or eliminate the threat of WNS. In areas impacted by WNS, the next priorities are to protect NLEB in hibernacula and maternity roost trees, and to continue to monitor populations in summer habitats (e.g., identify where the species continues to survive after the detection of Pd or WNS and determine the factors influencing its resilience).

From our assessment of the species' status/environmental baseline, we have observed NLEB population declines within a few years following the arrival of WNS, and can expect further declines as the disease moves through the Action Area. Based on post-WNS occupancy rates inferred from summer survey data and assumptions about colony size and distribution in forested habitats, we estimate that the population of NLEB is currently about 6,546,700 adult NLEB.

Activities that may affect the NLEB, but will not cause prohibited take under the final 4(d) rule, primarily include timber harvest, prescribed fire, forest conversion, and wind turbine operation. We estimate that these activities will disturb up to 117,267 volant NLEB (both adults and juveniles) each year, all within roosting areas (both maternity and non-maternity), and mostly (65.5 percent) resulting from timber harvest. The Action is expected to harm up to 3,285 non-volant juvenile NLEB annually, all within maternity roosting areas, and mostly resulting from prescribed burning and tree clearing activities conducted during the active season. The Action is also expected to harm up to 980 adults annually, mostly from wind turbine operation and removal of undocumented occupied roosts.

The disturbance estimate amounts to 1.2 percent of the total NLEB population, including young-of-the-year (1 per adult female following parturition), and less than 2.3% of the total number of NLEBs in each individual state. We do not expect disturbance of less than 2.3% of a state's population to significantly affect the numbers or reproduction of the species in the states, as only a small fraction of those fleeing roosts due to disturbance are likely to suffer injury from day-time predators or other hazards encountered before roosting elsewhere. Further, we do not expect disturbance to significantly affect the distribution of the species on the Forests, as the disturbances causing it are temporary, ceasing when project-level activity ceases.

The harm estimate of 3,285 NLEB pups amounts to less than 0.1 percent of the total population of non-volant pups. Less than 1% of the total number of NLEB pups may be harmed in individual states. However, these numbers are overestimates. As noted above, most of this harm is caused by prescribed burning and tree clearing activities, where the potential for death or injury depends largely on site-specific circumstances, e.g., the likelihood of felling a tree containing a maternity colony. Not all tree clearing activities through maternity roosting areas will kill or injure all pups present, but our methodology in this BO estimates that all potentially vulnerable individuals within the expected area of activity/occupancy overlap are affected. The same is true for prescribed fire. We also estimated that 980 adults (less than 0.02% of the total population) may be affected by wind turbine operation and tree clearing activities. Less than 1% of the total number of NLEB adults may be affected in all individual states. These numbers are more realistic estimations because we did not assume that all potentially vulnerable individuals would be affected – we assumed that only 3% of adults would be impacted.

There are no additional interrelated and interdependent actions to the proposed Action or cumulative effects that are not included in the analysis of the proposed Action.

The final 4(d) rule determined that the conservation of the NLEB as a threatened species is best served by limiting the full suite of prohibitions applicable to endangered species under section 9 of the Act to its most vulnerable life stages, i.e., while in hibernacula or in maternity roost trees within the WNS zone, and to activities, tree removal in particular, that are most likely to affect the species. Activities excepted from the requirements to obtain incidental take statements or incidental take permits will affect relatively small numbers of individuals, which is not anticipated to impair conservation efforts or the recovery potential of the species. The vast majority of individuals and populations that survive WNS are unaffected by these activities. It is likely that the species will persist in the individual states based on the number of maternity colonies and widely-dispersed nature of the activities. Based on the relatively small numbers affected annually compared to the state population sizes, we conclude that adverse effects from timber harvest, prescribed fire, forest conversion, wind energy, and other activities will not cause population-level declines in this species.

The Service defines "to jeopardize the continued existence of a listed species" as to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of the species. After reviewing the current status of the NLEB, environmental baseline, effects of the Action, and cumulative effects, it is the Service's biological opinion that the Action, as proposed, is not likely to jeopardize the continued existence of the NLEB. The Service has not proposed or designated critical habitat for this species; therefore, none is affected.

Incidental take that is not expressly prohibited under the final 4(d) rule does not require exception in an Incidental Take Statement. This BO has evaluated major categories of actions that may affect the NLEB, but for which incidental take is not prohibited. Accordingly, there are no reasonable and prudent measures or terms and conditions that are necessary and appropriate for these actions. Federal agencies may rely on this BO to fulfill their project-specific section 7(a)(2) responsibilities under the framework specified in section 1.3 of this BO, which provides a process by which agencies may verify that their proposed actions do not include activities that would cause prohibited incidental take. Prohibited incidental take requires either a separate consultation (federal actions) or an incidental take permit (non-federal actions).

7 REINITIATION NOTICE

Reinitiation of formal consultation is required and shall be requested by the Service, where discretionary federal involvement or control over the action has been retained or is authorized by law and: (a) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (b) If the identified action is subsequently modified in a manner that has an effect to the listed species or critical habitat that was not considered in the biological opinion; or (c) If a new species is listed or critical habitat designated that may be affected by the identified action. The section 7 regulations also require that consultation be reinitiated if the amount or extent of taking specified in the incidental take statement is exceeded (50 CFR 402.16); however, this condition does not apply to this consultation because all incidental take resulting from actions carried out in compliance with the final 4(d) rule is not prohibited.

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APPENDIX P: INTEGRATED PEST MANAGEMENT PLAN

Enviro tracking #	ARNG ENVIRONMENTAL CHECKLIST	State ARNG
FY17VAFM70		VAARNG

PART – A PROJECT INFORMATION

1. Project name: Integrated Pest Management Plan (IPMP)
2. Project number: (MILCON if applicable)
3. Date prepared: 21 September 2017
4. Description and location of the project/proposed action.

a. Location (Include a detailed map if applicable):

The proposed action is for all Army National Guard locations across the state of Virginia.

b. Description:

Update the 2008 VA ARNG Integrated Pest Management Plan (IPMP) to include new regulatory updates and changes to current ARNG operations on Virginia facilities. Updated IPMP will codify pesticide procurement, use, storage, training, and reporting for all VA ARNG personnel and facilities and will be valid for 5 years. Format will follow the approved template developed by NGB for new IPMPs and incorporate all federal and state regulatory requirements to ensure that personnel and the environment are protected during all pest management actions within the organization. The implementation of the new IPMP will result in a reduction of historic pesticide usage by up to 50% through mechanical, cultural, and biological approaches.

c. The proposed action will involve (check all that apply):

☐ Training activities/areas ☐ Construction ☐ Natural resource management
☐ Maintenance/repair/rehabilitation ☐ Real estate action ☒ Environmental plans/surveys
☐ Innovative readiness training project
☐ Other (Explain): New Equipment Fielding and Training

d. Project size in acres: *(if applicable)* Acres of proposed new surface disturbance: *(if applicable)*

5. Start date of proposed action (dd-mmm-yy): January 2018 *NOTE: this must be a future date.*
6. Programmed fiscal year: FY 18
7. End date (if applicable):

PART B – DECISION ANALYSIS GUIDE

To use a categorical exclusion, the project must satisfy the following three screening criteria: no segmentation, no exceptional circumstances and a qualifying categorical exclusion that covers the project. The following decision tree will guide the application and documentation of these three screening criteria. The criteria were extracted from 32 CFR Section 651.29 and represent the most common screening conditions experienced in the ARNG. NOTE: Each question in Part B must have an applicable block checked for concurrence with REC.

1. Is this action segmented (the scope of the action must include the consideration of connected, cumulative, and similar actions)? ☐ Yes (go to #30) ☒ No (go to #2)

2. Is there reasonable likelihood of significant environmental effects (direct, indirect, and cumulative)? If action meets screening criteria but is assessed in an existing EA or EIS, check NO and proceed to the next question.
☐ Yes (go to #30) ☒ No (go to #3)

3. Is there a reasonable likelihood of significant effects on public health, safety or the environment? If action meets screening criteria but is assessed in an existing EA or EIS, check NO and proceed to the next question.
☐ Yes (go to #30) ☒ No (go to #4)

4. Is there an imposition of uncertain or unique environmental risks? If action meets screening criteria but is assessed in an existing EA or EIS, check NO and proceed to the next question. ☐ Yes (go to #30) ☒ No (go to #5)

5. Is the project of greater scope or size than is normal for the category of action? If action meets screening criteria but is assessed in an existing EA or EIS, check NO and proceed to the next question.
☐ Yes (go to #30) ☒ No (go to #6)

6. Does the project introduce or employ unproven technology? If action meets screening criteria but is assessed in an existing EA or EIS, check NO and proceed to the next question.
☐ Yes (go to #30) ☒ No (go to #7)

7. Will there be reportable releases of hazardous or toxic substances as specified in 40 CFR Part 302? If action meets screening criteria but is assessed in an existing EA or EIS, check NO and proceed to the next question.
☐ Yes (go to #30) ☒ No (go to #8)

8. If proposed action is in a non-attainment or maintenance area, will air emissions exceed de minimus levels or otherwise require a formal Clean Air Act (CAA) conformity determination? If action meets screening criteria but is assessed in an existing EA or EIS, check NO and proceed to the next question.
☐ Yes (go to #30) ☐ No (go to #9) ☒ N/A (go to #9)

9. Will the project have effects on the quality of the environment that are likely to be highly controversial? If action meets screening criteria but is assessed in an existing EA or EIS, check NO and proceed to the next question.
☐ Yes (go to #30) ☒ No (go to #10)

10. Will the project establish a precedent (or make decisions in principle) for future or subsequent actions that are reasonably likely to have future significant effects? If action meets screening criteria but is assessed in an existing EA or EIS, check NO and proceed to the next question. ☐ Yes (go to #30) ☒ No (go to #11)

11. Has federal funding been secured for the Innovative Readiness Training (IRT) project?
☒ Not applicable (go to #13) ☐ Yes (go to #13) ☐ No (go to #12)

12. NOTE: IRT projects not currently funded can secure approved NEPA documentation. However, once funding is secured State ARNG is required to coordinate with ARNG-ILE-T to complete natural and cultural surveys via proponent funding. ☐ Confirmed (go to #27)

13. Do you have a species list from the U.S. Fish and Wildlife Service that is less than 90 days old?
☐ Yes (go to #14) ☞ Date of list: ☒ No (update species list, return to #13)

14. In reviewing the species list, what determination was made by the State ARNG?
- ☐ No species present (go to #16)
- ☒ No affect (go to #16)
- ☐ May affect but not likely to adversely affect ☞ Date of USFWS concurrence (go to #16)
- ☐ May affect likely to adversely affect (go to #15)

15. Does an existing biological opinion cover the action? ☐ Yes ☞ Date of BO: (go to #16) ☐ No (go to #30)

16. Have the Endangered Species Act, Section 7 requirements been completed?
☐ Yes ☞ Date of documentation: 11 February 2016 (go to #17) ☒ No (complete documentation, return to #16)

17. Does the project involve an undertaking to a building or structure that is 50 years of age or older?
☐ Yes (go to #18) ☒ No (go to #20)

18. Has the building or structure been surveyed for the National Register of Historic Places?
☐ Yes (go to #19) ☐ No (complete inventory, return to #18)

19. Is the building or structure eligible for or listed on the National Register of Historic Places?
☐ Yes (go to #20) ☐ No (go to #20)

20. Does the action involve ground disturbing activities? ☐ Yes (go to #21) ☒ No (go to #22)

21. Has an archaeological inventory or research been completed to determine if there are any archaeological resources present? ☐ Yes (go to #22) ☐ No (complete inventory, return to #21)

22. In reviewing the undertaking, under the National Historic Preservation Act (NHPA) (for both above and below ground resources), what determination was made by the State ARNG?
- ☐ No 106 undertaking; no additional consultation required under NHPA (go to question #27)
- ☒ No properties affected ☞ Date of SHPO concurrence: See item 23a., below (go to #24)
- ☐ No adverse effect ☞ Date of SHPO concurrence: (go to #24)
- ☐ Adverse effect (go to #23)

23. Has the State ARNG addressed the adverse effect?
☐ Yes (place date of MOA or existing PA and explanation of stipulations below, go to #24) ☐ No (go to #30)

23a. Date of MOA or PA and explanation:

The action covered by this REC is an undertaking as defined in 36 CFR Part 800 (NHPA Section 106) at 800.16(y): ". . . a project, activity, or program funded in whole or in part under the direct or indirect jurisdiction of a Federal agency, including those carried out by or on behalf of a Federal agency; those carried out with Federal financial assistance; and those requiring a Federal permit, license or approval." However, according to 36 CFR Part 800.3(a)(1), the undertaking has no potential to cause effects on historic properties so VaARNG has no further obligations under Section 106; and this is consistent with the VaARNG PA, executed DEC 2016 (Ref. *Programmatic Agreement Among the Virginia Army National Guard, the National Guard Bureau, Virginia State Historic Preservation Office, and the Advisory Council on Historic Preservation Regarding Routine Operations, Maintenance, Development, and Training Actions at Virginia Army National Guard Properties Throughout Virginia*), as set forth at II.A.1.a. As set forth in the IPMP, treatments to be carried out under it will be coordinated under the PA and according to the Section 106 process where applicable.

24. Per DoDI 4710.02 did the state ARNG determine that tribal consultation was necessary for this project?
☐ Yes (go to #25) ☒ No (Provide reason in block below, go to #27)

24a. Reason for no consultation:
According to ongoing consultation with Federal and State Tribes, this is a type of project that would not be of interest to Tribes for routine consultation, since it does not involve an action that has the potential to cause effects on historic properties. As set forth in the IPMP, treatments to be carried out under it will be coordinated with Tribes as needed and as appropriate.

25. Did the Tribes express an interest or respond with concerns about the project?
☐ Yes (go to #26) ☐ No ☞ Date of MFR: (go to #27)

26. Has the State ARNG addressed the Tribal concerns?
☐ Yes (place date of MOU or explanation in box below, go to #27) ☐ No (address concerns, return to #26)

26a. Date of MOU or explanation of how State addressed tribal concerns:

27. Does the project involve an unresolved effect on areas having special designation or recognition such as those listed below? For any yes responses go to #30 otherwise go to #28. If any No response is a result of negotiated and/or previously resolved effects please describe resolution in box 27a below.

Type	Unresolved Effects?	Type	Unresolved Effects?
a. Prime/Unique Farmland	☐ Yes ☒ No	e. Wild/Scenic River	☐ Yes ☒ No
b. Wilderness Area/National Park	☐ Yes ☒ No	f. Coastal Zones	☐ Yes ☒ No
c. Sole-Source Aquifer	☐ Yes ☒ No	g. 100-Year Floodplains	☐ Yes ☒ No
d. Wetlands	☐ Yes ☒ No	h. National Wildlife Refuges	☐ Yes ☒ No

27a. Resolution:

28. Is this project addressed in a separate EA or EIS review?
☒ Yes (complete information below, go to Part C, Determination) ☐ No (go to #29)
Document Title: 2008 VA ARNG Integrated Pest Management Plan (IPMP) Environmental Assessment
Lead Agency: VA ARNG
Date of Decision Document: 2008

29. Does the project meet at least one of the categorical exclusions listed in 32 CFR 651 App B?
☒ Yes (complete information below, go to Part C, Determination) ☐ No (go to #30)
Primary CAT EX code: (b)(1)
Reason why CAT EX code applies: Proposed action is the update to the 2008 VA ARNG Integrated Pest Management Plan (IPMP)

30. At this time your project has not met all the qualifications for using a categorical exclusion under 32 CFR 651. Unless the scope of the project is changed, it will require an Environmental Assessment or possibly an Environmental Impact Statement. If you feel this is in error, please call your NEPA Regional Manager to discuss. If needed, go to Part C Determination.

Additional information (if needed):

PART C – DETERMINATION

On the basis of this initial evaluation the following is appropriate:

☐ In accordance with 32 CFR 651 Appendix B, the proposed action qualifies for a categorical exclusion that does not require a record of environmental consideration.
☒ A record of environmental consideration.
☐ An environmental assessment.
☐ A notice of intent to prepare an environmental impact statement.

Signature of Proponent (requestor)
Name: Webb, Brian MAJ
Date: 26 OCT 2017

Signature of Environmental Program Manager
Name: Pamela Coleman
Date: 27 Oct 17

Other concurrence (as needed):

Signature
Name: COL Charlton Dunn
Title/Division: Facilities Management Officer
Date:

Enviro tracking #	ARNG RECORD OF ENVIRONMENTAL CONSIDERATION	State ARNG
FY17VAFM70		VAARNG

1. Project name: Integrated Pest Management Plan (IPMP)	
2. Project number: (MILCON if applicable)	3. Date prepared: 21 September 2017
4. Start date of proposed action (dd-mm-yy): January 2018	*NOTE: this must be a future date.*
5. Programmed fiscal year: FY18	
6. End date (if applicable):	

7. Description and location of the project/proposed action.

a. Location (Include a detailed map if applicable):

The proposed action is for all Army National Guard locations across the state of Virginia.

b. Description:

Update the 2008 VA ARNG Integrated Pest Management Plan (IPMP) to include new regulatory updates and changes to current ARNG operations on Virginia facilities. Updated IPMP will codify pesticide procurement, use, storage, training, and reporting for all VA ARNG personnel and facilities and will be valid for 5 years. Format will follow the approved template developed by NGB for new IPMPs and incorporate all federal and state regulatory requirements to ensure that personnel and the environment are protected during all pest management actions within the organization. The implementation of the new IPMP will result in a reduction of historic pesticide usage by up to 50% through mechanical, cultural, and biological approaches.

8. Choose one of the following:

☒ An existing environmental assessment* adequately covers the scope of this project. Attach FNSI if EA was completed by another federal agency (non-ARNG).
Date of EA (dd-mmm-yy): 9 August 2004 Lead Agency: VA ARNG

☐ An existing environmental impact statement* adequately covers the scope of this project.
Date of EIS (dd-mmm-yy): Lead Agency:

☒ After reviewing the screening criteria and completing the ARNG environmental checklist, this project qualifies for a categorical exclusion (select below).
CAT EX Code: (b)(1): Preparation of regulations, procedures, manuals, and other guidance documents that implement, without substantive change, the applicable HQDA or other federal agency regulations, procedures, manuals, and other guidance documents that have been environmentally evaluated
CAT EX Code:
CAT EX Code:

☐ This project is exempt from NEPA requirements under the provisions of:
Cite superseding law:

**Copies of the referenced environmental assessment or environmental impact statement can be found in the ARNG Environmental Office within each state.*

9. Remarks (if needed):

Signature of Proponent (requestor)	Signature of Environmental Program Manager
Name: Webb, Brian, MAJ	Name: Pamela Coleman
Date: 26 OCT 2017	Date: 27 Oct 17

Proponent Information
10. Proponent: NGVA-VAFM-E
11. Address: Fort Pickett Bldg 316 Blackstone, Virginia 23824
12. POC:
13. Comm. Voice:
14. Proponent POC e-mail:

THE VIRGINIA ARMY NATIONAL GUARD

INTEGRATED PEST MANAGEMENT PLAN

FIELD MANUAL

JANUARY 2018

Table of Contents

1 Purpose

This IPMP is a framework that defines how pest management is accomplished by the VAARNG. This version is abridged from the October 2017 version approved by National Guard Bureau. A full version is available from the Integrated Pest Management Coordinator upon request. The plan identifies elements of the program to include health and environmental safety, pest identification, and pest management, as well as pesticide storage, transportation, use and disposal. This plan is used as a tool to reduce reliance on pesticides, to enhance environmental protection, and to maximize the use of IPM techniques.

2 Responsibilities

2.1 Integrated Pest Management Coordinator (IPMC)

2.1.1 Prepare and maintain the IPMP with 5-year revisions.

2.1.2 Annually review and update the IPMP as needed.

2.1.3 Ensure all pesticides are approved by the ARNG PMC prior to their use at VAARNG Federally-owned (Appendix A) sites and all pesticide used at VAARNG sites are listed on the VAARNG State Pesticide Use List (SPUL) (Appendix C).

2.1.4 Coordinate with personnel conducting pest surveillance and/or control to ensure all applicable information is recorded and reported as required by National Guard Bureau.

2.1.5 Function as a point of contact between those individuals who store and apply pesticides (e.g., facility management, pest control contractors) and activities or individuals who document or are impacted by pesticide usage at VAARNG sites (e.g., Environmental Office, Safety Office, Fire Department, and Industrial Hygienist).

2.1.6 Coordinate with the VAARNG Natural Resources Manager (NRM) about pest control actions in semi-improved or unimproved grounds where there may be endangered, threatened or sensitive animals (including insects) or plants.

2.1.7 Coordinate with the VAARNG Cultural Resources Manager (CRM) when pest control actions might impact native plants, potentially of interest to Indian tribes with which VAARNG consults, or might impact landscape areas or materials, or other resources with cultural significance, or might affect a building greater than 50 years old that may be eligible for listing in the National Register of Historic Places.

2.1.8 Coordinate with the VAARNG Directorate of Plans, Training, Mobilization and Security (DPTMS) for all pest management performed on training or maneuver land.

2.1.9 Coordinate with local health officials to determine the prevalence of disease vectors and other public health pests in the area surrounding VAARNG sites. Oversee surveillance at

VAARNG sites for known vectors for diseases such as West Nile, Dengue, Chikungunya and Zika viruses.

2.1.10 Coordinate with the State Surgeon for any necessary measures for control of disease vectors and other public health pests at VAARNG sites.

2.1.11 Oversee the technical aspects of the Self-Help Program (Appendix E) with respect to pest control products and training of program participants.

2.1.12 Monitor certification and continuing pest management training for pesticide applicators at VAARNG sites. Maintain copies of current certifications in Appendix K of this plan.

2.1.13 Coordinate with the CFMO to ensure that contracts including pest management activities at VAARNG Federally-owned (Appendix A) sites are forwarded to the ARNG PMC for technical sufficiency review prior to solicitation of the contract. For contracted pre-construction treatment of soil to control termites at Federally-owned VAARNG sites, ARNG PMC review and approval of the termite management section of contracts is not required if the contract language is in accordance with the current Unified Facilities Guide Specification for chemical termite control.

2.1.14 Ensure that pest management contracts at VAARNG Federally-owned (Appendix A) sites with efforts that exceed 0.25 work-years are monitored by a certified PMQAE.

2.1.15 Coordinate with local, state and federal agencies, as necessary, to conduct the VAARNG IPM program in accordance with federal, state, and local laws and regulations that apply to pest management, pesticide use, applicator certification, record-keeping, and reporting.

2.1.16 Provide answers to questions concerning pest management from Commanders, ARNG Directorate, Headquarter Department of Army (HQDA), and interested state agencies.

2.1.17 Perform design review of new construction and landscaping projects to ensure that pest entry points and potential harborage sites have been eliminated and that proper preconstruction termite treatment is included in project specifications.

2.1.18 Prepare, with assistance from a PMC certified in DOD Category 11: Aerial Application Pest Control, an Aerial Spray Statement of Need (ASSON) for any potential aerial application of pesticides to Federally-owned (Appendix A) VAARNG sites.

2.1.19 Obtain IPMC certification within two years of being appointed to the position and maintain certification with refresher training every three years.

2.2 Pest Management Quality Assurance Evaluator (PMQAE)

2.2.1 Monitor pest management contracts at VAARNG Federally-owned (Appendix A) sites when total efforts exceed 0.25 work-years for a single location.

2.2.2 Obtain PMQAE certification and maintain certification with refresher training every three years.

2.2.3 If a single location's pest management contract efforts are less than 0.25 work-years, the presence of a trained PMQAE at the installation is not mandatory.

2.3 Pest Management Provider (PMP)

2.3.1 Use IPM techniques to the maximum extent possible.

2.3.2 Maintain current DOD or Virginia Department of Agriculture & Consumer Services, Office of Pesticide Services certification to apply pesticides in the category of pest control for work being initiated at Federally-owned VAARNG (Appendix A) sites and comply with all state and federal regulations. Non-restricted use pesticides may be applied by Registered Technicians at State properties (those not in Appendix A) without use of the Self-Help program. All others must use the Self-Help program (Appendix E). Send a copy of all certifications to the IPMC annually.

2.3.3 Control pests according to the provisions of this plan, in accordance with state and local laws and regulations, and DOD, Army and ARNG instructions, regulations and policies (DODI 4150.07, AR 200-1, ARNG Integrated Pest Management Program Policy Memorandum).

2.3.4 Conduct surveillance for mosquitoes, ticks, bed bugs, cockroaches, or other pests that could adversely affect the health and welfare of installation personnel.

2.3.5 Operate in a manner that minimizes risk to personnel and the environment.

2.3.6 When using pesticides, always read and follow the label. The label is the law.

2.3.7 Keep records of all pest surveillance and control efforts using the Pesticide Management Treatment Record and provide reports to the IPMC by the end of each month.

2.3.8 Maintain effective liaison with county, state, and federal health and environmental officials, as necessary.

2.4 Pest Management Contractors

2.4.1 Use IPM and conduct pest management in accordance with this plan, including ARNG PMC contract pre-approval of pesticides applied at VAARNG Federally-owned (Appendix A) sites.

2.4.2 Comply with all federal, state, and local laws and regulations.

2.4.3 When using pesticides, always read and follow the label. The label is the law.

2.4.4 Submit written records of all pest management activities to the Contract POC using the Pesticide Management Treatment Record (Appendix D) within one week of application.

2.5 Fort Pickett Department of Public Works (DPW) and CFMO Operations and Maintenance (O&M)

2.5.1 Determine the pest management requirements for the VAARNG sites and request appropriate funding to support contracted pest control operations.

2.5.2 Ensure that VAARNG personnel performing pest control as a part of their assigned duties receive adequate training in accordance with this plan, and achieve pest management certification, as required.

2.5.3 Ensure all pest management activities, including those that are part of the Self-Help Program, are recorded in accordance with this plan and reports are provided to the IPMC at intervals as specified in this plan. Maintain records of pest management operations as required.

2.5.4 Request and monitor contracted pest control operations.

2.5.5 Coordinate with the IPMC to ensure that contracts including pest management activities at VAARNG Federally-owned (Appendix A) sites are forwarded to the ARNG PMC for review for technical sufficiency prior to solicitation of the contract. For contracted pre-construction treatment of soil to control termites at VAARNG Federally-owned (Appendix A) sites, ARNG PMC review and approval of the termite management section of contracts is not required if the contract language is in accordance with the current Unified Facilities Guide Specification for chemical termite control.

2.5.6 Provide a copy of each finalized pest control contract to the IPMC.

2.5.7 Initiate requests for aerial application of pesticides, when necessary.

2.5.8 Stray animal control is coordinated and performed by the Fort Pickett Entomologist for requests within the installation using in-house personnel and through an agreement with local municipal animal control authorities. For animal control outside of Fort Pickett, contact local municipal animal control services.

2.6 Directorate of Plans, Training, Mobilization and Security (DPTMS)

2.6.1 Determine the pest management requirements for the VAARNG training and maneuver lands and request appropriate ITAM funding when pests are impeding training/maneuvers.

2.6.2 For management of pests that are not impeding training/maneuvers (e.g., hornet nests in bivouac areas, noxious/invasive weeds in maneuver areas, etc.), use all non-chemical pest control techniques as recommended in the IPM outlines (Appendix B) before requesting further assistance from DPW for in-house or contracted pest control.

2.6.3 Coordinate with the IPMC for any pest management activities occurring on VAARNG training and maneuver lands.

2.6.4 Ensure all pest management activities on training and maneuver lands, including those that are part of the Self-Help Program, are performed in accordance with this plan, including the records and reporting of pesticide usage.

2.6.5 Request and assist with the monitoring of contracted pest control operations.

2.6.6 Coordinate with the IPMC to ensure that contracts including pest management activities at Fort Pickett training and maneuver lands are forwarded to the ARNG PMC for review for technical sufficiency prior to solicitation of the contract.

2.6.7 Initiate requests for aerial application of pesticides to the IPMC no later than 12 months from the desired application date. Do not plan aerial spraying of defoliants or other pesticides within the northern long-eared bat active season.

2.7 Facility Managers and Maintenance Personnel

2.7.1 Apply good sanitary practices, landscape maintenance, and materials management to prevent pest infestations.

2.7.2 Use all non-chemical pest control techniques as recommended in the IPM outlines (Appendix B) before requesting further assistance from the O&M Office for in-house or contracted pest control.

2.7.3 Ensure all pest management activities, including those that are part of the Self-Help Program, are recorded in accordance with this plan and reports are provided to the IPMC at intervals specified in this plan.

2.7.4 Cooperate fully with pest management personnel in scheduling pest management operations, to include preparing the areas to be treated.

2.7.5 Have available on-site Safety Data Sheets (SDSs) for any pesticide stored or used on the premises.

2.8 Unit Commanders

2.8.1 Assure the proper use of the DOD Arthropod Repellent System and other personal protective measures while troops are exposed to potential disease vectors such as mosquitoes and ticks.

2.8.2 Brief troops on potential biological threats (such as poison ivy) before training exercises.

2.8.3 Appoint a field sanitation team for each company, troop, or battery-size unit. Assure that field sanitation teams are trained at resident courses, supplied, and mission capable prior to deployment to training areas.

2.9 Building Occupants

2.9.1 Apply good sanitary practices to prevent pest infestations. Areas need to be free of open food containers. Don't accumulate pest harborage materials such as empty boxes or dunnage.

2.9.2 Cooperate fully with contractors and billeting personnel in scheduling pest management operations, to include preparing the areas to be treated.

2.9.3 Report all pest management issues to the Maneuver Training Center (MTC) Fort Pickett Entomologist while on the installation and the appropriate Regional Armory Maintenance Manager for other facilities.

2.10 Self-Help Program Participants (generally maintenance workers, but Self-Help is available to all VAARNG members and employees)

2.10.1 Keep all areas clean, dry, and sanitary. Areas need to be free of open food containers. Don't accumulate pest harborage materials such as empty boxes or dunnage.

2.10.2 Determine if Self-Help is allowed for the pest problem using the IPM outlines in Appendix B.

2.10.3 If Self-Help is appropriate, follow the requirements found in Appendix E covering the Self-Help Program. Only pesticides that are pre-approved for Self-Help Program use and listed as such on the VAARNG SPUL (Appendix C) are allowed. All training, recording, reporting, handling and storage of pesticides must be done as specified under the Self-Help Program and in accordance with the pesticide label.

2.10.4 If Self-Help is not appropriate for the pest or level of the pest problem, fill out a work-order requesting assistance with your pest problem and submit it to the Facility Manager.

2.10.5 When using pesticides as part of the Self-Help Program, always read and follow the label. The label is the law.

3 Integrated Pest Management Operations

3.1 The four basic principles of IPM work together to provide long term control of pest populations at acceptable levels with the least detrimental impact on the environment. Although the use of the least-toxic pesticide is an integral part of IPM, non-chemical control is emphasized. Use of pesticides is almost always a temporary measure and often more expensive if used regularly. Non-chemical control may initially be more expensive, but will usually be more cost effective long-term with ongoing pest management. Non-chemical controls have the added advantage of being less toxic which reduces the potential risk to human health and the environment. Surveillance and monitoring of pests are stressed in an IPM program since it is important to determine the cause of the pest infestation and the most effective management of the problem. Insect and vertebrate pests require food, water, and harborage (a place to rest or breed). Long term control is dependent upon eliminating or restricting pests' access to these requirements.

3.2 Mechanical and Physical Control: This type of control alters the environment where pests live, excludes pests, or traps and removes pests where they are not wanted. Examples of mechanical and physical control include: harborage elimination in structures through caulking or filling voids, screening, mechanical traps or glue boards, and nets and other barriers to prevent entry into buildings.

3.3 Cultural Control: Strategies in this method involve manipulating environmental conditions to suppress or eliminate pests. For example, judicious sanitation at dining facilities reduces the attractiveness of the area to flocks of birds that may cause increased air strike hazard. Replacing ornamental trees and shrubbery with native plants that are less attractive to defoliating pests is another cultural measure.

3.4 Biological Control: In this control strategy, predators, parasites or disease organisms are used to control pest populations. For example, the introduction of ragwort flea beetle, and the cinnabar moth have dramatically reduced the prevalence of tansy ragwort. Release of these biological controls in infested areas can eliminate tansy ragwort at that location. Introduction of new biological controls is the responsibility of the United States Department of Agriculture (USDA), Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine, Biological Control Program.

3.5 Chemical Control: Pesticides kill living organisms, whether they are plants, insects or other animals. At one time, pesticides were considered to be the most effective control available, but pesticide resistance has rendered many ineffective. In recent years, the trend has been to use pesticides that have limited residual action. While reducing human exposure and lessening environmental impact, the cost has risen due to requirements for more frequent application. Since personal protection and special handling and storage requirements are necessary with the use of pesticides, the overall cost of control can be quite high when compared with non-chemical control methods. However, the use of chemicals may be warranted to control some pests and invasive species when other control methods are not sufficiently effective.

4 Health and Safety

4.1 Medical Surveillance of Pest Management Personnel

Pesticide applicators must read and follow all health and safety information on the label. If applying pesticides requires formal medical surveillance or respirators, VAARNG personnel must work with the VAARNG Safety Office to initiate medical surveillance physical exams, as appropriate. Contractors performing pest management services are responsible for their own medical surveillance program.

4.2 Hazard Communication

Safety Data Sheets (SDSs) for pesticides used are made available to all individuals who have contact with these chemicals. Hazard Communication (HAZCOM) training is mandatory for individuals working with hazardous materials, including pesticides.

4.3 Personal Protective Equipment

4.3.1 Personal Protective Equipment (PPE) as specified on the pesticide's label is provided to pest management personnel by the Safety Office. Submit purchase order requests when supplies of PPE become low.

4.3.2 Appropriate respiratory protection (High-Efficiency Particulate Air (HEPA) filter cartridges) should be used when working in enclosed areas infested with rodents and rodent waste, as well as additional measures like disposable gloves and the use of disinfectants. Rodent waste is associated with Hantavirus and Hantavirus pulmonary syndrome.

4.4 Fire Protection

The usual hazards presented by a fire are compounded in the case of a pesticide fire by the danger of pesticide poisoning and contamination. Fire protection of pesticides will be governed by the label and the VAARNG Hazardous Material, Waste and/or Spill Management Plans.

4.5 Pest Management Vehicle(s)

Whenever possible, designate a single vehicle to transport and apply pesticides. Large quantities of pesticides that meet thresholds for placarding must be transported in approved vehicles by appropriately licensed drivers. Pesticides are never transported in the cabs of vehicles, in personally-owned vehicles, or in vehicles generally used for non-pesticide related activities unless the pesticides are being used in the Self-Help program and constitute a small quantity with no human health risks for transportation. Whenever possible, pesticides are transported in a lockable storage compartment of an assigned vehicle. In addition, care is taken to secure pesticides to prevent damage to the containers and spillage of the chemicals. At no time are pesticides to be left unsecured in an unattended vehicle at an unsecure location.

