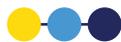


Natural Selections



Department of Defense Natural Resources Program



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OFFICE OF PREPUBLICATION AND SECURITY REVIEW

SPOTLIGHT: EXPLORING THE BASH MANAGEMENT TOOLBOX

By Jenny Washburn, U.S. Department of Agriculture (USDA), Animal and Plant Health Inspection Service-Wildlife Services

Wildlife strikes cost the U.S. military more than \$101 million annually and have caused at least 21 aircrafts to be totaled and 34 deaths since 2000. Fixed wing and rotary aircraft are all vulnerable to encounters with wildlife. While DoD protects and enhances important ecosystems on its properties, the Department also must meet the needs of testing and training activities. Reducing the rate of wildlife strikes through BASH management serves the dual purpose of ensuring a safe working environment for DoD personnel and protecting wildlife from harm. Both missions — protecting personnel and conserving wildlife — are possible with effective BASH planning and implementation.



Natural resources managers work to prevent BASH incidents across all DoD airfields. Source: USDA Wildlife Services

A preliminary step in addressing and preventing BASH incidents is determining why, how, where, and when strikes are occurring. Only through robust data collection can managers determine what measures will successfully reduce BASH incidents. Quality data from strike databases (i.e., Web Enabled Safety System Database, Federal Aviation Administration National Wildlife Strike Database, Air Force Safety Automated System), along with data from natural resources managers and researchers, are the foundation of a strong BASH program. Reporting all wildlife strikes maximizes the validity

of data collections and serves as the basis for BASH management. Rigorous strike data collection provides key information about wildlife on or around military airfields.

Cataloging information on strike history and using real-time data is important to lowering risks of future strikes. For example, pilots can use strike history data to change their flight patterns and times. Natural resources managers also can provide transient aircraft with information on wildlife in the area and in the airspace based on seasonal movements and sightings. When strikes do occur, DoD natural resources managers and USDA biologists can use the information to inform and modify their management activities by focusing BASH efforts on specific species or areas that pose greater BASH risks.

While several tools are commonly used in BASH management, they often are tailored to meet unique installation needs. For example, standardized surveys and strike reporting can show specific species occurrences on and around each runway that could present a strike hazard — providing a customized picture of hazards at installation runways. Mapping software can elevate these pictures to a new level. As the technology becomes more readily available on mobile devices, DoD personnel can map hotspots for wildlife activity and prioritize habitat management efforts to focus resources on problem areas.

DoD works with USDA across 125 installations to carry out integrated wildlife management plans that effectively use a full suite of tools to reduce BASH risks. In one case, a USDA-led BASH management program

MESSAGE FROM THE NR PROGRAM

By Alison A. Dalsimer, Program Manager

Before I give you the short overview of this issue and how it thematically holds together, let me summarize the congressionally mandated DoD reorganization: the Office of the Under Secretary of Defense for Acquisition, Technology and Logistics has reorganized into the Under Secretary of Defense for Research and Engineering and the Under Secretary of Defense for Acquisition and Sustainment (USD(A&S)). On October 11th, the Senate confirmed Hon. Robert McMahon as the Assistant Secretary of Defense for Sustainment (ASD(S)). The NR Program now resides within the Office of the ASD(S) under the leadership of Ms. Maureen Sullivan who is now the Deputy Assistant Secretary of Defense for Environment (DASD(Env)). The NR portfolio remains unchanged so, aside from our office name, we will continue to operate as before. And now to *Natural Selections*...

This issue highlights just a few of the many tools and strategies that DoD natural resources managers use to conserve habitat and manage species on the ~25 million acres of land, air, and water resources it owns or operates. As anyone who is familiar with our program knows, these properties encompass an incredible array of habitats that DoD uses for military readiness activities. To ensure these lands remain usable, our managers work closely with neighboring landowners, DoD colleagues, and other federal, state, local partners to develop and implement tools and strategies that facilitate collaborative problem-solving to achieve common goals. This collaboration often results in new and unique approaches and solutions.

If you were able to come to the DoD Sustaining Military Readiness (SMR) Conference last August, then you got to see and hear about many of the amazing tools, techniques, and technologies that DoD natural resources managers are using to sustain readiness and keep our soldiers, staff, and families safe. If you didn't make it, you can check out the offerings on the [SMR website](#) (and maybe make plans to attend the next SMR in 2020).

Although DoD controls just 2% of the federally-owned land in the U.S., the impact of its management extends far beyond its boundaries. The tools and strategies highlighted in this issue demonstrate the importance of sharing data and technology, engaging in both internal and external partnerships, and working collaboratively to lower management costs and facilitate long-term planning to achieve strategic goals. We also touch on those areas that directly impact personnel safety. For example, our spotlight article outlines the complex challenge of managing to reduce BASH risks, which are a danger to military pilots and cost DoD over \$100M annually (the Federal Aviation Administration estimates that cost to the civil side is nearly \$1 billion per year). Cost aside, when a plane strikes a bird or other animal, pilot's lives can be jeopardized, so preventing strikes is a top priority.



Alison Dalsimer and fellow panelists gather at SMR to discuss how natural resources management supports DoD mission. Source: Megan Scanlin

Another priority is proactively managing for wildfires. Dry conditions, the proliferation of fire-prone invasive plants, and rising temperatures all contribute to more frequent and intense fires — the consequences of which we are seeing now with the Camp Fire in California, the deadliest and most destructive wildfire in the State's history. According to the National Interagency Fire Center, over the last 10 years there has been an average of 60,000 fires per year affecting over 6.3 million acres of land, including DoD lands. We feature an article from Dugway Proving Ground (DPG), which developed a comprehensive fire plan in response to a lightning strike that resulted in an 11,000-acre wildfire. That plan may serve as a model to other DoD installations.

And, of course, species matter too. With roughly 3% of all species worldwide at risk of extinction, DoD wants to prevent further losses, not just to minimize training restrictions, but also because it's the right thing to do. On the island of Kaua'i in Hawai'i, DoD is working with nine partners to simultaneously implement coordinated conservation plans for native bird species on the verge of listing due to increased predation by non-native predators. This island-wide partnership is the first of its kind, and can serve as a model to other Hawai'ian Islands, as well as to any DoD installation looking to cooperatively manage habitat and enhance mission readiness.

Before I close, I want to take a moment to acknowledge the passing of Dr. David Pashley. I first met Dave in the early 1990s when the national Partners in Flight (PIF) program was being stood up. Dave was there from the start, and had a HUGE impact on bird conservation during the following 25+ years. Rich Fischer, who knew him better than I, provides insight into Dave as a person and the impact he had on bird conservation. What I remember most was that he was a genuinely nice person and that he started talking about the impacts from our changing climate way before it was popular. He will be missed personally and professionally by many, many people.

(Exploring the BASH Management Toolbox, continued from page 1)

at Naval Air Station (NAS) Kingsville combined information from historical radar detection data and real-time observations to avoid pockets of birds in critical airspace. Radar detection is commonly used in BASH management because it tracks large bodied birds and large flocks of birds. USDA personnel used radar to determine species population counts and predict peak bird presence by time of day in each month or season.