4.6 Protection of the Public

Take precautions during pesticide application to protect the public, on and off VAARNG sites. Follow all precautions listed on the label. Pesticides are not applied outdoors when the wind speed exceeds label-specified levels. Whenever pesticides are applied outdoors, ensure that any drift is kept away from individuals, including the applicator. At no time are personnel permitted in a treatment area during pesticide application unless they are appropriately trained, have met the medical monitoring standards, and are protected in accordance with the pesticide label requirements.

4.7 Pesticide Shop Health, Safety, and Hazards

4.7.1 Personnel will follow all label precautions that deal with the storage of pesticides. Pesticides should be kept secure at all times. Pesticides should be under the applier's direct control or located in a secure locked facility or cabinet that is marked "Pesticide Storage" and posted with applicable "Danger", "Poison" and/or "Flammable" signs. Pesticides are a hazardous material and should be stored according to the SDS.

More information on pesticide storage can be found in the Armed Forces Pest Management Board (AFPMB) Technical Guide No. 17, "Design of Pest Management Facilities". This technical guide can be found on the AFPMB website (go to: http://www.acq.osd.mil/eie/afpmb/ search for "AFPMB") or obtained from the ARNG PMC.

4.7.2 Used pesticide aerosol cans must be turned-in to the Hazardous Waste Program Manager as hazardous waste. Other pesticide containers must be disposed of according to the label directions or turned-in as hazardous waste.

5 Environmental Considerations

5.1 Sensitive Areas

5.1.1 Special consideration is given prior to conducting pest control operations in sensitive areas that are identified on pesticide labels. No pesticides are applied directly to wetlands or water areas (lakes, rivers, etc.) unless their use is specifically approved on the label and in compliance with National Pollutant Discharge Elimination System (NPDES) regulations for application over or into waters of the United States. Separate NPDES permitting may be required in some instances and will require coordination with the VAARNG Environmental Office personnel.

5.1.2 In addition to aquatic and marine habitats, sensitive areas also include critical habitat of endangered, threatened, or rare flora or fauna species, and unique geological and other natural features.

5.1.3 All aerial application of pesticides to Federally-owned (Appendix A) VAARNG sites requires an Aerial Spray Statement of Need (ASSON) that has been approved by the ARNG PMC. The ASSON is prepared by VAARNG personnel with assistance from a PMC certified in DOD Category 11: Aerial Application Pest Control. Aerial application of pesticides to Federally-owned (Appendix A) VAARNG sites also requires additional environmental documentation.

5.2 Endangered or Protected Species and Critical Habitats

5.2.1 Protected migratory birds that occur on VAARNG property cannot be controlled without a permit. Migratory birds and their nests are protected. Neither migratory birds nor their eggs may be harmed. Birds may be scared or herded to encourage them to move (unless the birds are otherwise protected under separate authority such as the ESA). Nuisance nests may be destroyed (not collected) before eggs are laid or after chicks have fledged unless protected under the ESA or the Bald and Golden Eagle Protection Act (BGEPA).

5.2.2 The IPMC periodically reviews, with assistance from the VAARNG Natural Resources Manager (NRM), ongoing pest control operations and also evaluates all new pest management operations to ensure compliance with the ESA, Migratory Bird Treaty Act, the BGEPA and state wildlife regulations. No pest management operations are conducted that are likely to have a negative impact on endangered or protected species or their habitats without prior approval from the ARNG PMC. Special consideration must be given when using pest management tactics in areas where endangered species and/or nesting/roosting eagles are found. Refer to the Fort Pickett and Camp Pendleton-specific Integrated Natural Resources Management Plans (INRMP) for special environmental concerns pertaining to endangered species and coordinate with the VAARNG NRM before performing any pest management operations that might affect endangered or protected species or their habitats.

5.2.3 Coordinate with the VAARNG NRM regarding pest control operations that could affect pollinators (such as insecticides or herbicides that kill flowering plants). All efforts should be made to reduce the use of pesticides that may affect pollinators. If pesticides must be used, apply the lowest toxicity pesticide available and apply pesticides at times of day and/or season when pesticide use will have the least impact on pollinators, but achieve pest contract objectives.

5.3 Cultural and Historical Sites

All IPM activities must be in accordance with the VAARNG Integrated Cultural Resources Management Plan (ICRMP). In case of an inadvertent discovery of cultural materials, follow the procedures and notifications specified in the ICRMP immediately upon discovering cultural materials, as set forth in the ICRMP Standard Operating Procedure No. 5 for Inadvertent Discovery of Cultural Materials. Prior to beginning pest control operations, the VAARNG Cultural Resources Manager will review any necessary ground disturbance or work requiring alteration of a building eligible for the National Register of Historic Places, or actions that might impact culturally significant landscape areas and materials. Sufficient time must be allowed to coordinate with the Cultural Resources Program in advance of implementing pest controls, as consultation outside VAARNG might be required.

5.5 Pesticide Spills and Remediation

An adequate pesticide spill cleanup kit is maintained wherever bulk pesticides are stored or used. All pesticide spills are reported to the VAARNG Hazardous Waste Program Manager. Spills are governed by the label and the VAARNG Hazardous Material, Waste and/or Spill Management Plans.

6 Program Administration

6.1 Pest Management Operations

6.1.1 Pest management operations are conducted in accordance with Appendix B, "Integrated Pest Management (IPM) Outlines".

6.1.2 If the pest problem cannot be solved using the Self-Help Program (see Appendix E), then a request for pest control is sent to the Facility Manager or Department of Public Works.

6.1.3 All pesticides used at VAARNG sites will be approved prior to use by the ARNG PMC and listed on the VAARNG SPUL (Appendix C).

6.2 Pest Management Contracts and Contract Quality Assurance

6.2.1 VAARNG site personnel may use contracts when essential pest management services are not provided in-house. Contracts are administered in accordance with DODI 4150.07 for VAARNG Federally-owned (Appendix A) sites. The requesting office will contact the IPMC for guidance for any contracts that include pest management.

6.2.2 Pest management contracts for VAARNG Federally-owned (Appendix A) sites are forwarded to the ARNG PMC for technical sufficiency review prior to advertisement of the contract. For contracted pre-construction treatment of soil to control termites, PMC review and approval of the termite management section of contracts is not required for VAARNG Federally-owned sites if the contract language is in accordance with the current Unified Facilities Guide Specification for chemical termite control.

6.2.3 State contracting procedures and regulations are utilized to contract pest control on VAARNG State-owned sites.

6.2.4 Pest management contracts are initiated on an "as needed" basis. Regularly scheduled, monthly or periodic treatments will be eliminated unless deemed necessary after surveying and monitoring pest population levels. Regularly scheduled monthly or periodic treatments at VAARNG Federally-owned (Appendix A) sites must be approved by the ARNG PMC. Use of IPM techniques is encouraged in all contracts to decrease DOD's use of toxic chemicals and pollutants. Pest problems threatening the health, safety, or welfare of installation personnel receive priority.

6.2.5 Contractors will conduct pest management in accordance with this plan and may only apply pesticides listed on the VAARNG SPUL at VAARNG sites. Contractors may request addition of pesticides to the VAARNG SPUL via the IPMC.

6.2.6 Once a contract is awarded, it is the responsibility of the originating office to establish a date and time for work to commence.

6.2.7 The IPMC is responsible for ensuring the requirements of this plan are implemented for contracted pest management and for assuring the quality of all pest management activities via the Facility Managers. Work performed by contracted pest management personnel is evaluated based on the adherence to the contract statement of work negotiated through the originating office, the requirements outlined in this plan, and the Facility Manager's review of contracted pest control work to determine the effectiveness of control efforts. Failure of a contractor to adequately control pests is reported to the IPMC. Ongoing contracts are evaluated annually or as necessary. An evaluation to confirm the satisfactory completion of all work is performed prior to payment being made.

6.3 Reports and Records

6.3.1 The VAARNG IPMC is responsible for the maintenance of pesticide use records for all in-house and contracted pest management operations.

6.3.2 Records of pesticide applicator certification must be retained by the applicator and available for review. Current in-house pesticide applicator records are provided to the IPMC.

6.3.3 All pest surveillance and control operations are recorded by the pesticide applicator or pest management provider (PMP). This includes pest management actions done in-house, by contractors, Self-Help Program participants, and as part of land management and forestry programs. These records must contain at a minimum:

a. Date and time of pesticide application
b. Target pest(s)
c. Specific pesticide application location(s)
d. Name of the person (and company, if contractor) applying the pesticide and their certification number (if applicable)
e. Name and manufacturer of pesticide
f. EPA registration number of the pesticide
g. Sufficient information to determine the amount (in pounds) of pesticide active ingredient applied (such as amount of undiluted pesticide used, total amount of concentrate used, or amount of diluted pesticide applied, and the dilution rate)

6.3.4 Pest surveillance and control operations are recorded using the Pest Management Maintenance Record (DD Form 1532-1), the VAARNG Pesticide Management Treatment Record (Appendix D) or an equivalent hard-copy or electronic form. These records are maintained indefinitely at the Natural Resources Entomology Office on Fort Pickett or by Regional Operations and Maintenance Manager Offices at Readiness Centers and are a permanent record of pest management activities.

6.3.5 Reports of pesticides used at VAARNG sites are compiled at the end of each fiscal year by the IPMC to compute total pounds of active ingredients used. PMPs provide reports to their respective Facility Manager to assemble the state-wide data for future reports. Facility Managers will forward all application reports from Contractors or PMPs for their properties to the IPMC at the end of each calendar month.

6.3.6 The IPMC calculates and provides the data required for the annual Plan Update Form (PUF). All pesticide usage will be reported in pounds of active ingredient (PAI) yearly via the PUF, or when requested by the ARNG PMC. The PUF is sent to the ARNG PMC. Only pest-management activities performed at VAARNG Federally-owned sites (Appendix A) are reported on the PUF.

6.3.7 For pest management activities at VAARNG State-owned sites (those not listed in Appendix A), the IPMC collects the data for annual recording as required by the Virginia Department of Environmental Quality.

6.3.8 The IPMC (or designee) provides the data required for the quarterly IPM Installation Status Report (ISR). This data is reported in square footage (indoor pest management) or acreage (outdoor pest management) treated and is reported to the State ISR Program Manager. Only Federally-funded pest management activities are reported in the ISR.

6.3.9 The IPMC (or designee) is responsible for answering all IPM-related data calls and submittal of information via the Army Environmental Database Environmental Quality/Headquarters Army Environmental System (AEDB-EQ/HQAES) or another electronic reporting system as specified by ARNG-IEZ.

6.4 Training and Certification

6.4.1 All individuals who apply pesticides at VAARNG Federal sites (Appendix A) are to hold current pesticide applicator certification in the appropriate categories for the pests being treated, unless the pesticide application is done under the Self-Help Program. In-house pesticide applicators are to be certified by the DOD or the Virginia Department of Agriculture & Consumer Services, Office of Pesticide Services. Individuals who apply non-restricted use pesticides at State properties must be Registered Technicians unless they are using pesticides that are covered in the Self-Help section. All contractors who apply pesticides must be certified by the Commonwealth of Virginia in order to apply pesticides at VAARNG sites. Initial training, apprenticeship periods and refresher training will be completed as required by the certifying agency to maintain current pesticide applicator certification.

6.4.2 The VAARNG IPMC must complete an initial DOD-taught PMQAE/IPMC training course within two years of being appointed IPMC and take refresher training every three years. HAZCOM training is also appropriate since exposure to pesticides may occur in the course of the job. The IPMC is not required to be a certified pesticide applicator if the IPMC will not apply pesticides as part of their duties.

6.4.3 Self-Help Program participants training will consist of reading the Self-Help Handouts for the applicable pest, signing the Training Use Agreement (page E-5), and following the directions of the label for each pesticide used. HAZCOM training is mandatory for personnel exposed to pesticides. When pest management actions are performed in accordance with the requirements of the Self-Help Program (Appendix E), participants are not required to be certified pesticide applicators.

6.4.4 PMQAEs must complete an initial DOD-taught PMQAE/IPMC training course and take refresher training every three years. PMQAEs are not required to be a certified pesticide applicator if the PMQAE will not apply pesticides as part of their duties.

6.5 Pesticide Security

Pesticides and pesticide equipment must be properly stored in facilities and safeguarded. Facilities must be well lighted with a secure perimeter. Video cameras, alarm systems, and self-locking doors are appropriate measures of security. Access to pesticides should be restricted with appropriate warning signs posted. Refer to the AFPMB Technical Guide No. 7, "Installation Pesticide Security" for more information on proper storage and security of pesticides. This technical guide can be found on the AFPMB website (go to: http://www.acq.osd.mil/eie/afpmb/ search for "AFPMB") or obtained from the ARNG PMC.

Appendix A – Federally-owned VAARNG Sites

1. Sandston Readiness Center
2. Sandston Army Aviation Support Facility (AASF)
3. Hampton Readiness Center
4. Fort Pickett MTC
5. Fort Belvoir (29^{th} Infantry Division, 91^{st} Cyber Command, and Field Maintenance Shop)
6. Fort AP Hill (Bowling Green Readiness Center)
7. Defense Supply Center Richmond (VA ARNG Joint Forces Headquarters, CSMS, and CIF)

Appendix B – Integrated Pest Management (IPM) Outlines

IPM Outline 1
American Cockroaches

Target Pest or Group	American cockroaches.
Target Area(s)	Office buildings, warehouses, residences; storm sewers
Impact on Mission	▪ May cause food damage through contamination. ▪ Affect human health through allergic reactions or "entomophobia". ▪ An aesthetic or morale nuisance. ▪ Large size often frightens people.
Scope	Base-wide in buildings and in sewers.
Responsibility	▪ All personnel: Ensure proper sanitation in all living and working spaces. ▪ Self-Help Program Participants: Conduct integrated pest management to control infestations indoors and in outdoor living areas and around the perimeter of buildings using approved Self-Help control methods. ▪ Food Service personnel (FSP): Ensure compliance with food handling regulations that prevent pest infestations. ▪ Pest Management Provider (PMP), In-House or Contract: Conduct integrated pest management to control infestations. ▪ Facilities Maintenance Provider (FMP): Perform facilities repairs and improvements that exclude and minimize pest infestations as requested.
Reporting	Record all pest management operations using the Pesticide Management Treatment Record and report usage to the IPMC every month

Survey

Survey Method(s)	▪ Visual inspections:
	  ▪ Visual surveys of low to moderate infestations may require visiting the facility at night.
	  ▪ Observation of pests in harborages.
	  ▪ Look around areas with heat and moisture.
	  ▪ Inspect floor drains.
	▪ Application of a flushing agent (or canned air) to suspected harborages.
	▪ Sticky trap surveys.

	▪ Vacuum surveys of harborages. ▪ Personnel complaints: including information on when pests were observed, where, and how many. ▪ Conduct pre and post-treatment surveys to determine whether control operation was effective.
Survey Frequency / Schedule	▪ Daily observation by building occupants ▪ Monthly observation and/or sticky trap monitoring by pest management personnel.
Action Threshold(s)	▪ Visual sighting of 1 or more cockroaches (all life stages) per room per survey. Flushing agents or sticky traps may be used. ▪ Sighting of 1 egg capsule per survey.

Non-Chemical Control

Type	Method	Responsibility
Sanitation	▪ Thorough cleaning of potential food sources in buildings, especially coffee and food preparation areas. ▪ Clean up spills immediately. ▪ Clean out floor drains by rinsing with hot water or using cleaners specifically designed to remove sludge from pipes. ▪ Store food in pest-proof containers ▪ Empty trash cans daily, or avoid putting food items in trash. ▪ Do not eat at desk; eat in a designated coffee break or dining area.	All personnel; Self-Help Program Participants; FSP
Mechanical Removal	▪ Vacuum cockroaches from their harborages. ▪ Used canned air to flush cockroaches from their harborages. ▪ Then use a wet/dry vacuum cleaner filled with water or empty and dispose of vacuum bag immediately.	Self-Help Program Participants; FSP; PMP
Pest Proofing	▪ Seal holes in walls, ceilings and other areas that may serve as cockroach harborage, as required. ▪ Request support from facilities maintenance provider if necessary.	Self-Help Program Participants; FSP; FMP
Prevention	▪ Inspect food boxes before bringing them into a building	All personnel; Self-Help Program Participants; FSP
Eliminate harborage	▪ Seal cracks and crevices with caulk ▪ Remove corrugated cardboard and other materials that can serve as harborage	Self-Help Program Participants; FSP; FMP

Eliminate Standing Water	▪ Fix plumbing leaks, especially around sinks, faucets and dishwashers. ▪ Remove standing water from floors after daily cleaning.	FSP; FMP
Education	▪ Proper storage of food and sanitation to prevent infestations and increase effectiveness of pesticide applications. ▪ Understanding the delayed effect of baits.	In-House PMP; IPMC

Chemical Control

Application Site	Apply pesticides as required based on survey information to areas where cockroaches are known to live or travel.
Site Preparation	<u>Pre-treatment procedures</u>: ▪ Visual inspections (canned air may be used, but no flushing agents) or placement of sticky traps may be accomplished while the space is occupied. ▪ All pesticide applications shall be done only when the space is unoccupied. ▪ Pesticide applicators shall notify building occupants prior to pesticide use. ▪ If insecticidal baits are used, thorough cleaning is required to remove competing food sources. ▪ Remove all food from exposed areas, cover or store processing equipment and utensils, and turn off ventilation system. ▪ Remove and dispose all food debris to increase the effectiveness of bait stations. ▪ Clean grease off surfaces. Oil can interact with some insecticides and reduce their effectiveness. <u>Post-treatment procedures</u>: ▪ Thoroughly clean all food preparation surfaces. ▪ Do not remove bait stations or bait gel placements.
Sensitive Areas	▪ Exposed food products, food containers, counter tops, any surface where food may be stored or prepared, or any food storage area. ▪ Minimize application of pesticides directly into drains. ▪ Use care in selecting pesticides for use in storm sewers as this can lead to stormwater pollution. Applications should be made when storm sewers are dry and rain is not anticipated within a week.
Restrictions	▪ Preventive baseboard spraying in the absence of a pest is prohibited. ▪ Do not apply liquid or dust formulations to occupied spaces or near exposed food. ▪ In food service areas, use only insecticides specifically labeled for those areas.
Prohibited Items	▪ Use of ultrasonic pest repelling devices is prohibited.
Common Active Ingredients	▪ Abamectin ▪ Borate-based products ▪ Fipronil ▪ Hydramethylnon

	▪ Imidacloprid ▪ Indoxacarb ▪ Insect Growth Regulators (IGRs) ▪ Pyrethroids (i.e. bifenthrin, cyfulthrin, cyhalothrin, esfenvalerate, permethrin, tetramethrin)	
Types of Pesticides		**Authorized Applicators**
Baits	▪ Use Cockroach baits (stations containing solid bait or injectable style gel baits) as much as possible. ▪ Gel bait can be applied to a sheet of hardware cloth and hung in manholes. ▪ Proper bait placement is critical to the success of treatment. ▪ Do not apply other insecticides around bait treatment areas.	Self-Help Program Participants; In-House PMP; Contracted PMP
Flushing Agents	▪ Use aerosol contact pesticides directed into potential harborage areas to flush out and kill pests as needed.	In-House PMP; Contracted PMP
Crack and Crevice Residuals	▪ A residual pesticide may be applied (by crack and crevice technique) to all known or suspected harborages, feeding sites, or passageways.	In-House PMP; Contracted PMP
Spot Treatment Residuals	▪ A residual pesticide may be applied as a "spot treatment" to indicated areas (such as under dishwashers and refrigerators or behind stoves).	In-House PMP; Contracted PMP
Dusts	▪ Boric acid dust is an effective low toxicity insecticide that can be applied to wall voids and into manholes of storm sewers. The treatment area should remain dry after the application to avoid washing the dust away.	In-House PMP; Contracted PMP
Growth Regulators	▪ Insect growth regulators will always be mixed with "knock-down" pesticides.	In-House PMP; Contracted PMP
Fogging	▪ For rapid knockdown of large infestation; follow up with crack and crevice treatments and/or bait placement if needed.	In-House PMP; Contracted PMP

Contract or Work Considerations

Time Period to Respond	▪ Dependent on impact on mission. ▪ In food service areas, where impact is on health, and office spaces, where impact is on aesthetics and morale, response time should be within 24 hours. ▪ Warehouses and unoccupied or rarely occupied spaces may warrant a longer response time.

Time Period to Obtain Control	▪ Baits are designed to have a delayed toxic effect which allows cockroaches to take the bait to other cockroaches in their harborage. Generally, baits should result in fatalities within 3 days. ▪ Other insecticide treatments should result in immediate kill of the pest. ▪ Many insecticides are ineffective on egg cases (ootheca) and nymphal cockroaches may emerge within days after treatment, causing another infestation.
Level of Control	Post-treatment survey of the target area should result in a pest population lower than the action threshold number.
PMQAE Assessment	▪ Sticky traps are the best way to quantify and compare pre- and post-treatment surveys. ▪ Visual surveys of low to moderate infestations may require visiting the facility at night. ▪ Follow up surveys should be done one week later to see if eggs have hatched and resulted in another infestation.
Reasons for Treatment Failure	▪ Improper application of the insecticide ▪ Harborages not identified and treated ▪ Eggs hatched after treatment ▪ Insecticide resistance ▪ Improper placement of bait stations or gel baits.
Safety Considerations	▪ Do apply liquid and dust Insecticides to occupied spaces or when food is exposed; baits may be applied when spaces are occupied ▪ Allow for ventilation of spaces after liquid insecticides have been applied. ▪ Clean food preparation surfaces after treatment. ▪ Applicators must wear personal protective equipment as required by the product label. ▪ Most insecticides used for indoor pest control are low in toxicity (signal word "Caution"), but care should be taken to prevent exposure to humans and domestic animals
Environmental Considerations	▪ Outdoor treatments with pyrethroids are susceptible to runoff and contamination of stormwater. ▪ Disposing of pesticides in a drain or stormdrain is strictly prohibited.
Special Applicator Qualifications	▪ Cockroach control using canned air and approved bait stations may be accomplished by non-certified personnel as part of the Self-Help Program. ▪ All PMP applying pesticides must be DOD or State-certified as pesticide applicators.

Resources

http://www.extension.umn.edu/garden/insects/find/cockroaches/

http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7467.html (helpful for identifying types of cockroaches)

http://pestsense.cahnrs.wsu.edu/Search/MainMenuWithFactSheet.aspx?CategoryId=2&ProblemId=799

IPM Outline 2

Filth Flies

Target Pest or Group	House flies (*Musca domestica*), face flies (*Musca autumnalis*), stable flies (*Stomoxys calcitrans*), little house flies (*Fannia* spp.), and other fly species that breed in garbage, compost, manure, or other organic debris.
Target Area(s)	▪ Dumpsters ▪ Garbage dumps and recycle centers ▪ Any places where organic debris may accumulate
Impact on Mission	▪ Nuisance that interferes with mission ▪ Mechanical transmission of pathogens leading to illnesses
Scope	Management of biting and non-biting flies associated with organic debris. Excludes flies of public health importance such as mosquitoes, biting gnats, black flies, and bot flies.
Responsibility	• All personnel: Ensure proper sanitation in all living and working spaces. • Self-Help Program Participants: Conduct integrated pest management to control infestations indoors and in outdoor living areas and around the perimeter of buildings using approved non-Chemical control methods. • Food Service personnel (FSP): Ensure compliance with food handling regulations that prevent pest infestations • Pest Management Provider (PMP), In-House or Contract: Conduct integrated pest management to control infestations. • Janitorial Service Provider (JSP): Ensure that refuse containers are frequently emptied and sanitized. • Facilities Maintenance Provider (FMP): Perform facilities repairs and improvements that exclude and minimize pest infestations as requested.
Reporting	Record all pest management operations using the Pesticide Management Treatment Record and report usage to the IPMC every month.

Survey

Survey Method(s)	Visual sighting: ▪ Flies are active during the daytime in warm weather ▪ Flies may be seen flying around and landing on dumpsters and trash cans ▪ Fly larvae (maggots) may be seen at the bottom of trash cans ▪ Flies that enter buildings will congregate around windows ▪ Flies may be seen crawling on or flying around organic debris ▪ Visual surveys of adult flies should also identify where flies are entering a building and where they are breeding. Bites: ▪ Adult stable flies will inflict a painful bite on humans, dogs, and livestock. ▪ Most filth flies do not bite. Trapping: ▪ Light traps: Flies are attracted to ultraviolet light and trapped on a sticky pest strip. These traps can also be used to control adult flies as well as monitor populations. ▪ Sticky traps: Place around areas where filth flies are known to be a problem. Many types contain visual lures. ▪ Pheromone traps: Fly pheromones (such as muscamone) attract flies to a container. Speck counts: ▪ 3X5 index cards may be placed around areas to be monitored. Flies that land on the cards will leave vomit or fecal specks that can be counted. Though inexpensive and simple, this technique gives no indication of fly species, and may overestimate fly numbers since a single fly may leave multiple specks. Note: Identification of adult flies is helpful in determining where flies are breeding, in order to target control at the source of the infestation. If the breeding location of the flies cannot be found, collect some flies and identify or send to an
Survey Frequency/ Schedule	▪ Visual observations should be made around likely breeding sites (i.e. dumpsters). ▪ Traps should be inspected weekly. More frequent inspection may be necessary if sticky traps are placed in areas where they will quickly become covered with dust, insects, or other debris.
Action Threshold(s)	▪ The presence of biting flies in numbers constituting a nuisance for people or animals indicates a need for control within 24 hours if it is interfering with the mission or activities. ▪ In sensitive areas (i.e. kitchens, medical facilities) the threshold should be low: 2 flies/room. ▪ For counts on sticky traps, 100 flies per week indicates a need for control.

Non-Chemical Control

Type	Method	Responsibility
Sanitation	▪ Eliminating breeding sites is critical for effective filth fly control. ▪ Filth flies often breed in neglected refuse containers. ▪ Cover outdoor trash containers with tight-fitting lids. ▪ Empty trash containers frequently. ▪ Sanitize trash containers that have accumulated organic material. ▪ Steam clean dumpsters regularly.	All personnel, including: Self-Help Program Participants; JSP
Exclusion	▪ Seal cracks and other openings around doors and windows. ▪ Use tight-fitting screens. ▪ Air-curtains may be installed in commercial facilities.	Self-Help Program Participants; FMP
Trapping	▪ Ultraviolet light traps may be used to reduce adult fly populations in buildings invaded by flies. Light traps shall not be used outdoors. ▪ Exercise caution when placing traps; if the trap is visible from outside the structure, it may attract flies into the building. ▪ Traps by themselves are unlikely to control heavy fly infestations. ▪ Do not use bug zappers that electrocute flies in food-preparation areas or eating facilities. Use attractant light traps that collect flies on sticky traps.	All personnel, including: Self-Help Program Participants
Biological	▪ Several species of parasitic wasps can be purchased for use against filth flies. ▪ Biological control agents do not kill adult flies. Wasps lay their eggs in fly pupae, where the wasp larvae consume the developing fly, preventing it from emerging. ▪ Biological control agents will not sting or otherwise harm humans or animals. ▪ Biological control agents are not compatible with chemical insecticides. ▪ Release timing, climatic conditions, release frequency, and number of agents released are all critical for biological control success. ▪ Contact pest management consultants for additional information before instituting a biological control program.	In-House PMP; Contracted PMP
Education	▪ Educate building occupants on sanitation, excluding flies by closing doors and maintaining screens, and proper food storage	In-House PMP; IPMC

Chemical Control

Application Site	▪ Fly resting areas	
Site Preparation	Do not apply residual insecticides during high temperatures, high winds, or if precipitation is expected.	
Sensitive Areas	▪ Food service areas. Ensure that the insecticide is labeled for use in food preparation areas, and that foods are not contaminated during application. ▪ Emphasize non-chemical control in these areas. ▪ Ensure that insecticides do not enter drains, streams, lakes and other surface water.	
Restrictions / Regulations / Permits	▪ Do not apply liquid or dust formulations in occupied spaces. ▪ Dichlorvos is a carcinogen and cannot be placed in occupied spaces.	
Common Active Ingredients	▪ Neonicotinoids ▪ Pyrethroids ▪ Methomyl ▪ Cyromazine ▪ Other insecticides	
Methods of Application		**Authorized Applicators**
Non-residual space spray or aerosol	▪ Will temporarily control adult fly populations in buildings and outdoors. ▪ Will not provide long-term control unless breeding sites are eliminated.	In-House PMP; Contracted PMP
Residual insecticides	▪ May be applied to outside areas where adult flies rest. ▪ Will not provide long-term control unless breeding sites are eliminated.	In-House PMP; Contracted PMP
Baits	▪ May be used around refuse containers and other places to which flies are attracted. ▪ Pheromone baits are commonly used so that competing food sources are not a problem. ▪ Do not use baits indoors or in other areas where flies are not already present. ▪ Baits may attract flies to an otherwise fly-free area.	In-House PMP; Contracted PMP
Impregnated strips	▪ Plastic strips impregnated with dichlorvos will kill adult flies. ▪ Use only inside trash cans or other unoccupied spaces.	In-House PMP; Contracted PMP
Insect repellents	▪ May be used on humans for temporary prevention of fly bites. ▪ Will not provide long-term control of fly populations, and must be frequently re-applied.	All personnel

Larvicides	▪ Control fly larvae in breeding sites. ▪ Can be used simultaneously with adulticides. ▪ Some larvicides are insect growth regulators with lower toxicity for non-target organisms.	In-House PMP; Contracted PMP

Contract or Work Considerations

Time Period to Respond	Indoor infestations should have shorter response time than outdoor infestations.
Time Period to Obtain Control	Most control methods result in rapid kill and so control should be obtained in a short period of time
Level of Control	100% control indoors. Outdoors the level can be lower depending on the level of tolerance by people around the buildings. If the source of flies is treated then you should expect 100% control in that area.
Safety Considerations	▪ Take precautions when using pesticides around food service areas ▪ Applicator should use personal protective equipment as required by the product label
Environmental Considerations	▪ Avoid contaminating water with pesticides. ▪ Space spraying outdoors can result in drift and impact on non-target organisms.
Special Applicator Qualifications	▪ Fly control using non-chemical/biological methods may be used by non-certified personnel as part of the Self-Help Program. ▪ All PMP or GMP applying pesticides (including herbicides) must be DOD or State-certified as pesticide applicators.

Additional Information

The numbers of products available for filth fly monitoring and control is overwhelmingly large. The efficacy of a given product often depends on local climatic characteristics, the severity of the infestation, the species comprising the infestation, and other localized conditions. Also, many products are available that do not work, or whose efficacy is unproven. Pest management consultants or county or state extension personnel can assist with choosing fly control methods that are most appropriate for a given area.

Resources

http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7457.html
http://www.acq.osd.mil/eie/afpmb/docs/techguides/tg30.pdf
http://www.acq.osd.mil/eie/afpmb/docs/techguides/tg29.pdf

IPM Outline 3
Ticks

Target Pest or Group	Ticks
Target Area(s)	Outdoors, especially near or in wooded areas.
npact on Mission	To prevent the spread of tick-borne diseases.
Scope	Near training or encampment areas.
Responsibility	▪ <u>All personnel</u>: Wear proper clothing and use repellents when working or training in areas where there are ticks. ▪ <u>Pest Management Provider (PMP), In-House or Contract</u>: Apply pesticides, as needed. ▪ <u>Grounds Maintenance Provider (GMP)</u>: Mowing and removal of vegetation. ▪ <u>IPMC/Environmental Office</u>: Surveillance. Recommendations and approval for land modifications near improved areas to eliminate tick harborage.
Reporting	Record all pest management operations using the Pesticide Management Treatment Record Form and report usage to the IPMC every month

Survey

Survey Method(s)	▪ Personnel complaints. ▪ Cloth drag surveys. ▪ CO_2 ground traps.
Survey Frequency / Schedule	▪ As needed. ▪ Areas identified by personnel complaints, or with a history of infestation.
Action Threshold(s)	▪ 5 or more adult vector species captured in a 5 minute drag near training or encampment areas.

	▪ During declared disease emergencies, one or more adults or nymphs that have been identified as carrying the disease within 5 miles. NOTE: Action thresholds can be changed on advice of an APHC entomologist

Non-Chemical Control

Type	Method	Responsibility
Cultural	▪ Personnel should wear proper clothing such as long pants with the legs tucked into their socks and boots. ▪ Tick infested areas should be avoided for use when an alternative site is feasible.	All personnel
Habitat Modification	▪ Eliminate brush and high grass from training, encampment, improved and high traffic areas. ▪ Mow and otherwise clear overgrown areas next to wood margins with substantial under story. ▪ Rake up leaf litter in smaller, contained areas that receive high human use. ▪ Controlled burning, where environmentally acceptable, has been shown to reduce tick populations for six months to a year.	GMP
Prohibited Items	Use of ultrasonic pest repelling devices is prohibited.	

Chemical Control

Application Site	Apply pesticides as required based on survey information.
Site Preparation	Pre-treatment procedures: ▪ Visual inspections. Post-treatment procedures: ▪ Populations of ticks can be expected to fully recover within 18 months of the last treatment.
Sensitive Areas	▪ Waterways. Avoid stormwater runoff of insecticides and do not apply directly to water. Many insecticides are highly toxic to aquatic organisms. ▪ Areas with high density of pollinators. Many acaricides are highly toxic to bees, butterflies and other beneficial pollinators.
Restrictions	▪ Making large area applications when personnel are present is prohibited

Common Active Ingredients	Repellents for Personal Use: ▪ DEET ▪ Permethrin Residual Pesticides: ▪ Bifenthrin ▪ Cyfluthrin ▪ Cyhalothrin ▪ Cypermethrin ▪ Deltamethrin ▪ Esfenvalerate ▪ Resmethrin ▪ Other synthetic pyrethroids ▪ Pyrethrins or natural Pyrethrum	
Types of Pesticides		**Authorized Applicators**
Repellents	▪ Tick repellent should be applied to exposed skin and around the edge of openings in clothing such as cuffs and waistbands and around boot tops. ▪ Effectiveness of skin-applied repellents decreases over time, especially if the user sweats. They should be periodically re-applied. ▪ Treating clothing with an approved tick repellent pesticide containing DEET or Permethrin to provide additional protection. ▪ Never apply Permethrin directly to the skin.	All personnel
Barrier sprays or granules	▪ Vegetation surrounding training areas and encampments may be treated with a pesticide that leaves a residual barrier to ticks. ▪ Dispersal is done with a back-pack or truck-mounted power sprayer ▪ Reapply if needed in 4 to 6 weeks (or as directed on the pesticide label).	In-House PMP; Contracted PMP

Contract or Work Considerations

Time Period to Respond	Ticks are generally not an emergency and do not require immediate response. If high densities of ticks are found in bivouac areas during training exercises, immediate response may be necessary.
Time Period to Obtain Control	Immediately after treatment.
Level of Control	It is not possible to totally eliminate tick pest populations; control is achieved when the human health concern has been reduced to a nuisance level.
Safety Considerations	▪ Applicators must wear personal protective equipment as required by the product label. ▪ Permethrin repellent should never be applied directly to the skin.
Special Applicator Qualifications	▪ All PMP or applying pesticides (including herbicides) must be DOD or State-certified as pesticide applicators. ▪ Repellents used for personal protection are exempt from applicator certification requirements. However, they must always be applied in accordance with the label directions.

Additional Information

All personnel should check for ticks after working or training in areas where ticks are known to occur.

Removing ticks within 24 hours of their attachment significantly decreases the chances of contracting tick-borne diseases.

Care must be taken when removing an attached tick. Not every tick is infested with a human disease pathogen, but all ticks should be treated as a risk to human health.

Do not apply heat (lighted match) to the tick in hopes it will release. This action may cause the tick to expel its contents (including disease pathogens, if present) into the bite victim.

Do not apply grease or coat the tick in Vaseline. This will kill the tick and likely cause it to expel its contents into the bite victim.

To remove a tick:

- Firmly grasp the head of the tick as close to the skin as possible with tweezers. If you grasp the tick by the abdomen and pinch with the tweezers, you may inject the contents of the tick (including any disease pathogens) into the bite victim. Pinch with only enough pressure to firmly hold onto the tick.
- With gentle but steady pressure, pull on the tick. Usually, the tick will release its hold. Ticks have hooks on their mouthparts and forceful removal may leave the mouthparts imbedded in the skin where they could cause a secondary infection requiring medical attention.

Resources

AFPMB TG 26, Tick-Borne Diseases: Vector Surveillance and control, http://www.acq.osd.mil/eie/afpmb/docs/techguides/tg26.pdf

AFPMB TG 36, Personal Protective Measures Against Insects and Other Arthropods of Military Significance http://www.acq.osd.mil/eie/afpmb/docs/techguides/tg36.pdf

IPM Outline 4
Nuisance Ants

Target Pest or Group	Black ants, Pavement ants, Odorous house ants, Pharaoh ants, Argentine ants, Crazy ants and other nuisance species.
Target Area(s)	Offices, food preparation areas, food storage, patios, barracks, medical treatment facilities.
Impact on Mission	Eat and contaminate food; make spaces uninhabitable or unusable.
Scope	Base-wide, in and around buildings.
Responsibility	▪ All personnel: Ensure proper sanitation in all living and working spaces. ▪ Self-Help Program Participants: Conduct integrated pest management to control infestations indoors and in outdoor living areas and around the perimeter of buildings using approved Self-Help control methods. ▪ Pest Management Provider (PMP), In-House or Contract: Conduct integrated pest management to control infestations indoors and in outdoor living areas and around the perimeter of buildings. ▪ Grounds Maintenance Provider (GMP): Control aphids and similar insects on ornamental plants. Aphids may attract and feed ants. ▪ Facilities Maintenance Provider (FMP): Perform facilities repairs and improvements that exclude and minimize pest infestations as requested.
Reporting	Record all pest management operations using the Pesticide Management Treatment Record Form and report usage to the IPMC every month.

Survey

Survey Method(s)	▪ Visual inspections
	  ▪ Observation of foraging scout ants or ant trails.
	  ▪ Follow ant trails to entryways into building and to food sources.
	  ▪ Follow ant trails to nests.
	▪ Personnel complaints: including information on when pests were observed, where, and how many.
	▪ Conduct pre and post-treatment surveys to determine whether control operations were effective.

Survey Frequency / Schedule	▪ Daily observation by building occupants. ▪ Monthly inspections by PMP, In-House or Contract, outdoors around buildings to identify ant nests.
Action Threshold(s)	▪ Food service areas: 3 per room ▪ Living areas: 5 per room ▪ Medical treatment facilities: 1 per room ▪ Grounds: 2 mounds per yard

Non-Chemical Control

Type	Method	Responsibility
Sanitation	▪ Thorough cleaning of potential food sources in buildings, especially coffee and food preparation areas. ▪ Thoroughly clean food preparation surfaces, countertops, and stoves. ▪ Remove and discard food scraps that may be attractive to ants. ▪ Clean up food and drink spills as soon as possible. ▪ Do not leave dirty dishes on countertops or in sinks	All personnel, including: Self-Help Program Participants
Mechanical Removal	▪ Use a wet sponge or cloth to wipe up ants. ▪ Spray ant trails with household cleaner or soapy water, then wipe up. ▪ This is **not** an effective control method for Pharaoh ants.	All personnel, including: Self-Help Program Participants
Pest-Proofing	▪ Put food in tightly sealed containers. ▪ Seal holes in walls with caulk or temporarily with petroleum jelly.	All personnel, including: Self-Help Program Participants
Control of Plant Insects	▪ Ants live in cooperation with some plant-infesting insects such as aphids. These insects produce sugars that are food for the ants, while the ants provide protection for the plant juice-sucking insects. Control aphids and other plant juice-feeding insects on plants	GMP

Education	▪ Proper food storage and sanitation to prevent infestations. ▪ Use of soapy water to control ants indoors.	In-House PMP, IPMC
Prohibited Items	▪ Use of ultrasonic pest repelling devices is prohibited.	

Chemical Control

Application Site	When non-chemical methods do not control pests to an acceptable level, apply pesticides to areas where ants nest or travel as based on surveillance information.	
Site Preparation	<u>Pre-treatment procedures</u>: ▪ Visual inspections. ▪ Pesticide applicator shall contact building occupants prior to pesticide applications. ▪ All food should be removed from exposed areas and processing equipment and utensils covered or stored. <u>Post treatment procedures</u>: ▪ Thoroughly clean all food preparation surfaces. ▪ Do not remove bait stations or other bait placements.	
Sensitive Areas	▪ Exposed food products, food containers, counter tops, or any surface where food may be stored or prepared, or any food storage area. ▪ Outdoors where children or pets may be exposed to pesticides. ▪ Medical treatment facilities. ▪ Waterways. Avoid stormwater runoff of insecticides and do not apply directly to water. Many insecticides are highly toxic to aquatic organisms.	
Restrictions	▪ Use baits and spot treatments indoors; do not apply to baseboards as a preventive residual spray. ▪ Do not apply liquid or dust formulations of insecticides in occupied spaces.	
Common Active Ingredients	▪ Abamectin ▪ Borate-based products ▪ Fipronil ▪ Hydramethylnon ▪ Indoxacarb ▪ Insect Growth Regulators (IGRs) ▪ Pyrethroids (i.e. bifenthrin, cyfulthrin, cyhalothrin, esfenvalerate, permethrin, tetramethrin) ▪ Sulfluramid	
Types of Pesticides		**Authorized Applicators**
Baits	▪ Bait stations can be used indoors or outdoors. ▪ Granular baits can be applied outdoors near nests. ▪ Baits are specific to the species of ant. ▪ Most effective since it kills the egg-producing queen of the colony. ▪ May require 2 to 7 days for complete control.	Self-Help Program Participants; In-House PMP; Contracted PMP

Barrier Spraying	▪ Application of a residual outdoors around a building may be necessary if there are many nests and entryways into the building. ▪ May also be necessary if nests are difficult to find. ▪ Usually requires periodic reapplication if ant nests are not destroyed. ▪ Application is not allowed in occupied interior spaces.	In-House PMP; Contracted PMP
Dusts	▪ Boric acid dust is an effective low toxicity insecticide that can be applied into wall voids where ants may be nesting. ▪ The treatment area should remain dry after the application to avoid washing the dust away. ▪ Application not allowed in occupied interior spaces.	In-House PMP; Contracted PMP
Granular Insecticides	▪ Acute toxicant in granular form. ▪ Only effective if applied directly to the nest.	In-House PMP; Contracted PMP

Contract or Work Considerations

Time Period to Respond	Ant infestations are generally not an emergency and do not require immediate response. At sensitive sites, such as medical treatment facilities, immediate response may be necessary
Time Period to Obtain Control	For indoor infestations control should be within 2 hours when liquid formulations are used. Baiting indoors or outdoors may take up to a week or more for complete control.
Level of Control	100% control indoors is required.
PMQAE Assessment	Usually customer complaints and follow-up are sufficient to assess efficacy of work.
Safety Considerations	▪ Liquid and dust insecticides should not be applied to occupied spaces or when food is exposed. ▪ Baits may be applied when spaces are occupied. ▪ Allow for ventilation of spaces after liquid insecticides have been applied. ▪ Clean food preparation surfaces after treatment. ▪ Applicators must wear personal protective equipment as required by the product label.
Environmental Considerations	▪ Pyrethroid insecticides can be highly toxic to aquatic organisms.
Special Applicator Qualifications	▪ Ant control using approved bait stations may be used by non-certified personnel as part of the Self-Help Program. ▪ All PMP or GMP applying pesticides (including herbicides) must be DOD or State-certified as pesticide applicators.

Additional Information

For most people, ants become a problem and require action only when they enter a building. Sometimes ants may nest in walls, especially if there is moisture in those areas. This is a common problem in bathrooms and kitchens. Surveys may be used to determine if the source of the infestation is indoors or outdoors. Control of ant nests outdoors during the spring and early summer may reduce ant problems later in the season. The most effective ant baits are slow acting which gives worker ants enough time to carry small amounts of bait back to the nest. Worker ants will feed the bait to the other ants and eventually kill the entire colony. For this reason, it may take several days to see results from baiting. Different species of ants prefer different forms of bait, and sometimes preferences even vary by season. Ants can be given a "taste test" of several baits to see which ones they prefer and to ensure bait is still effective for that species.

Resources

http://www.ipm.ucdavis.edu/PMG/menu.ants.html

http://www.extension.umn.edu/garden/insects/find/what-to-do-about-household-ants/

http://www.p2pays.org/ref/14/13177.pdf

IPM Outline 5

Mosquito Control

Target Pest or Group	Flying adult mosquito species.
Target Area(s)	All areas, base-wide.
Impact on Mission	▪ Transmission of mosquito-borne diseases to installation personnel ▪ Nuisance biting interfering with occupational and recreational activities
Responsibility	Installation Preventive Medicine Technicians (PMTs): Conduct adult mosquito trapping to identify problem areas and mosquito species. ▪ Map locations of trapping sites. ▪ Conduct disease risk assessments including pathogen testing if that laboratory capability is available. ▪ Provide information to personnel on how to prevent mosquito bites. Pest Management Provider (PMP), In-House or Contract, or Mosquito Control Provider: ▪ Conduct surveys to verify presence of adult mosquitoes at site to be treated. Treat only when and where adult mosquitoes are present. ▪ Use integrated pest management methods to control adult mosquitoes. ▪ Use pesticides in accordance with the label.

Responsibility (continued)	Natural Resources Manager (NRM): ▪ Review and approve mosquito control operations conducted in sensitive areas to ensure minimal impact on the environment. Integrated Pest Management Coordinator (IPMC): ▪ Coordinate with PMTs, control provider, PMPAR, and natural resource manager to identify mosquito-breeding sites that can be permanently eliminated by non-chemical methods. ▪ Maintain mosquito control operation records. Conduct pre- and post-treatment surveys to monitor efficacy of control measures. Facilities Maintenance Provider/Grounds Maintenance Provider (FMP/GMP): ▪ Keep building window and door screens in good repair. ▪ Remove tall and/or overgrown vegetation that provides resting areas for adult mosquitoes. Self-Help Program Participants: ▪ Conduct integrated pest management to control infestations in outdoor areas using approved Self-Help non-chemical control methods. Unit Commanders and Building Supervisors: ▪ Ensure maintenance of window and door screens. ▪ If screens are not available, keep doors and windows closed when mosquitoes are present. ▪ Ensure distribution of mosquito prevention and control information to personnel. All Personnel: ▪ Use personal protective measures to prevent mosquito bites.
Reporting	▪ PMTs report surveillance results to IPMC and Mosquito Control Provider. ▪ Record all pest management operations using the Pesticide Management Treatment Record Form and report usage to the IPMC every month.

Survey

Survey Method(s)	▪ Conduct surveys using visual assessments (i.e. landing counts) and/or traps at sites where personnel complain about mosquito bites to verify presence of mosquitoes. ▪ Record sites of verified complaints on a map. Use GPS device if available. ▪ Use traps weekly at same locations to reveal seasonal trends in mosquito abundance. Can be used in subsequent years to plan mosquito control program. ▪ Trap mosquitoes for virus testing.

Survey Frequency / Schedule	▪ Ongoing surveys by residents. ▪ Survey prior to application of adulticide. ▪ For visual surveys, post-treatment surveys may be conducted immediately after the treatment. ▪ For traps, within 24 hours after application.
Action Threshold	▪ Light traps: 25 biting females or 1 vector species in an un-baited light trap ▪ Landing counts: 4 per 15 minutes ▪ Disease emergencies declared: light traps: 1 female of a species which has been identified as carrying disease within 5 miles of base caught in a trap NOTE: Action thresholds can be changed on advice of a DOD entomologist or State Public Health Department personnel

Non-Chemical Control

Type	Method	Responsibility
Personal Protection	▪ Encourage use of repellents when outdoors in mosquito-infested areas. ▪ Products with the active ingredient diethyl toluamide (DEET) are most effective. ▪ Picaridin (KBR 3023) and IR3535 are also effective. ▪ Avoid outdoor activities at dusk and during the evening hours to lessen chances of being bitten. ▪ Wear long-sleeved shirts and pants when outdoors in mosquito infested areas.	FMP; GMP
Exclusion / Pest Proofing	▪ Window and door screens ▪ Remove tall weeds and overgrowth to remove possible resting areas for mosquitoes.	All personnel, including: Self-Help Program Participants; FMP; GMP
Traps	▪ Propane powered trapping devices that use heat and a chemical attractant have been shown to be effective for small to moderate area control of certain species of mosquitoes.	All personnel, including: Self-Help Program Participants

Chemical Control

Application Site	When the use of non-chemical methods and larvicide do not control adult mosquitoes to an acceptable level, apply adulticides based on surveillance information and risk of mosquito-borne disease.

Site Preparation	▪ Survey treatment site prior to application to ensure presence of flying mosquitoes. ▪ Ensure building occupants are given warning of spray operations if they will be in the area during treatment. They should be advised to stay indoors and keep doors and windows closed during spraying. ▪ Check for thermal inversion (the ground is cooler than the air) to ensure pesticide stays close to ground. ▪ Check for light wind (3-5 mph) perpendicular to path of vehicle travel to maximize swath width. ▪ Check direction of wind and ensure pesticides do not drift into environmentally-sensitive areas. The pesticide label will indicate what animal species are at risk for pesticide poisoning. ▪ Survey area surrounding treatment area to ensure that bee hives will not be in the path of pesticide drift.	
Sensitive Areas	▪ All ULV and aerial applied pesticides may affect aquatic organisms especially fish. Care should be taken to ensure proper insecticide droplet size, timing of application, environmental conditions and calibration of equipment.	
Restrictions / Regulations / Permits	▪ Pesticide applications to, over, or near waters of the US may require coverage under a NPDES Aquatic Pesticide Permit depending on size of treatment area.	
Common Active Ingredients	▪ Naled ▪ Malathion ▪ Permethrin ▪ Resmethrin ▪ d-Phenothrin (Sumithrin) ▪ Prallethrin ▪ Etofenprox ▪ Various Herbicides (for habitat reduction)	
Type	**Method**	**Responsibility**
Mosquito Adulticides	▪ Apply with ULV or fog generating ground equipment. ▪ Some chemicals may be corrosive and areas where cars are parked should be avoided or owners notified prior to application.	In-House PMP; Contracted PMP;_Mosquito Control Provider
Aerial Application of Adulticides:	▪ Emergency control operations as the result of a disease outbreak may require large area application of an adulticide. ▪ Aerial spraying with an appropriately labeled pesticide and application equipment may be used. ▪ An Aerial Application Statement of Need must be prepared by the IPMC and approved by the ARNG PMC prior to aerial application of pesticides. ▪ Additional NEPA documentation and permitting may be required	Contracted PMP; Mosquito Control Provider

Herbicides	▪ Herbicides may be used to remove vegetation where removal by mechanical means is impractical.	In-House PMP; Contracted PMP
Special Applicator Qualifications	▪ All PMP and Mosquito Control Providers applying pesticides (including herbicides) must be DOD or State-certified as pesticide applicators.	

Additional Information

See AFPMB Technical Guide No. 13 for information on ULV application of pesticides:
http://www.acq.osd.mil/eie/afpmb/docs/techguides/tg13.pdf

IPM Outline 6

Stinging Insects

Target Pest or Group	Wasps, hornets yellow-jackets and bees.
Target Area(s)	Outdoors.
Impact on Mission	▪ Stinging insects can cause painful stings, massive envenomization, or serious allergic reactions in personnel. ▪ Hives and nests can cause property damage and attract other unwanted pests.
Scope	▪ Outdoors where stinging insects are a threat to personnel. ▪ In occupied buildings and outbuildings where stinging insects nest.
Responsibility	▪ <u>Self-Help Program Participants</u>: Conduct integrated pest management to control infestations indoors, in outdoor living areas and around the perimeter of buildings using approved Self-Help control methods. ▪ <u>Pest Management Provider (PMP), In-House or Contract</u>: Conduct inspections and integrated pest management to control infestations through killing or removal. Remove wasp/hornet/yellowjacket nests and beehives in buildings. Relocate European honey bee swarms and beehives. ▪ <u>Facilities Maintenance Provider (FMP) and Grounds Maintenance Provider (GMP)</u>: Report any stinging insect nest sightings.
Reporting	▪ Record all pest management operations using the Pest Management Treatment Record and report usage to the IPMC every month. ▪ Unusually aggressive bee colonies should be immediately reported to the IPMC.

Non-Chemical Control

Type	Method	Responsibility
Discourage and Eliminate Nests	▪ Nests should be removed or relocated by trained personnel.	In-House PMP; Contracted PMP
Avoidance	▪ Stay away from stinging insects if possible.	All personnel
Eliminate Food Sources	▪ Feed pets indoors. ▪ Cover trash cans.	All personnel
Eliminate Standing Water	▪ Some stinging insects are attracted to water. ▪ Repair leaking outdoor faucets and other mechanical water sources. ▪ Eliminate standing water.	FMP; GMP
Traps (Wasps and Yellowjackets)	<u>Wasps, hornets and yellowjackets:</u> ▪ Trapping should start in the spring and be continued through the summer. Early elimination of the queen will reduce the size of populations later in the year. ▪ Lure traps – baited with a chemical attractant or with meat. ▪ Water traps – Meat hung on a string 1-2 inches over a bucket of soapy water. Cover bucket with mesh to exclude other animals. <u>Bees:</u> ▪ Swarming bees can be lured into a trap that mimics a nesting site. ▪ Trapped bees can be relocated to less populated areas.	In-House PMP; Contracted PMP
Mechanical Removal	▪ Wet/dry vacuums may be used to remove bees, but this should only be done by trained personnel.	In-House PMP; Contracted PMP
Pest Proofing	▪ Seal holes in exterior walls of buildings. Request support from facilities maintenance provider if necessary. ▪ Remove debris that can serve as nesting areas. ▪ Cover tree holes or fill with expanding spray foam.	FMP; GMP

Chemical Control

Application Site	▪ Apply pesticides, as required based on survey information, to areas where stinging insects are known to harbor or rest.

Site Preparation	Pre-treatment procedures: ▪ Determine the extent of nesting in buildings to determine whether hive removal will be necessary after removing bees. ▪ Ensure the safety of people in the immediate area of the treatment. Do not allow unprotected bystanders to watch control procedures ▪ Pest management personnel should don protective bee suits. Post-treatment procedures: ▪ Remove dead bees and hive material from buildings. The melting of hive materials can cause extensive damage to building structures as well as attract other pests.	
Sensitive Areas	▪ Places where personnel may be harmed by bees or pesticide application. ▪ Buildings that may be damaged by hives.	
Restrictions	▪ Do not apply water-based aerosol pesticides in vicinity of electrical equipment. ▪ Do not apply liquid, aerosol or dust formulations of insecticides in occupied spaces.	
Common Active Ingredients	▪ d-trans Allethrin ▪ Cypermethrin ▪ Deltamethrin ▪ Ethofenprox ▪ Esfenvalerate ▪ lambda-Cyhalothrin ▪ n-Octyl bicycloheptene dicarboximide ▪ Permethrin ▪ d-Phenothrin ▪ Piperonyl butoxide ▪ Prallethrin ▪ Pyrethrins ▪ Prallethrin	
Types of Pesticides		
Aerosol Knockdown Agents	▪ High pressure aerosols that can be applied from a long distance can be used. ▪ Application of these insecticides results in a rapid knockdown of the insects.	Self-Help Program Participants, In-House PMP; Contracted PMP
Dusts	▪ Dusts can be applied to nesting areas.	In-House PMP; Contracted PMP
Baits	▪ Baits mixed with a toxicant can be used for wasps, hornets and yellowjackets.	In-House PMP; Contracted PMP

Environmental Considerations	▪ Ensure that insecticides do not enter drains, streams, lakes and other surface water. ▪ Some pollinators (including bees) are protected under the Endangered Species Act. Check with your Environmental Natural Resources office to determine if you have any protected species of bees in your area.
Special Applicator Qualifications	▪ Stinging insect control using approved aerosol insecticides may be used by non-certified personnel as part of the Self-Help Program. ▪ All PMP applying pesticides must be DOD or State-certified as pesticide applicators.

Additional Information

Rusty patched bumble bees are a protected species and should never be harmed. For more information and to learn how to identify these endangered bees from other common bumble bees, go to: https://www.fws.gov/midwest/endangered/insects/rpbb/pdf/RPBBFactSheet10Jan2017.pdf

Resources

http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7450.html

IPM Outline 7
Subterranean Termites

Target Pest or Group	Several species of termites in the family Rhinotermitidae, particularly: ▪ Arid Land Subterranean Termite – *Reticulitermes tibialis* ▪ Dark Southeastern Subterranean Termite – *Reticulitermes virginicus* ▪ Desert Subterranean Termite – *Heterotermes aureus* ▪ Eastern Subterranean Termites – *Reticulitermes flavipes* ▪ Western Subterranean Termite – *Reticulitermes hesperus*
Target Area(s)	Structures containing wood.
Impact on Mission	Damage to wood structures.
Scope	Base-wide, in and around buildings
Responsibility	▪ All personnel: Report termite sightings and damage to the IPMC, FMP or PMP. ▪ Pest Management Provider (PMP), In-House or Contract: Conduct integrated pest management to control infestations. ▪ Grounds Maintenance Provider (GMP): Perform grounds maintenance that minimizes pest infestations, as requested. ▪ Facilities Maintenance Provider (FMP): Perform facilities repairs and improvements that exclude and minimize pest infestations, as requested. ▪ Construction and Facility Management Office (CFMO): Ensure design, construction and pre-treatment techniques that can help prevent subterranean termite infestations are used in all new construction and structure renovations.
Reporting	Record all pest management operations using the Pesticide Management Treatment Record Form and report usage to the IPMC every month.

Survey

Survey Method(s)	Visual Inspections: ▪ Inspect wood that is touching or near the soil surface. ▪ Pay particular attention to wood that is damp. ▪ Look for shelter tubes in crawl spaces and in walls. ▪ Termite galleries will be filled with excrement and other debris ▪ Infested wood may be discolored (darkened) and can often be easily punctured by a knife or screwdriver. ▪ The surface of a severely damaged piece of wood may appear blistered or peeled. ▪ Conduct pre and post-treatment surveys to determine whether control operation was effective.
Survey Frequency / Schedule	▪ Annually in most regions. ▪ Biannually in arid regions. ▪ Ongoing observation by building occupants. ▪ During inspections done by PMP for other wood destroying pests, such as carpenter ants, as they occur.
Action Threshold(s)	▪ Presence of termites infesting wood indicates a need for control.

Non-Chemical Control

Type	Method	Responsibility
Building Design	Several design and construction techniques can help prevent subterranean termite infestations: ▪ Use wood species that are resistant to termite attack. ▪ Keep all wooden components at least 12-inches above the surface of the soil. ▪ Replace soil around the foundation of the building with sand (particle size ranging from 10 to 16 mesh). Before pouring slab, install termite-resistant mesh and eliminate openings around plumbing and other utilities protruding from slab. ▪ Provide adequate ventilation in crawl spaces to keep wood dry.	CFMO, FMP
Cultural	▪ Do not place firewood or other wood against the outside of the building. Doing so can: ▪ Bring wood infested with termites into proximity to the building. ▪ Provide habitat for termites. ▪ Hold moisture next to the building. ▪ Prevent inspection of that section of the building. ▪ Do not allow lawn sprinklers to constantly hit wooden portions of the building or allow water to puddle next to building foundations.	All personnel, FMP, GMP
Physical/ Mechanical	▪ Reduce sources of moisture, such as condensation and leaks.	FMP, GMP

	▪ Trim vegetation against siding and roofs. ▪ Use sealants, such as caulking, to minimize access into buildings. ▪ Clean gutters and ensure they are pitched for proper drainage. ▪ Check to ensure soffits are seated and roofing materials are in good repair. ▪ Replace severely damaged wood. ▪ Remove scrap wood from around structures. ▪ Replace soil around foundation and in crawl spaces with sand. Sand particles should be 10 to 16 mesh. Termites are unable to tunnel through sand.	
Prohibited Items	Use of ultrasonic pest repelling devices is prohibited.	

Chemical Control

Application Sites	▪ Structures containing wood that are infested with termites. ▪ Construction sites determined to be good candidates for pre-treatment.
Site Preparation	<u>Pre-treatment procedures</u>: ▪ Visual inspection of crawl spaces and review of structural plans to determine the best locations for insecticide injections. ▪ Pesticide applicator shall contact building occupants prior to pesticide applications. ▪ All food should be removed from exposed areas and processing equipment and utensils covered or stored. ▪ Cover furnishings and surfaces to protect from dust generated during drilling. <u>Post treatment procedures</u>: ▪ Do not remove bait stations or other bait placements. ▪ Thoroughly clean surfaces and furnishings that may have been covered with dust during drilling ▪ Plug drill holes with cement, caulking, or other appropriate material and repair any other damages associated with drilling and termite survey. ▪ Thoroughly clean all food preparation surfaces in treated buildings.
Sensitive Areas	▪ If properly applied, insecticide pre-treatments and injections should pose little risk of unwanted insecticide exposure. ▪ Bait stations should be placed to minimize the chances that children or facilities maintenance personnel will disturb them. ▪ Ensure that insecticides do not enter drains, streams, lakes and other surface water.
Common Active Ingredients	▪ Diflubenzuron ▪ Fipronil ▪ Hydramethylnon ▪ Sulfluramid ▪ Plus other termiticides

Types of Pesticides		Authorized Applicators
Chemically Treated Lumber	▪ Use lumber near the soil surface that has been impregnated (pressure treated) with a variety of repellent/fungicidal/insecticidal chemicals prior to construction. ▪ Some of these products are also available for topical application to wood after construction. ▪ These products are not effective for controlling pre-existing termite infestations.	FMP; Construction Contractors; In-House PMP; Contracted PMP
Pre-Construction Soil Treatment	▪ The soil under and around the perimeter of a slab is treated with an insecticide prior to construction. ▪ The insecticide acts as a barrier, either by killing termites that contact the treated soil. ▪ Only non-repellent termiticides should be used.	In-House PMP; Contracted PMP
Baits	▪ Bait stations containing a slow acting insecticide are placed around the building. ▪ Termites feed on the bait, then return to the colony where they share the bait with other members of the colony. ▪ Although some baits are available to the general public, proper and thorough bait placement is critical to the success of the procedure and must be performed by pest management personnel with experience in termite baiting.	In-House PMP; Contracted PMP
Soil Insecticide Injection	▪ Most common method for controlling termites if a pre-construction chemical barrier fails or was never applied. ▪ Holes are drilled through the foundation of the building, and insecticides are injected into the soil. ▪ Insecticides will kill termites already infesting the building and prevent future infestations for several years. ▪ A licensed professional is need for this work. Applying pesticide to the wrong place can cause contamination in the plumbing or heating ducts.	In-House PMP; Contracted PMP

Contract or Work Considerations

Time Period to Respond	Subterranean termite infestations progress very slowly. Take time to select the proper control measures and find a PMP with termite-control experience.
Time Period to Obtain Control	Termiticides are slow acting. Treatments target not only foragers but the colony and queen as well, and require time before there is a noticeable effect.
Level of Control	Once the colony is destroyed control level should be 100%
PMQAE Assessment	▪ Observe mixing and application during pre-construction treatments to ensure that the PMP uses the proper concentration and amount of termiticide, and that the ground is thoroughly treated to prevent gaps in coverage. ▪ Conduct pre and post-treatment surveys with PMP for post construction treatments to determine efficacy.

Safety Considerations	▪ Applicators must wear personal protective equipment as required by the product label.
Environmental Considerations	▪ Termiticides have a long residual in soil. Care must be taken when applying to prevent contamination of non-target areas.
Special Applicator Qualifications	▪ All PMP must be DOD or State-certified as pesticide applicators. ▪ Subterranean termite control is NOT part of the Self-Help Program.

Resources

http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7415.html
http://www.acq.osd.mil/eie/afpmb/docs/techguides/tg29.pdf

Subterranean termite shelter tubes.

IPM Outline 8
Mice and Rats

Target Pest or Group	Norway rats, roof rats, house mice, and deer mice
Target Area(s)	Buildings, utility vaults, and other structures
Impact on Mission	▪ May transmit disease ▪ Contaminate food ▪ Damage equipment ▪ Nuisance / morale
Scope	Only commensal rodents and those that are frequent pests of structures. Does not include landscape rodents such as gophers and squirrels.
Responsibility	▪ All personnel: Ensure sanitation and other measures to prevent introduction and propagation of pests. ▪ Self-Help Program Participants: Conduct integrated pest management to control infestations indoors and around the perimeter of buildings using non-chemical control methods. ▪ Pest Management Provider (PMP): Conduct integrated pest management to control infestations. ▪ Facilities Maintenance Provider (FMP): Perform facilities repairs and improvements that exclude and minimize pest infestations as requested. ▪ Grounds Maintenance Provider (GMP): Remove potential food sources (i.e. fruit on trees) and create barriers (i.e. by vegetation removal) around buildings to deter rodent invasion. ▪ Natural Resources Manager (NRM): Provide guidance when rodent control operations may impact endangered or threatened species or species of concern.
Reporting	▪ Record all pest management operations using the Pesticide Management Treatment Record Form and report usage to IPMC every month.

Survey

Survey Methods	▪ Visual inspections: observations of rodents or signs of rodents, such as nests, rubmarks, gnawing, earth mounds, burrows, etc. ▪ Use of tracking powder ▪ Personnel complaints: including information on when pests were observed, where, and how many. ▪ Conduct pre and post treatment surveys to determine whether control operations were effective ▪ Use of ultraviolet inspection lights (rodent urine and hair will fluoresce under UV light)
Survey Frequency / Schedule	▪ Daily observation by building occupants. ▪ Routine facilities inspections by PMP or pest control service provider.
Action Threshold(s)	Sighting of any rodent or sign of rodent in or immediately surrounding the building.

Non-Chemical Control

Type	Method	Responsibility
Sanitation	▪ Remove or prevent access to all potential food and harborage sources inside and outside of buildings.	All personnel, including: Self-Help Program Participants
Eliminate Standing Water	▪ Fix plumbing leaks around buildings	FMP
Rodent Proofing	▪ Trim ornamental plants and trees to remove harborage. ▪ Seal holes that may serve as entryways through exterior walls. ▪ Trim tree limbs so that they are at least 6 feet from buildings. ▪ Trim vegetation around buildings. ▪ Clean up debris from inside and around buildings. ▪ Request support from facilities maintenance and/or grounds maintenance provider if necessary.	FMP, GMP
Habitat Modification	▪ For field mice: removing vegetation and disking soil in a barrier 50 ft. around buildings will prevent rodent invasion. This is usually done after area wide rodenticide application. ▪ Use of native landscaping will tend to reduce peridomestic and landscape rodent infestations. Avoid heavy ground covers that provide harborage and cover. This type of planting allows rodents to move into buildings from unimproved grounds.	GMP

Trapping	▪ Glue boards, snap traps, or other mechanical trapping devices. (see health precautions below)	Self-Help Program Participants, In-House PMP; Contracted PMP
Education	▪ Awareness of the importance of sanitation on preventing rodents ▪ Understanding and preventing diseases associated with rodents.	In-House PMP; IPMC
Prohibited Items	▪ Use of ultrasonic pest repelling devices is prohibited. ▪ Myth: Allowing cats to live around buildings controls rodent population. Reality: Cats are inefficient at rodent control especially when they are already being fed. In many situations, cats pose greater hazards than rodents.	

Chemical Control

Application Site	Apply pesticides as required based on survey information to areas where rodents are known to harbor, feed or travel.
Site Preparation	Pre-treatment procedures: ▪ Pesticide applicators shall contact building occupants prior to pesticide applications. ▪ All bait locations must be mapped. ▪ Bait stations should be secured to prevent removal. ▪ Bait stations must be properly labeled and marked with the date on which they were placed. Post treatment procedures: ▪ Bait stations should be checked to ensure that stations are refilled, intact, and no bait has fallen from them. ▪ Remove bait stations once post treatment surveys indicate that rodents have been eliminated.
Sensitive Areas	▪ Areas where people and non-target animals may come into contact with the rodenticide. ▪ Areas where endangered or threatened rodent species occur and may consume bait. ▪ Areas where rodents may be the primary food source for an endangered or threatened animal. ▪ Habitat destruction to reduce rodent food sources or harborage may also be destructive to critical habitats of endangered or threatened species. ▪ The IPMC must consult the NRM before any pest management operations are conducted outdoors on unimproved grounds or wildlands.

Common Active Ingredients	Second generation anti-coagulants: ▪ Brodifacoum ▪ Bromadiolone ▪ Difenacoum ▪ Difethialone First generation anti-coagulants: ▪ Diphacinone ▪ Chlorophacinone ▪ Warfarin Others: ▪ Zinc phosphide ▪ Cholecalciferol ▪ Bromethalin Fumigants: ▪ Aluminum phosphide

Types of Pesticides		**Authorized Applicators**
Bait	▪ Anticoagulant bait: Multi or single dose blocks or pellets; toxicant effect is delayed. ▪ Single dose acute toxicant bait: Acute toxicant effect. ▪ Liquid bait: Used in areas where water sources are scarce. ▪ All rodenticide baits must be applied in tamper-proof bait stations. ▪ Baits may also be applied directly into burrows in some circumstances and when explicitly allowed according to the product label.	In-House PMP; Contracted PMP
Fumigants	▪ Used for control of rodents in burrows. ▪ Fumigants are often restricted use pesticides and may require additional record-keeping and certification.	In-House PMP; Contracted PMP

Contract or Work Considerations

Time Period to Respond	▪ Rodents indoors require an immediate response. ▪ High priority areas (i.e. food service establishments) with known rodent problems may require continuous surveillance and subsequent baiting as part of a recurring contract.
Time Period to Obtain Control	▪ Trapping may take several days to complete. ▪ Most rodenticides have a delayed effect and may take 24-48 hours to kill the rodent.
Level of Control	100% indoors.
Safety Considerations	▪ Active ingredients in rodenticides are highly toxic to humans and precautions must be taken to prevent human exposure. ▪ Applicators must wear proper protective equipment as required by the product label

Environmental Considerations	▪ Rodenticides can adversely impact non-target animals through direct poisoning or secondary poisoning. ▪ Traps, such as sticky traps, may catch non-target animals such as reptiles and birds. Sticky traps should only be used indoors.
Special Applicator Qualifications	▪ Rodent control using mechanical methods (traps) may be used by non-certified personnel as part of the Self-Help Program. ▪ All PMP applying pesticides must be DOD or State-certified as pesticide applicators.