Historically, spring migration was the peak season for bird strike events at NAS Kingsville. Avian radar population counts confirmed this trend, showing a significant increase in bird activity during those months. More importantly, a high percentage of bird activity was present between the hours of 7:00 PM and 5:00 AM. These data are particularly important to pilots because night training is essential in the curriculum for aircraft-carrier-qualified jet pilots. When briefed on the data, the NAS Kingsville commander took immediate action to reschedule student pilot training based on spring migration trends rather than focusing on historic weather patterns as was previously the case. This action, combined with stopping flight operations during peak bird activity during the spring migration (March-May), lowered the strike rate by approximately 40% at NAS Kingsville.



USDA biologists and DoD natural resources managers track bird migration and daily movements to decrease the risk of BASH incidents. Source: USDA Wildlife Services.

DoD and its USDA partners also use other tools to prevent BASH incidents. For example, natural resources managers and USDA use relocation as a strategy to prevent strikes with protected raptor species. DoD airfields are popular among raptors because the airfields have edge habitat, can be located near wooded areas, and have opportunities for perching and potential nesting on man-made structures. Although mowing plants along runways discourages small mammals and removes raptors' food sources, raptor sightings remain common. If an installation has the proper permits, personnel can safely trap and capture raptors, band them, and relocate them to a suitable and safer habitat. Managers have relocated birds over 100 miles away to discourage their return to an airfield, but research shows that adults, especially red-tailed hawks, often return.

BASH incidents are not limited to birds. Planes can strike deer and other large mammals as they cross runways. Fencing is commonly used to enhance security and protect airfields from animals. However, fences are not perfect because they can have gaps, lack skirting, or have unsecured gates that make them ineffective. Coyotes and foxes also can dig under fences, giving animals access to runways. Some DoD facilities, such as Sheppard Air Force Base, are following the example of newer highway systems and developing escape ramps, also known

as "jump outs" or dirt ramps, near fences. These ramps give mammals a safe way to escape fenced airfields, also better ensuring the safety of DoD pilots.

Proper habitat management is an effective, long-term tool that prevents species from coming onto or near the airfield. Natural resources managers can alter landscapes to make airfields less hospitable to wildlife and encourage them to move to other preferred habitat. For example, geese are known to feed on grass near runways. The National Wildlife Research Center scientists have identified several commercially available tall, narrow-leaved grasses to discourage this behavior. Planting these grass types removes the food source and decreases the number of geese around airfields, lowering strike risk. At NAS Key West, the USDA biologist worked alongside DoD personnel to change the infrastructure of their airfield. They painted gravel green to deter least terns (*Sternula antillarum*), a species listed as threatened in the state of Florida, from nesting in the runway safety area.



Habitat management - like the grid wires to deter waterfowl seen here - helps to keep birds away from airfields. Source: USDA Wildlife Services

Wildlife are unpredictable, so natural resources managers continue developing BASH tools to prevent collisions. In one case, Chinook salmon (*Oncorhynchus tshawytscha*) at Beale Air Force Base in northern California surprised managers by making an unexpected appearance in waters near the flight line. DoD personnel and the USDA biologist set a small cage trap to keep the fish from reaching the runway and attracting birds of prey. Once trapped, DoD personnel moved the salmon to a safer water source nearby. Unexpected events like this show the challenges of managing to reduce BASH risk. DoD personnel must be innovative and collaborative to fulfill the dual mission of protecting military operations and conserving wildlife.

Wildlife are known to be dynamic and the airfield environment is challenging and ever changing. Balancing the dual mission of conservation and military operations requires innovative thinking, creativity, and the application of current research findings. Continuing research and strong partnerships and cooperation among DoD operations and natural resources managers, as well as with committed partners such as USDA, will help keep personnel and wildlife safer.

TRIBUTE TO DR. DAVID PASHLEY

By Richard Fischer, PhD, DoD Bird Conservation Program Coordinator

Dr. David Pashley was an unparalleled leader in bird conservation for over three decades. During his accomplished tenure with American Bird Conservancy, David focused his work on migratory bird conservation in the Western Hemisphere. His leadership in DoD PIF, the North American Bird Conservation Initiative (NABCI), and the Joint Ventures, is credited with bringing together key bird conservation leaders internationally and working across the Americas to secure funding. David served as the first NABCI Coordinator, helping facilitate international partnerships to conserve bird species. A master of inclusion, encouragement, and vision, he was a true partnership builder, and was constantly striving to bring people together to find common ground and advance bird conservation. These partnerships improved research and data sharing — ultimately benefiting birds and the habitats they rely on throughout North America. David was an invaluable resource to the DoD PIF Steering Committee, helping to identify declining bird species relative to mission impacts among many other conservation-related activities. His knowledge and expertise will be sorely missed in the bird conservation community; however, David's achievements will continue to benefit conservation for years to come.



Dr. David Pashley. Source: DoD PIF

USING FIRE TO MANAGE BUTTERFLY HABITAT

By Elizabeth Crone, Tufts University and Cheryl Schultz, Washington State University

Prescribed fire is a labor-intensive tool that can be risky for endangered species populations. Although beneficial to ecosystems as a whole, prescribed fires can cause short-term mortality and habitat loss that diminish already tenuous species populations. Despite the inherent risk of using prescribed fire, burning can be critical to the regeneration of native plants, which improves overall habitat quality. DoD natural resources managers are working to understand how both prescribed fires and unanticipated wildland fires impact military training lands that offer realistic, natural habitats and require regular, low-intensity fires.

In a Strategic Environmental Research and Development Program funded project (SERDP RC-2119), researchers evaluated the effects of fire on the endangered Fender's blue butterfly (*Plebejus icarioides fenderi*) to learn how to manage its habitat at the Army Corps of Engineers Fern Ridge Reservoir near Eugene, Oregon. Researchers measured the demographic responses of butterflies to small-scale experimental burns during the hot (summer) and cool (fall) seasons. In both cases, fire killed most Fender's blue caterpillars. In the year after the fire, however, many native plants flourished, including the food plant of Fender's blue caterpillars — Kincaid's lupine. Fender's

blue butterflies laid more eggs on lupines in recently burned areas than in areas where no burning occurred, and they were more likely to survive and become adult butterflies in burned areas the year following the burn.



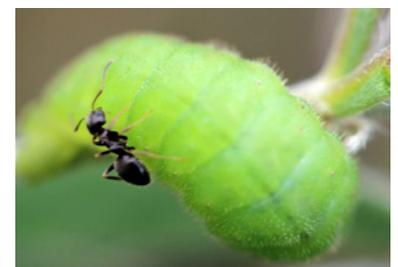
An adult Fender's blue butterfly feeds on a lupine plant. Source: Alexa Carlton

Researchers developed models for a cost/benefit analysis of prescribed fires, comparing the cost of fire-induced butterfly mortality with the benefit of improved habitat and long-term Fender's blue butterfly survival. There is a tradeoff between more or less intensive fires. If natural resources managers burn in the peak of the Oregon summer heat, the fires are hotter, and the heat results in almost all dead caterpillars. Hot summer fires require butterflies to recolonize the site and, if butterflies do recolonize, they lay a lot of eggs in burned areas the following season. In contrast, managers can create a "fire mosaic" with patchy burns to create an assortment of zones, each with a different fire history. Within fire mosaics, some caterpillars survive the fire, meaning that they do not need to recolonize. The downside to cool fall fires is that the Fender's blue butterfly lays less eggs the following spring, meaning that more management is needed to increase populations. Therefore, a manager who is risk-averse might plan smaller burns or a cooler fall burn and use other management tools to further boost butterfly populations.



Managers oversee an experimental burn in Fender's blue habitat at Baskett Slough National Wildlife Refuge, OR. Source: Cheryl Schultz

One surprising result of this work is the importance of other animals in helping Fender's blue butterflies benefit from fire. In many blue butterfly species, ants protect caterpillars from predators like spiders and, in exchange, the caterpillars exude nectar as food for the ants; this is known as "ant-tending." Ant-tending leads to higher caterpillar survival and is more common in recently burned areas. Researchers thus concluded that if ant habitats are improved by fires, then those habitats are also better for Fender's blue butterflies.



Ant tending a Fender's blue caterpillar. Source: Carole Bastianelli

The project team is currently funded by SERDP for related work, but not fire management. However, they plan to continue their analysis and evaluate whether natural resources managers at Joint Base Lewis McChord (JBLM) can use the Fender's blue butterfly fire responses from this study to manage another at-risk butterfly, the Puget blue butterfly (*Plebejus icarioides blackmorei*). In addition to prescribed fires, there was an extensive wildland fire in the prairie habitat on JBLM in 2017. Researchers plan to study whether there are similar costs and benefits from fire for the Puget blue butterfly as the Fender's blue butterfly, and whether ant-tending is an important part of the Puget blue butterfly response. Continuing the evaluation of fire's costs and benefits to priority butterfly species can help DoD natural resources managers better determine how and when to use fire as a management tool, and enable them to understand the impacts that wildland fires have on the habitats and landscapes the military relies on for testing and training activities.

A NEW TECHNIQUE FOR ESTIMATING DENSITIES AND DETECTION PROBABILITIES OF SECRETIVE REPTILES

By Dr. John D. Willson, University of Arkansas; Chris Petersen and Rob Lovich, DoD Partners in Amphibian and Reptile Conservation (PARC)

Accurate estimates of population density are a critical component of effective wildlife conservation and management. However, many snake species are so secretive that researchers cannot determine their density using traditional methods such as capture-mark-recapture. Snakes as a group have evolved remarkable behaviors to avoid detection by predators, including humans. This natural ability to remain secretive has resulted in the status of most snake populations remaining completely unknown, presenting a substantial obstacle to wildlife inventory or management plans, and impeding effective management of these species.

With help from DoD PARC, Drs. J. D. Willson and Shannon Pittman developed a new technique for estimating the density of secretive snakes without relying on capture-mark-recapture data. In this DoD Legacy Program-funded project, researchers tested the new technique through two case studies of the imperiled southern hognose snake (*Heterodon simus*) in the North Carolina Sandhills, and the invasive Burmese python (*Python molurus bivittatus*) in Everglades National Park, Florida. Researchers drove through study areas and recorded when they encountered a southern hognose or Burmese python crossing the road, documenting each snake's pattern of movement and



The southern hognose snake prefers dry, open habitats like the North Carolina Sandhills. Source: Dr. J. D. Willson

the distance and direction they traveled. They then combined these data with existing tracking information from snakes with radio transmitters to estimate how often each snake crosses a road. With this information, researchers determined the probability of observing a snake at any given time by creating an equation using the speed of the survey vehicle and speed at which the snake crosses the road. Finally, researchers used the probability of snake observation and combined it with existing data on snake sightings to generate a population density estimate for each species.

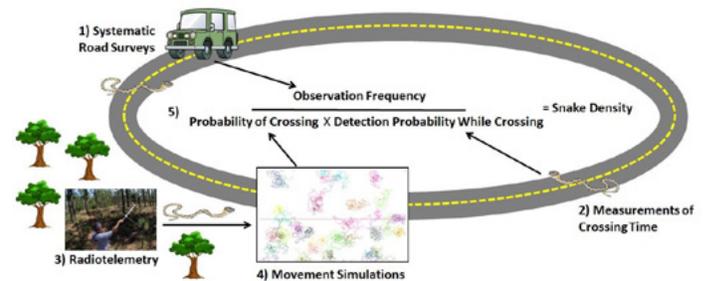


Diagram of the datasets used to estimate the density of secretive snakes.

Testing this new method resulted in the first density estimates for both the rare and declining southern hognose snake and for the invasive Burmese python. Researchers discovered that southern hognose snakes exist at relatively low densities (0.17 per ha), raising concerns that this species may not only have declined in geographic range but may also occur at relatively low densities and/or be declining in their strongholds, such as the North Carolina Sandhills.

Conversely, estimates of Burmese python density suggest that current control measures are insufficient to curb population growth and spread of pythons in South Florida, and highlighted some significant variation in python density over time. Burmese pythons are a destructive invasive, preying on vulnerable native species.



Dr. J. D. Willson and Chris Petersen with a Burmese python. Source: Dr. J.D. Willson

Project researchers estimated python density in Everglades National Park, which is critical to the management of this harmful invasive. Specifically, they estimated that python density nearly doubled between 2003 and 2009, reaching a peak of approximately 5 per km² prior to a severe freeze event in 2010 that resulted in a nearly 70% reduction in the Park's estimated python abundance.

This project enhances strategic planning and management of DoD's natural resources by providing density information critical to managing priority species that was previously unavailable. This new method offers an easy-to-implement standardized protocol, applicable to many species, regions, and military installations to help resource managers reduce or avoid training restrictions.

FASHIONABLE AND PRACTICAL: ISLAND FOX RADIO COLLARS PRODUCE SIGNALS OF SUCCESS

By Cody Wooden, Institute for Wildlife Studies

San Clemente Island (SCI), a Naval Auxiliary Landing Field and training range off the coast of Southern California, is home to a variety of endemic species and subspecies including the diminutive SCI fox (*Urocyon littoralis clementae*). Related to the gray fox (*Urocyon cinereoargenteus*), the SCI fox plays an important ecological role as an island predator. A stable SCI fox population is an indicator of overall ecosystem health. As military training continues on SCI, researchers monitor the fox population to ensure that the species continues to coexist with its human neighbors.

The SCI foxes have managed to thrive despite the inherent hardships of island life, like geographic isolation and an increased risk of food scarcity. Despite a relatively healthy population, the state of California classified the SCI fox as “threatened” primarily due to the species’ geographic isolation. By taking proactive steps to keep the SCI fox off the federal endangered species list, the Navy enables uninterrupted training and testing on SCI. In a recent example of proactive conservation, researchers are working with Navy biologists who use radio collars to monitor the SCI fox population. A radio-collar is a classic monitoring tool that supplies movement and mortality data on species ranging from foxes to mice to elephants.