Additional Information

Precautions on indoor rodent control:

- Most rodents are infested with ectoparasites (fleas, mites, lice) that may also infest or transmit disease to humans. Ectoparasite control should be conducted prior to eliminating (trapping or rodenticides) rodents.
- Rat control indoors using rodenticides should be avoided. The most commonly used rodenticide baits have a delayed toxic effect that does not kill the rodent until hours (or days for multi-dose) after they have consumed the bait. Rodents may die in walls and other voids where the carcass is difficult to retrieve leading to odor problems caused by the decaying carcass.

Disease Prevention:

Rodents can harbor a number of human disease agents; among them are hantavirus and plague. Precautions must be taken when working in rodent infested areas. Rodent feces and dried urine may contain hantavirus that is transmitted when these waste materials are inhaled. Precautions should also be taken when handling dead rodents in traps, and when carcasses are found after rodenticide use. The following precautions should be taken:

- Avoid disturbing feces and other rodent waste when entering enclosed spaces. Use a fitted respirator with high efficiency particulate air (HEPA) filter if necessary.
- Soak rodent waste and dead rodents with a household disinfectant or 10% bleach solution before removing.
- Wear gloves when cleaning or picking up rodent carcasses. Put material in a double plastic bag and dispose of in regular trash.

Resources

House mice: http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7483.html

Rats: http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74106.html

IPM Outline 9
Nuisance Birds



<table>
<tr><td>Target Pest or Group</td><td>Birds
Most birds are protected under the Migratory Bird Treaty Act (MBTA).
Without a permit issued by the U.S. Fish and Wildlife Service (USFWS), no actions that affect birds can be taken.
Actions that affect birds includes:
Harassment, using non-lethal means
Shooting
Live trapping for relocation
Removal of active nest (or inactive nest of eagles and threatened/endangered species of birds)
Or any action that is considered an impact by the USFWS.
Bald and Golden eagles are protected under the Bald and Golden Eagle Protection Act (BGEPA) that has greater protections and requirements than the MBTA.
The following birds are some of the common non-native birds to the United States. These birds are not protected by the MBTA or BGEPA:
European Starlings – Sturnus vulgaris
House Sparrows – Passer domesticus
Pigeons (or Rock Doves) – Columba livia domestica
Mute Swans – Cygnus olor</td></tr>
<tr><td>Target Area(s)</td><td>Areas near buildings or populated areas.</td></tr>
<tr><td>Impact on Mission</td><td>Most birds do not pose any serious medical hazard or create a significant threat to government property or mission accomplishment.
Birds may carry diseases and parasites that can infect humans.
Bird feces may contain several pathogenic disease-causing organisms such as Histoplasma and Cryptococcus.
Nests may also contain ectoparasites, such as mites or swallow bugs (similar to bed bugs), that may feed on humans if there are no longer birds using the nest. While this is usually a minor medical issue, it can cause significant morale issues.
Birds that build nests or deposit feces on the exterior of structures can adversely impact the aesthetics of the structure and surrounding area.</td></tr>
</table>

Scope	▪ Base-wide (For control of birds at airfields/heliports, please refer to the site-specific Bird/Wildlife Airstrike Hazard (BASH/WASH) Plan or contact the IPMC.)
Responsibility	▪ Pest Management Provider (PMP), In-House or Contract: Conduct integrated pest management of nuisance birds. ▪ Facilities Maintenance Provider (FMP): Perform facilities repairs and improvements that exclude nuisance birds from buildings. ▪ Base Operation Support: Ensure that dumpsters and trashcans are emptied on schedule, and that they are securely covered to prevent entry by nuisance birds. ▪ Natural Resources Manager (NRM): Provides information regarding any regulatory protections of nuisance birds. ▪ All Installation Personnel: Practice good sanitation and do not feed unwanted or nuisance birds to prevent attracting them.
Reporting	▪ Record all pest management operations to the IPMC using the Pest Management Treatment Record and report usage to IPMC every month.

Survey

Survey Method(s)	▪ Visual sighting of birds, nests or bird feces.
Survey Frequency / Schedule	▪ As needed.
Action Threshold	▪ Any verified sighting of a bird where it enters a building or poses a safety or health hazard.

Non-Chemical Control

Type	Method	Responsibility
Exclusion	▪ Primary methods for controlling nuisance birds. ▪ Use screening, hardware cloth and metal flashing to cover holes and cracks to prevent entry of birds into buildings. ▪ Use netting to prevent access to the area under building eaves. ▪ Use lids / covers that can be secured on dumpsters and trashcans.	FMP; PMP
Cultural	▪ Keep loading dock doors and unscreened windows closed when not in use. ▪ Deny access to trash and other sources of food. ▪ Prevent personnel from feeding birds other than at authorized bird feeding locations. ▪ Repair leaking plumbing to remove sources of water. ▪ Raising the mowing height of grass can discourage nuisance birds (especially Canada geese). ▪ Erect nesting platforms for birds such as osprey to offer nesting locations other than power poles.	All personnel

Mechanical/ Physical	▪ Nesting in and roosting on buildings can be reduced by architectural modifications of ridges and openings.
	▪ Silicone-based, anti-graffiti paint can be used to discourage nesting of swallows (the surface of the paint is too slick for the mud nests to stick to it).
	▪ Removal of inactive nests (unless it is an eagle or threatened/endangered species nest).
	▪ Power washing with water can remove inactive nests, but NRM must be consulted prior to any nest removal.
	▪ Shooting may be used to control small populations (i.e., geese, crows) in areas where:
	  ▪ Shooting is legal and completed by a professional.
	  ▪ Shooting can be safely conducted.
	  ▪ Appropriate permits have been obtained.
	▪ Must have NRM coordination and oversight.
		FMP; Qualified PMP; NRM coordination

Trapping	▪ Live cage-type traps may be used for birds, especially if inside buildings. ▪ Lethal trapping may be appropriate in instances when nuisance birds are non-native species. ▪ Extreme care must be taken to prevent killing non-target animals. ▪ All trapping of nuisance birds must be done with coordination and oversight of the NRM.	PMP In-House or Contract; NRM coordination
Harassment	▪ Use of specially-trained dogs can be very effective to discourage non-migratory Canada geese from foraging/roosting on turf in cantonment areas. ▪ Flashing lights and sounds typically have only temporary effects and are not recommended for most circumstances. ▪ All harassment of nuisance birds must be done with coordination and oversight of the NRM.	PMP In-House or Contract; NRM coordination
Prohibited Practices	▪ Use of electronic or ultrasonic pest repelling devices is prohibited. ▪ Predator (owls, coyotes, etc.) statues/decoys are ineffective and prohibited. ▪ Relocation of trapped animals farther than one mile from point of capture is prohibited. ▪ Killing, trapping, relocating or harassing any birds protected under the MTBA, BGEPA and/or Endangered Species Act (ESA) is prohibited, unless the proper permit/authorization is obtained.	
Sensitive Area/ Environmental Concerns	▪ Coordinate with the Cultural Resources Manager (Environmental Office) before undertaking any architectural modifications involving buildings or structures over 50 years old; allow sufficient time for coordination, as consultation outside VAARNG might be required. ▪ Most birds are protected and the identity of nuisance bird species should be certain before any control work takes place.	
Permitting	▪ The appropriate USFWS permit/authorization must be obtained if control actions have any potential to affect MBTA, BGEPA or ESA-protected birds (birds other than European Starlings, Pigeons, House Sparrows, and Mute Swans).	

Special PMP Qualifications	▪ All PMPs performing bird control should hold appropriate licenses and permits to legally capture, transport and release (or euthanize) nuisance birds. ▪ Nuisance birds should never be handled alive or dead with bare hands. PPE should be worn when removing inactive nests and/or bird feces.

Chemical Control

Chemical control (avicides) is rarely used for the control of birds at ARNG sites. Chemical control is only performed in extreme cases, such as when birds are nesting on aircraft or causing danger to human life. In most cases, control is achieved with non-chemical methods since using avicides may kill endangered or threatened birds, and/or non-target species. All chemical control of birds must be pre-approved by the ARNG PMC.

Additional Information

Woodpeckers often "drum" on buildings during the mating season to attract a mate. Drumming typically does not cause any damage to the building. If a woodpecker is causing damage to a building, there is usually an infestation of wood-boring insects. More information on woodpeckers can be found in the link listed in the Resources section below.

Swallows (especially Cliff and Barn Swallows) may carry Swallow Bugs. Swallow Bugs are very similar in appearance to Bed Bugs. If there is a reported outbreak of Bed Bugs in buildings where swallows nest, ensure the infestation is actually Bed Bugs. Swallow bugs are considerably less costly to control than Bed Bugs and require different control techniques.

Some populations of Canada Geese have become non-migratory and may live year-round in cantonment areas, often where there is turf surrounding an ornamental pond. Limiting access to the pond with taller vegetation or a low fence around the entire edge of the pond can help to discourage the geese from using the area since geese prefer to walk into the pond rather than fly up and over a boundary to get to the water.

Resources

Swallow management: http://ipm.ucanr.edu/PMG/PESTNOTES/pn7482.html
Woodpecker management: http://ipm.ucanr.edu/PMG/PESTNOTES/pn74124.html

IPM Outline 9

Vertebrate Wildlife Pests

Target Pest or Group	Vertebrate pests, such as: ▪ Raccoons ▪ Skunks ▪ Squirrels and chipmunks ▪ Voles ▪ Moles and shrews ▪ Groundhogs ▪ Beavers ▪ Opossums ▪ Deer ▪ Coyotes, bobcats and other carnivores ▪ Other nuisance wildlife
Target Area(s)	Areas near buildings or populated areas.
Impact on Mission	▪ Wild and feral animals are dangerous when they are cornered and can become aggressive. ▪ Many wild and feral animals may carry rabies and other diseases and parasites that can infect humans. ▪ Nuisance wildlife can cause severe damage to buildings, other structures and equipment.
Scope	▪ Base-wide

Responsibility	▪ Pest Management Provider (PMP), In-House or Contract: Conduct integrated pest management of vertebrate pests. ▪ Facilities Maintenance Provider (FMP): Perform facilities repairs and improvements that exclude vertebrate pests from buildings. ▪ Base Operation Support: Ensure that dumpsters and trashcans are emptied on schedule and that they are securely covered to prevent entry by vertebrate pests. ▪ Natural Resources Manager (NRM): Provides information regarding any regulatory protections of vertebrate pests. ▪ All Installation Personnel: Practice good sanitation and do not feed wild and feral animals to prevent attracting them.
Reporting	▪ Record all pest management operations using the Pesticide Management Treatment Record Form and report usage to the IPMC every month.

Survey

Survey Method(s)	▪ Visual sighting of vertebrate pests or signs of raccoons. ▪ A number of vertebrate pests are nocturnal, so visual surveys may need to be conducted at night. ▪ Verify personnel reports of vertebrate pest activity.
Survey Frequency / Schedule	▪ As needed.
Action Threshold	▪ Any verified sighting of a vertebrate pest when it enters a building or poses a safety or health hazard.

Non-Chemical Control

Type	Method	Responsibility
Exclusion	▪ Use lids / covers that can be secured on dumpsters and trashcans. ▪ Use hardware cloth and metal flashing to cover holes and cracks to prevent entry of vertebrate pests into buildings. ▪ Repair leaking plumbing to remove source of water for vertebrate pests.	FMP

Trapping	▪ Live cage-type traps may be used for most wildlife and for feral cats and dogs. ▪ Use cat food containing fish or canned tuna as a bait for most vertebrate pests. ▪ Ensure that the target pest cannot reach through the back or side of the trap to steal the bait. ▪ Secure trap to the ground to prevent the animal from tipping it over. ▪ Lethal trapping may be appropriate for instances of nuisance wildlife that is not easily relocated or is a non-native species. ▪ Extreme care must be taken to prevent killing non-target animals. ▪ **All trapping of nuisance wildlife must be done with coordination and oversight of the NRM.**	PMP In-House or Contract; NRM coordination
Food Removal	▪ Deny access to trash and other sources of food. ▪ Prevent personnel from feeding wildlife and feral animals.	All personnel

Shooting	▪ Shooting may be used to control small populations in areas where:
	  ▪ Shooting is legal.
	  ▪ Shooting can be safely conducted.
	  ▪ Appropriate permits have been obtained.
	▪ Qualified marksmen should perform the shooting.
	▪ Not generally practical for large populations
	▪ **All shooting of nuisance wildlife must be done with coordination and oversight of the NRM.**
		Qualified PMP

Prohibited Practices	▪ Use of ultrasonic pest repelling devices is prohibited. ▪ Relocation of trapped animals greater than one mile from point of capture is prohibited. ▪ Killing, trapping, relocating or harassing any wildlife protected under the Endangered Species Act is prohibited.	
Special PMP Qualifications	▪ All PMP performing vertebrate pest control should hold appropriate licenses and permits to legally capture, transport and release (or euthanize) nuisance wildlife and vertebrate pests. ▪ Vertebrate pests should never be handled alive or dead with bare hands. ▪ All PMP performing vertebrate pest control should have pre-exposure immunization against rabies.	

Chemical Control

Chemical control is rarely used for the control of most vertebrate pests.

If sufficient control of vertebrate pests cannot be achieved using the non-chemical controls, contact your IPMC or the ARNG PMC for further guidance. Chemical control of some vertebrate pests may be allowed under certain circumstances. However, all chemical control of vertebrate pests must be in accordance with a site-specific IPM outline/SOP for chemical control of that pest.

Additional Information

Beaver management: http://agrilifecdn.tamu.edu/txwildlifeservices/files/2016/07/fs_beaver.pdf

Coyote management: http://icwdm.org/handbook/carnivor/coyotes.asp

Deer management: http://ipm.ucanr.edu/PMG/PESTNOTES/pn74117.html

Groundhog management: http://icwdm.org/handbook/rodents/woodchucks.asp

Mole management; http://ipm.ucanr.edu/PMG/PESTNOTES/pn74115.html

Opossum management: http://ipm.ucanr.edu/PMG/PESTNOTES/pn74123.html

Raccoon management: http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74116.html

Skunk management: http://ipm.ucanr.edu/PMG/PESTNOTES/pn74118.html

Squirrel management: http://ipm.ucanr.edu/PMG/PESTNOTES/pn74122.html

IPM Outline 10
Weeds and Unwanted Vegetation

Target Pest or Group	Grasses, broadleaf weeds and woody weeds.
Target Area(s)	Fence lines, road shoulders, parking lots, around fuel storage tanks, utility easements, sidewalks, landscaped areas, lawns and turf, recreational fields and ranges.
Impact on Mission	▪ Fire hazard. ▪ Dense weeds encourage rodent and other pest infestations. ▪ Weeds along roadways hide wildlife increasing the risk for vehicle and animal collisions. ▪ Weeds impair sight-lines along security fences and on training ranges. ▪ Degrades installation appearance.
Scope	Improved and semi-improved grounds, rights-of-way, fence lines, paved areas and ranges.
Responsibility	▪ <u>Self-Help Program Participants</u>: Conduct integrated pest management to control weeds using approved Self-Help control methods. ▪ <u>Pest Management Provider (PMP), In-House or Contract</u>: Conduct integrated pest management to control weeds. ▪ <u>Grounds Maintenance Provider (GMP) and/or Facilities Maintenance Provider (FMP)</u>: Mechanical control methods and/or mowing to reduce height of weeds.
Reporting	Record all pest management operations using the Pesticide Management Treatment Record Form and report usage to the IPMC every month.

Survey

Survey Method(s)	▪ Visual observation and identification during routine inspections. ▪ Annual surveys of roadways and fence lines. ▪ Personnel complaints of weeds impeding mission, contributing to pest infestations, fire hazard or degradation of aesthetics. ▪ Conduct pre and post-treatment surveys to determine whether control operations were effective.
Survey Frequency / Schedule	▪ Daily inspection of areas with extreme fire hazard. ▪ Weekly inspection of landscaped areas. Can be done in conjunction with regular landscape maintenance.
Action Threshold(s)	▪ There is a zero tolerance for weeds installation areas where ordinance or other flammable/explosive materials are stored, due to fire hazard. Consequently, visual sighting of any weed warrants control.

Non-Chemical Control

Type	Method	Responsibility
Mechanical Removal	Pulling or hoeing: ▪ Pull weeds either by hand or with tools that work well on large plants, such as a weed. ▪ Pull up as much root as possible since plants can re-sprout new shoots from the root. ▪ Digging or hoeing is sometimes used in conjunction with pulling to remove the entire root. ▪ Follow-up work will be necessary until desired plants become well established. Mowing: ▪ Mow unwanted plants before they have a chance to set seeds. Chaining: ▪ Drag heavy chains across the tops of target weeds, destroying the foliage and reducing weed density. Root plowing: ▪ Plow with horizontal blades beneath the surface of the ground to sever the root system of target weeds.	Self-Help Program Participants, In-House PMP, Contracted PMP, GMP (or FMP)
Steam	▪ Apply steam to foliage to kill plants. ▪ This technique is unlikely to be cost effective for most weed-control situations and is not recommended by the IPMC.	In-House PMP, Contracted PMP, GMP (or FMP)
Plant Competition	▪ Plant areas with desirable low-growing plants, such as native grasses, to shade-out and outcompete weeds.	GMP (or FMP)
Weed Control Mat	▪ Apply weed control matting. ▪ Matting is composed of synthetic polyester fibers spun tightly together to prevent weed growth by blocking sunlight while still allowing water percolation for drainage. ▪ The matting is unrolled to cover weed-infested areas.	GMP (or FMP)

Improve Vigor of Desirable Plants	▪ Healthy landscaping plants are better able to compete with weeds, thereby slowing the rate of weed invasion. ▪ Aerate and remove thatch in lawns. ▪ Maintain proper watering, fertilizing, and pruning schedules for desirable landscape plants. This is particularly important for managing crabgrass in turf.	GMP (or FMP)
Mulch	▪ Apply course-textured mulches up to 4 inches deep. ▪ Apply fine-textured mulches to a depth of about 2 inches. ▪ Organic mulches: wood chips, sawdust, yard waste, and bark chips. ▪ Inorganic mulches: sand, gravel and pebbles. Use a porous landscape fabric underneath to prevent mulch from sinking into soil. ▪ Synthetic mulches: include geotextiles and landscape fabric. Can be used in conjunction with organic and inorganic mulches.	GMP (or FMP)

Chemical Control

Application Site	When non-chemical methods do not control weeds to an acceptable level, apply herbicides as required based on survey information, to areas where target weeds are problematic.
Site Preparation	<u>Pre-treatment procedures:</u> ▪ Check the local weather forecast. Rain can reduce or negate the effectiveness of an herbicide by washing herbicide off the plant. If precipitation is expected in the next 24-hours, delay application. ▪ Modify irrigation schedule, if necessary. Ensure that sprinklers do not come on immediately following an herbicide application. ▪ Check the local wind conditions. Herbicides can drift and affect non-target plants if applied during windy conditions. ▪ Do not apply herbicides during high temperatures (>95ºF), as this can result in excess vaporization of the herbicide. <u>Post-treatment procedures:</u> ▪ Survey the area to establish the efficacy of control. The length of time between application and survey is dependent upon the species of weed being controlled. ▪ Multiple applications may be necessary, particularly if conditions during the first application were too warm, too dry, or too wet.

Sensitive Areas	▪ Use mechanical controls instead of chemical controls whenever possible around playgrounds and areas frequented by children. ▪ Natural areas containing endangered or threatened plant or animal species are normally off-limits for chemical weed control. Do not apply herbicides or allow herbicide drift onto these areas. ▪ Desirable landscape plants. Prevent herbicide drift onto these plants. ▪ Waterways. Avoid stormwater runoff of herbicides and do not apply directly to water unless allowed by the label. Many herbicides are highly toxic to aquatic organisms.	
Restrictions/ Permitting	▪ When applying herbicide to riparian areas or other sites near water, use only formulations labeled for aquatic sites. ▪ Herbicide applications to, over, or near waters of the US may require coverage under a NPDES Aquatic Pesticide Permit.	
Prohibited Items	▪ Application of salt to control weeds.	
Common Active Ingredients	▪ Glyphosate ▪ Imazapyr ▪ Dichlobenil ▪ Bromacil ▪ Diuron ▪ Pendimethalin ▪ Prometon ▪ Tebuthiuron ▪ Hexazinone ▪ Dicamba ▪ 2,4-D ▪ Diflufenzopyr ▪ Triclopyr ▪ Metsulfuron methyl ▪ Sulfometuron ▪ plus others	
Types of Pesticides		**Authorized Applicators**
Ready-to-Use Glyphosate Herbicides	▪ Spray herbicide directly onto the foliage of the weed. ▪ Apply after the weed emerges, but before seed set. ▪ Foliar application is most effective when weeds are young and the weather is clear. ▪ Spot treat weeds growing in paved areas.	Self-Help Program Participants; In-House PMP; Contracted PMP
Pre-Emergent Herbicides	▪ Apply herbicide to the soil before the first leaves emerge to prevent the weed from developing. ▪ Apply pre-emergent herbicides to the soil just before seed germination. ▪ Selective pre-emergent herbicides must be used so that desirable landscape plants are not harmed.	In-House PMP; Contracted PMP

Foliar-Sprayed Post-Emergent Herbicides	▪ Spray herbicide directly onto the foliage of the weed. ▪ Apply post-emergent herbicides after the weed emerges, but before flowering and seed set. ▪ Foliar application is most effective when weeds are young. ▪ Spot treat weeds growing in paved areas.	In-House PMP; Contracted PMP
Soil-Applied Post-Emergent Herbicides	▪ Apply herbicide to the soil around the weed. ▪ The herbicide is absorbed by the plant through its root system.	In-House PMP; Contracted PMP

Contract or Work Considerations

Time Period to Respond	Dependent on service levels. Can be scheduled annually for pre-emergent applications if there is an established history of weed problems.
Time Period to Obtain Control	Dependent on service levels. May take several days before signs of herbicide effect appear.
Level of Control	Dependent on service levels. Complete removal of weeds from sidewalks and other paved surfaces. For fence lines, weed should be low enough to maintain sight lines. Control weeds around fuel tanks to reduce fire risk.
Safety Considerations	▪ Applicators must wear personal protective equipment as required by the product label. ▪ Restrict entry of personnel into treated areas as directed by the product label.
Environmental Considerations	▪ Prevent herbicide drift to non-target areas and prevent contact with desirable plants. Avoid contaminating water.
Special Applicator Qualifications	▪ Small-scale weed control using approved low-toxicity, ready-to-use herbicides may be performed by non-certified personnel as part of the Self-Help Program. ▪ All PMP or GMP applying pesticides (including herbicides) must be DOD or State-certified as pesticide applicators.

Additional Information

Correct timing of the herbicide application is often essential for effective weed control. Timing will depend on the species of weed, the mode of action and persistence of the herbicide, non-chemical practices in use, soil conditions, and climate.

Resources

Weed Management in Landscapes: http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7441.html
Weed Management in Lawns: http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn74113.html
Roadside Weed Management: http://edis.ifas.ufl.edu/topic_roadside_weeds
Integrated Roadside Vegetation Management: http://www.tallgrassprairiecenter.org/irvm
DOT Roadside Vegetation Management: https://www.environment.fhwa.dot.gov/ecosystems/vegmgmt.asp

IPM Outline 11
Non-Native, Invasive/Noxious Weeds
In Natural Areas, Ranges and Training Areas

Target Pest or Group	Non-native plants that are widespread and adversely affect the habitats they invade, economically, environmentally or ecologically.
Target Area(s)	Natural areas, ranges, riparian areas, training areas, encroachment buffers.
Impact on Mission	▪ Control required by law ▪ Impacts access to and use of training areas and ranges ▪ Interferes with mission operations ▪ Degrades natural habitats ▪ Impacts endangered and threatened species habitats ▪ May increase wildfire hazard
Scope	Installation unimproved grounds.
Responsibility	▪ <u>Natural Resources Manager (NRM)</u>: Oversees weed program coordinating detection and control. ▪ <u>Pest Management Provider (PMP), In-House or Contract</u>: Conducts integrated pest management to control weeds. ▪ <u>IPM Coordinator (IPMC)</u>: Ensures environmental compliance of the program.

Control Strategy	▪ Develop a plan to determine what resources need protection against invasive species and which plants pose an actual threat. ▪ Place highest priority on the weeds that have the highest mission impact. ▪ The plan should include solid knowledge of the target plant, such as growing habit, how often it sets seed, months of seed production, etc. and a solid knowledge of the native species whose populations need to be maintained. ▪ Use the following resource: http://plants.usda.gov/java/noxiousDriver - Federal and State Noxious Weed Lists to help prioritize. . ▪ Strategy options are generally to eradicate or to control and maintain invasive species at an acceptably low threshold. ▪ One strategy is to map the infestation then break the map into sections depending on the density of the invasive weed. Some areas will be dense and completely overrun, while other patches are relatively free of weeds. Removal efforts should begin in outlier areas that are only lightly infested. Efforts should move gradually from the easiest areas to the more densely infested areas. The densest patches should be eliminated last. Refer to the Bradley Method referenced below. At each step of the way the areas targeted for clean-up must be of a size and quality that goals are achievable within one growing season. ▪ Because of the bank of seeds stored in the soil, weeds will re-sprout for years after the plants have been removed. In the case of some weeds, the seeds can survive for decades. It is important to return and maintain cleared areas until the seed bank has been exhausted. ▪ After weeds have been removed, it is important to recover the area in native plants to crowd out and help stop the reinvasion of invasive species.
Reporting	▪ Record all pest management operations using the Pesticide Management Treatment Record Form and report usage to the IPMC every month. Report invasive weed control operations to Natural Resources Personnel in cases where weeds are being removed to protect or restore natural habitats. ▪ Reporting of herbicide use and application monitoring to local Water Regulatory Agency is required when the operation is covered under a NPDES Aquatic Pesticide Permit.

Survey

Survey Method(s)	Visual inspection and mapping
Survey Frequency / Schedule	Ongoing inspection, especially in the spring and summer when plants are easy to identify by their blooms.
Action Threshold(s)	▪ Priority of control of weeds is based upon the Federal and State Noxious Weeds list and impact on mission. ▪ Areas of installations where ordinance or other flammable/explosive materials are stored have zero tolerance for weeds due to fire hazard. Consequently, visual sighting of any weed warrants control.

Non-Chemical Control

Type	Method	Responsibility

Prevention	▪ Preventing just one new invasive weed is of greater conservation benefit in the long run and is far less costly than controlling a widespread rampant pest.
	▪ Block the transport of plant materials onto relatively clean sites or sites that are actively being cleaned.
	▪ Common means of spreading plant materials are:
	  ▪ Tire tread from bicycles and vehicles
	  ▪ Vehicle undercarriages
	  ▪ Boot treads
	  ▪ Top soil; seeds are often brought in with imported soils
	  ▪ Seed mixes; Invasive species are often included in planting mixes.
	  ▪ Potted plants; Seeds are sometimes transported in the potting soil
	  ▪ Fill for construction sites such as rock fill and soil
	▪ Check plants that are intentionally brought in to ensure none of them are invasive.
	▪ Keep vehicles, tire treads and boots free of dirt and seeds before entering a sensitive area.
	▪ Import fill dirt and gravel from areas that do not have invasive weeds or purchase from suppliers that are certified weed free.
		NRM oversees prevention program

Pulling	▪ Tools are available that help pull weeds. ▪ When pulling plants bring as much of the root as possible out of the ground since many plants can re-sprout from even a small amount of root. ▪ Digging can be used along with pulling to lift the entire plant from the soil.	In-House PMP; Contracted PMP
Cutting	▪ Cutting works well for woody plants that do not re-sprout. Especially if those plants are cut as close to the ground as possible. ▪ If the plant is likely to re-sprout, chemical herbicides can be painted on top of the cut stump. ▪ For invasive trees the herbicide needs to come in contact with the cambial ring between the wood and bark of the trunk. The cambial tissues will transport the herbicide to the roots.	In-House PMP; Contracted PMP

Flaming	▪ Flaming does not involve incinerating the plant, rather to heat it just long enough to produce visible wilting. Heat causes cell walls to burst, which interrupts the flow of water and nutrients. ▪ Flaming is most effective when plants are in very early stages of growth. Older plants with significant stored reserves will require repeat applications and/or concentrating enough heat on the root crown to produce mortality. ▪ Flaming is generally used as a way of coping with the huge flush of seedlings which is often triggered by the removal of parent plants. ▪ This technique is most effective and best done when the ground and vegetation are too wet to carry fire. Avoid conditions that may lead to injury or wildfire.	In-House PMP; Contracted PMP
Solarization	▪ Weeds and insect pests can be killed by covering the ground with layers of clear plastic allowing the sun to create enough heat to destroy all living things.	In-House PMP; Contracted PMP
Prescribed Fire	▪ Prescribed fire can be effective in removing fire-sensitive invasive species from communities that evolved with fire. ▪ Blowtorches and flamethrowers can also be used to burn individual plants or small areas.	NRM Coordinates; In-House PMP; Contracted PMP
Competition and Restoration	▪ Use native plants to out-compete invasive weeds. To do so natives must be planted and cared for until they are well established. ▪ When choosing seed mixes choose seeds that are from adjacent sites and well adapted to the climate. ▪ Choosing plants from far away sources is a common cause of failure. ▪ Be careful of seed mixes that include other invasive plants.	NRM coordinates
Grazing	▪ Grazing animals can selectively control or suppress weeds. ▪ Cattle, sheep, goats, geese, and chickens have been used to graze undesirable species. ▪ Grazing must be continued until the weed's seed bank is exhausted. ▪ It is important never to move the animals from an infested to an uninfested site since seeds can be spread in the animals' droppings.	NRM coordinates
Biological Control	▪ Beneficial organisms can reduce a few specific plants. For example two species of leaf beetle have been very effective in wiping out populations of purple loosestrife. ▪ To be effective, the insect or pathogen must be host-specific and not pose a threat to other plants.	NRM coordinates

Plant Disposal	▪ Avoid leaving plant remains onsite. Many plants can re-root themselves and continue to grow if left in piles. ▪ When invasive plants are removed they should be placed directly into plastic bags which are sealed at the end of the removal process. The sealed bags should be disposed of by being buried in a landfill or burned.	In-House PMP; Contracted PMP
Cleaning of Vehicles and Equipment	▪ In order to prevent the introduction and spread of invasive weeds, all vehicles and equipment used on a base (especially those used for weed control) must be cleaned of dirt, mud, and visible plant material prior to being brought on base (if coming from off-base) or prior to coming on site (if coming from another location on base). ▪ Vehicles and equipment must also be cleaned after being used on a construction site, prior to being used elsewhere on base. ▪ Vehicles/equipment moved from site to site during weed control should also be inspected and cleaned in order to prevent further spread. ▪ Equipment to be cleaned may include things like weed whackers, shoes, shovels, etc. Before leaving a site workers should brush off shoes in order to prevent tracking seeds on the way to other sites.	In-House PMP; Contracted PMP

Chemical Control

Application Site	Apply herbicides as required based on survey information to areas where target weeds are problematic.
Site Preparation	<u>Pre-treatment procedures:</u> ▪ Check the local weather forecast. Rain can reduce or negate the effectiveness of an herbicide by washing the herbicide off the plant. If precipitation is expected in the next 24-hours, delay application. ▪ Check the local wind conditions. Herbicides can drift and affect non- target plants if applied during windy conditions. ▪ Do not apply herbicides during high temperatures (>95□F), as this can result in excess vaporization of the herbicide. <u>Post-treatment procedures:</u> ▪ Survey the area to establish the efficacy of control. The length of time between application and survey is dependent upon the species of weed being controlled. Multiple applications may be necessary, particularly if conditions during the first application were too warm, too dry, or too wet.

Sensitive Areas	Areas frequented by children: ▪ Use mechanical controls instead of chemical controls whenever possible around playgrounds. Sensitive habitat: ▪ Use non-chemical methods in natural areas containing endangered or threatened plant or animal species, or use herbicides with care. ▪ Use drift reduction methods to prevent damage to non-target plants and other organisms and sensitive sites.	
Restrictions / Regulations / Permits	• When applying herbicide to riparian areas or other sites near water use only formulations labeled for aquatic sites. • Herbicide applications to, over, or near waters of the US may require coverage under a NPDES Aquatic Pesticide Permit.	
Common Active Ingredients	▪ Imazapyr ▪ Dichlobenil ▪ Bromacil ▪ Diuron ▪ Pendimethalin ▪ Prometon ▪ Tebuthiuron ▪ Hexazinone ▪ Dicamba ▪ 2,4-D ▪ Diflufenzopyr ▪ Glyphosate ▪ Triclopyr ▪ Metsulfuron methyl ▪ Sulfometuron ▪ plus others	
Methods of Application		**Authorized Applicators**
Selective Broadcast Herbicides	▪ These herbicides selectively kill one class of plants and are safe for other classes of plants. ▪ The herbicide is applied evenly over a large area of land, usually through a boom sprayer. ▪ Boom sprayers can be mounted on a tractor, ATV, truck, airplane or helicopters. ▪ Relatively small areas can be treated with a backpack sprayer or hand-compressed sprayer.	In-House PMP; Contracted PMP
Non-selective Spot Treatment Herbicides:	▪ This method directly targets individual plants. ▪ Non-selective herbicides are used and are applied directly to the target plant. ▪ Care must be taken to reduce drift that could harm non-target plants. ▪ Direct application sometimes is used in conjunction with	In-House PMP; Contracted PMP

	non-chemical treatments, especially when removing invasive trees and shrubs which require root kill to prevent re-sprouting. (See "Cutting" in the Mechanical Control section.)	
Foliar Spray	▪ Herbicide is sprayed directly onto the foliage of the weed. ▪ Post-emergent herbicides should be applied after the weed emerges, but before seed set. ▪ Foliar application is most effective when weeds are young.	In-House PMP; Contracted PMP
Cut Stump Treatment	▪ Herbicide is brushed or sprayed on freshly-cut stumps	In-House PMP; Contracted PMP
Aerial Application of Pesticides:	▪ An Aerial Application Statement of Need must be prepared by the IPMC and approved by the ARNG PMC prior to aerial application of pesticides (including herbicides). ▪ Additional NEPA documentation and permitting may be required	Contracted PMP

Contract or Work Considerations

Time Period to Respond	Control is often conducted during surveys. This may involve observing a plant and then hand pulling or applying an herbicide. Responding to a large area of weeds will depend on timing factors.
Time Period to Obtain Control	Most non-chemical methods and many herbicides result in immediate or rapid kill. However, signs of the effectiveness of some herbicides (i.e. browning of leaves) may not be visible for several days.
Level of Control	In high priority areas a high level of control must be maintained.
Safety Considerations	Applicators use personal protective equipment required by the product label.
Environmental Considerations	When operations are conducted in natural areas, care must be taken to prevent adverse impact to the environment by control measures, vehicles, and workers.
Special Applicator Qualifications	▪ All PMP (or GMP/FMP) applying pesticides (including herbicides) must be DOD or State-certified as pesticide applicators. ▪ PMP conducting invasive weed control must be knowledgeable about identifying and controlling the target plants. ▪ PMP conducting invasive weed control must also be knowledgeable about preventing the spread of invasive plants. ▪ PMP conducting invasive weed control should also be able to produce maps (preferably using GPS and GIS) and write detailed reports.

Additional Information

Correct timing of the herbicide application is essential for effective weed control. Timing will depend on the species of weed, the mode of action and persistence of the herbicide, non-chemical practices in use, soil conditions, and climate.

References

www.cal-ipc.org/ip/inventory/index.php - California Invasive Plant Council; lists of invasive species and control advice http://courses.washington.edu/ehuf462/462_mats/bradley_method.pdf - The Bradley Method for Control of Invasive Plants

http://www.cal-ipc.org/ip/management/wwh/ - California Invasive Plant Council; a guide to techniques for removing Bay Area invasive plants. Site has a downloadable handbook
http://plants.usda.gov/java/noxiousDriver - Federal and State Noxious Weed Lists

http://www.weedcenter.org/ - Center for Invasive Plant Management;
http://www.weedcenter.org/dodworkshop/2009/index.html - DoD Strategic Management of Invasive Species in the Southwestern U.S.

IPM Outline 12
Bed Bugs

Target Pest or Group	Bed Bugs (Cimex species).
Target Area(s)	Primarily billeting areas, especially transient billeting.
Impact on Mission	Bed bugs bite people, cause allergic reactions, and are generally a nuisance that negatively affect morale and quality of life.
Scope	Base-wide, but most likely in billeting.
Responsibility	▪ Billeting Managers: ▪ Establish rules and regulations to prevent establishment and propagation of pests. ▪ Prevent movement of furniture between rooms when bed bugs are identified. ▪ Contact the IPMC when bed bugs are discovered. ▪ Billeting Residents: ▪ Comply with billeting rules and regulations. ▪ Maintain sanitation and cleanliness of personal items such as bedding. ▪ Immediately report suspected infestations of bed bugs to Billeting Managers. ▪ Pest Management Provider (PMP), In-House or Contract: Conduct surveillance and integrated pest management to control infestations. ▪ Facilities Maintenance Provider (FMP): Perform facilities repairs and improvements that exclude and minimize pest infestations as requested.
Reporting	▪ Report all bed bug infestations to IPMC to assist in identifying and preventing further infestations. ▪ Record all pest management operations to the IPMC using the Pest Management Treatment Record and report usage to IPMC every month.

Survey

Survey Method(s)	▪ Personnel complaints: Complaints are commonly received when personnel go to medical with itching or dermatitis due to bites. ▪ Visual inspections: ▪ Look for pests in mattresses, box springs, bed frames and headboards.

	Less commonly bed bugs are found on baseboards and on walls behind furniture. ▪ Apply a flushing agent to cracks and crevices. ▪ Sticky trap surveys. ▪ Vacuum surveys of harborages. ▪ Dry ice / CO_2 attractant traps. ▪ Conduct pre and post treatment surveys to determine whether control operation was effective
Survey Frequency / Schedule	▪ In billeting, housekeeping should perform inspections during cleaning. ▪ Daily observation by residents in billeting. ▪ Observation during inspections of billeting by unit command leadership personnel. ▪ Monthly observation and/or sticky trap monitoring by PMP of spaces post-treatment
Action Threshold(s)	▪ Detection of 1 bedbug, cast skins, or fecal stains should initiate survey and control as needed.

Non-Chemical Control

Type	Method	Responsibility
Sanitation	▪ Thorough cleaning shall be performed in each room. ▪ Remove all clutter particularly from under and around beds to reduce harborage. Removal of clutter also enables easier inspection of furniture and mattress. ▪ **When removing materials from an infested room, either treat the material or place in bags. Seal bags before taking out of room to prevent spread of the bugs.**	Billeting Residents
Washing/ Cleaning	▪ Before washing, place all clothes and bedding in a dryer and dry on the highest setting for at least 20 minutes to kill bed bugs. ▪ Thoroughly wash bedding in hot water and dry on highest heat setting until dry. ▪ Clean mattresses, box springs, frames, headboards with soap and water.	Billeting Residents; Billeting Manager
Mechanical Removal	▪ Vacuum bedbugs from their harborages on mattresses, headboards and other surfaces where they are found. Use a wet/dry vacuum cleaner filled with water or empty and dispose of vacuum bag immediately.	Billeting Residents; Billeting Manager
Isolation and Exclusion	▪ Prevent removal of furniture from rooms found to be infested until each item is cleaned. ▪ Remove debris from around outside of buildings. ▪ Repair cracks in walls. ▪ Caulk cracks and crevices in bed frames and furniture. ▪ Specially designed mattress encasements will prevent bed bugs from getting on mattresses and leaving mattresses to infest other areas. They do not have seams that can harbor the bugs.	Billeting Manager; FMP

Heat	▪ Heat infested areas to at least 113° F (45° C) for at least 1 hour. ▪ A pesticide barrier around doorways may be necessary to prevent spread of fleeing bed bugs to adjacent spaces. ▪ Heat may damage sprinkler systems. Implement protective measures before treatment of rooms. ▪ Place all bedding and clothing into a dryer on the highest heat setting for a minimum of 20 minutes then laundered in hot water for at least 10 minutes. Dryer must not be loaded more than 50% capacity. ▪ Due to its prolonged contact with skin, clothing cannot be treated with pesticides. Laundering is crucial to ensure the treatment program does not fail with the re-introduction of bed bugs from infested clothing.	Contract PMP; Billeting Residents
Prohibited Items	Ultrasonic pest repelling devices are useless and prohibited.	

Chemical Control

Application Site	▪ Apply pesticides as required based on survey information to areas where bed bugs are known to harbor. Including:
	  ▪ Bed frames
	  ▪ Mattresses
	  ▪ Baseboards
	  ▪ Furniture
	▪ For heavy infestations, barrier treatments may be required, especially around doors, to prevent bed bugs from fleeing to adjacent areas during treatment.
	▪ Chemical control using insecticides alone will not control/prevent bed bug infestations.

Site Preparation	▪ Pre-treatment procedures:
	  ▪ No pesticide applications shall be initiated until the space is unoccupied.
	  ▪ Do not remove furniture or beds until PMP has conducted an inspection.
	  ▪ Pesticide applicator shall contact the Billeting Manager prior to pesticide applications.
	  ▪ All bedding and personal items should be removed from exposed areas, placed in bags, and washed or cleaned.

Sensitive Areas	▪ Some people may be sensitive to pesticides. The insecticide on treated mattresses should be allowed to dry and then covered with a mattress cover before being used. ▪ Ensure that insecticides do not enter drains, streams, lakes and other surface water.

Restrictions	▪ Insecticide resistance may cause treatment failure ▪ Aerosols, dusts and other insecticide formulations that can become airborne shall not be applied in occupied spaces. ▪ Spaces must be vacated before treatment, and then ventilated and the insecticide allowed to dry before personnel reoccupy the space. ▪ Foggers are mostly ineffective in controlling bed bugs because bed bugs hide in crevices and voids where aerosols do not penetrate and they are able to avoid contact with the insecticides. Use of foggers is not recommended.	
Common Active Ingredients	▪ Bifenthrin ▪ Cyhalothrin ▪ Deltamethrin ▪ Other Pyrethroids ▪ Pyrethrin For pyrethroid-resistant bed bugs: ▪ Hydroprene (IGR) ▪ Chlorfenapyr (▪ Silica gel ▪ Boric acid	
Types of Pesticides		**Authorized Applicators**
Flushing Agents	▪ Use aerosol contact pesticides directed into potential harborage areas to flush out and kill pests as needed.	In-House PMP; Contracted PMP
Crack and Crevice Residuals	▪ Apply (by crack and crevice technique) a residual pesticide spray to all known or suspected harborages.	In-House PMP; Contracted PMP
Spot Treament Residuals	▪ Apply as a "spot treatment" to indicated areas.	In-House PMP; Contracted PMP
Mattress Treatment	▪ Apply to infested mattresses.	In-House PMP; Contracted PMP
Insect Growth Regulators	▪ IGRs affect the development and reproduction of insects. ▪ When properly applied, IGRs have essentially no effect on vertebrate metabolism because of their mode of action and low application rates, but they can have a significant impact on bed bug molting, fertility and egg hatching success. ▪ Apply according to label directions.	In-House PMP; Contracted PMP

Contract or Work Considerations

Time Period to Respond	Discovery of bed bugs in any area requires a response within 24 hours.
Time Period to Obtain Control	One to two weeks.
Level of Control	100% control
Safety Considerations	▪ Do not treat occupied rooms with liquid or dust formulations.
Special	▪ All PMP or GMP applying pesticides (including herbicides) must be

Applicator Qualifications	DOD or State-certified as pesticide applicators.

Additional Information

Treatment failures are due to incomplete surveys for the pest, improper application, and insecticide resistance. Follow up inspections and control is crucial to eliminating the bugs.

Resources

http://www.ipm.ucdavis.edu/PMG/PESTNOTES/pn7454.html
http://www.acq.osd.mil/eie/afpmb/docs/techguides/tg44.pdf

http://www.epa.gov/pesticides/bedbugs/

IPM Outline 12

Feral Dogs and Cats

Target Pest or Group	▪ Feral Dogs and Cats. (For control of birds and other vertebrate wildlife pests, please refer to their specific IPM outlines.)
Target Area(s)	Areas near buildings or populated areas.
Impact on Mission	▪ Feral animals may be dangerous when they are cornered and can become aggressive. ▪ Many feral animals may carry rabies and other diseases and parasites that can infect humans.
Scope	▪ Base-wide
Responsibility	▪ <u>Pest Management Provider (PMP), In-House or Contract</u>: Conduct integrated pest management for vertebrate pests. ▪ <u>Facilities Maintenance Provider (FMP)</u>: Perform facilities repairs and improvements that exclude vertebrate pests from buildings. ▪ <u>Base Operation Support</u>: Ensure that dumpsters and trashcans are emptied on schedule and that they are securely covered to prevent entry by vertebrate pests. ▪ <u>Natural Resources Manager (NRM)</u>: Provides information regarding any regulatory protections of vertebrate pests. ▪ <u>All Installation Personnel</u>: Practice good sanitation and do not feed feral animals to prevent attracting them.
Reporting	▪ Record all pest management operations using the Pesticide Management Treatment Record Form and report usage to the IPMC every month.

Survey

Survey Method(s)	▪ Visual sighting of feral animals or signs of their presence. ▪ Some feral animals may become mainly nocturnal, so visual surveys may need to be conducted at night. ▪ Verify personnel reports of feral dog or cat activity.
Survey Frequency / Schedule	▪ As needed.
Action Threshold	▪ Any verified sighting of a feral dog or cat.

Non-Chemical Control

Type	Method	Responsibility
Exclusion	▪ Use lids / covers that can be secured on dumpsters and trashcans. ▪ Use hardware cloth and metal flashing to cover holes and cracks to prevent entry of feral animals into buildings. ▪ Repair leaking plumbing to remove sources of water for feral animals.	FMP
Food Removal	▪ Deny access to trash and other sources of food. ▪ Prevent personnel from feeding feral animals.	All personnel
Education	▪ Teach site personnel the impact of feral dogs and cats on native wildlife, especially birds, reptiles and small mammals. ▪ Teach site personnel about the threat to human health posed by feral dogs and cats. ▪ Provide resources for pet fostering and adoption organizations.	In-House PMP; IPMC
Trapping	▪ Only live cage-type traps should be used for feral dogs and cats. ▪ Use cat food containing fish or canned tuna for bait. ▪ Ensure that the target pest cannot reach through the back or side of the trap to steal the bait. ▪ Secure trap to the ground to prevent the animal from tipping it over. ▪ Situate and regularly monitor traps to prevent unnecessary stress to trapped animals. ▪ Trap-Neuter-Release (TNR) programs are prohibited.	PMP In-House or Contract; NRM coordination

Shooting	▪ In instances where there is a known threat to human health, shooting may be used to control small populations in areas where: ▪ Shooting is legal. ▪ Shooting can be safely conducted. ▪ Appropriate permits have been obtained. ▪ Qualified marksmen should do the shooting. ▪ Not generally practical for large populations. ▪ Lethal control has considerable risk for generating negative public relations. ▪ Make completely sure that target animals are feral animals and not stray pets.	Qualified PMP
Prohibited Practices	▪ Use of ultrasonic pest repelling devices is ineffective and prohibited. ▪ Relocation of trapped animals is prohibited. ▪ Trap-Neuter-Release (TNR) programs are prohibited. ▪ Killing, trapping, relocating or harassing any wildlife protected under the Endangered Species Act is prohibited.	
Special PMP Qualifications	▪ All PMP performing vertebrate pest control should hold appropriate licenses and permits to legally capture, transport and/or euthanize feral animals. ▪ Feral animals should never be handled, alive or dead, with bare hands. ▪ All PMP performing feral animal control should have pre-exposure immunization against rabies.	

Chemical Control

Chemicals are never used for the control of feral cats and dogs.

Additional Information

Informational brochure about hazards associated with cats:
http://www.denix.osd.mil/nr/otherconservationtopics/invasivespecies/publications/don-t-let-your-cat-go-awol-indoor-cats-are-safe-cats/

Feral cat management:
http://extensionpublications.unl.edu/assets/pdf/ec1781.pdf

Rabies in domestic animals:

https://www.cdc.gov/rabies/exposure/animals/domestic.html

Appendix C – VAARNG State Pesticide Use List (SPUL)

EPA Reg No.	Label Name	ACTIVE Ingredient (Primary)
228-139-71368	2,4-D L.V. 4 (EC) Ester	2,4-dichlorophenoxy-, 2-ethylhexyl ester
62719-556	Accord XRT II (GF-1280/Durango DMA/Duramax)	Glyphosate, dimethylammonium salt
81927-23	Alliagare Imazapyr 2 SL	Imazapyr, isopropylamine salt
83851-3	Amtide MSM 60 DF	Metsulfuron-methyl
228-365	Aquaneat Aquatic Herbicide	Glyphosate-isopropylammonium
241-299	Arsenal AC (Applicators Concentrate) Herbicide	Imazapyr, isopropylamine salt
3862-176-13051	Assualt Wasp and Hornet Killer	Permethrin, mixed cis, trans
706-110-10320	Bed Bug, Lice and Dust Mite Spray	Permethrin, mixed cis, trans
53883-118	Bifen IT (TC) Termaticide/Insecticide	Bifenthrin
34704-955	Bisect L	Bifenthrin
83923-2	Bithor SC	Bifenthrin
67603-11-64695	Blast 'Em Wasp and Hornet Killer	Permethrin, mixed cis, trans
4-392	Bonide Wasp & Hornet Spray	Permethrin, mixed cis, trans
64405-1	Bora-Care	Boron sodium oxide (B8Na2O13), tetrahydrate
73079-4	Boractin Insecticide Powder	Boric Acid
9444-129	Borid	Boric Acid
50534-188-100	Bravo (720) Weather Stik	Chlorothalonil
55467-9	Buccaneer Plus Glyphosate Herbicide	Glyphosate-isopropylammonium
3862-174-11861	Buzz Off Wasp & Hornet Killer	Permethrin, mixed cis, trans
10088-115-68562	Buzz Saw Wasp and Hornet Killer	d-Phenothrin
62719-572	Capstone (Milestone VM Plus)	Aminopyralid, triisopropanolamine salt
432-1332	Centerfire (Premise 75) Insecticide	Imidacloprid
9688-190-8845	Chemisco (Spectricide/Hot Shot) Wasp & Hornet Killer (LE)	lambda-Cyhalothrin
241-430	Chopper Gen2 Herbicide	Imazapyr, isopropylamine salt
73079-12	CimeXa Dust (Silicide)	Silicon dioxide
64240-45	Combat Quick Kill Roach Killing Gel	Fipronil

12455-79	**Contrac All Weather Blox (Rat & Mouse Bait)**	**Bromadiolone**
55809-3	**CRC Wasp & Hornet Killer Plus**	**d-Phenothrin**
62719-260	**Crossbow**	**Butoxyethyl 2,4-dichlorophenoxyacetate**
1021-2776	**Crossfire Insecticide**	**Clothianidin**
8959-10	**Cutrine-Plus Algaecide/Herbicide**	**Copper ethanolamine complex**
499-304	**Cy-Kick CS Contolled Release Cyfluthrin**	**Cyfluthrin**
53883-261	**Cyzmic (Lamba CSI 9.7) CS**	**lambda-Cyhalothrin**
829-287	**Daconil SA-50 Liquid Ornatmental and Vegetable Fungicide**	**Chlorothalonil**
100-1066	**Demand (Patrol) CS Insecticide**	**lambda-Cyhalothrin**
352-853	**DuPont LeadOff Herbicide**	**Thifensulfuron methyl**
432-1549	**Escort XP Herbicide**	**Metsulfuron-methyl**
432-1528	**Esplanade EZ**	**Diquat dibromide**
EX-2	**Essentria (EcoEXEMPT) JET Wasp & Hornet Killer**	**Rosemary Oil**
34704-915	**Evade 4 FL**	**Prodiamine**
12455-97	**Fastrac Place Pacs**	**Bromethalin**
12455-91	**Final Rodenticide Place Pac**	**Brodifacoum**
100-1084	**Fusilade II Turf and Ornamental Herbicide**	**Fluazifop-p-butyl**
62719-37	**Garlon (Element) 3A**	**Triethylamine triclopyr**
62719-40	**Garlon (Element) 4**	**Butoxyethyl triclopyr**
2724-484	**Gentrol (RF 9707) Aerosol**	**(7s)-Hydroprene**
2724-351	**Gentrol IGR (Zoecon RF-259) Emulsifiable Concentrate**	**(7s)-Hydroprene**
42750-61	**Gly Star (Cornerstone/Glyphosate 41) Plus (Pro)**	**Glyphosate-isopropylammonium**
67760-47-9688	**Glyfos Ultra-Kill Ready-To-Use 1.92% Weed & Grass Killer**	**Glyphosate-isopropylammonium**
4787-23	**Glyfos X-tra**	**Glyphosate-isopropylammonium**
72159-14	**Glyphosel Pro Herbicide**	**Glyphosate-isopropylammonium**
241-426	**Habitat Herbicide**	**Imazapyr, isopropylamine salt**
1021-1780-3	**Harris Yellow Jacket Wasp and Hornet Spray**	**d-Phenothrin**
524-445	**Honcho (Plus) (Roundup) (MAX)**	**Glyphosate-isopropylammonium**
524-454	**Honcho (Plus) (Roundup) (Original II)**	**Glyphosate-isopropylammonium**
352-346	**Hyvar X-L Herbicide**	**Bromacil, lithium salt**
73079-6	**InTice Perimeter Bait**	**Boric Acid**
45385-101	**JT EATON Kills Bed Bugs Plus**	**Piperonyl butoxide**

7405-73-10320	**K-2 Spray (DO NOT REORDER)**	**Permethrin, mixed cis, trans**
40208-7	**Kibosh Wasp, Hornet, Bee & Yellow Jacket Killer**	**Piperonyl butoxide**
42750-66-7401	**Kilz all (Gly Star)**	**Glyphosate-isopropylammonium**
10404-43	**Lesco Three-Way Selective Herbicide**	**Dicamba, dimethylamine salt**
12455-61	**Liqua-Tox II**	**Diphacinone, sodium salt**
7173-188	**Maki (Boot Hill) Rat and Mouse Bait Packs (Pellets)**	**Bromadiolone**
11694-107	**Marksman (The End/Tough Guy 720) Wasp & Hornet Killer**	**Permethrin, mixed cis, trans**
432-1264	**Maxforce FC Professional Insect Control Ant Killer Bait Gel**	**Fipronil**
432-1455	**Maxforce Fly Spot Bait**	**cis-9-Tricosene**
6218-73	**Mosquito Bits**	**Bacillus thuringiensis subspecies israelensis Strain**
64405-2	**Niban (Redzone) Granular Bait**	**Boric Acid**
9688-325	**No-Pest Wasp & Hornet Killer5**	**Cypermethrin**
228-570	**Nufarm Polaris AC Complete Herbicide**	**Imazapyr, isopropylamine salt**
228-480	**Nufarm Polaris AC Herbicide**	**Imazapyr, isopropylamine salt**
228-534	**Nufarm Polaris Herbicide**	**Imazapyr, isopropylamine salt**
1021-1603	**Nyguard IGR Concentrate Insecticide (Nylar 10 EC)**	**Pyriproxyfen**
1021-1780-239	**Ortho Hornet & Wasp Killer**	**d-Phenothrin**
432-1557	**Oust Extra Herbicide**	**Metsulfuron-methyl**
241-392	**Phantom (SD) Termiticide-Insecticide**	**Chlorfenapyr**
66222-22	**Pramitol 25E**	**Prometon**
499-550	**PT Waso-Freeze II Wasp & Hornet Insecticide**	**Prallethrin**
66222-192	**Quali-Pro Bifenthrin (Golf & Nursery 7 9F)**	**Bifenthrin**
66222-176	**Quali-Pro Glyphosate (Glyphogan) Plus Herbicide**	**Glyphosate-isopropylammonium**
66222-230	**Quali-Pro Prodiamine 4L Herbicide**	**Prodiamine**
228-366	**Razor Pro Herbicide**	**Glyphosate-isopropylammonium**
305-55	**Repel Mosquito Stop (Permanone)**	**Permethrin, mixed cis, trans**
9688-190-305	**Repel Wasp, Hornet & Yellowjacket Killer**	**lambda-Cyhalothrin**
62719-324	**Rodeo (Glypro/Accord Concentrate) Herbicide**	**Glyphosate-isopropylammonium**

524-549	**Roundup PowerMax Herbicide**	**Glycine, n-(phosphonomethyl)-potassium salt**
524-475	**Roundup Pro (Ultra) Herbicide**	**Glyphosate-isopropylammonium**
524-529	**Roundup Pro Concentrate**	**Glyphosate-isopropylammonium**
524-535	**Roundup Quickpro Herbicide**	**Diquat dibromide**
71995-33	**Roundup Weed & Grass Killer Ready-to-Use Plus**	**Glyphosate-isopropylammonium**
61842-37	**Sevin Brand XLR Plus Carbaryl Insecticide**	**Carbaryl**
9688-141-8845	**Spectracide Pro Wasp & Hornet Killer**	**Permethrin, mixed cis, trans**
2217-833	**Speed Zone Broadleaf Herbicide For Turf**	**2,4-dichlorophenoxy-, 2-ethylhexyl ester**
498-156	**SprayPak Wasp , Bee & Hornet Killer**	**d-Phenothrin**
228-690	**Spyder Extra**	**Metsulfuron-methyl**
352-622-85588	**Sulfomet Extra Herbicide**	**Metsulfuron-methyl**
432-763	**Suspend SC Insecticide (K-Othrine® SC Insecticide)**	**Deltamethrin**
228-520	**Tahoe 3A (Triclopyr 3) Herbicide**	**Triethylamine triclopyr**
279-3206	**Talstar TC Flowable Termaticide/Instecticide**	**Bifenthrin**
432-1483	**Temprid SC Insecticide**	**beta-Cyfluthrin**
7969-329	**Termidor HE Highly Effective Termiticide**	**Fipronil**
7969-210	**Termidor SC Termiticide/Insecticide**	**Fipronil**
149-8	**Terro Ant Killer II**	**Borax (B4Na2O7.10H2O)**
11694-109	**The END Wasp & Hornet Killer**	**Piperonyl butoxide**
9688-190	**Ultra-Kill/Black Flag/Chemisco Wasp and Hornet Killer (LE)**	**Prallethrin**
706-109-9250	**United 173 Wasp Whacker**	**Tetramethrin**
7969-88-829	**Vantage (Poast Plus) Herbicide (DO NOT REORDER)**	**Sethoxydim**
71368-14-55467	**Weedone LV4 Solventless Herbicide**	**2,4-dichlorophenoxy-, 2-ethylhexyl ester**
499-290	**Whitmire PT (Prescription Treatment) 565 Plus XLO**	**n-Octyl bicycloheptene dicarboximide**
11694-111-1270	**Zep Stay Away (DO NOT REORDER)**	**n,n-Diethyl-meta-toluamide and other isomers**
2724-786	**Zoëcon (RF 2050) Wasp-X™ Wasp & Hornet Spray**	**Ethofenprox**

Appendix D – VAARNG Pesticide Management Treatment Record Form

Virginia Army National Guard
PESTICIDE MANAGEMENT TREATMENT RECORD

Instructions:
Submit to the VAARNG Integrated Pest Management Coordinator. Use a separate form for each pesticide when using multiple chemistries on single application.

1. Date	2. Time of Application	
3. Facility/Address/Room Number		
4. Applicator's Name and Certification No.	5. Company Name (If Contractor)	
6. Pesticide Used (Trade Name)	EPA REG No.	
7. Active Ingredient (From Label)	% Active Ingredient	
8. Total Quantity of Pesticide Used Before Mixing (i.e. gallons/fluid ounces or pounds/dry ounces)		
9. Total Quantity Applied After Mixing (i.e. gallons/fluid ounces or No. of bait stations, etc.)	_______________ lbs of active ingredient applied	
10. Site Description/Size of Treated Area/Wind Speed & Direction/Weather		
11. Purpose of Application (Target Organism and Nature of Problem)		
12. Application Status (Circle One)	Preventive Recurring Problem One Time Treatment	
13. Recommend Alternative Methods to Alleviate the Problem	(i.e. Physical, Mechanical, Cultural, Biological)	

______________________ ___________ ______________________ ___________
Applicator **Date** **Facility Manager** **Date**

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Appendix E – VAARNG Self-Help Program

The VAARNG Self-Help Program allows maintenance workers, facility managers, building occupants and unit personnel to use Integrated Pest Management (IPM) measures for control of minor pests. This program features ready-to-use, low toxicity pesticides pre-approved by the ARNG Pest Management Consultant (ARNG PMC).

VAARNG Self-Help Program participants may only perform pest management actions listed in the Self-Help sections of the IPM Outlines (Appendix B) for the pest(s) being controlled.

Only pesticides that are specifically listed on the VAARNG SPUL for use in the Self-Help Program (Appendix B) may be used and participants must review the educational materials for the pest and the control method prior to their use.

All application, safety, storage, disposal and recording requirements as outlined on the pesticide label, the Self-Help training materials, this IPMP and the Self-Help IPM Outlines are to be followed.

When pest management actions are performed in accordance with the requirements of the VAARNG Self-Help Program, participants are not required to be certified pesticide applicators.

Step 1. Determine if Self-Help is appropriate. Use the Self-Help IPM Outlines (pages E-5-84) to help identify the pest, assess the level of the pest problem and determine what IPM controls can be used to reduce pest presence to acceptable levels.

Step 2. If there is not a Self-Help IPM Outlines (pages E-5-84) for the pest, Self-Help control is NOT appropriate for the pest or, if the level of the pest problem is greater than can be controlled with Self-Help, put in a Work-Order with O&M or DPW.

Step 3. If Self-Help control is appropriate for the pest and the level of the pest problem, use the Self-Help control methods in the order they are given in the Self-Help IPM Outline (pages E-5-84) for the pest. Use all Self-Help cultural, mechanical and physical control methods before using Self-Help chemical control methods. Also, keep in mind that it is rarely possible to completely eradicate a pest and the goal is to control the pest to acceptable levels.

Step 4. If non-chemical Self-Help control methods do not control the pest(s) to acceptable levels, Self-Help-approved pesticides listed in the Self-Help IPM Outlines may be used. These are low-toxicity, ready-to-use pesticides and are the only pesticides allowed for use by Self-Help Program participants.

Pesticides that require dilution are not allowed for use in the Self-Help Program at VAARNG sites.

Step 5. Obtain pesticides/equipment listed on Self-Help SPUL from those distributed by Building 303 (Entomology) or DPW Warehouse 224.

All pesticides used for Self-Help MUST have the exact EPA Registration Number as the pesticide listed on the VAARNG SPUL as approved for Self-Help Use. Pesticide approval is based on the EPA Registration Number of the pesticide and, even if the active ingredient is the same and the pesticide contains the same concentration, a pesticide is not approved for use unless it is listed on the SPUL with that specific EPA Registration Number.

If a Self-Help pesticide for the pest(s) with the listed EPA Registration Number cannot be reasonably procured, contact the IPMC to determine if there is a substitute available. The IPMC can request the addition of pesticides to the Self-Help Program list by submitting the pesticide name, manufacturer, EPA registration number, target pest and target site to the ARNG IPMC for review and approval.

Step 6. Review the Self-Help IPM Outline for the pest (pages E-5-84) and the pesticide label(s) BEFORE applying any Self-Help pesticides.

Those who are applying pesticides on Federal properties (Appendix A) who are not licensed applicators must complete a VAARNG Self-Help Training Acknowledgement before applying the pesticide. After reviewing the training materials and label(s), sign and submit a VAARNG Self-Help Training Acknowledgement of Understanding (in Appendix E, page E-5) to the IPMC (MAJ Webb, brian.j.webb14.mil@mail.mil) and keep a copy locally. The pest/pesticide-specific educational materials must be reviewed at least annually and a VAARNG Self-Help Training Acknowledgement of Understanding is to be resubmitted to the IPMC at that time.

The pesticide label must be reviewed before EVERY application of the pesticide since label requirements can change.

Step 7. Apply the pesticides in accordance with the label and the pest-specific Self-Help IPM Outlines (pages E-5-84). Pesticide labels are legal documents and all directions and restrictions on the label MUST be followed.

Step 8. Report pesticide applications using the VAARNG Pesticide Management Treatment Record (Appendix D). This report is to be completed at time of application and a copy sent to the Facility Manager within one calendar week from application. Facility Managers will send all treatment records to the IPMC on the last business day of each month. Complete all fields in the section marked “Self-Help”.

Step 9. Store and dispose of pesticides as directed by the VAARNG IPMP and in accordance with label directions.

Step 10. If the Self-Help control methods in the Self-Help IPM Outline do not control the pest to acceptable levels, put in a Work Order with O&M or DPW.

Pesticides Approved for use by Self-Help Program Participants:

EPA Reg No.	Label Name	ACTIVE Ingredient (Primary)
3862-176-13051	Assualt Wasp and Hornet Killer	Permethrin, mixed cis, trans
67603-11-64695	Blast 'Em Wasp and Hornet Killer	Permethrin, mixed cis, trans
4-392	Bonide Wasp & Hornet Spray	Permethrin, mixed cis, trans
10088-115-68562	Buzz Saw Wasp and Hornet Killer	d-Phenothrin
9688-190-8845	Chemisco (Spectricide/Hot Shot) Wasp & Hornet Killer (LE)	lambda-Cyhalothrin
64240-45	Combat Quick Kill Roach Killing Gel	Fipronil
55809-3	CRC Wasp & Hornet Killer Plus	d-Phenothrin
EX-2	Essentria (EcoEXEMPT) JET Wasp & Hornet Killer	Rosemary Oil
67760-47-9688	Glyfos Ultra-Kill Ready-To-Use 1.92% Weed & Grass Killer	Glyphosate-isopropylammonium
1021-1780-3	Harris Yellow Jacket Wasp and Hornet Spray	d-Phenothrin
40208-7	Kibosh Wasp, Hornet, Bee & Yellow Jacket Killer	Piperonyl butoxide
42750-66-7401	Kilz all (Gly Star)	Glyphosate-isopropylammonium
432-1264	Maxforce FC Professional Insect Control Ant Killer Bait Gel	Fipronil
9688-325	No-Pest Wasp & Hornet Killer5	Cypermethrin
1021-1780-239	Ortho Hornet & Wasp Killer	d-Phenothrin
499-550	PT Waso-Freeze II Wasp & Hornet Insecticide	Prallethrin
9688-190-305	Repel Wasp, Hornet & Yellowjacket Killer	lambda-Cyhalothrin
71995-33	Roundup Weed & Grass Killer Ready-to-Use Plus	Glyphosate-isopropylammonium
9688-141-8845	Spectracide Pro Wasp & Hornet Killer	Permethrin, mixed cis, trans
498-156	SprayPak Wasp , Bee & Hornet Killer	d-Phenothrin
11694-109	The END Wasp & Hornet Killer	Piperonyl butoxide
9688-190	Ultra-Kill/Black Flag/Chemisco Wasp and Hornet Killer (LE)	Prallethrin
706-109-9250	United 173 Wasp Whacker	Tetramethrin

499-290	Whitmire PT (Prescription Treatment) 565 Plus XLO	n-Octyl bicycloheptene dicarboximide
2724-786	Zoëcon (RF 2050) Wasp-X™ Wasp & Hornet Spray	Ethofenprox

VAARNG SELF-HELP TRAINING
Acknowledgement of Understanding

Type of Pest:

Control Methods:

1. I have read and understand the instructions for performing Self-Help pest control for _______________________________________ and have read and understand the pesticide label(s). I will follow the label instructions and all other instructions given to me. If I do not understand the instructions, I will have a qualified person explain them to me before continuing. I understand that any pesticide application not in accordance with the label is a violation of the Federal Insecticide, Fungicide, and Rodenticide Act.

2. I will make sure pets, children, and individuals who may be sensitive or allergic to pesticides will not be present during any application nor will they be allowed back into the treated area(s) before thorough post-treatment ventilation.

3. I will perform the control procedures myself, at my facility area only.

4. Once I have received the Self-Help pest control items, I will not use any of the products in a manner inconsistent with the label. Unused items and empty containers will be disposed of as specified by the Integrated Pest Management Coordinator (IPMC) and the product label.

5. I will record and report Self-Help actions as directed by the IPMC.

Signature:____________________________________ Date:________________________

Name:_______________________________________ Facility:______________________

VAARNG Self-Help IPM Outlines

SELF-HELP IPM Outline 1

Stinging Insects

A. PURPOSE

The Self-Help pest management program authorizes the use of approved Self-Help products (ready-to-use aerosol bee, wasp, and hornet control pesticides) by installation maintenance and VAARNG personnel who encounter stinging insects during the normal course of their assigned duties.

B. RESPONSIBILITIES

- Self-Help Program participants are responsible for proper use, recording, reporting, storage and disposal of Self-Help products.
- **All** label instructions must be read and followed – **The Label is the Law!**
- A Safety Data Sheet (SDS) should accompany the Self-Help product and be readily available to personnel using the product and working in the area where the product is used.
- Only use products that are pre-approved for use in the VAARNG Self-Help Program. Contact the VAARNG IPMC (MAJ Brian Webb) for a current list of approved Self-Help products.
- Self-Help products can be obtained by submitting a Work Order to O&M. Pesticides will be shipped or picked up at the warehouse (Bldg 224) on Fort Pickett.
- Record and report usage of Self-Help products to the VAARNG IPMC at the end of each month using the Pest Management Treatment Record form.

C. ACTIONS

STEP 1. Surveillance.

- Identify the type of stinging insect using the information in this outline.
- Self-Help Program participants **MUST** identify the stinging insect(s) before control is attempted. Controlling some stinging insects and/or the nests may be too dangerous for Self-Help Program participants.
- Many types of stinging insects are "social" and can act together as a single unit. This can increase the risk during control operations since numerous insects can attack simultaneously to defend their nest.
- Additionally, several different species of bees, wasps, and hornets are capable of inflicting severe stings and can sting multiple times.
- Some people are allergic to venomous stings and can have a serious physical reaction if stung. More people die annually from allergic or severe allergic (anaphylactic) reaction caused by insect stings than from snake bites.