A healthy SCI fox being observed from afar. Source: Institute for Wildlife Studies Fox Crew

Tracking movement is crucial to understanding the complexities of SCI fox life. For this purpose, biologists on SCI have been fitting SCI foxes with radio collars that use traditional very high frequency (VHF) and the more modern global positioning system (GPS) technologies. Approximately 10% of the SCI fox population is currently collared, providing representation of the population’s status. Those wearing GPS collars provide more detailed information on the fox’s use of space and habitat preferences, while those wearing VHF collars provide data on survival and status.

Gathering all of this information is vital for SCI fox management. Biologists track collared foxes twice per week either on the ground via handheld antennas or, more commonly, from fixed-wing aircraft. When collars emit specific signals communicating potential mortality, biologists can swiftly respond. Detecting threats to the fox is the first step in sustainably managing the population’s long-term survival.



Hiking to receive radio collar signals via handheld antennas is a weekly task for biologists on SCI. Source: Institute for Wildlife Studies Fox Crew



An SCI fox napping amongst native and non-native plants. Source: Institute for Wildlife Studies Predator and Ecosystem Management Crew

Although the SCI fox population is currently stable; its long-term survival remains a high priority for the Navy. Ongoing tracking and conservation efforts will help prevent the species from being federally listed as endangered, thereby avoiding increased regulations and land use limitations that could disrupt testing and training activities. Projects like the SCI fox monitoring initiative contribute important information that managers can use to ensure that unique species and their habitat remain healthy while preventing disruptions to DoD readiness training and testing activities.

CROWDSOURCING FEDERAL PROBLEM SOLVING WITH CHALLENGE.GOV

Invasive species continue threatening native species and challenging DoD natural resources



managers, who use a myriad of management techniques to control and eradicate each unique invader. The enormity and complexity of the problems invasive species create often daunts natural resources managers. Creating the new scientific and technological advancements required to control the spread of invasives on public lands is a daunting task. In response to complex invasive species issues, the U.S. government has created [Challenge.gov](https://www.challenge.gov) as a forum for federal managers to ask for innovative solutions.

Launched in 2010, Challenge.gov facilitates crowdsourcing by federal agencies to solve problems with thinkers from any sector or area of expertise. The initiative allows federal personnel to upload “challenges” online. The public is then able to propose novel solutions to each challenge by submitting projects for consideration. To date, federal agencies have run nearly 1,000 challenges to solve mission-critical problems, engage thinkers outside the federal government, and find ways to better measure and report impacts and results.

Challenge.org is helping the natural resources community find solutions to complex problems like the ongoing spread of deadly chytrid fungus (*Batrachochytrium dendrobatidis*) that has infected 500 species of frogs and salamanders, and caused the decline of nearly half of all amphibian species worldwide.

To learn more about Challenge.gov and how to create a challenge of your own, visit the [Agency Toolkit](#). To help find ways to rapidly discover and effectively treat chytrid fungus, check out the new crowdsourcing challenge.

AN eDNA-BASED DATABASE OF BIODIVERSITY FOR DOD

By Dr. Taylor Wilcox, National Genomics Center for Wildlife and Fish Conservation, U.S. Forest Service (USFS) and Dr. Richard Lance, U.S. Army Engineer Research and Development Center (ERDC) Environmental Lab

Recently, eDNA sampling has emerged as a cost-effective method for characterizing biodiversity across taxonomic groups. eDNA sampling detects unique genetic signatures to determine what species are present in an ecosystem, thereby providing an accurate inventory of the species in the sampled area. These inventories inform natural resources management and contribute to the emerging national database, the eDNAtlas. The eDNAtlas contains data from across the U.S., enabling information sharing and facilitating collaboration between natural resources managers which, in turn, improves DoD's ability to support mission readiness

Unlike most conventional sampling methods, which are time- and labor-intensive, researchers can collect eDNA samples quickly and easily, in as little as 15 minutes by one person. The funding required to collect and process these samples is often much



Collecting eDNA samples, as seen here, is less time intensive than other conventional sampling methods. Source: Kellie Carim, USFS

less than using traditional survey methods like capture-mark-recapture. Importantly, eDNA samples typically contain genetic material from many different species groups, including fungal pathogens, plants, invertebrates, fishes, mammals, and more. If a species was present in the area within a few days of sample collection, then its DNA should appear in the environmental sample. If properly stored, researchers can explore samples for the presence of different species of interest even many years after collection. Thus, while an eDNA sample represents an archive of information that allows DoD to address current environmental challenges or needs, it may also provide critical information that natural resources managers can use to help address future challenges.



Researchers will gather eDNA samples at southwestern installations like White Sands Missile Range. Source: Bob Wick, Bureau of Land Management

Led by the National Genomics Center for Wildlife and Fish Conservation and the U.S. Army ERDC Environmental Lab, a new research project, *Engaging a Crowd-Sourced eDNA Database to Enhance DoD-relevant Conservation Goals (SERDP Project RC18-C1-1348)*, aims to use eDNA sampling to help DoD installations in the southwestern U.S. catalogue the distribution of species of interest, both on and around their installations. Researchers are working with DoD installation biologists and other partners to determine species of interest for eDNA sampling, improving eDNA capture methods, testing the capacity of eDNA for detecting non-aquatic species, and maximizing sample input. Researchers can then use these tools to inventory relevant biodiversity and, where appropriate, add samples and data to the eDNAtlas.

The eDNAtlas will integrate sampling from this project with regional and national eDNA data, as well as data from previous and future eDNA sampling efforts — providing robust perspectives on the distribution of important aquatic and terrestrial species. These data can be used to characterize resources on installation lands, and inform conservation and mitigation efforts. The tool also can be used for working with partner stakeholders to detect impending species invasions, and to discover or rediscover alternate locales where rare and endangered taxa may reside. Researchers envision this SERDP project and the eDNAtlas serving as key resources for facilitating collaborative conservation efforts and providing increased flexibility for training and operational activities on DoD lands.

For more information on the SERDP project or to get involved, please contact Dr. Richard Lance, U.S. Army ERDC Environmental Lab (601-634-3971; email: richard.f.lance@usace.army.mil) or Dr. Taylor Wilcox, National Genomics Center for Wildlife and Fish Conservation, USFS (406-926-9614; email: taylorwilcox@fs.fed.us).

BANDING TOGETHER TO SAVE IMPERILED BIRDS ON KAUA'I

By Kimberly Alles, Booz Allen Hamilton

As people moved onto the Hawai'ian Islands, they brought with them non-native species like cats, pigs, and rats. These non-native species have spread across the Hawai'ian Islands and preyed on an array of other species, including native bird populations. DoD is spearheading efforts to address catastrophic decreases in native bird populations by funding the U.S. Navy Pacific Missile

Range Facility (PMRF) Barking Sands Seabird Conservation Initiative to control predators and protect native seabirds. In an unprecedented island-wide partnership, the Navy, under the Readiness and Environmental Protection Integration (REPI) Program, is working closely with partners including the National Fish and Wildlife Foundation,



A soldier checks for firing clearance during a training exercise at PMRF. Source: Sgt. 1st Class Claudio Tejada, US Army

U.S. Fish and Wildlife Service (USFWS), and the State of Hawai'i to collectively implement predator control techniques that provide landscape-level seabird colony protection. This partnership is critical to ensuring training, testing, and operations — currently at risk due to species' threatened or endangered status — can continue unimpeded and with maximum operational flexibility.

Located on the island of Kaua'i, PMRF Barking Sands is the world's largest instrumented, multi-dimensional testing and training missile range. The island is also home to three species of threatened and endangered seabirds: Newell's shearwaters (*Puffinus newelli*), band-rumped storm petrels (*Oceanodroma castro*), and Hawai'ian petrels (*Pterodroma sandwichensis*). Although these seabirds do not nest on the installation, their last remaining colonies are within close proximity to PMRF Barking Sands along the Nā Pali coast and in Koke'e at high elevation. This active missile range has numerous communication towers in place to enable its mission, some of which pose a risk to seabirds flying over the installation as they transit to and from their colonies each night. When seabirds fly over DoD lands at night, the light pollution and communications infrastructure pose a number of risks. PMRF Barking Sands has put in place comprehensive conservation measures to reduce these risks, such as implementing a "Dark Skies" program, turning off all non-essential lighting from September 15 to December 15 during the Newell's shearwater fledging season. Unfortunately, it is extremely difficult to prevent these negative impacts to the birds without severely limiting installation operations. As PMRF Barking Sands project partners faced land-use limitations because of increased protections for declining bird populations, they looked for creative problem-solving solutions. The best path to mitigate restrictions on operations was working to enhance listed seabird populations through conservation initiatives like the PMRF Barking Sands seabird colony protection project.



Bird species like the endangered Hawai'ian petrel are benefiting from the PMRF Barking Sands predator control project. Source: National Park Service

This REPI initiative will support military readiness and conservation by protecting state-listed seabird species and those federally listed under the Endangered Species Act and Migratory Bird Treaty Act through a cooperative predator control program located off-installation where these species are known to nest. PMRF Barking Sands is collaborating with the State of Hawai'i Division of Forestry and Wildlife and nine partner entities on an island-wide program to remove predator populations at priority seabird breeding sites. Focused on managing rats, feral cats, feral dogs, feral pigs, and barn owls, project partners are lowering predator populations to reduce predation and expand native seabird populations across Kaua'i.

Through this REPI initiative, partners can share resources and collaborate on solutions while implementing predator control solutions simultaneously. The multi-agency, multi-stakeholder conservation effort on a landscape scale is a truly innovative step forward in natural resources management on the Hawai'ian Islands. Collaborative, landscape-level management is increasingly important to DoD and conservation stakeholders, facilitating information sharing and innovation that reduces costs and contributes to healthier habitats across DoD borders to conserve species and better enable the military mission.

WNS MANAGEMENT: STATUS AND FUTURE DIRECTIONS

By Eric R. Britzke, U.S. Army ERDC; Jeremy T.H. Coleman and Jonathan D. Reichard, USFWS

WNS is a bat disease that first appeared in the U.S. in the winter of 2005/2006 near Albany, NY. The disease is caused by a newly described invasive fungus, *Pseudogymnoascus destructans* (*Pd*), that grows well in the cold, humid conditions that are characteristic of caves and hollow trees that bats use for hibernation during the winter. WNS is confirmed present in 11 North American bat species to date, and that number is expected to grow as the fungus advances west. Mortality rates vary considerably by species, with no demonstrable declines observed in some species yet catastrophic results in others. WNS has resulted in USFWS postponing the de-listing assessment for the federally endangered gray bat (*Myotis grisescens*), initiating listing assessments for tri-colored (*Perimyotis subflavus*) and little brown bat (*Myotis lucifugus*), and listing the northern long-eared bat (*Myotis septentrionalis*) as threatened. As *Pd* continues to expand its range into central and western North America, effects of WNS may result in additional evaluations for potential species listings — placing an increased regulatory burden on DoD. Researchers and DoD natural resources managers are working tirelessly to identify the management strategies needed to ensure uninterrupted military testing and training, and reduce the impacts of WNS.



WNS impacts a number of bat species including the tri-colored bat. Source: Pete Pattavina, USFWS

With *Pd* moving west, biologists know from experience what to expect because WNS disease progression follows a consistent pattern at most infected hibernacula. When *Pd* initially arrives, the prevalence of the fungus on bats and in the environment is generally low. However, once the fungus is established in a site with susceptible bats species, the prevalence and amount of fungus (fungal load) increases quickly through the second year of contamination. This second year is generally when mass



A little brown bat with the fuzzy white fungal growth typical of WNS. Source: Marvin Moriarty, USFWS

morality in bats begins, particularly for species that are highly susceptible like little brown and tri-colored bats. Once fungal loads in hibernacula have reached these critical levels, they remain high for years, dooming susceptible resident bats to lethal levels of infection. Extensive research is expanding on this basic understanding of WNS to find ways to disrupt this cycle before the mass mortality stage.

When researchers first identified WNS, they developed [A National Plan for Assisting States, Federal Agencies, and Tribes in Managing White-Nose Syndrome in Bats](#) to coordinate the response among federal and state agencies and tribes, and to provide a framework to address topics such as disease surveillance; conservation and recovery actions; and management tool development. DoD natural resources managers and biologists have expressed considerable interest in disease management, prevention, control, and eradication. Unfortunately, researchers have been unable to identify any strategies to eradicate *Pd*. Efforts have therefore focused on slowing or stopping *Pd* spread and minimizing its impacts. Researchers are currently exploring multiple control strategies including:

- Manipulation of microclimates in hibernacula to reduce *Pd* growth and/or improve survival of infected bats.
- Application or introduction of biological or chemical agents to hibernacula environments or directly on bats to kill or retard fungal growth and/or to reduce ability of *Pd* to infect bats.
- Delivery of agents, such as a vaccine, to bats to improve their immunological ability to combat *Pd* infection.
- Using specific frequencies of ultraviolet light to kill or weaken *Pd* and reduce its capacity to infect bats.

ANNOUNCEMENTS

SERDP Fiscal Year (FY) 2020 Request for Proposals

The DoD SERDP is seeking to fund environmental research and development in the Resource Conservation and Resiliency program area. SERDP



invests in a broad spectrum of basic and applied research, as well as advanced technology. This year, SERDP is requesting proposals that respond to the following focused Statements of Need (SONs):

- Installation Resilience Research: Theoretical Frameworks for Compound Threats
- Improved Understanding of Response of DoD Relevant Marine Mammal Populations to Multiple Stressors
- DoD Wildland Fire Management Research for Improved Military Land Use

The Resource Conservation and Resiliency program area supports the development of the science, technologies, and methods needed to manage DoD's installation infrastructure in a sustainable way.

Proposals responding to the FY2020 SON will be selected through a competitive process. All pre-proposals are due to SERDP by January 8, 2019 by 2:00 p.m. ET. The SONs and detailed instructions are available on the [SERDP website](#).