STEP 2. Decide if Self-Help is appropriate.

- If it is determined the type of stinging insect is not appropriate for Self-Help Program control, contact the O&M Branch or Entomology to arrange for control by a Pest Management Professional (PMP).
- The decision to use Self-Help for control of stinging insects is often based on personal judgement and common sense. If you have **any** doubts that the stinging insects cannot be controlled with Self-Help actions, do not proceed with Self-Help.
- Approved Self-Help products are tools to assist Self-Help Program participants with the control of small, non-threatening stinging insect nests so that designated tasks can be completed without loss of time waiting for a Pest Management Professional (PMP) to arrive. Trying to control too large a nest could result in multiple stings, loss of work time, and unacceptable risk to VAARNG personnel.

STEP 3. Perform Chemical Control (aerosol spray)

- Self-Help products for stinging insects can be obtained by request from the O&M or Entomology.
- Only use products that are pre-approved for use in the VAARNG Self-Help Program.
- Read the entire product label. **The Label is the Law!**
- Wear appropriate Personal Protective Equipment (PPE) as directed on the label.
- Do **NOT** eat, drink or smoke while using any pesticide.
- Use product as directed on the label for control of the stinging insect and/or nest.
- Always thoroughly wash hands with soap and water after using product and before eating, drinking or smoking.

STEP 4. Storage and Disposal of Self-Help Products.

- Store and/or dispose of any leftover Self-Help products as directed on the label and the VAARNG IPMP.
- If you have any questions on storage or disposal of the Self-Help products, contact the VAARNG IPMC (MAJ Brian Webb).

STEP 5. Recording and Reporting.

- Report Self-Help product use to the VAARNG IPMC (MAJ Brian Webb) using form the Pest Management Treatment Record form.
- The form(s) recording usage should be sent to the VAARNG IPMC at the end of the month.

STEP 6. Follow-up and Assessment.

- If the Self-Help control methods in this outline do not control the pest to acceptable levels, put in a Work Order with the CFMO or contact the Entomologist.

STEP 7. Perform Physical and Cultural Controls.

- Use of chemical controls (pesticides) will only provide temporary control. Habitat modification, building practices (exclusion), or nest removal are more permanent controls.
- Report repeated encounters with stinging insects to the O&M Office or Entomology so that more permanent controls can be implemented.

Honey Bees

- Honey bees are about ½" long, black and yellow, with fuzzy hair on most of their body.
- Honey bees are highly-organized social group insects with a queen, drones, and potentially hundreds to thousands of workers.
- Nests are found in building walls, hollow trees and hollow pillars.
- Honey bees are active during the day and tend to be quiet during the cooler evenings and night, staying close-by or in the nest.
- In most cases, honey bees are fairly docile and will not attack humans unless the nest is disturbed.

Do Not Kill Honey Bees Unless Necessary!

Honey bees are excellent pollinators of plants and are considered beneficial insects.

Honey Bee Nest Control:

- Nest removal by a bee keeper should always be the first control option.
- **Honey bee nest removal is NOT done by Self-Help Program participants!**
- Most honey bee nests will be large. Self-Help Program participants should **NOT** attempt control.
- Contact the VAARNG IPMC (MAJ Webb) for honey bee nest removal.

Mud Daubers

- Mud Daubers are “solitary” wasps (i.e. one adult maintains one nesting site) that build small pipe-shaped mud nests on the underside of roofs, soffits, porches, and other structural members.
- The adults are brown and about ¾” long.
- The mud tube nest is the key to identification of this species.
- Mud daubers can sting repeatedly, but seldom sting unless disturbed.

Mud Dauber Nest Control:

- Mud dauber nests are commonly encountered by maintenance personnel and can generally be controlled by using Self-Help products that have been approved for use on stinging insects.
- Exercise caution when multiple nests are in the same location or if the nests are in a confined location.
- Spray the attending adult with the Self-Help product and quickly move away from the area, then knock off the mud tubes using a screw driver or some other tool.
- It is best to control mud daubers at dawn, dusk, or at night, when the adult is present, and most docile.

Paper Wasps

- Paper wasps are ½” to 1” in length, typically a black, red or brownish color, and may have yellow or orange highlights.
- Many people call this group “umbrella wasps” because of the umbrella-shaped paper comb nest, and identifying the nest is the easiest way to identify this group of wasps.
- The nest is usually a single tier, open paper comb with the cells pointed downwards.
- The nests will be found beneath eaves, soffits, window enclosures, under porches, under wooden shelves, below or in electrical enclosures, in tightly enclosed ornamentals plantings, etc.
- Paper wasp colonies can contain from a few up to a few hundred adults.
- The size of the nest is a direct indicator of the number of adult wasps attending the nest.
- Paper wasps are generally docile and will not attack as a large group like some types of bees. However, paper wasps can sting repeatedly.

Congregations of Paper Wasps:

- Paper wasps over-winter as adults and, in the fall, hundreds to thousands of them may congregate (group together) on the highest structure in an area, such as a church bell tower, an airport control tower, or the peak of an administrative building.
- While this may seem threatening, control is not usually required because the wasps will move on after a while.
- After congregation, these insects will hunt for protected sites to overwinter and will enter buildings around windows, under soffits, past loose flashing, and into any location that may provide shelter.
- On warm winter days, paper wasps can become active and enter the interior of the buildings, causing a nuisance to occupants.

Paper Wasps (continued)

- Generally, these wasps are not aggressive in this situation and a fly swatter or rolled up magazine is the most effective control for small numbers that are found inside of buildings.

Paper Wasp Nest Control:

- Paper wasp colonies are commonly encountered by maintenance personnel and most of them can be controlled using Self-Help products that have been approved for use on stinging insects.
- The nests increase in size as the summer season progresses.
- Exercise common sense if the nest appears large or if there are multiple nests in the area.
- When a nest is sprayed, the adult wasps at the nest will get aggressive, so quickly move away from the area after spraying.
- After the adults die, knock the nest down (if possible).
- It is best to control paper wasps at dawn, dusk, or at night when the adults are at the nest site and the insects are most quiet.

Cicada Killers

- The cicada killer is a very large wasp (1” to 2” long) that is usually seen flying close to the ground.
- The body is shiny black with bright yellow highlights.
- These wasps nest in the ground.
- Because of the large size, many fear this insect.
- Cicada killers are semi-social wasps, but are typically not aggressive.
- There is little chance of being stung unless the insect is handled, agitated, or stepped on with bare feet.
- Control is usually **NOT** required.

Other Solitary Ground-Nesting Wasps & Bees

- Some species of wasps and bees are solitary ground or lawn nesters.
- The nests are typically single round holes in turf or ground with a small untidy mound of excavated soil around the entrance.
- **Control is NOT done by Self-Help Program participants!**
- Control of these ground or lawn-nesting wasp or bee species should **NOT** be performed unless there is a huge number of nests causing turf damage or their presence in a frequently occupied area threatens human health. In such cases, contact O&M or Entomology to arrange for control by a Pest Management Professional.

Yellowjackets

- Yellowjacket wasps are black and yellow insects about ½-inch in length.
- This group of wasps is social and builds large paper comb nests in the ground, in wall voids, or other well protected areas.
- A yellowjacket colony will grow throughout the summer and have thousands of workers by the fall of the year.
- Yellowjackets can sting repeatedly and will attack as a group if the nest is disturbed.
- Yellowjackets are sometimes described as an insect with a bad attitude and many feel that this is the most dangerous of the stinging wasps because of their unpredictable behavior.
- Yellowjacket wasps tend to scavenge at human food sources. Often, they will be found foraging around open trash cans, trash dumpsters, outdoor food serving areas, etc.
- Keeping areas clean, trash cans covered, soda cans properly disposed of etc. will lessen the attractiveness of an area and generally result in adequate control.

Yellowjackets (continued)

Yellowjacket Nest Control:

- **Extreme CAUTION is required.**
- Yellowjackets will fiercely defend their nest. Most incidents of people being repeatedly stung occur when a person unknowingly disturbs an underground nest.
- The nests can be hidden in an ornamental garden, in tall un-mowed grass, under foundations, under large rocks, or in some location that offers concealment for the yellowjacket entrance.
- Self-Help products are inadequate for controlling a nest full of yellowjackets.
- Self-Help Program participants should **NOT** attempt to control yellowjacket nests that are underground or in wall voids unless positive the nest is small.
- To gauge the size of a yellowjacket colony:
    1. Consider the time of year – nests start small in the spring and get larger as the season progresses.
    2. Watch the entrance. If it is late summer and yellowjackets are observed coming and going every second or two, assume it is a large colony and do **NOT** attempt control.
- When controlling small yellowjacket nests, perform the work at dawn, dusk, or at night when most of the adults are in the nest, and the insects are least active.
- Usually the best choice for yellowjacket nest control is to contact O&M or Entomology to arrange for control by a Pest Management Professional

Hornets (Bald-faced and European)

- Bald-faced and European hornets are wasps that are about 3/4" in length, generally brown and black in color, with vivid yellow or white markings on the face.
- This group of social, stinging insects will build spectacular aerial nests in plain view. The nests are large, grayish-brown, teardrop-shaped, paper carton structures.
- Nests can be found hanging from a tree branch, in a tall ornamental bush, or attached to the eve of a dwelling.
- The nest encloses many tiers and may be tended by thousands of insects by the end of the summer.
- The Bald-faced and European hornets are two common varieties found throughout the United States. They are very aggressive when disturbed, can sting repeatedly, and will attack as a group.
- Generally, hornets should only be controlled by experienced Pest Management Professionals.

Hornets (Bald-faced and European) (continued)

Hornet Nest Control:

- Self-Help Program participants should **NOT** attempt control of aerial hornet nests unless the nest is very small (smaller than a softball).
- If the nests are bigger than a softball, or if there is any doubt about personal safety or risk, do **NOT** attempt Self-Help control and report nest location(s) to the O&M Office or Entomology to arrange for control by a Pest Management Professional (PMP).
- Spraying an aerial nest with an aerosol pesticide will generally split open the nest and agitate the hornets to a stinging frenzy, resulting in their attack of anything nearby. Self-Help products are a very poor defense against frenzied hornets.
- If control is attempted, perform it at dawn, dusk, or after dark when the hornets are in the nest, and most quiet.

Carpenter Bees

- Carpenter bees are semisocial bees that look very much like large bumble bees.
- The size of carpenter bees make them appear intimidating, but they are not aggressive unless handled or agitated.
- Carpenter bees can sting repeatedly.
- Carpenter bees are most likely seen flying close to flowers to collect pollen or hovering near wooden structures where they nest.
- These insects make a ½" to ¾"-round hole in wood such as eves, porch ceilings, window sills, telephone poles, fence posts, etc.
- Unpainted, soft woods are preferred.
- Carpenter bees lay their eggs in the holes.
- Maintenance personnel usually encounter the holes of the carpenter bee rather than the bee itself.
- Do not spray Self-Help products into the hole since it will likely splash back out of the hole.
- Since these holes are often used year after year by succeeding generations or carpenter bees, they should be sealed. Carpenter bee holes can be caulked and the surface repainted to reduce likelihood for reuse.

Approved Self-Help Products for Control of Stinging Insects:

EPA Reg No.	Label Name	ACTIVE Ingredient (Primary
3862-176-13051	Assualt Wasp and Hornet Killer	Permethrin, mixed cis, trans
67603-11-64695	Blast 'Em Wasp and Hornet Killer	Permethrin, mixed cis, trans
4-392	Bonide Wasp & Hornet Spray	Permethrin, mixed cis, trans
10088-115-68562	Buzz Saw Wasp and Hornet Killer	d-Phenothrin
9688-190-8845	Chemisco (Spectricide/Hot Shot) Wasp & Hornet Killer (LE)	lambda-Cyhalothrin
55809-3	CRC Wasp & Hornet Killer Plus	d-Phenothrin
EX-2	Essentria (EcoEXEMPT) JET Wasp & Hornet Killer	Rosemary Oil
1021-1780-3	Harris Yellow Jacket Wasp and Hornet Spray	d-Phenothrin
40208-7	Kibosh Wasp, Hornet, Bee & Yellow Jacket Killer	Piperonyl butoxide
9688-325	No-Pest Wasp & Hornet Killer5	Cypermethrin
1021-1780-239	Ortho Hornet & Wasp Killer	d-Phenothrin
499-550	PT Waso-Freeze II Wasp & Hornet Insecticide	Prallethrin
9688-190-305	Repel Wasp, Hornet & Yellowjacket Killer	lambda-Cyhalothrin
9688-141-8845	Spectracide Pro Wasp & Hornet Killer	Permethrin, mixed cis, trans
498-156	SprayPak Wasp , Bee & Hornet Killer	d-Phenothrin
11694-109	The END Wasp & Hornet Killer	Piperonyl butoxide
9688-190	Ultra-Kill/Black Flag/Chemisco Wasp and Hornet Killer (LE)	Prallethrin
706-109-9250	United 173 Wasp Whacker	Tetramethrin
2724-786	Zoëcon (RF 2050) Wasp-X™ Wasp & Hornet Spray	Ethofenprox

SELF-HELP IPM Outline 2

Cockroaches

A. PURPOSE

The Self-Help pest management program authorizes the use of approved Self-Help products (ready-to-use cockroach baits) by installation maintenance and VAARNG personnel who encounter cockroaches during the normal course of their assigned duties.

B. RESPONSIBILITIES

- Self-Help Program participants are responsible for proper use, recording, reporting, storage and disposal of Self-Help products.
- **All** label instructions must be read and followed – **The Label is the Law!**
- A Safety Data Sheet (SDS) should accompany the Self-Help product and be readily available to personnel using the product and working in the area where the product is used.
- Only use products that are pre-approved for use in the VAARNG Self-Help Program. Contact the VAARNG IPMC (MAJ Brian Webb) for a current list of approved Self-Help products.
- Self-Help products can be obtained by request from the O&M Warehouse or Fort Pickett Entomology (Bldg 303).
- Record and report usage of Self-Help products to the VAARNG IPMC at the end of each month using the Pest Management Application Report form.
- Approved Self-Help products are tools to assist Self-Help Program participants with the control of small-scale cockroach infestations that have yet become extensive enough to warrant Pest Management Professional (PMP) control. Trying to control an excessively large infestation can result in loss of work time and higher costs resulting from cockroach contamination of facilities.
- Cockroach feces and saliva contain proteins and allergens that may trigger asthma attacks in some people. In densely populated areas, scientists have identified a correlation between roach presence and the incidence of asthma.
- Cockroaches can also spread various pathogens, including bacteria, viruses and parasitic worms.

C. ACTIONS

<u>STEP 1. Surveillance.</u>

- Identify the type of cockroach, the extent of the infestation and possible entry points into the building, food sources and water sources.
- It is important to identify the type of cockroach so the most effective baits are used. The size and type of bait depends on the type of the cockroach. Use the fact sheets attached to this outline to identify the type of cockroach.
- Determine the extent of the cockroach infestation to help decide if the control needed

is beyond that available to Self-Help Program participants.

- Locating where cockroaches are entering the building(s) and their sources of food and water is vital to long-term control of cockroaches. There is an endless source of cockroaches in the world and control will be a never-ending battle if cockroaches can easily get into the building and/or there is readily-available food and water.

STEP 2. Decide if Self-Help is appropriate.

- If it is determined the extent of the cockroach infestation is not appropriate for Self-Help Program control, contact the O&M Office or Fort Pickett Entomology to arrange for control by a Pest Management Professional (PMP).
- The decision to use Self-Help for control of cockroaches is often based on personal judgement and common sense. If you have **any** doubts that the cockroach infestation can be controlled with Self-Help actions, do not use Self-Help.

STEP 3. Perform Physical and Cultural Controls.

- Using cockroach baits as the only control method will rarely provide sufficient control of cockroach infestations.
- Habitat modification (cleaning up food sources and nesting locations) and building maintenance practices (repairing holes, cracks and other paths that cockroaches use to enter buildings) are vital in controlling cockroach infestations.
- If all the actions in STEP 3 and 4 have been done and there are still on-going or repeated cockroach infestations at the same facility, contact the VAARNG IPMC (MAJ Brian Webb). More extensive control methods may need to be done by contract or the Fort Pickett Entomologist.

STEP 4. Perform Chemical Control (baiting).

- Self-Help products for cockroaches can be obtained by submitting a Work Order request to O&M. Only use products that are pre-approved for use in the VAARNG Self-Help Program.
- Read the entire product label. **The Label is the Law!**
- Wear appropriate Personal Protective Equipment (PPE) as directed on the label.
- Do **NOT** eat, drink or smoke while using any pesticide.
- Use product as directed on the label for control of cockroaches.
- See Section 3 Control, Chemical below for further guidance on using cockroach baits.
- Always thoroughly wash hands with soap and water after using product and before eating, drinking or smoking.
- Bait will not kill all the cockroaches immediately – the pesticide has a delayed effect so the cockroaches that have eaten the bait can expose other cockroaches. They do this by spreading small amounts of the bait around on their body/feet, when other cockroaches eat their pesticide-containing feces, or when other cockroaches eat the bodies of pesticide-killed cockroaches.
- Use of chemical controls (pesticides) only will rarely provide sufficient control of cockroaches. Habitat modification through cleaning and sanitation, and building

practices (exclusion) are more permanent controls.

<u>STEP 5. Storage and Disposal of Self-Help Products.</u>

- Store and/or dispose of any leftover Self-Help products as directed on the label and the VAARNG IPMP.
- If you have any questions on storage or disposal of the Self-Help products, contact the VAARNG IPMC (MAJ Brian Webb).

<u>STEP 6. Recording and Reporting.</u>

- Report Self-Help product use to the VAARNG IPMC using the Pest Management Treatment Record form.
- The form recording usage should be sent to the VAARNG IPMC at the end of the month with any other IPM reports.

<u>STEP 7. Follow-up and Assessment.</u>

- If the Self-Help control methods in this outline do not control the cockroaches to acceptable levels with 30 days, put in a Work Order with the O&M Office.

COCKROACH CONTROL

WHY IS CONTROL NEEDED?

Cockroaches are often the most abundant and troublesome pests in offices, dining halls and other buildings.

The cockroach's appearance, odor and habits make them objectionable to many people. A few cockroaches can become a large infestation very quickly because of their extraordinary ability to reproduce and how well they are able to co-exist with people.

Cockroaches' feces and saliva contain proteins and allergens that may trigger asthma attacks in some people. In densely populated areas, scientists have identified a correlation between roach presence and the incidence of asthma.

Cockroaches can also spread various pathogens, including bacteria, viruses and parasitic worms.

1. GENERAL BIOLOGY

There are several thousand species of cockroaches throughout the world. Four species are of primary economic importance: German, Brown-Banded, Oriental and American. However, seven species/groups are commonly found in buildings (depending on geographic area). The Asian cockroach (a recently introduced species) is being seen with increasing frequency.

See information sheets below for more information on each of the common cockroach species.

2. INSPECTION AND SURVEY

Cockroaches are seldom seen during daylight hours and, in colder climates, they will live year round in structures. In warmer climates, once cockroaches gain entry into buildings, they seek out safe areas (harborages) and make the regular trips, usually during dark periods, to food sources from their harborages. Inspection for cockroach infestations normally involves flushing of pests from harborages (using canned air), sticky traps and/or inspection for droppings.

<u>Visual Sighting:</u> A good flashlight is an essential tool for cockroach inspections. Cracks and crevices should be examined with specific attention near sources of food and water, or in damp areas. Canned air can be sprayed into cracks as a flushing agent to force the cockroaches out where they can be seen and identified.

An indicator of a heavy cockroach infestation is fecal spots near likely harborages (places where they hide).

Cockroach fecal droppings are sometimes confused with rodent droppings. The feces of small cockroaches are black and resemble ground coffee or black pepper. Larger cockroaches leave black or brown droppings which are cylindrical in shape and have ridges down the side.

Rodent fecal droppings are usually dark, moist, soft and shiny, if recent, or dry and hard, if a few days old. When examined under a magnifier or microscope, hairs can usually be seen in rodent droppings. Mouse droppings have pointed ends.

Trapping:
Sticky traps (aka glue boards or glue traps) are excellent tools for cockroach surveys. They are inexpensive, non-toxic and easy to use. Placement of sticky traps near suspected cockroach harborages (places where they hide) for 24 hours will provide quantitative results of current infestations. However, catching no roaches does not necessarily mean there are no roaches. Sticky trap catches are proportionate to roach population size and activity in the area where the trap is placed.

Sticky traps should never be placed outdoors or in areas where non-target wildlife (such as birds, bats or snakes) may be accidentally trapped. If non-target wildlife is found alive on a sticky trap, talcum powder, cornstarch or vegetable oil can be applied to the exposed glue around the trapped wildlife and the animal can then usually free itself. For birds and bats, it is best to immediately take the trap, without attempting to remove the animal, to a licensed wildlife rehabilitator for assistance.

3. CONTROL METHODS

Cultural:

Sanitation: Most cockroach infestations can usually be traced to poor sanitary conditions that provide a source of food for the cockroaches. A control program should include removal of the food supply by improving food and refuse storage and removal.

- Keep kitchen scraps in sealed containers.
- Clean up food and beverage spills immediately.
- Do not leave food out overnight.
- Vacuum or sweep frequently.
- Fix leaking faucets and plumbing.

Because of cockroach habits, good sanitation is important to achieving and maintaining successful control of cockroaches. In the absence of good sanitation, chemical control measures cannot be expected to be fully effective.

Physical:

Exclusion: Cockroaches can get inside of buildings by hiding themselves or their egg cases in packages (such as cartons of supplies, cases of soda, boxes of vending machine foods, etc.) that are brought into the building. It is impossible to inspect all incoming boxes, but efforts should be made to inspect as much as possible.

Movement of cockroaches between buildings may be along steam and water lines, or in sanitary and storm drain sewers. In warmer climates where they can live outdoors most of the year, cockroaches may simply walk into a building looking for food or water. The use of exclusion practices such as caulking and sealing cracks and other possible entrances is very helpful in preventing and controlling cockroach infestations.

Since cockroaches often enter through small openings, seal the following areas:

- Cracks and crevices where cockroaches can hide, such as crevices where countertops and kickboards meet the walls.
- Holes in the walls that lead into the wall void, such as around pipes.
- Around doors and windows.
- Cracks, crevices and holes in walls and foundation; this will reduce entry of the larger cockroaches (such as American cockroaches) from the outdoors.
- Seal exterior cracks and crevices with silicone caulk, making sure all windows have tight fitting screens in good repair.
- Use door sweeps and screen doors.

Mechanical:

Sticky Traps: Sticky traps (aka glue traps or glue boards) alone will not control most cockroach infestations. Although sticky traps are simple to use and may be effective in stopping an infestation from occurring, chemical control is usually necessary once an infestation is established.

Ultrasonic and/or Electromagnetic Repellent Devices: These devices have been proven to be ineffective and may **NOT** be used.

Chemical:

As a general rule, 4-6 bait stations are needed for every 100 square feet (10' x 10' room) of infested area.

Use a higher number of bait stations where the infestations are heaviest.

Placement should be concentrated where there is a food source, in areas that have not been treated with other pesticides, or where there are access routes from untreated adjoining areas.

Do not spray insecticides in areas where bait stations are placed. Insecticide sprays kill cockroaches on contact and then they are not able to expose other cockroaches to the bait.

The bait must be placed where cockroaches live or travel so the insects have maximum access to it. Bait stations should usually be placed next to walls and/or in dark, enclosed areas.

For active infestations, the bait stations should be replaced every 90 days.

<u>German or Brown Banded Cockroaches (smaller infestations – less than 10 cockroaches found in one room only):</u>

- Use 6 small bait stations and 3 sticky traps.
- Place the sticky traps along baseboards, usually behind appliances and other objects that are not moved on a daily basis.
- Read the entire bait station label. **The Label is the Law!**
- Wear appropriate Personal Protective Equipment (PPE) as directed on the label.
- Do NOT eat, drink or smoke while using any pesticide.
- Place the bait stations along floor/wall junctions in protected places, especially in those areas where cockroaches have been seen.
- Bait stations can also be placed under appliances, preferably next to the sides of the devices.

Always follow the label directions for the use, placement and disposal of bait stations.

<u>German or Brown Banded Cockroaches (for larger infestations – cockroaches found in more than one room):</u>

- Get 6-12 small bait stations and 6-8 sticky traps.
- Read the entire bait station label. **The Label is the Law!**
- Wear appropriate Personal Protective Equipment (PPE) as directed on the label.
- Do NOT eat, drink or smoke while using any pesticide.
- Place the bait stations along floor/wall junctions in protected places, especially in those areas where cockroaches have been seen.
- Bait stations can also be placed under appliances, preferably next to the sides of the devices.

Always follow the label directions for the use, placement and disposal of bait stations.

<u>American, Smokybrown, Oriental or Australian Cockroaches:</u>

- Use 3-5 large bait stations and 3 sticky traps per each room where cockroaches are found (i.e., bathrooms, kitchens and utility rooms).
- Read the entire bait station label. **The Label is the Law!**

- Wear appropriate Personal Protective Equipment (PPE) as directed on the label.
- Do NOT eat, drink or smoke while using any pesticide.
- Place the sticky traps along baseboards, usually behind appliances and other objects that are usually not moved on a daily basis.
- Place the bait stations along floor/wall junctions in protected places, especially in those areas where cockroaches have been seen.
- Bait stations can also be placed under appliances, preferably next to the sides of the devices.
- Adult American, Smokybrown and Oriental cockroaches are too large to enter the small bait stations.

Always follow the label directions for the use, placement and disposal of bait stations.

Asian Cockroaches:

- Control with cultural and physical controls:
  - Change white light bulbs to yellow bulbs around entrance doors.
  - Seal exterior cracks and crevices with silicone caulk, making sure all windows have tight fitting screens in good repair.
  - Use door sweeps and screen doors.
  - If cultural and physical controls are not enough, put in a Work Order with O&M for PMP control of outdoor populations.

Wood Cockroaches:

- Bait stations are not effective for wood cockroaches.
- Vacuum or sweep up individual wood roaches and dispose of them outside.

Wear appropriate Personal Protective Equipment (PPE) as directed on the label whenever handling cockroach bait stations.

Bait will not kill all the cockroaches immediately – the pesticide has a delayed effect so the cockroaches that have eaten the bait can expose other cockroaches to the bait. They do this by spreading small amounts of the bait around on their body/feet, when other cockroaches eat their pesticide-containing feces, or when other cockroaches eat the bodies of pesticide-killed cockroaches.

Dispose of used bait stations as directed on the label. If the label is missing, dispose of by wrapping the bait station and placing in a garbage can.

4. AFTER TREATMENT SURVEILLANCE

Clean up or remove egg cases, cast skins and droppings/stains in order to tell if there is new cockroach activity.

Continue to use sticky traps and check them regularly, noting what is captured. Look for cockroaches at night just after the lights in a room are switched on. Look for egg cases, cast skins, fecal droppings or staining.

If there is a reduction in the number of cockroaches, then Self-Help control efforts are working. Remove sticky traps after 30 days if additional roaches are not caught.

If sticky traps are full of cockroaches and/or there are still egg cases, cast skins and droppings/stains being seen after cleaning up those from the initial infestation, put in a Work Order with O&M for PMP control.

German Cockroach

- The German cockroach is the most common pest in homes, barracks, dining facilities, and warehouses.
- It is a small brownish insect about 5/8-inches long and easily identified by two longitudinal black bars on the pronotum (the disc-like plate behind head).
- German cockroaches live in warm, dark places and are most commonly found in places close to food and water such as dining facilities, bathrooms and pantries. They live in walls, cabinets and other hiding places in these rooms.
- They will also live anywhere that has adequate food, water and shelter present. They may be found near plants, pet food, in clutter such as clothing on the floor, books, magazines, newspapers, boxes and paper bags.
- They secrete a fluid that leaves a characteristic odor. This odor may even linger after the cockroaches are gone if there was a large infestation.
- German cockroaches can be found in almost all geographical areas of the United States.
- In addition to common human foods, German cockroaches will feed on almost anything with nutritional value such as saps, glue and toothpaste.
- German cockroaches breed year-round.
- The females produce from 4-5 egg capsules during their life span. Each egg capsule (called an "ootheca") produces about 30 nymphs.
- The adult female carries her egg case until 1-2 days before hatching. The egg case is then deposited in a sheltered place.
- Nymphs hatch from the egg case and are somewhat similar in appearance to adults except that they lack wings.
- Development from egg to adult ranges from about 50 to 200 days depending on temperature and relative humidity.

Asian Cockroach

- Asian cockroaches were introduced to Florida in 1980's and have quickly become established in the southeastern United States. Their range is expanding and Asian cockroaches have been found as far north as Michigan.
- Asian cockroaches are almost identical in appearance to the more common German cockroach. Adults of both species are approximately 5/8-inches long and 3/16-inches wide. Both are similar in color, with prominent dark stripes just behind the head. However, their behavioral patterns are quite different.
- Unlike German cockroaches that are repulsed by light and the presence of people, Asian cockroaches live outdoors in warm climates, are attracted to light and take little notice of human presence.
- Asian cockroaches usually live outside buildings in moist shady leaf litter and grassy areas and are generally not active during the day. If the leaf litter is disturbed, adult Asian cockroaches will fly to escape.
- If the temperature is 70 degrees F. or higher at dusk, Asian cockroaches fly towards any light source. They are very strong flyers and can fly as far as 120 feet. They are attracted to light and usually invade buildings by entering around doors and windows. Once inside, they fly to sources of light.
- Asian cockroaches are omnivorous and will eat pet food, seeds, flowers, and even pet feces.
- In the winter, Asian cockroaches survive by burrowing into leaf litter and soil. In the spring, they begin to emerge, and their numbers grow into large populations that can reach 30,000 to 240,000 cockroaches per acre.
- Asian cockroaches are often mistaken for German cockroaches, and control measures are applied the interiors of buildings but not outside where Asian cockroaches live.
- Because Asian cockroaches live outdoors, management practices need to target leaf litter and mulch. It is imperative that cockroaches be identified correctly so that control and management practices can be applied in the correct locations.

Female Asian and German cockroaches.
Asian cockroach on the left and German cockroach on the right.

- Asian and German cockroaches are best told apart by looking to see if the wings of the female cover the egg case (ootheca) when it is being carried. Males can only be told apart using magnification.
- In contrast, German cockroaches live strictly inside homes, flee from sources of light, and, although adult German cockroaches have fully developed wings, German cockroaches do not fly.
- Asian cockroaches are easily controlled with most pesticides; in contrast, German cockroaches often have resistance to many classes of insecticides.

Oriental Cockroach

- Oriental cockroaches are medium sized, black cockroaches that are often called “waterbugs”.
- They are shiny, blackish-brown and are approximately ¾ to 1-inches long.
- The wings of adult male Oriental cockroaches cover two-thirds of the abdomen. Adult

female specimens are wingless, and their small wing pads extend only to the middle of the abdomen.

- Oriental cockroaches do not fly and prefer warm, damp places such as cellars and sewers.
- Oriental cockroaches are primarily an outdoor species. Most outdoor populations live beneath mulch in landscape beds, in leaf litter, beneath stones or debris outside.
- They frequently get into buildings beneath doors, through open doors or gaps beneath siding. If access is available, Oriental cockroaches can thrive in the voids or openings beneath porches, in wall voids and crawlspaces.
- In urban areas, Oriental cockroaches can be found in large numbers living in storm drains and sewers.
- Oriental cockroaches are known for their preference for feeding on garbage, filth or material that has begun to decay.
- Oriental cockroaches are very dependent on water. Studies have shown they can survive up to a month without food, but they cannot survive for more than two weeks without water.
- Although their natural habitat is outdoors, Oriental cockroaches may infest homes in summer. Inside, they tend to remain on lower floors.
- Oriental cockroaches tend to gather in large numbers near water sources.
- In areas where large populations of Oriental cockroaches are present, a musty odor can often be detected
- On average, an adult male oriental cockroach will live 110 to 160 days and the adult female can live anywhere from 35 to 180 days.
- A single female oriental roach can produce approximately eight egg cases with approximately 16 eggs per case.
- Approximately 30 hours after a female Oriental cockroach has produced an egg case, she will drop it in a protected area where it will stay until the young hatch.
- In the warmer months, the time it takes for an egg to develop into an adult may be as few as 200 days. However, when the weather becomes colder, or during the late fall and winter months, it can take as many as 800 days for Oriental cockroaches to go from egg to adult.
- Oriental cockroaches are found worldwide, although they are more common in the northern states than in the southern United States.

American Cockroach

- American cockroaches are one of the largest commonly-found roaches in the United States.
- They are about 1¼ to 1½-inches long and dark brown to mahogany color with somewhat obscure yellow margins on the pronotum (the disc-like plate behind the head). The adults have fully developed wings that completely cover the back end of their body.
- In northern states, American cockroaches almost always live indoors and are found in warm, damp places such as sewers, steam tunnels, around floor drains, near sump pumps, crawl spaces and damp basements. In basements, they may be found in corners areas high on the walls or in floor drains. They more commonly congregate in open spaces instead of small cracks and crevices.
- In southern states, American cockroaches live and reproduce outdoors and are capable of flight. They can be found in moist, shady areas like yards, hollow trees, woodpiles and mulch. At times they can be found under roof shingles or attics. Usually, they will live outside but will wander inside in search of food and water or during extremes in weather conditions.
- American cockroaches enter buildings to find water or food. They forage under appliances, in drains, in food storage cabinets and on the floor for crumbs, and scraps of food. They will also eat any food that is left out overnight and will even chew through thin plastic food packaging.
- Adult American cockroaches live from 200 to 400 days.
- The American cockroach will reproduce indoors (and outdoors in warmer climates).
- The female can produce as many as 90 egg capsules in its life time. Each egg capsule has approximately 15 eggs.
- The young or nymphs (1/4-inch long) emerge from the eggs in about 60 days. It takes about 30 days for the young to mature to adulthood, but this is temperature dependent and means the nymphs will mature faster in warmer temperatures and slower in colder temperatures.
- American cockroaches are the most common cockroach found in the sewers of the United States. Because of their longevity and reproductive capacity, American cockroaches can produce very large populations. As many as 5,000 American cockroaches have been collected from a single sewer manhole.