These broad examples demonstrate the wide range of strategies researchers are currently developing that can limit the impacts of WNS on hibernating bat populations. While researchers have shown that many treatments work in controlled situations or under specific circumstances, ideal solutions are ones that are scalable to improve survival of bats at the population level. Bats live on DoD lands across the U.S., making successful WNS management critical to the healthy ecosystems required to carry out mission activities. As researchers pursue innovative approaches to improve and expand the reach of these promising management strategies, they are confident the ongoing collaboration between researchers and DoD natural resources managers will bring solutions that facilitate uninterrupted testing and training, and support sustainable populations for all native bat species affected by WNS.



A biologist examines a bat for symptoms of WNS. Source: Ann Froschauer, USFWS

A GREEN LINE IN THE SAND? TACKLING WILDFIRE AND INVADDED ECOSYSTEMS

By Robert Knight, U.S. Army DPG and Elizabeth M. Kellogg, Tierra Data, Inc.

U.S. Army DPG, in western Utah, is facing increasingly frequent wildfire. This increase has impacted more and more acres, resulting in the loss of healthy habitat. The increase in wildfires at DPG is partially caused by the highly invasive, non-native annual grass, cheatgrass (*Bromus tectorum*). Researchers estimate that cheatgrass has invaded more than 100 million acres in western states. Once established, cheatgrass can lead to repeated wildfires across a landscape. Recurring wildfires result in a permanent loss of shrub and woodland communities, creating an environment vulnerable to additional fires, and allowing wildfire to easily spread to nearby areas. Uncontrolled wildfire poses a long-term risk to DPG's core mission of military testing and training, which benefit from a healthy, intact habitat. Smoke and dust on fire degraded lands also deteriorate air quality, compromising the value and safety of the mission. These fires and their numerous impacts threaten DoD personnel safety and landscape health required for mission readiness.

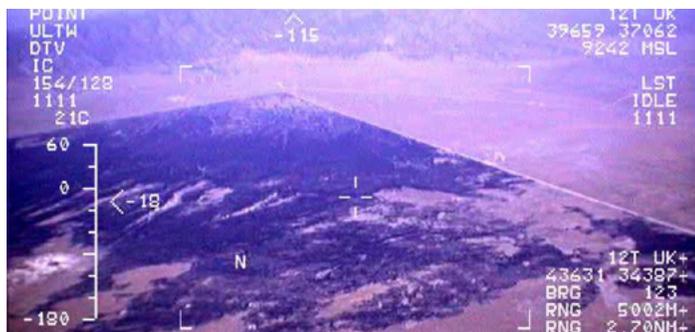


The Granite Peak Fire burned nearly 3,700 acres of cheatgrass-invaded habitat. The fire spread at an accelerated rate of up to 10 miles per hour and burned over several mission-critical areas, historic sites, and natural springs. Source: Gray Eagle Unmanned Aircraft System

Currently, any spark at DPG — whether caused by lightning or a military explosive — has the potential to exceed the capacity of ground suppression resources within minutes. When in-house resources cannot control wildfires, DPG requires assistance from pilots to suppress fire from the air. However, this assistance is costly and not always available when multiple western states are aflame. To identify alternative wildfire reduction strategies and limit the need for costly air suppression, multiple departments at DPG completed an *Integrated Wildland Fire Management Plan (IWFMP)* in 2017. The plan established a suite of multi-faceted tools, techniques, and procedures to address wildfire risk in DPG's Utah West Desert.

One of the primary tools in the IWFMP is the daily Fire Danger Rating (FDR). Collaborating with Bureau of Land Management (BLM) meteorologists, the DPG Fire Department (FD) publishes a daily FDR based on combined wind and weather predictions, and data on environmental fuel loads (i.e., the amount of brush or dry debris in the area). Personnel gather the weather and fuel load data through Remote Automated Weather Station technology by way of an interagency agreement. These daily reports inform explosive and livefire training schedules, reducing the probability of fires on high-risk days.

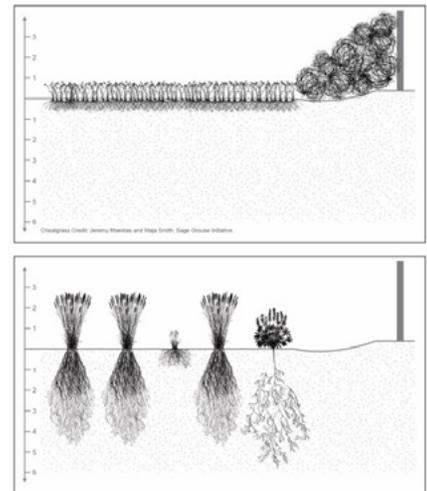
The DPG Natural Resources Office and FD, through the IWFMP, also have begun implementing a fire and fuelbreak system for fire suppression and protection of military assets and vulnerable natural resources. Firebreaks and fuelbreaks are strips of bare ground or vegetation, respectively, that provide a break in combustible material within a landscape. Because these breaks are far less combustible than their surroundings, they slow the progress of wildfires. DPG mostly uses "greenstrip" fuelbreaks in their wildfire management system. Greenstrip fuelbreaks are designed to reduce fire intensity and acreage, providing firefighters safe access to fight wildfires. Placed to protect sensitive habitat, the greenstrip fuelbreaks are fully vegetated and maintained by natural resources managers. In 2017, a lightning-strike related wildfire spread through 11,000 acres of DPG. Thankfully, the fire and fuelbreak system stopped the fire from leaving DPG and entering BLM managed lands where it would threaten a historical landmark and public campground. Establishment of effective fuelbreaks requires the planting of deep-rooted perennial grasses and herbaceous perennial understory plants that provide sufficient cover and root systems to outcompete cheatgrass. Deep-rooted native plants reduce fire intensity by their natural spacing, higher moisture content, and robust root systems that competitively exclude weed invasion. DPG maintains their fuelbreak system with aggressive weed control, seeding, and grass planting, and a Rangeland Sustainability Center supports the fuelbreak by using a greenhouse production system for perennial vegetation.



The defined edges of the DPG fire and fuelbreak system are seen here after an 11,000 acre wildfire in 2017. Source: Patrick Carnahan, Dugway Fire Department, US Army Garrison

DoD natural resources managers plan to monitor greenstrip fuelbreak success through a database designed to track fuelbreak condition and prioritize maintenance needs. Altogether, this system should reduce the size and frequency of fires while tracking progress to meet fire reduction goals.

The implementation of the IWFMP at DPG mutually benefits the military mission and the Utah desert environment. The DPG IWFMP shows the capabilities of an interagency approach that incorporates cutting-edge research with traditional wildland fire management. The plan serves as a model to other DoD installations of how integrated management can reduce wildfire potential; provide policy, guidance, structure, and standardization for wildland fire management; and lay a foundation of sound science, risk management, and support for reducing the incidence and impact of wildfires.



Cheatgrass (top) is prone to wildfire compared to naturally fire-resistant native plants (bottom). Source: Jeremy Maestas and Maja Smith, Sage Grouse Initiative

WHY IS BIRD MONITORING IMPORTANT ON DOD INSTALLATIONS?