Smokeybrown Cockroach

- Smokybrown cockroaches are approximately 1¼-inches long. They are typically brownish black but their color can vary from dark mahogany to black, they.do not have markings and are shiny, Both sexes have wings that extend beyond their abdomen.
- They live primarily outdoors and are good fliers. Smokybrown cockroaches are attracted to lights and may enter buildings because they are drawn to interior lighting.
- Smokybrown cockroaches enter buildings through openings or gaps beneath siding, through attic or soffit vents, openings around utility and plumbing penetrations, and through open windows or doors.
- Smokybrown cockroaches are found outside in areas that are warm, very moist and protected from the elements. They can easily become dehydrated, so the availability of a moist environment is critical for survival. Around buildings and structures, smokybrown cockroaches can be found in tree holes and cavities, beneath mulch beds and ground cover, and around soffits and eaves, or areas where moisture problems may exist.
- Smokybrown cockroaches primarily feed during the late dusk or early dawn hours when they leave their hiding places in search of food. They will feed on any food that may be available, including human food scraps, dead insects, fecal matter and even plant materials. They may also be seen drinking available water.
- Female smokybrown cockroaches deposit their egg cases approximately one day after it is formed and firmly glue it to an object. Females produce from 4-32 egg cases in a lifetime with each case containing from 4-29 eggs.
- The time spent from egg to adult is about 400 days depending on humidity and temperature.
- An adult female smokybrown cockroach can live about 250 days.
- Smokybrown cockroaches are common pests of the southeastern United States. Although they are mainly found from central Texas eastward, and as far north as North Carolina, smokybrown cockroaches have also been found as far north as Indiana and Illinois.

Australian Cockroach

- The Australian cockroach is slightly smaller in size (about 1-inch long) and similar in appearance to the American roach.
- It can be recognized by the vivid pale area surrounding the edge of the pronotum (the disc-like plate behind head).
- Australian cockroaches can be found in wall voids, tree holes, leaf piles, mulch, wood piles, tree bark, in and around shrubs and greenhouses. Inside they are found in attics, kitchens, garbage cans and garages.
- Australian cockroaches feed on plant material and decaying material. They will also eat starchy materials like book bindings and glue in boxes.
- Australian cockroaches are good fliers and they will enter buildings where enough food, moisture, and heat are available.
- Females drop egg cases in hidden areas and cracks and crevices. Each case has about 24 eggs with a smaller percentage that hatch. The nymphs are marked with yellow patches and take about a year to develop.
- They are mostly found in the south and tropical areas like Hawaii. They have been found in houses in the northern states due to transportation and shipping. They can populate well when temperatures stay above 80 degrees.
- Australian cockroaches are more common in Florida and California than in more northern, colder states.

Brown Banded Cockroach

- Adult brown banded cockroaches are 1/2 to 5/8-inches long and are reddish brown to dark brown in color. They have two cross bands of lighter color, one is at the base of the wings and the other is about 1/3 of the way down the back. The female is broader than the male; her wings do not extend to the tip of her abdomen like the male's wings.
- Brown banded cockroaches are not as common as German cockroaches, but they are found nationwide.
- Brown-banded cockroaches like warm temperatures and are found in places where cockroaches are usually not expected, such as on closet shelves and inside/under large and small electrical appliances (electric clocks, computers, radios and television sets). They tend to hide in places up off the floor, including behind pictures and wall hangings.
- Brown-banded cockroaches are not normally as troublesome as German cockroaches, but they can reach large numbers if food and water are abundant.
- They produce an unpleasant odor and will feed on food product, glues and fabrics.
- The female produces about 13 egg capsules in her lifetime. Each egg capsule contains 10 to 18 eggs.
- Female brown banded cockroaches frequently glue their egg capsules beneath furniture and behind pictures.
- Adult brown-banded cockroaches live about 6 months. The developmental time from egg to adult is over 200 days.

Wood Cockroaches

- Wood cockroaches are light to dark brown, about ¾ to 1-inch long, and the sides of the thorax and front half of the wings have a yellow border. The females are wingless and are rarely seen.
- Wood cockroaches are found mostly in the eastern United States.
- Wood cockroaches live outside, but will occasionally enter homes by coming in with firewood or other items stored outside. They are often confused with German, American or Smoky Brown cockroaches.
- Behavior is the best way to tell the difference between wood cockroaches and other cockroaches. Wood cockroaches can be seen day or night, they aren't skittish and are less likely to scurry away when approached, and they wander around when inside a building without gathering in any particular area.
- Wood cockroaches normally live outdoors in moist woodland areas, including woodpiles, mulch, under the loose bark of trees, branches or decaying logs. Wood cockroaches eat decaying organic matter such as rotting trees and leaf litter.
- They are generally considered a minor pest since they prefer to be outside, need an environment that is consistently moist, and do not survive long nor breed indoors
- Wood cockroaches don't breed inside and pesticides that control other roaches are not as effective against them, so it is best to simply pick them up with a vacuum cleaner or broom and dustpan and discard them outside.

Approved Self-Help Products for Control of Cockroaches:

Combat Quick Kill Roach Killing Gel EPA Registration Number 64240-45

SELF-HELP IPM Outline 3

Nuisance Ants

A. PURPOSE

The Self-Help pest management program authorizes the use of approved Self-Help products (ready-to-use ant baits) by installation maintenance and VAARNG personnel who encounter ants during the normal course of their assigned duties.

B. RESPONSIBILITIES

- Self-Help Program participants are responsible for proper use, recording, reporting, storage and disposal of Self-Help products.
- **All** label instructions must be read and followed – **The Label is the Law!**
- A Safety Data Sheet (SDS) should accompany the Self-Help product and be readily available to personnel using the product and working in the area where the product is used.
- Only use products that are pre-approved for use in the VAARNG Self-Help Program. Contact the VAARNG IPMC (MAJ Brian Webb) for a current list of approved Self-Help products.
- Record and report usage of Self-Help products to the VAARNG IPMC at the end of each month using the Pest Management Treatment Record form.
- Approved Self-Help products are tools to assist Self-Help Program participants with the control of small-scale ant infestations that have not become extensive enough to warrant Pest Management Professional (PMP) control. Trying to control an excessively large infestation can result in loss of work time, higher costs and unnecessary exposure of personnel to pesticides.

C. ACTIONS

<u>STEP 1. Surveillance.</u>

- Identify the type of ant, the extent of the infestation and possible entry points into the building, food sources and water sources.
- It is important to identify the type of ant so the most effective baits are used. The type of bait and methods used depend on the type of the ant. Use the fact sheets attached to this outline to help identify the type of ant or contact the VAARNG IPMC for assistance.
- Determine the extent of the ant infestation to decide if the control needed is beyond that available to Self-Help Program participants.
- Locating where ants are entering the building(s) and their sources of food and water is vital to long-term control. There is an endless source of ants outdoors, and ant control will be a never-ending battle if ants can easily get into the building and/or there is readily-available food and water.

STEP 2. Decide if Self-Help is appropriate.

- After identifying the type of ant using the information in this outline and determining the type of ant is **NOT** appropriate for Self-Help Program control, do not attempt Self-Help.
- Approved Self-Help products are tools to assist Self-Help Program participants with the control of small-scale ant infestations that have not yet become wide-spread enough to warrant Pest Management Professional (PMP) control. Trying to control an excessively large infestation will result in loss of work time, higher costs and unnecessary exposure of VAARNG personnel to pesticides.

STEP 3. Perform Physical and Cultural Controls.

- Using ant baits as the only control method will rarely provide sufficient control of nuisance ant infestations.
- Habitat modification (cleaning up food sources) and building maintenance practices (repairing holes, cracks and other paths that ants use to enter buildings) are vital in controlling nuisance ant infestations.
- If all the actions in STEP 3 and 4 have been done and there are still on-going or repeated ant problems at the same facility, contact the VAARNG IPMC. More extensive control methods may need to be done by contract or the O&M Office or Fort Pickett Entomology.

STEP 4. Perform Chemical Control (baiting).

- Self-Help products for ants can be obtained by submitting a Work Order request to O&M.
- Only use products that are pre-approved for use in the VAARNG Self-Help Program.
- Read the entire product label. **The Label is the Law!**
- Wear appropriate Personal Protective Equipment (PPE) as directed on the label.
- Do **NOT** eat, drink or smoke while using any pesticide.
- Use product as directed on the label for control of ants.
- See section 3 Control, Chemical, below for further guidance in effectively using ant baits.
- Always thoroughly wash hands with soap and water after using product and before eating, drinking or smoking.
- Baits will not kill all the ants immediately – the pesticide has a delayed effect so ants that have eaten the bait can carry it back to the nest to feed to other ants.
- Use of chemical controls (pesticides) will only rarely provide sufficient control of ants. Habitat modification through cleaning and sanitation, and building practices (exclusion) are more permanent controls.

STEP 5. Storage and Disposal of Self-Help Products.

- Store and/or dispose of any leftover Self-Help products as directed on the label and the VAARNG IPMP.
- If you have any questions on storage or disposal of the Self-Help products, contact the VAARNG IPMC.

STEP 6. Recording and Reporting.

- Report Self-Help product use to the VAARNG IPMC using the Pest Management Treatment Record form.
- The form recording usage should be sent to the VAARNG IPMC at the end of each month that the treatment is conducted.

STEP 7. Follow-up and Assessment.

- If the Self-Help control methods in this outline do not control the ants to acceptable levels with 30 days, put in a Work Order with O&M.

ANT CONTROL

1. WHY IS CONTROL NEEDED?

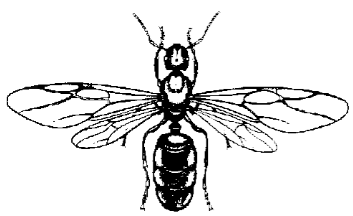
Ants are common pests across the United States.

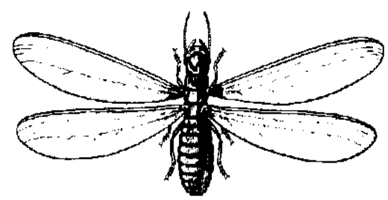
With the exception of carpenter ants, most ant species do not cause damage to structures.

However, ants enter buildings in search of food/water and their presence is disruptive to most people. Also, some ants may bite or sting.

2. GENERAL BIOLOGY

Ants are small, usually wingless insects. However, winged ants may be seen swarming at certain times during the year.
Ants are 1/8 to 1/2-inch in length and may be yellow, red, brown, or black.





Ants (above left) should not be confused with termites (above right). Both ants and termites swarm at various times of the year. Ants have a thin waist (pedicel), elbowed antennae, and the forewings are distinctly larger than the hind set of wings. Termites have a fat waist (actually, no waist), the antennae are straight, and all four wings are of equal size.

Where ant nests occur may change with the seasons or where in the United States they occur. Ant species found nesting in structures in the north may be found nesting both in and out of structures in the south.

Ants enter structures through cracks and crevices as they search for food, water and shelter.

Ants generally live outdoors, but a few species may build nests inside buildings.

Ant nests are usually found behind loose baseboards, behind hollow walls, or in other protected voids.

Adult ants are the only life stage normally seen inside facilities.

A colony of ants consists of one or more queens, workers and males. As many as 500,000 ants may live in one colony.

Males and queens emerge in the late spring or early summer when it is time for mating. Mating usually occurs in flight and the queen loses her wings afterwards, then starts a new colony or joins an existing colony.

The queen is the only ant that lays eggs. Depending on the type of ant, she lays as few as 15-20 eggs per year or as many as 5-20 eggs per day.

See attached information sheets for each of the common ant species.

2. INSPECTION AND SURVEY

It is very important to determine which species (one or more may be involved) of ants are present and, if possible, the nest locations.

Visual Sighting: Follow ant trails to find the nests. Ants lay down a chemical pheromone trail along their established routes to and from a food source so other ants can easily find the food.

Inside a building, inspect along the carpet edges, doors, windows, and especially areas where food is stored or eaten. The easiest way to find a trail to the nest is to watch where ants go after reaching a food source.

Outside of a structure, inspect around foundation walls, areas of vegetation, and mulch. Any vegetation found near patios and walls may hide ant nests or their trails. Check under any item that is on the ground. Some ant nests are well hidden.

Use of non-toxic baits is also a very effective surveillance tool. Survey bait items may include, but are not limited to, peanut butter, jelly, hamburger, bacon grease, french fries, or honey. The combination of a sweet and a meat/grease is a very enticing combination. Map the premises and note the locations of the baits and where ants are seen each day.

3. CONTROL METHODS

Carpenter Ant control is NOT done by Self-Help Program participants.

Cultural:

Sanitation: Most ant infestations can usually be traced to a source of food for the ants. A control program should include removal of the food supply by improving food and refuse storage and removal.

- Keep food in sealed containers.
- Clean up food and beverage spills immediately.
- Vacuum or sweep regularly to remove spilled food particles.
- Do not leave food out overnight.

- Fix leaking faucets and plumbing.
- Store garbage cans in dry places, keep them clean and empty often.

Good sanitation is important to achieving and maintaining successful control of ants. In the absence of good sanitation, chemical control measures are not fully effective.

Physical:

Exclusion: The use of exclusion practices such as caulking and sealing cracks and other possible entrances can be very helpful in preventing and controlling ant infestations.

Since ants often enter through small openings, seal the following areas with caulking:
- Cracks, crevices or holes that provide entry into the facility, especially in the walls and foundation.
- Holes in the walls that lead into the wall void, such as around pipes.
- Around doors and windows, making sure all windows have tight fitting screens in good repair.

Ants may also be carried into buildings in or on objects. Inspect plants and other items before bringing them indoors.

Move firewood, dead trees and limbs away from facilities. Keep vegetation trimmed so it does not touch buildings.

Mechanical:

Sticky Traps: Sticky traps are not effective in controlling ants and are generally not used.

Ultrasonic and/or Electromagnetic Repellent Devices: These devices have been proven to be ineffective and may NOT be used.

Chemical:

While sanitation will help a great deal in controlling ants, it will not always completely solve the problem if large numbers of ants are entering or nesting in the structure.

Toxic Ant Baits: Toxic ant baits are an effective control for most species of ants, and an appropriate control method for Self-Help program participants.

Ants take the toxic bait back to the nest and feed it to the other ants in the colony. After a number of days (or weeks in some cases), all of the ants in the colony have eaten, or been fed, the bait and die.
Using a toxic bait that is attractive to the species of ant is important. The lure part of the bait may be solid or liquid and based on sugar, fat or protein. With some species of ants, different baits may be preferred at different seasons. If ants are not showing any interest in a bait, try another formulation that has a different type of lure.

Bait should be replaced regularly and an ample amount should be used.

As a general rule, one bait station is adequate for every 100 square feet (10' x 10' room) of infested area.

Toxic ant bait is best placed along an active trail. Otherwise, place it in areas where there is a food source, that have not been treated with other chemicals and/or where there are access routes from untreated adjoining areas.

Do not spray insecticides in areas where bait has been placed. Insecticide sprays kill ants on contact and they are not able take the bait back to other ants in the colony.

Do not clean up ant trails that lead between the bait and the ant nest. The ants must be able to access the bait **and** return to the nest with it.

Practice good sanitation in the areas where the bait is located so the bait is not competing with other sources of food.

For active infestations, the bait should be replaced every 30 days or when the ants have eaten it all.

Wear appropriate Personal Protective Equipment (PPE) as directed on the label whenever handling toxic ant bait.

Bait will not kill all the ants immediately – the pesticide has a delayed effect so ants can carry the bait back to the nest to feed to other ants.

Dispose of used bait stations as directed on the label. If the label is missing, dispose of by wrapping the bait station and placing in a garbage can.

Be sure to continue to do the cultural and mechanical controls (sanitation and exclusion). As long as the ants can enter the building and food/water are available, they may continue to be a problem even though bait stations are in place.

<u>Ants that are Nesting Inside Buildings:</u>

- Use approximately one bait station/100 square feet.
- Always wear appropriate Personal Protective Equipment (PPE) as directed on the label whenever handling ant bait.
- Place bait stations next to ant trails and/or where ants have been seen.
- Replace bait stations that are empty and relocate stations that have little or no ant activity.
- Bait stations should be used until ants disappear.

Always follow the label directions for the use, placement and disposal of bait stations.

Pharaoh Ants:

Pharaoh ants are a special problem because their colonies "bud" when stressed or threatened and create multiple new colonies. When dealing with pharaoh ants, use ant baits that have Hydramethylnon as an active ingredient. They have been the most effective to date against the pharaoh ant. Other type of insecticidal baits (such as those containing the active ingredient methoprene) have a delayed action and are generally not successful with pharaoh ants.

- Baits are usually the only effective method of control.
- Use approximately one bait station/100 square feet.
- Always wear appropriate Personal Protective Equipment (PPE) as directed on the label whenever handling ant bait.
- Place a bait station as close as possible to a line of foraging ants without disturbing them.
- Do not disturb the colonies or spray them with insecticides since it can cause them to “bud” and form new colonies in the building.

Always follow the label directions for the use, placement and disposal of bait stations.

Ants that are Nesting Outside and Foraging Inside (other than Fire Ants or Carpenter Ants):

Perform the Cultural and Physical controls listed in the previous sections, especially sealing the routes ants are using to get into the building.

If ants are **NOT** entering structures and are **NOT** Fire Ants, Carpenter Ants or a species of ant that poses a risk to the environment, human health or property, there is usually not a need to control them.

If Cultural and Physical controls have been performed to the greatest extent possible and ants continue to enter a building:

- Toxic ant baits are usually the secondary method of control.
- Get approximately one bait station/100 square feet.
- Always wear appropriate Personal Protective Equipment (PPE) as directed on the label whenever handling ant bait.
- Place a bait station as close as possible to a line of foraging ants without disturbing them.
- Replace bait stations that are empty and relocate stations that have little or no ant activity.
- Bait stations should be used until ants disappear.

Always follow the label directions for the use, placement and disposal of bait stations.

Put in a Work Order with the O&M Office or contact the Fort Pickett Entomologist to arrange for control of Carpenter ants by a Pest Management Professional (PMP).

4. AFTER TREATMENT SURVEILLANCE

The number of ants should diminish within days (or weeks in some cases) after using toxic ant baits.

Remove toxic bait after 30 days if ants are no longer being seen.

If ants are still being seen after 30 days, even after trying different formulations of bait, put in a Wok Order with the O&M Office or contact the Entomology Office for PMP control.

INTERIOR-NESTING ANTS

- Most ants that nest in buildings and structures range from 1/15 to1/4-inches long and range in color from a light yellow to a reddish yellow and jet black.
- These ants will nest in walls, woodwork, behind cabinets and beneath masonry.
- Indoor colonization by ants occurs year-round, especially in warmer climates.
- They will feed on all types of food material, such as sweets, fruits or nuts, and fatty, greasy, or oily materials.
- Once ants find a food source, they will leave a pheromone trail for other ants to follow.
- The thief ant and the odorous house ant (pictured above) are two of the more common species nest indoors.
- Other ants that may nest indoors are Argentine Ants, Crazy Ants, Fire Ants, Ghost Ants, Leafcutter Ants, Pavement Ants and Pharaoh Ants.

OUTDOOR-NESTING ANTS
(other than Fire Ants or Carpenter Ants)

- Many species of ants that nest outdoors and will forage indoors for food.
- Pavement ants prefer to nest under rocks, next to buildings and under cracks in pavement. Harvester ants (pictured above) are often confused with fire ants, but harvester ants are much larger than fire ants and make large bare areas around their nests with a single entrance hole to the colony.
- Leafcutter ants are also much larger than fire ants and have a distinctive built-up dense cluster of mounds at the colony's center called a "town", and have many entrance holes over a very large area.
- The large yellow ant (citronella ant) nests near structures and their winged reproductives are often confused with termites.
- Field ants occasionally invade structures. They nest in open areas in small mounds.
- If ants are **NOT** entering structures and are **NOT** Fire Ants, Carpenter Ants or a species of ant that poses a risk to the environment, human health or property, there is usually not a need to control them.

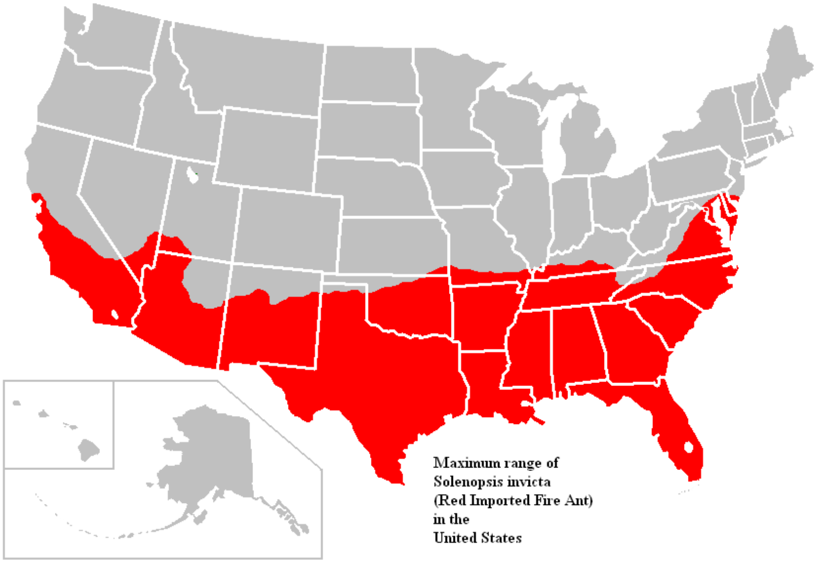
PHARAOH ANTS

- Workers are approximately 1/5 to 1/2-inches long. The body is often pale yellow or red with a darker abdomen.
- Pharaoh ants may bite.
- They will feed on all types of food material.
- Pharaoh ant workers search actively for food and often use pipes, electrical and telephone wires to enter buildings. They also get inside through poorly caulked windows or under flashing.
- Once pharaoh ants invade a building, they will infest other rooms and are usually found year-round.
- Pharaoh ants tend to nest in inaccessible areas such as behind baseboards, in wall voids, wall sockets, in furniture and appliances, in ceilings and under floors.
- Pharaoh ants can also nest outside, but cannot survive outdoors during winter in northern areas of the United States.
- Pharaoh ants are a special problem because their colonies "bud" when stressed or threatened and create multiple new colonies.
- Pharaoh ant queens can produce 400 eggs in a lifetime. New nests can be formed by the migration of as few as 10 immatures, 5 workers, and one queen. This process is called “budding”.
- Colonies consist of queens, males, workers and brood (eggs, larvae, and pupae). Flights of swarmers seldom ever take place even through winged reproductive ants are produced.
- Development time from egg to adult for workers averages 38 days at 80F.
- A queen can live from 4-14 months, a worker lives for about 10 weeks, and males live 3-5 weeks.
- Pharaoh ants have many queens. More than one nest may occur inside a home and individual ants from one nest do not fight with their counterparts from any other nests.
- Baits are usually the only effective method of control. Place bait station as close as possible to line of foraging ants without disturbing them. Do not disturb the colonies or

spray them with insecticides as this can cause them to "bud" and form new colonies in the building.

- When controlling pharaoh ants, use ant baits that have Hydramethylnon as an active ingredient. Other type of toxic ant baits (such as those containing the active ingredient methoprene) have a delayed action and are generally not successful with pharaoh ants.
- Never attempt control of pharaoh ants using a contact insecticide since it will only cause the colony to "bud" and spread to other areas.

FIRE ANTS



- Fire ants are medium-sized red and black colored ants that build mounds of soft soil.
- Worker fire ants vary in size from small (1/16-inch long) to large (almost 1/4-inch long). Many other ant species have worker ants that are uniform in size and may be a similar color.

- Other small to medium-sized ants that build small nests in soil often have central nest openings through which the ants enter and leave. Fire ant mounds have no central openings.
- Harvester ants are much larger than fire ants and make large bare areas with a single entrance hole to the colony.
- Leafcutter ants are also much larger than fire ants and have a distinctive built-up dense cluster of mounds at the colony's center called a "town", and have many entrance holes over a very large area.

- Red and black imported fire ants (Solenopsis invicta, and Solenopsis richteri) are native to South America. They were accidentally introduced into the United States around the 1930's through the port of Mobile, Alabama; probably in soil used for ship ballast, and have spread through the southern United States.
- There are several other species of fire ants that are native to the United States.
- Mounds are rarely larger than 18″ in diameter. In cold, dry areas, mounds are usually much smaller and harder to detect.
- When disturbed, fire ants emerge aggressively, crawling up vertical surfaces, biting and stinging. Their sting usually leaves a white pustule on the skin.
- Fire ants are sensitive to vibration or movement and tend to sting when the object they are on moves. Usually, whatever causes one ant to bite and stings triggers the other ants to sting as well.
- A very small portion of the human population (approximately 1%) are hypersensitive to ant venom and can experience potentially lethal allergic reactions. However, even healthy individuals may experience severe reactions such as anaphylactic shock if they suffer from a multiple stinging incident.

CARPENTER ANTS

- Carpenter ants are large, black or red, and 3/8 to 1/2-inch long.
- Carpenter ants live in damp wood where they excavate the softer wood to make a nest.
- The presence of carpenter ants usually indicates excess dampness or leaking water.
- Carpenter ants most often forage at night.
- **Carpenter Ant control is NOT done by Self-Help Program participants.**
- Put in a Work Order with the O&M Office or contact the Fort Pickett Entomology Office to arrange for control of Carpenter ants by a Pest Management Professional (PMP).

Approved Self-Help Products for Control of Ants:

Maxforce FC Professional Insect Control Ant Killer Bait Gel, EPA Registration Number 432-1264

SELF-HELP IPM Outline 4

Rodents (Mice & Rats)

A. PURPOSE

The Self-Help pest management program authorizes the use of approved Self-Help products (mechanical and physical controls only) by installation maintenance and VAARNG personnel who encounter rodents (mice and rats) during the normal course of their assigned duties.

B. RESPONSIBILITIES

- Self-Help Program participants are responsible for proper use, recording, reporting, storage and disposal of Self-Help products.
- Only use products that are pre-approved for use in the VAARNG Self-Help Program. Contact the VAARNG IPMC (MAJ Brian Webb) for a current list of approved Self-Help products.
- **NO chemical control products (rodent baits and/or poisons) are allowed for Self-Help use at VAARNG sites.**
- Self-Help products can be obtained by submitting a Work Order to O&M.
- Rodents can harbor a number of human disease agents; among them are hantavirus and plague. Precautions must be taken when working in rodent infested areas. Rodent feces and dried urine may contain hantavirus that is transmitted when dust from these waste materials is inhaled. Precautions should also be taken when handling dead rodents in traps.

C. ACTIONS

STEP 1. Surveillance

- Identify the type of rodent, the extent of the infestation and possible entry points into the building, food sources and water sources.
- It is important to identify the type of rodent so the most effective physical and mechanical controls are used. The size of any traps used depends on the size of the rodent. Use the fact sheets attached to this outline to identify the type of rodent.
- As much as possible, determine the extent of the rodent infestation as much as possible to decide if the control needed is beyond that available to Self-Help Program participants.
- Locating where rodents are entering the building(s) and their sources of food and water is vital to long-term control of rodents. There is an end-less source of rodents outdoors. Rodent control will be a never-ending battle if rodents can easily get into the building, especially if there is readily-available food and water.

STEP 2. Decide if Self-Help is appropriate.

- The decision to use Self-Help for control of rodents is often based on personal judgement and common sense. If you have **any** doubts that the rodents can be controlled with Self-Help actions, contact the O&M Office or Fort Pickett Entomology for help with assessing the situation and/or to arrange for control by a Pest Management Professional (PMP).

STEP 3. Perform Physical and Cultural Controls.

- Seal all cracks and crevices, especially those over 1/4-inch wide where the rodents may be entering the building. Screening 1/8-inch square or smaller, steel wool and/or metal flashing can be used. Rodents will often chew through calking, although some elastomeric sealants can be used successfully to exclude mice.
- Do not leave unscreened doors and windows open.
- Regularly check objects that are brought into the building, such as boxes, furniture and equipment, to make sure they do not contain rodents.
- Seal food items in metal or rodent-proof containers.
- Store food items in the refrigerator.
- Regularly empty interior garbage cans and place garbage in secure, rodent-proof containers outside until it is removed from the site.

STEP 4. Perform Mechanical Control (trapping).

- Self-Help products for control of rodents can be obtained by submitting a Work Order request to O&M.
- Only use products that are pre-approved for use in the VAARNG Self-Help Program.

NO chemical control products (rodent baits and poisons) are approved or allowed for Self-Help use at VAARNG sites.

- Wear gloves when performing rodent control actions such as setting traps and handling rodents.
- Wear additional Personal Protective Equipment (PPE) (such as eye and/or respiratory protection) if directed on the label or in areas where Hantavirus is known to occur.
- Do **NOT** eat, drink or smoke while performing rodent control actions.
- Read all instructions for the trap. If no instructions are provided, refer to the fact sheets attached to this outline for guidance on placing and using traps for the target pest.
- Always thoroughly wash hands with soap and water after setting or handling traps/dead rodents, and before eating, drinking or smoking.

STEP 5. Storage and Disposal of Self-Help Products.

- Store and/or dispose of any leftover Self-Help products as directed on the label and the VAARNG IPMP.
- If you have any questions on storage or disposal of the Self-Help products or disposal of dead rodents, contact the VAARNG IPMC (MAJ Webb).

STEP 6. Recording and Reporting.

- Report Self-Help product use to the VAARNG IPMC using the Pest Management Treatment Record form.
- The form recording usage should be sent to the VAARNG IPMC at the end of each month.

STEP 7. Follow-up and Assessment.

- Using trapping as the sole control method will only provide temporary control.
- Habitat modification (cleaning up food sources, removing nesting locations) and building practices (repairing holes, cracks and other paths that rodents use to enter buildings) are more permanent controls.
- If all the actions in STEP 4 have been done and there are still on-going or repeated rodent infestations at the same facility, contact the VAARNG IPMC. More extensive permanent controls may need to be done by contract.

S

RODENT CONTROL

WHY IS CONTROL NEEDED? Rodents like to live the same places and eat the same food as people do. They will contaminate food, destroy fabrics and furniture in search of nesting material and gnaw woodwork, cabinets, furniture and other materials and objects in order to gain access into buildings. They are capable of transmitting diseases to humans such as Rocky Mountain spotted fever, Hantavirus, and Bubonic plague (via the fleas they carry).

1. GENERAL BIOLOGY

See attached information sheets for each of the common rodent pests.

2. INSPECTION AND SURVEY

The normal harborages (places where they rest and nest) indoors are in spaces between walls, attics, eaves, in cabinets and other furniture, and in stored food products. Outdoors, rodents will nest in weeds, rubbish, dense vegetation or in grasslands.

Rodents are usually nocturnal and secretive. They are rarely seen during the day except when infestations are very heavy. Therefore, it is necessary to interpret signs indicating the presence of rodents. Inspection techniques will involve searching for "signs" in the areas of suspected harborage. Signs are found along walls, under piles of rubbish, behind or under storage areas, and in thick vegetation. The following signs are indicative of a rodent infestation.

Fecal droppings: Fecal droppings are usually dark, moist, soft and shiny. In a few days the droppings become dry and hard. When examined under a magnifier or microscope, hairs are usually evident in rodent droppings.

- House mouse: Droppings are typically ¼-inch or less long and are pointed at the ends.
- Norway rat: Droppings are typically ¾-inch long and have blunt ends.
- Roof rat: Droppings are typically ½-inch long and are curved with pointed ends.

Runways: Rodents are creatures of habit and will utilize the same runways between their food source, and nesting areas. Because of their well-developed sense of touch, they prefer body contact with a vertical surface such as a wall or fence and will develop a pathway that can be recognized both outdoors and indoors.

Rub Marks: Mice do not leave obvious rub marks like rats unless there is an extremely heavy infestation. The rub marks of mice will be very low to the floor, and appear more as worn paint or paper rather than oily paint or paper. If rub marks are grossly evident, then the infestation of rodents is probably rats.

Tracks: Wherever there is dust, or when powder or flour is placed out in suspected runways, the tracks left by the animals' feet can give a clue as to the direction of their nests.

3. CONTROL METHODS

Cultural:

Sanitation: Most rodent infestations can usually be traced to poor sanitary conditions that provide a source of food for rodents. A good control program should include removal of the food supply by improving refuse storage and removal.

Elimination of Shelter: Trash and waste materials should be removed to prevent their use as shelters and nesting areas. Lumber and all other materials that can be used as shelters should be stacked on platforms, at least 18 inches above the ground, and at least 18 inches away from walls. Vegetation near buildings should be removed or kept trimmed.

Physical:

Rodent Proofing: House mice can enter through openings as small as 1/4 inch. If a pencil can fit through a crack, so can a house mouse. Structural openings around pipes and electrical conduits should be sealed with metal mesh, metal flashing or steel wool. Most rodents can chew through caulking, however elastomeric sealant may be effective against mice. All openings less than 4 feet above ground should be sealed with metal plates or concrete. Doors should be self-closing and tight fitting at the bottom. Spaces at the door bottoms may be sealed by attaching metal strips.

Mechanical:

Trapping: Trapping is recommended for rodent control when physical and cultural control methods are not enough to control the population.

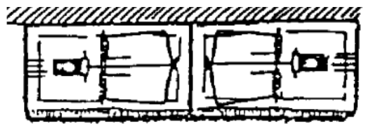
However, trapping alone is rarely effective. There is an unlimited supply of rodents outdoors and they will continue to enter facilities unless food sources are removed, shelter/nesting areas are eliminated and the means of accessing the facility are sealed.

Using cultural methods (sanitation, elimination of shelter), physical methods (rodent proofing) along with mechanical methods (trapping) can control most rodent infestations.

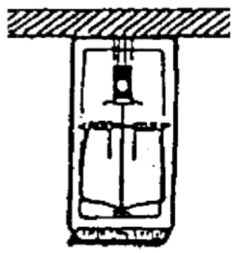
"Old-fashioned" snap traps are highly effective and inexpensive to purchase.

A large number of snap traps should be set in the areas of rodent activity. Placing 12 traps in a room is not too many.

Where the snap traps are placed is very important. Snap traps should be placed in runways along walls, and not in the open. The traps should be placed against the wall, back-to-back with the triggers facing out and/or perpendicular to the wall, with the trigger portion near the wall.



TWO SNAP TRAPS WITH TRIGGERS FACING OUT



SNAP TRAP WITH TRIGGER NEAR WALL

Another effective method of setting snap traps is to place a board so it leans against the wall to make a shadowy "tunnel" and place the traps under the board with the trigger against the wall. Several traps can be set in a row with a ½-inch space between each trap to capture rodents that attempt to jump over the traps.

Peanut butter is a popular and easy to use bait for snap traps. Bacon, chocolate and nuts are also good baits (tie solid baits to the trap trigger with dental floss).

Commercial rodent trap lure baits (that do not contain a pesticide) are available in convenient syringes or squeeze bottles, but are not necessarily better than the above food baits. However, they do not contain any peanut products, which protects individuals with peanut allergies in the vicinity of the baited traps.

Rodents (especially rats) may be scared of new objects in their environment and may not go near the trap at first. To help overcome this, traps can be pre-baited (bait the trap, but do not set the trigger) for a couple of days to get rodents accustomed to the trap. Then rebait and set the trigger.

Rodents can become trap shy if the trap is triggered but they are not caught. Changing the bait often helps. For example, changing to bait from peanut butter to bacon (tied to the trap trigger with dental floss) can be effective for trap-shy rodents. Changing the location of the traps may also help.

Traps should be inspected daily. Remove and dispose of dead rodents. Always wear proper PPE when handling rodents.

In addition to snap traps, several other rodent traps can be used successfully. Other traps are usually metal boxes with one or more openings, with trade names like "Ketch-all" or "Tin Cat". These traps rely on rodent curiosity and the rodents enter the trap to explore what is inside. Some of these traps have snap devices to kill and collect the rodents as they enter, and others are constructed so that rodents cannot escape once they are inside the trap. The traps must be inspected frequently to dispose of dead or trapped rodents.

Sticky Traps: Sticky traps (aka glue traps or glue boards) are not as effective as mechanical traps for rodents. Although sticky traps are simple to use, mice often can free themselves, and this type of trap is ineffective with adult rats.

Sticky traps are not recommended for trapping rodents in most instances.

Sticky traps should **never** be placed outdoors or in areas where non-target wildlife (such as birds, bats or snakes) may be accidentally trapped. If non-target wildlife is found alive on a sticky trap, talcum powder, cornstarch or vegetable oil can be applied to the exposed glue around the trapped wildlife and the animal can then usually free itself. For birds and bats, it is best to immediately take the trap, without attempting to remove the animal, to a licensed wildlife rehabilitator for assistance.

Ultrasonic and/or Electromagnetic Rodent Repellent Devices: These devices have been proven to be ineffective and may NOT be used.

Chemical:

Rodent Baits: Rodent baits are **NOT** allowed as part of the Self-Help Program. In nearly all instances, trapping of rodents is the preferred control over using toxic baits. Rodents do not immediately die from ingesting bait, and often die in walls and other enclosed spaces where the carcasses cannot easily be removed. The resulting unpleasant odors may persist for three or more months. Also, many baits are still active in the bodies of rodents even after they have died. Any other animal that scavenges and eats the rodent can also be killed by the toxic ingredient in the bait.

HOUSE MICE

- House mice are about 6 inches long, including the tail. The length of the head and body together is about 3 inches. The tail is almost naked and about as long as the head and body combined. The color of mice ranges from dark gray to light brown and most are dusky gray with lighter bellies. A mouse's head and feet are proportional to its body size. A young rat will have a head and feet that look way too big for its body.
- In areas where facilities are next to open fields or wooded areas, deer mice may enter buildings. Deer mice are slightly larger than house mice, have big ears and eyes, and are usually reddish brown in color. Because of the association of deer mice with Hantavirus (which can be easily spread to humans and causes death), immediately call the Environmental Office for assistance in identification and take appropriate steps to protect human health if you think you have this species present.
- Adult mice usually live 1/2 to 3 years. Mice become sexually mature at about 35 days. The average female has about 8 litters in her lifetime and litter average about 6 young.
- The house mouse is found throughout the world and is the most domesticated of all rodents. They prefer to live in association with humans and man-made structures, but the house mouse can live outside as a field rodent.
- Mice are nibblers compared to the voracious appetite of rats.
- The house mouse can survive in dry habitats and metabolize water from its food source. They do not always need a source of water.
- Mice can enter a structure through holes in walls, floors and the foundation. They can also enter through cracks and crevices around doors and windows. All it takes for a mouse to enter a structure is a 1/4 inch square hole.
- House mice eat and contaminate human food. They urinate and defecate continually. They gnaw and destroy furniture, woodwork, books, paper products, clothing and fabrics. Their urine and feces stain these objects. House mice are also capable of transmitting *Salmonella*, other bacterial diseases, roundworms, and tapeworms.

NORWAY RATS

- Norway rats (*Rattus norvegicus*) are stocky burrowing rodents, about 16 inches long, including the tail. They were unintentionally introduced to North America around 1775 and have spread throughout the contiguous 48 states. Also called the brown rat, house rat, barn rat, sewer rat, gray rat, or wharf rat, it is a slightly larger animal than the roof rat.
- The nose of a Norway rat is blunt, the ears are small, close set and do not reach the eyes when pulled down. The tail is scaly, semi-naked and shorter than the head and body combined.
- Adult Norway rats weigh about one pound, with coarse fur that is usually is brownish or reddish-gray above, and whitish-gray on the belly. Blackish individuals occur in some locations.
- Norway rats live in close association with people. They burrow to make nests under buildings and other structures, beneath concrete slabs, along stream banks, around ponds, in garbage dumps, and at other locations where suitable food, water and shelter are present. In urban areas they live in and around residences, in basements, warehouses, docks, and in sewers. Although they can climb, Norway rats tend to inhabit the lower floors of multi-story buildings.
- Norway rats will eat nearly any type of food. When given a choice, they select a varied diet and choose fresh foods over stale or contaminated foods. They prefer cereal grains, meats and fish, nuts, and some types of fruit.
- Rats require 1/2 to 1 ounce of water daily when feeding on dry foods but need less when moist foods are available. Food items in household garbage offer a fairly balanced diet and also satisfy their moisture needs.
- Norway rats are primarily nocturnal and usually become active around dusk. Some individuals may be active during daylight hours when the rat population is high, when disturbed (weather change, construction, etc.) or when their food source is threatened.
- Norway rat territories are usually 50-150 feet surrounding nests. In populations where there is plenty of food and shelter, the territories are smaller. However, rats will travel 300 feet or more to obtain their food and water if necessary. In urban areas most rats

remain around the buildings and areas that provide their necessities, and do not move great distances unless disturbed.

- Rats have poor eyesight beyond 3-4 feet, relying more on their hearing and excellent senses of smell, taste and touch. Norway rats are very sensitive to motion up to 30-50 feet away, but are considered colorblind.
- Rats use their keen sense of smell to locate food items and to recognize other rats. Norway rats also have an excellent sense of touch due to very sensitive body hairs and whiskers they use to explore their environment. Much of a rodent's movement in a familiar area relies heavily on the senses of touch and smell to direct it around its home range.
- Rodents prefer a stationary object on at least one side of them as they travel, so they commonly move along walls. This is helpful in deciding where to place traps.
- Rats' sense of taste is excellent, and they can detect some contaminants in their food at levels as low as 0.5 parts per million. This highly developed taste sensitivity can lead to bait rejection if the rodent baits are contaminated with insecticide odors or other chemicals.
- Norway rats typically construct nests in below-ground burrows or at ground level that may be lined with shredded paper, cloth, or other fibrous material.
- Litters of 6 to 12 young are born 21 to 23 days after conception. Newborn rats are naked and their eyes are closed, but they grow rapidly and start eating solid food at 2½ to 3 weeks. They become completely independent at about 3 to 4 weeks and reach reproductive maturity at 3 months of age, sometimes as early as 8 weeks.
- Female Norway rats may come into heat every 4 or 5 days, and they may mate within a day after a litter is born. The average female rat has 4 to 6 litters per year and may successfully wean 20 or more offspring annually.

ROOF RATS

- The roof rat (*Rattus rattus*) is distinguished between Norway rats and roof rats by pulling the tail back over the body. The tail of a roof rat will reach the nose. The tail of the Norway rat will not reach beyond the ears.

- Roof rats range along the lower half of the East Coast and throughout the Gulf States and upward into Arkansas. They also exist along the Pacific Coast and are found on the Hawaiian Islands. Occasionally isolated populations are reported from areas not within their normal distribution range, but these instances are rare.
- Roof rats prefer higher areas than Norway rats and often will live in trees or on vine covered fences. Landscaped areas and vegetation along waterways provide good habitat. Being agile climbers, roof rats frequently enter buildings from the roof or openings near utility lines that they use to travel from area to area. They have been found in sewer systems, but this is not very common.
- The food habits of roof rats resemble those of tree squirrels. They mainly eat fruit and nuts, but also feed on a variety of ornamental and native plant materials. Like the Norway rat, they are omnivorous and will feed on most anything if hungry. Roof rats usually require water daily, though their local diet may provide an adequate amount if high in water content.
- Litters containing 5-8 young are born about 21 to 23 days after conception. The young rats are naked and their eyes are closed when born, but develop rapidly, growing hair within a week. When they are 9 to 14 days old, their eyes open and they begin to explore for food and move about near their nest. In the third week they begin to take solid food.
- The young may continue to nurse until 4 or 5 weeks old. Young rats generally cannot be trapped until about 1 month old. At about 3 months of age, they are completely independent of the mother and are reproductively mature.
- In tropical or semitropical regions, the breeding season may be nearly year-round. Usually the peaks in breeding occur in the spring and fall.

- Roof rats usually begin searching for food shortly after sunset. If the food is in an exposed area and too large to be eaten quickly, they often carry it to a safe hiding place before eating it. Many rats will hoard considerable amounts of solid food, which they may or may not eat later.
- When necessary, roof rats will travel considerable distances for food. They can often be seen at night running along overhead utility lines. They may live in trees or attics and climb down to a food source.
- All rats see poorly, relying more on smell, taste, touch and hearing. They are considered to be colorblind, responding only to the degree of lightness and darkness of colors. Roof rats also have an excellent sense of balance. They use their tails for balance while traveling along overhead utility lines and are very agile climbers.
- From the standpoint of pest control, traditional trapping on the ground or floor will not catch many roof rats. Traps are best set along roof rafters and beams that show signs (rub marks) of frequent roof rat travel.
- Roof rats have a strong tendency to avoid new objects in their environment and this can influence control efforts. These rats may take several days before they will approach a trap.
- Roof rats can be very difficult to trap and their control may often be beyond the scope of the Self-Help program.

Approved Self-Help Products for Control of Mice:

Snap Traps

SELF-HELP IPM Outline 5

Weeds

A. PURPOSE

The Self-Help pest management program authorizes the use of approved Self-Help products (low-toxicity, ready-to-use herbicides) by installation maintenance and VAARNG personnel who control weeds during the normal course of their assigned duties.

B. RESPONSIBILITIES

- Self-Help Program participants are responsible for proper use, recording, reporting, storage and disposal of Self-Help products.
- **All** label instructions must be read and followed – **The Label is the Law!**
- A Safety Data Sheet (SDS) should accompany the Self-Help product and be readily available to personnel using the product and working in the area where the product is used.
- Only use products that are pre-approved for use in the VAARNG Self-Help Program. Contact the VAARNG IPMC (MAJ Brian Webb) for a current list of approved Self-Help products.

C. ACTIONS

STEP 1. Estimate the area of the weeds to be treated.

If the area to be treated is more than 500 square feet or 200 linear feet of fenceline/roadside/building foundation, a Pest Management Professional (PMP) may be needed to control the weeds. The number of weeds in the area should also be considered.

STEP 2. Self-Help products for weeds can be obtained by submitting a Work Order request to O&M. Only use products that are low-toxicity, ready-to-use (do not require dilution or mixing) and pre-approved for use in the VAARNG Self-Help Program.

STEP 3. Receive training on the proper use of the pesticide upon pick-up from the O&M Warehouse. Sign a Self-Help training Acknowledgement of Understanding (Page E-5) and return the form to the IPMC before applying any pesticides.

STEP 4. Read the entire product label. **The Label is the Law!**

- Wear appropriate Personal Protective Equipment (PPE) as directed on the label.
- Do **NOT** eat, drink or smoke while using any pesticide.
- Use product as directed on the label for control of the weed.
- Always thoroughly wash hands with soap and water after using product and before eating, drinking or smoking.

STEP 5. Store and/or dispose of any leftover Self-Help products as directed on the label and the VAARNG IPMP. If you have any questions on storage or disposal of the Self-Help products, contact the VAARNG IPMC (MAJ Webb).

STEP 6. Report Self-Help product use to the VAARNG IPMC using the Pest Management Treatment Record form. The form(s) recording usage should be sent to the VAARNG IPMC at the end of the month.

STEP 7. If the Self-Help control methods in this outline do not control the weeds to acceptable levels, put in a Work Order with the O&M Office or contact the Fort Pickett Entomologist.

Approved Self-Help Products for Control of Weeds:

EPA Reg No.	Label Name	Active Ingredient
42750-66-7401	Kilz all (Gly Star)	Glyphosate-isopropylammonium
67760-47-9688	(Glyfos) Ultra-Kill Ready-To-Use 1.92% Weed & Grass Killer	Glyphosate-isopropylammonium
71995-33	Roundup Weed & Grass Killer Ready-to-Use Plus	Glyphosate-isopropylammonium

SELF-HELP IPM Outline 6

Flies

A. PURPOSE

The Self-Help pest management program authorizes the use of approved Self-Help products (including traps and baits) by installation maintenance and VAARNG personnel who encounter flies during the normal course of their assigned duties.

B. RESPONSIBILITIES

- Self-Help Program participants are responsible for proper use, recording, reporting, storage and disposal of Self-Help products.
- **All** label instructions must be read and followed – **The Label is the Law!**
- A Safety Data Sheet (SDS) should accompany the Self-Help product and be readily available to personnel using the product and working in the area where the product is used.
- Only use products that are pre-approved for use in the VAARNG Self-Help Program. Contact the VAARNG IPMC (MAJ Brian Webb) for a current list of approved Self-Help products.
- Approved Self-Help products are tools to assist Self-Help Program participants with the control of flies in their work and billeting areas. These Self-Help control efforts supplement fly control done at the site by Pest Management Professionals (PMPs).
- Flies can carry and transmit several diseases and parasites that can cause sickness in humans. All flies, including non-biting flies, can transmit disease organisms by tracking them from their source onto food or people.

C. ACTIONS

STEP 1. Surveillance.

- Identify the type of flies and, if possible, where they are breeding.
- It is important to identify the type of flies so the most effective controls are used. Sanitation is the best control method for some types of flies, and others are more effectively controlled by traps and habitat modification.
- Use the fact sheets attached to this outline to identify the type(s) of flies.

STEP 2. Decide if Self-Help is appropriate.

- After identifying the flies using the information in this outline and it is determined control of that type of fly is **NOT** appropriate for Self-Help Program, or additional control measures are needed, contact the O&M Office or Fort Pickett Entomology to arrange for control by a Pest Management Professional (PMP).
- Approved Self-Help products are tools to assist Self-Help Program participants with the control of flies in their work and billeting areas. These Self-Help control efforts

supplement fly control done at the site by Pest Management Professionals (PMPs). Attempting to control flies with methods that are not effective for the type of fly will result in loss of work time, higher costs and unnecessary exposure of VAARNG personnel to pesticides.

STEP 3. Perform Physical and Cultural Controls.

- Using pesticides as the only control method will rarely provide effective control of fly infestations.
- Habitat modification (removing sources of food and fly breeding locations) is vital in controlling flies.
- If all the actions in STEP 3 and 4 have been done and there are still on-going significant fly infestations at the same facility, contact the VAARNG IPMC (MAJ Webb). Further assessment and more extensive control methods may need to be implemented by contract or the CFMO.

STEP 4. Perform Chemical Control (trapping with chemical baits).

- Self-Help products for flies can be obtained by submitting a Work Order request to O&M. Only use products that are pre-approved for use in the VAARNG Self-Help Program.
- Read the entire product label. **The Label is the Law!**
- Wear appropriate Personal Protective Equipment (PPE) as directed on the label.
- Do **NOT** eat, drink or smoke while using any pesticide.
- Use product as directed on the label for baiting of flies.
- See Chemical Control options below for further guidance on using fly baits and traps.
- Always thoroughly wash hands with soap and water after using product and before eating, drinking or smoking.
- Use of chemical controls will rarely provide sufficient control of flies. Habitat modification by removing food sources and fly breeding areas provides additional control.

STEP 5. Storage and Disposal of Self-Help Products.

- Store and/or dispose of any leftover Self-Help products as directed on the label and the VAARNG IPMP.
- If you have any questions on storage or disposal of the Self-Help products, contact the VAARNG IPMC.

STEP 6. Recording and Reporting.

- Report Self-Help product use to the VAARNG IPMC using the Pest Management Treatment Record form.
- The form recording usage should be sent to the VAARNG IPMC at the end of the calendar month.

STEP 7. Follow-up and Assessment.

- If the Self-Help control methods in this outline do not control the flies to acceptable levels within 30 days, put in a Work Order with the O&M Office or contact the Fort Pickett Entomologist.

FLY CONTROL

WHY IS CONTROL NEEDED?

Flies can carry and transmit several diseases and parasites that can cause sickness in humans. All flies, including non-biting flies, can transmit disease organisms by tracking them from their source onto food or people.

Some flies, such as drain flies, can be a human health hazard due to respiratory problems associated with inhalation of fly hairs and body parts.

Other flies, such as deer flies, horse flies and stable flies, can inflict painful bites.

Besides their ability to transmit numerous diseases, the presence of flies can also be very annoying and distracting to personnel.

1. GENERAL BIOLOGY

Domestic flies are those that are commonly found in close association with people and the animals associated with humans.

House flies and other domestic flies may fly into buildings through open doors and windows. In some cases, they may also crawl in through holes, cracks, and crevices.

Flies can reproduce very quickly and in large numbers. For example, house flies will lay about 500 eggs in their lifetime. If all the offspring of a single female house fly survived and reproduced, in five months there would be approximately 191,010,000,000,000,000,000 flies.

Flies will not usually breed in structures unless garbage is present for longer than one week, or there is a dead animal in an attic, crawl space, or other interior area.

Flies generally reproduce outdoors, but they will enter homes or buildings in search of food, moisture and shelter. If there is suitable decaying organic material available, they will reproduce indoors.

The life cycle of most flies is completed in 1-4 weeks, but it depends on the type of fly and weather conditions. The females generally lay around 150 eggs at a time. The legless white larvae (maggots) hatch, feed on the decaying animal or plant material and develop into pupae in about 7-14 days. The adult emerges from the pupae in three or more days.

See the attached information sheets for more information on types of flies that can be commonly found in work areas.

2. INSPECTION AND SURVEY

Identify the type of flies using the fact sheets attached to this outline. It is important to identify the type of flies so the most effective controls are used.

Sanitation is the best control method for some types of flies and others are more effectively controlled by traps and habitat modification.

Visual Sighting:

- Observation of adult flies hovering around trash containers and resting on walls and cabinets near trash containers.
- Observation of fly larvae (maggots) in trash or trash containers.
- Adult drain flies often congregate on walls and windows of rooms containing drains where drain flies are breeding
- Locate the drain(s) from which drain flies are emerging in order to target their breeding sites.
- Adult fruit flies are usually seen near fruit or other rotting foods.

Trapping:

- Sticky (adhesive) fly strips (that do not contain a pesticide) can be used for fly surveillance.
- For drain flies, seal suspected drain openings with a glue board, masking tape, or inverted plastic cup overnight to trap adult drain flies if they are present.

3. CONTROL METHODS

House Flies

An occasional fly in a building is not out of the ordinary, but continual fly problems are not normal. Sanitation and exclusion are the best methods for controlling house flies.

Cultural:

Sanitation: Removing feeding and breeding sites is critical for effective house fly control.

- House flies often breed in dirty trash containers.
- Cover outdoor trash containers with tight-fitting lids.
- Empty trash containers frequently.
- Clean and sanitize trash containers that have accumulated organic material.
- Clean dumpsters regularly.

Physical:

Exclusion:

- Seal cracks and other openings around doors and windows.
- Use tight-fitting screens on windows and doors.
- Do not leave unscreened doors and windows open.

Mechanical:

Trapping:

- Ultraviolet light traps may be used to reduce adult fly populations inside buildings. Light traps may not be used outdoors.
- Do not place light traps so they are visible from outside the structure since it can attract flies into the building.
- Light traps by themselves are unlikely to control heavy fly infestations.
- Do not use electric bug zappers that electrocute flies inside food-preparation areas or eating facilities. At these sites, only use light traps that collect flies on sticky traps.

Fly Swatters: Fly swatters are an effective control method for small numbers of flies that are inside buildings.

Sticky Fly Strips:

- Sticky fly strips that **do not** contain pesticides can also be used to help control flies inside buildings.
- Use one or two strips per room.
- Do not place strips in the kitchen or food preparation areas.
- **NEVER** use fly strips that contain pesticides in occupied areas.
- Ultrasonic and/or Electromagnetic Repellent Devices: These devices have been proven to be ineffective and may NOT be used.

Chemical:

Trapping: Traps containing chemical bait (lures) may be used outside of buildings to reduce fly populations. However, there is a never-ending source of flies outside and sanitation/exclusion are more effective methods of house fly control in most circumstances.

Self-Help Chemical Control of House Flies using Chemical-Baited Traps:

- Jar traps, such as the Farnam Terminator or Captivator, with Starbar Fly Trap Attractant, are an effective system for trapping house flies in most instances.
- Read the entire product label. **The Label is the Law!**
- Wear appropriate Personal Protective Equipment (PPE) as directed on the label.

- Do NOT eat, drink or smoke while using any pesticide product.
- Use correct number, spacing and placement of fly traps as directed on the label.
- Use correct number of baits (lures) per trap as directed on the label.
- Place traps around refuse containers and other places that attract flies.
- Do not use traps/baits indoors or use in outdoor areas where flies are not already present because the bait may attract flies to an otherwise fly-free area.
- The bait (lure) usually has a strong, unpleasant odor and traps are best placed away from windows that are regularly kept open and areas where personnel congregate.
- Empty trap(s) regularly and add additional bait (lure), as directed on the label, throughout the fly breeding season.
- Always thoroughly wash hands with soap and water after using Self-Help products and before eating, drinking or smoking.

Always follow the label directions for the use, placement and disposal of pesticide-containing products.

Fruit Flies

An occasional fruit fly in a building is not out of the ordinary, but continual fly problems are not normal. Sanitation and eliminating food sources are the best methods for controlling fruit flies.

Cultural:

Sanitation: Eliminating feeding and breeding sites is critical for effective house fly control.

- Empty trash containers daily to prevent the buildup of decaying foods that can attract fruit flies.
- Fruit flies are attracted to moist fermenting foods. They require only a moist film of decaying organic matter to breed.
- Keep garbage disposals, empty bottles and cans, trash containers, mops and cleaning rags clean to prevent fruit flies from using them as breeding sites.
- The bottom and sides of trash containers, especially large dumpsters, should be periodically steam-cleaned or washed to remove accumulation of organic matter.

Eliminate Food Sources:

- Fruit flies are attracted to gases produced by ripening fruit.
- Store fruit in the refrigerator in order to avoid attracting fruit flies and other pests.
- Cover outdoor trash containers with tight-fitting lids.
- Empty trash containers frequently.
- Clean and sanitize trash containers that have accumulated organic material.

Physical:

Exclusion:

- Seal cracks and other openings around doors and windows.
- Use tight-fitting screens on windows and doors.
- Do not leave unscreened doors and windows open.

Mechanical:

Fly Swatters: Fly swatters are an effective control method for small numbers of flies inside buildings.

Sticky Fly Strips:

- Sticky fly strips that **do not** contain pesticides can also be used to help control flies inside buildings.
- Use one or two strips per room.
- Do not place strips in the kitchen or food preparation areas.
- **NEVER** use fly strips that contain pesticides in occupied areas.

Ultrasonic and/or Electromagnetic Repellent Devices: These devices have been proven to be ineffective and may **NOT** be used.

Chemical:

- If the cultural, physical and mechanical methods do not control fruit flies to acceptable levels, contact the O&M Office to arrange for control by a Pest Management Professional (PMP).

Drain Flies

Sanitation and eliminating breeding sites are the best methods for controlling drain flies.

Cultural:

Sanitation: Eliminating breeding sites is critical for effective drain fly control.

- Drain flies breed in accumulated organic matter that accumulates inside interior drain pipes.
- Remove this material with over-the-counter drain cleaners.
- Scrubbing drains with a stiff brush may be necessary to remove heavy buildup.

Physical:

Exclusion:

- Seal cracks and other openings around doors and windows.
- Use tight-fitting screens on windows and doors.
- Do not leave unscreened doors and windows open.

Mechanical:

Fly Swatters: Fly swatters are an effective control method for small numbers of flies inside buildings.

Sticky Fly Strips:

- Sticky fly strips that **do not** contain pesticides can also be used to help control flies inside buildings.
- Use one or two strips per room.
- Do not place strips in the kitchen or food preparation areas.
- **NEVER** use fly strips that contain pesticides in occupied areas.

Ultrasonic and/or Electromagnetic Repellent Devices: These devices have been proven to be ineffective and may **NOT** be used.

Chemical:

- If the cultural, physical and mechanical methods do not control fruit flies to acceptable levels, contact the O&M Office to arrange for control by a Pest Management Professional (PMP).

Fungus Gnats

An occasional gnat in a building is not out of the ordinary, but continual fly problems are not normal. Eliminating breeding habitat in indoor potted plants is the best method for controlling fungus gnats.

Cultural:

Eliminate Breeding Sites: Eliminating feeding and breeding sites is critical for effective fungus gnat control.

- Avoid overwatering potted plants. Allow the surface of the soil to dry between waterings.
- Dump excess water out the saucer/tray under plants after watering indoor plants.

- Use only sterilized potting soil in indoor plants. Unless potting soil is pasteurized first, it is often infested with fungus gnats.
- Do not move potted plants that are infested with fungus gnats to new areas where flies can infest other pots.
- In some cases, the best control is to dispose of severely infested plants.

Physical:

Exclusion:

- Seal cracks and other openings around doors and windows.
- Use tight-fitting screens on windows and doors.
- Do not leave unscreened doors and windows open.

Mechanical:

Sticky Fly Strips or Sticky (Glue) Traps:

- Sticky fly strips that **do not** contain pesticide or glue traps can also be used to help control adult fungus gnats after their removing breeding sites.
- Attach strips or sticky (glue) traps (they can be cut into smaller pieces) to wooden skewers or sticks and place in potted plants that are infested with fungus gnats.
- Do not place sticky traps in the kitchen or food preparation areas.
- **NEVER** use fly strips that contain pesticides in occupied areas.
- Sticky (glue) traps should never be placed outdoors or in areas where non-target wildlife (such as birds, bats or snakes) may be accidentally trapped. If non-target wildlife is found alive on a sticky trap, talcum powder, cornstarch or vegetable oil can be applied to the exposed glue around the trapped wildlife and the animal can then usually free itself. For birds and bats, it is best to immediately take the trap, without attempting to remove the animal, to a licensed wildlife rehabilitator for assistance.

Ultrasonic and/or Electromagnetic Repellent Devices: These devices have been proven to be ineffective and may **NOT** be used.

Chemical:

- If the cultural, physical and mechanical methods do not control fungus gnats to acceptable levels, contact the O&M Office to arrange for control by a Pest Management Professional (PMP).

Biting Flies

Biting flies are most commonly encountered outdoors and are difficult to control since they breed outside where there is a nearly unlimited source of flies and breeding sites. Trapping and use of repellents are also not as effective with these flies as with other flies and insects.

Cultural:

Eliminate Breeding Sites: The most effective and economical method for reducing stable fly numbers is to eliminate their breeding sites.

- Remove or compost grass clippings.
- Properly maintain compost piles, by periodically turning the pile, to prevent them from becoming breeding areas for flies.

Physical:

Exclusion:

- Use tight-fitting screens on windows and doors.
- Do not leave unscreened doors and windows open.

Mechanical:

Fly Swatters: Fly swatters are an effective control method for small numbers of flies inside buildings.
Ultrasonic and/or Electromagnetic Repellent Devices: These devices have been proven to be ineffective and may **NOT** be used.

Chemical: Chemical control methods that can be used for Self-Help are not effective for biting flies.

Trapping: Using traps for biting flies is not an effective control method since, unlike house flies, they are not attracted to traps using odor-based lures. Light traps may not be used outdoors.
Insect Repellents: Insect repellents are not typically effective for biting flies. Covering exposed areas of the body is preferred.

4. AFTER TREATMENT SURVEILLANCE

Fly strips that **do not** contain pesticide and sticky (glue) traps can be used to determine the effectiveness of fly control.
If there is a reduction in the number of flies, Self-Help control efforts are working. If using traps, continue to empty and bait traps until the end of the fly breeding season.
If there is not a reduction in the number of flies after 14 days of starting control efforts, put in a Work Order with the O&M Office or contact the Fort Pickett Entomologist for Pest Management Professional (PMP) assessment and possible additional control measures.

House Flies

- House flies (*Musca domestica*) are 3/16 to 1/2-inches long and have two wings. They have large compound eyes and their bodies are usually striped. Their color varies from light gray to metallic shades of green, blue, and blue-green.
- House flies have sponging mouthparts and eat solid food by first liquefying it with their saliva. House flies can also regurgitate onto a solid food to assist with the liquefying process.
- Like all flies, house flies have a four-stage life cycle: egg, larva, pupa, and adults.
- Female flies deposit eggs in animal feces, carrion or moist organic material where the larvae (maggots) complete their development.
- The rate of house fly development is dependent upon temperature; and under summertime conditions, flies may develop from egg to adult in as little as 7 days. Once the female fly has mated, she can lay several batches of eggs, typically containing over 100 eggs each.
- House flies cannot bite because they have sponging mouthparts.
- House flies can carry a number of disease organisms that they pick up while feeding on animal feces, animal body secretions, or kitchen waste and they can then deposit onto human foods during feeding.
- House flies leave dark fecal and regurgitation spots on wall surfaces where they rest.

Fruit Flies

- Fruit fly adults are small (about 1/8-inch long), yellow or brownish flies that usually have red eyes.
- Fruit flies are attracted to ripened fruits and vegetables. They can also breed in drains, garbage disposals, empty bottles and cans, trash containers, mops and cleaning rags.
- Fruit flies lay large numbers of eggs on fruit and the larvae feed on the fruit.
- Fruit flies are active during periods of warm weather, and a single generation may develop in less than a week when temperatures are between 80° and 89°F.
- Temperatures above 105°F kill adult fruit flies in a few minutes.
- Infestations can originate from over-ripened fruits or vegetables that were previously infested and brought inside.
- The adults can also fly in from outside through inadequately screened windows and doors.
- Fruit flies are primarily nuisance pests. However, they also have the potential to contaminate food with bacteria and other disease-producing organisms.

Drain Flies

- Drain flies, also called moth flies, are about 1/8-inch in length and often dark-colored. Their wings are covered with fine hairs that gives them a moth-like appearance.
- Drain flies rest on surfaces with their wings held over their back in a roof-like manner
- They are not good flyers, and usually fly with short hopping flights.
- Female drain flies lay eggs in wet organic matter, usually in sink or shower drains.
- Drain flies may also be found developing in wet animal manure, sewage or compost.
- Very large numbers of these flies in one area probably indicates a breeding site bigger than a few indoor drains.
- The life cycle of drain flies can be as short as 8 days, but can take as long as 24 days, depending on the temperature.
- Drain flies do not bite people or animals, and they cause no damage to structures or plants.
- However, because drain flies develop in decaying organic matter, they can carry disease organisms from their development sites to areas where sterility is important, such as health care facilities and food preparation areas.
- Drain flies may also affect human health when present in high numbers, because the bodies of dead flies may disintegrate to form potential allergens.

Fungus Gnats

- Fungus gnats (Orfelia and Bradysia species) are very small (1/8 to 1/16-inch long), dark flies that are similar in appearance to tiny mosquitoes. Adult fungus gnats have slender legs with segmented antennae that are longer than their head.
- Fungus gnats live in dirt, potting mix, and other sources of organic-rich soil.
- The source of fungus gnat infestations are usually potted plants.
- Fungus gnat larvae primarily feed on fungi and organic matter in soil, but can also chew on plant roots.
- Adult fungus gnats may emerge from indoor houseplants and become a nuisance.
- Adult fungus gnats are attracted to light and they are often seen flying near windows. They may also remain near potted plants and can be seen resting or moving on the soil or plant leaves.
- Females lay tiny eggs in moist organic debris or potting soil. The larvae have a shiny black head and an elongated, whitish-to-clear, legless body. If conditions are especially moist, the larvae may leave slime trails on the surface of soil that look like trails from small snails or slugs.
- Adult fungus gnats don’t usually damage plants or bite people. Their presence is primarily considered a nuisance.
- Adult fungus gnats are short-lived and a generation of fungus gnats (from female to female) can be produced in about 17 days depending upon temperature.

Biting Flies

- There are numerous flies that bite people and animals, including deer flies (pictured above), horse flies and stable flies.
- Deer flies range in size from about 1/4 to 1/3-inches long. Their wings are clear with dark bands or patches, and their bodies are gray or light brown and some species have yellow and black striping. They have large, often brightly colored, eyes and their antennae are usually longer than their head.
- Horse flies range in size from 3/4 to 1-1/4-inches long and usually have clear or solidly-colored wings and brightly colored eyes.
- Like mosquitoes, it is the female deer fly and horse fly that bites. Females require a meal of blood in order to produce eggs.
- The female deer fly bites with two pairs of mouthpart “blades” that cut the skin. Once the skin is cut, the female fly then laps up the blood from the wound.
- Deer flies feed on a variety of mammals, including humans, pets, livestock and deer. They usually bite moving targets and attack the top half of the body, such as the head or neck.
- Horse flies feed the same way as deer flies, but prefer biting lower half of the body, such as the legs, and tend to attack stationary targets.
- Deer fly females will continue to return and bite repeatedly if their feeding behavior is interrupted.
- Male deer flies and horse flies are mainly pollen and nectar feeders.
- Deer and horse flies are most likely encountered in hot summer and early fall weather, and are active during daylight hours.

Approved Self-Help Products for Control of Flies:

(Whitmire) PT (Prescription Treatment) 565 Plus XLO (Formula 2) (WB), EPA Registration Number 499-290.

Appendix F – IPM Points of Contact

VAARNG

MAJ Brian Webb Integrated Pest Management Coordinator	Phone 804-436-3784 Email brian.j.webb14.mil@mail.mil
Donald "Donnie" McDaniel VAARNG Entomologist	Phone 434-480-2120 Email donald.w.mcdaniel9.nfg@mail.mil
Brandon Martin Natural Resources Manager	Phone 434-292-2292 Email brandon.t.martin26.nfg@mail.mil
Susan Smead Cultural Resources Manager	Phone 434-298-6411 Email susan.e.smead.nfg@mail.mil
Ken Oristaglio Conservation Manager	Phone 434-298-6416 Email kenneth.l.oristaglio.nfg@mail.mil
Matt Thompson Environmental Compliance Manager	Phone 434-298-6402 Email matthew.thompson50.nfg@mail.mil
Pam Coleman Environmental Program Manager	Phone 434-298-6445 Email pamela.w.coleman.nfg@mail.mil
COL Charlton Dunn CFMO	Phone 434-298-6423 Email charlton.t.dunn.mil@mail.mil
Dave Short O&M Chief	Phone 434-292-2612 Email david.k.short.nfg@mail.mil
Derrick Hall Architecture and Engineering Manager	Phone 434-298-6232 Email derrick.hall11.nfg@mail.mil
Rebecca Moses Safety/Occupational Health Manager	Phone 434-298-5927 Email rebecca.m.moses5.nfg@mail.mil
Fort Pickett Fire and Rescue	Phone 434-292-2217

Other Resources

DOD Pesticide Hotline 410-436-3773 / DSN 312-584-3773
usarmy.apg.medcom-phc.mbx.pesticide-hotline@mail.mil

CHEMTREC

Emergency Number 1-800-424-9300

(For assistance in a chemical emergency involving a spill, leak, or exposure.)

Non-emergencies 1-800-262-8200

National Pesticide Telecommunications Network

Provides up-to-date technical reference material on toxicity, human and environmental effects, disposal, and proper use of pesticides.

http://npic.orst.edu/ 1-800-858-7378

Mobile Access to Pesticides and Labels (MAPL)

US EPA-sponsored pesticide and label finding tool for mobile devices.

http://pi.ace.orst.edu/mapl/