By Rich Fischer, PhD, DoD Bird Conservation Program Coordinator

Bird monitoring has been a primary natural resources activity on DoD installations for decades. DoD has significant stewardship responsibilities for a wide variety of federally listed, and otherwise sensitive species groups, including hundreds of migratory bird species. DoD PIF was established in 1991 to sustain and enhance the military mission through proactive, habitat-based conservation and management. The initiative gives DoD natural resources managers tools that work within and beyond installation boundaries to facilitate cooperative partnerships, study the status of bird populations, and prevent the listing of additional birds as threatened or endangered.



Bird monitoring efforts tend to focus on a variety of objectives, including using birds as indicators of breeding, wintering, and migratory stopover habitat quality; assessing both short- and long-term success of management techniques; and tracking the influence of a changing climate on regional and local bird populations. However, DoD monitoring efforts have a unique and, perhaps, more important focus — providing support for our testing, training, and operational missions on installation lands and waters. At least since the early 1990s, installation personnel have conducted basic inventories, establishing long-term monitoring programs and participating in regional or national monitoring efforts such as Christmas Bird Counts, Breeding Bird Surveys, and Monitoring Avian Productivity and Survival (MAPS)

stations. Basic inventories have yielded important information for installation Integrated Natural Resources Management Plans (INRMPs) and have assisted in guiding management efforts for a variety of focal species.

DoD PIF has widely supported inventory and monitoring efforts on installations, either directly through on-the-ground work, or indirectly through the development of recommendations and technical support. In 2012, DoD PIF worked with the U.S. Geological Survey to publish a [Coordinated Bird Monitoring \(CBM\) Plan](#) for use across all DoD installations. That CBM Plan helped standardize DoD monitoring techniques. At the same time, DoD PIF helped installations design and implement monitoring programs, including selecting techniques, appropriate sample sizes, and target species. DoD PIF support was an invaluable tool for natural resources managers supporting both bird conservation and operational readiness. PIF expert assistance with these monitoring plans led to improved management on DoD lands, taking some of the burden off installation managers while providing the long-term planning needed to ensure continued operational readiness.

With limited funding available for bird monitoring, it can be challenging for natural resources managers to determine how, when, and where to monitor species. Over the past decade, DoD PIF has provided recommendations for focused monitoring. They even sent resources to managers that are most impactful for INRMPs. In 2008, DoD PIF created a list of 60 bird “Mission-Sensitive Species” (MSS) that, if federally listed under the ESA, would have the biggest impact on mission capabilities. With updated information resulting from monitoring programs and efforts on DoD lands, DoD PIF recently pared the list down to 13 MSS to make it more realistic for installations to effectively manage these species. The Military Services are reviewing the new list, which will be available in early 2019. In addition, DoD PIF is developing recommendations for regionally-based monitoring efforts for MSS that could be accomplished cooperatively by multiple installations within the range of each species.

The national and regional MSS enable natural resources managers to spend their limited budgets effectively. Both DoD PIF and installation managers must balance the dual requirements associated with military readiness and conservation. Tools like the MSS and the CBM Plan help managers better protect DoD missions — planning for uninterrupted testing and training while managing habitat to ensure the persistence of priority species. As these tools evolve, DoD PIF will continue to be an important asset to DoD natural resources managers who want to locate partners, share data, and proactively manage bird species.

If you need assistance with bird monitoring, do not hesitate to contact your state or regional DoD PIF Representative. You can find your Representative on the new [DoD PIF website](#).

DOD PROJECT HIGHLIGHTS

Following are summaries of a few projects that DoD installation natural resource managers may find of interest. Find more projects on the Natural Resources page of the DoD Environment, Safety and Occupational Health Network and Information Exchange ([DENIX](#)) site.

Legacy Project 16-824: Landscape genomics and population viability analysis of the Flat-tailed Horned Lizard (*Phrynosoma mcallii*) in California and Arizona

The flat-tailed horned lizard (*Phrynosoma mcallii*) is a species of special conservation concern in California, Arizona, and Mexico. Much of this lizard's range in the U.S. is found on public land including various military installations.



A flat-tailed horned lizard in the Sonoran desert. Source: Paul Block, US Navy

This Legacy-funded effort sought to determine the genetic diversity of flat-tailed horned lizard populations through DNA sequencing. With the genetic profile of the population, managers can see historic migration corridors and interbreeding groups. This information can help natural resources managers ensure continued lizard genetic diversity while providing insight into areas where habitat management could promote more flat-tailed horned lizard migration.

SERDP RC-2243 Patterns and Processes: Monitoring and Understanding Plant Diversity in Frequently Burned Longleaf Pine (*Pinus palustris*) Landscapes

This project studied the drivers of diversity and the influence of fire in longleaf pine ecosystems. Found in the southeastern U.S., longleaf pine forests are a fire-dependent ecosystem that provide food and shelter to over a dozen priority species like the red-cockaded woodpecker and gopher tortoise.



Military training in southern longleaf pine habitat. Source: Spc. Michael J. MacLeod, US Army

Researchers used a variety of technologies to study a healthy longleaf forest, including light detection and ranging, 3D rendering, and thermography. By combining data from all these surveying methods, researchers now better understand the community dynamics in a healthy longleaf forest. DoD natural resources managers can use this data to determine where their lands may need improvement — pinpointing what management programs should be prioritized over others in longleaf systems.

SERDP RC-2330 Soil Microbial Communities: Critical Roles in Control of Non-Native Invasive Species and Restoration of Ecosystem Functions

DoD testing and training relies on intact habitats. The loss of native plant communities is a threat to these critical military operations. This project looked to determine if natural resources managers can use native soil fungi, arbuscular mycorrhizal (AM) fungi, as a management tool to support native plants. Researchers studied potential beneficial effects of AM fungi through field surveys, field planting, and greenhouse experiments. Their results found strong evidence that AM fungi inhibits non-native invasive plants, increases plant diversity, and improves the quality of native plant restoration. Research suggests that DoD natural resources managers may be able to use AM fungi to ensure that land management efforts are more successful, leading to healthier plant communities on DoD lands.

UPCOMING EVENTS, CONFERENCES, WORKSHOPS, AND TRAINING

National Invasive Species Awareness Week

February TBD

Each year during National Invasive Species Awareness Week, state, federal, local, and tribal officials meet with non-governmental organizations, industry, and stakeholder groups. Collectively they discuss invasive species, and examine laws, policies, and creative approaches to prevent and reduce invasive species threats to our health, economy, environment, and natural resources. Attend events in Washington, DC, or host your own event that explores local problems and solutions to invasive species.

Association of Partners for Public Lands Conservation Convention

February 24-28, Denver, CO

This annual meeting is the largest gathering of public lands professionals in the U.S. It brings together nonprofits, land management agencies, and companies to learn, network and engage on public lands issues. Organizers have planned a trade show, as well as educational sessions about leveraging partnerships, connecting to local communities, and developing strong leadership.

World Wildlife Day

March 3, Global

The United Nations designated World Wildlife Day to celebrate and raise awareness of wild animals and plants, drawing attention to the threats that endangered species face from habitat loss, poaching, and the pet trade.

Installation Innovation Forum

March 4-6, Miami, FL

This annual forum is the only professional development forum designed to bring together installation leadership with their community counterparts and top industry experts to share ideas and learn about tangible ways to advance innovation on base and in the community. Experts and DoD leaders, including keynote speaker Hon. Robert McMahon (Assistant Secretary of Defense for Sustainment) will describe projects that are pushing partnership and technological innovation boundaries.

The Big Dry Arm spring storm in the Great Basin Range. Source: USFWS



North American Wildlife and Natural Resources Conference

March 4-8, Denver, CO

This conference brings together natural resources professionals from all sectors to exchange knowledge and best practices on issues such as endangered species, migratory birds, and landscape management through workshops and meetings. The event serves as the annual forum to set conservation policy in North America and includes conference sessions, workshops, and more than 150 separate meetings and functions.

National Military Fish and Wildlife Association (NMFWA) Annual Training Workshop

March 4-8, Denver, CO

Held in conjunction with the North American Wildlife and Natural Resources Conference (above), the 84th NMFWA annual training workshop is the primary event where installation natural resources managers meet to discuss key concerns and opportunities, recent policy and legislative changes, ongoing activities and recent accomplishments, and emerging issues and potential new challenges. This year's training will include workshops on the new Legacy-funded *DoD Adaptation Planning for DoD Natural Resource Managers* ("Climate Smart for INRMPS") guide, which will offer a step-wise guide incorporating climate adaptation strategies into INRMPS; *Advanced Endangered Species Act: How to Effectively Write a Biological Evaluation to Get the Results You Want*; and *Integrated Monarch Monitoring Across DoD Properties and Nationwide*.

Naval Civil Engineer Corps Officers School (CECOS) Natural Resources Management and Compliance Course

March 18-21, Joint Base San Antonio, TX

This course offers instruction in specific natural resources laws, regulations, policies, Executive Orders, DoD Instructions, and other guidance, noting Service-specific requirements. The course addresses stewardship, preservation, and process; fish, game, and wildlife management laws; protection of wetlands, waterways, and other protected ecological areas; forest and land use management laws; Sikes Act and INRMPS; and inter-service cooperation.

US Regional Association of the International Association for Landscape Ecology Annual Meeting

April 7-11, Fort Collins, CO

The theme for this year's meeting is, "Conservative Innovation." Efforts within the field of landscape ecology often combine design science, sustainability science, and creative conservation. This annual meeting brings together leaders in landscape ecology who are dedicated to preserving and protecting natural resources, including educators and practitioners in the fields of geology, ecology, biology, geography, urban and regional planning, and landscape preservation and design.

LINKS OF INTEREST

DoD Natural Resources Program (NR Program)

DoD's NR Program provides policy, guidance, and oversight to manage natural resources on approximately 25 million acres of military land, air, and water resources. Visit the NR Program website for more information on DoD's natural resources initiatives, policy updates, presentations, and links to other conservation and natural resources sites.

DoD Environment, Safety and Occupational Health Network and Information Exchange (DENIX)

The DENIX Natural Resources website is another resource that provides access to natural resources information. Specifically, the website includes DoD Legacy Resource Management Program (Legacy Program) fact sheets and reports, as well as other natural resources materials.

Armed Forces Pest Management Board (AFPMB)

AFPMB recommends policy, provides guidance, and coordinates the exchange of information on pest management throughout DoD. Their mission is to ensure that environmentally sound and effective programs are in place to prevent pests and disease vectors from adversely affecting natural resources and DoD operations.

Strategic Environmental Research and Development Program (SERDP) and Environmental Security Technology Certification Program (ESTCP)

SERDP and ESTCP are independent DoD research programs that use the latest science and technology to develop innovative solutions to DoD's environmental challenges. They promote partnerships and collaboration among academia, industry, the Military Services, and other federal agencies that support military readiness and mission capabilities, quality of life, compliance with legislation and policy, and natural and cultural resources management.

Readiness and Environmental Protection Integration (REPI)

Under REPI, DoD partners with conservation organizations, and state and local governments to preserve land around military installations to combat encroachment. REPI promotes innovative land conservation, which preserves the military's ability to train and test on its lands now and into the future.

Cooperative Ecosystem Studies Units (CESU) Network

DoD participates in the CESU Network, which is a national consortium of federal agencies, tribes, academia, state and local governments, and non-governmental organizations working together to provide research, technical assistance, and training to federal agencies and their partners. DoD's CESU projects have netted savings of approximately \$51 million through combined efforts and a pre-negotiated, lower overhead rate for federal agencies. The CESU Network also provides managers with the adaptive management approaches necessary to preserve installation natural resources.

DoD Partners in Flight (PIF)

DoD PIF consists of natural resources personnel from military installations across the U.S. and works collaboratively with partners throughout the Americas to conserve migratory and resident birds and their habitats. In addition, DoD PIF supports and enhances the military mission through proactive, habitat-based management strategies that help protect birds on DoD lands and maintain healthy landscapes and training lands. Visit the DoD PIF website for fact sheets, reports, and other materials with information about DoD's migratory bird conservation efforts.

DoD Partners in Amphibian and Reptile Conservation (PARC)

DoD PARC is a partnership dedicated to the conservation and management of herpetofauna (reptiles and amphibians) and their habitats on military lands. DoD PARC membership includes natural resource specialists and wildlife biologists from the Military Services, and individuals from state and federal agencies, museums, universities, and environmental consultants. Visit the DoD PARC website for information about herpetofauna management projects on DoD lands.

DoD Pollinator Initiatives

Visit this website for an overview of pollinators and why they are important to DoD. The website also contains information on how people can help protect pollinators and their habitat, including fact sheets, technical reports, and how-to guides.

DoD Invasive Species Outreach Toolkit

This toolkit has materials to help DoD natural resources managers communicate with agencies, organizations, and the public about invasive species issues on DoD lands. Specifically, the tool kit includes modifiable outreach materials, such as posters, brochures, reference cards, and a PowerPoint presentation.

DoD Biodiversity Handbook

The DoD Biodiversity Handbook contains a thorough introduction to biodiversity and how it is essential to support the military mission. It also details the scientific, legal, policy, and natural resources management contexts for biodiversity conservation on DoD lands, and includes 17 case studies with practical advice from DoD natural resources managers.

DoD PARC Photo Library, DoD PIF Photo Library, and DoD Natural Resources Photo Library

Visit these three websites to share pictures, news, information, and ideas with the DoD Natural Resources, DoD PARC, and DoD PIF communities. Please review the [photo policy](#) and [photo submission instructions](#) to contribute your images. In addition, account users can download photographs for reports, Power Point presentations, and educational materials such as brochures and posters.





DOD NATURAL RESOURCES PROGRAM

Enabling the Mission, Defending the Resources

www.denix.osd.mil/nr

<http://twitter.com/#!/DoDNatRes>

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