



DoD Environmental Planning and Conservation Webinar Series



A Rangewide Western Pond Turtle (*Actinemys* spp.) Status Assessment on Military Lands: Occupancy, Population Structure, and Pathogens

November 14, 2024

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A Rangewide Western Pond Turtle (*Actinemys* spp.) Status Assessment on Military Lands: Occupancy, Population Structure, and Pathogens

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Western Pond Turtle (*Actinemys marmorata* & *A. pallida*)



A Regional Conservation Cooperative

Western Pond Turtle Range-wide Management Strategy 2020



Southwestern pond turtle (*Actinemys pallida*). Santa Barbara County, California.
Photo: U.S. Fish and Wildlife Service

Sponsored by the Western Pond Turtle Range-wide Conservation Coalition

Western Pond Turtle Regional Conservation Cooperative Mission Statement:

Foster a comprehensive and coordinated group of stakeholders across the range of the two species of WPT to manage, conserve, research and support the species in perpetuity.

WPT RCC Objective:

To ensure the long-term viability in the wild of WPT and to maintain self-sustaining populations of the two species.

Entity	NatureServe State Rank	Status
Washington	S1: critically imperiled	State Endangered; Species of Greatest Conservation Need, State Wildlife Action Plan
Oregon	S2: imperiled	Protected Wildlife, State Sensitive–Critical, Species of Greatest Conservation Need (Strategy Species), State Wildlife Action Plan
California	S3: rare, uncommon or threatened	Species of Special Concern (SSC), <i>A. marmorata</i> Priority 3, <i>A. pallida</i> Priority 1, Species of Greatest Conservation Need, State Wildlife Action Plan
Nevada	S2: imperiled	Species of Conservation Priority, State Wildlife Action Plan
Mexico	--	None

Entity	NatureServe State Rank	Status
Canada	--	Extirpated; Species at Risk Act (Priority 2); 2015 Recovery Strategy
IUCN Red List	--	VU – vulnerable
U.S. Forest Service	--	Regions 5 (California) and Region 6 (Oregon and Washington), Sensitive Species.
U.S. Bureau of Land Management	--	California, Oregon/Washington, and Nevada, Sensitive Species



A DoD Mission Sensitive Species

A Species Status Assessment

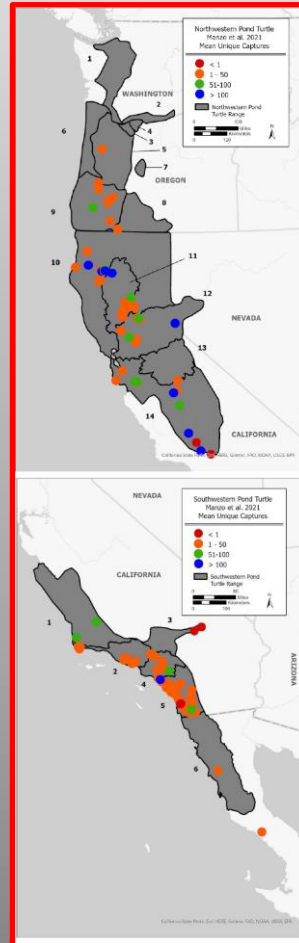
Species Status Assessment Report
for
Northwestern Pond Turtle (*Actinemys marmorata*)
and
Southwestern Pond Turtle (*Actinemys pallida*)



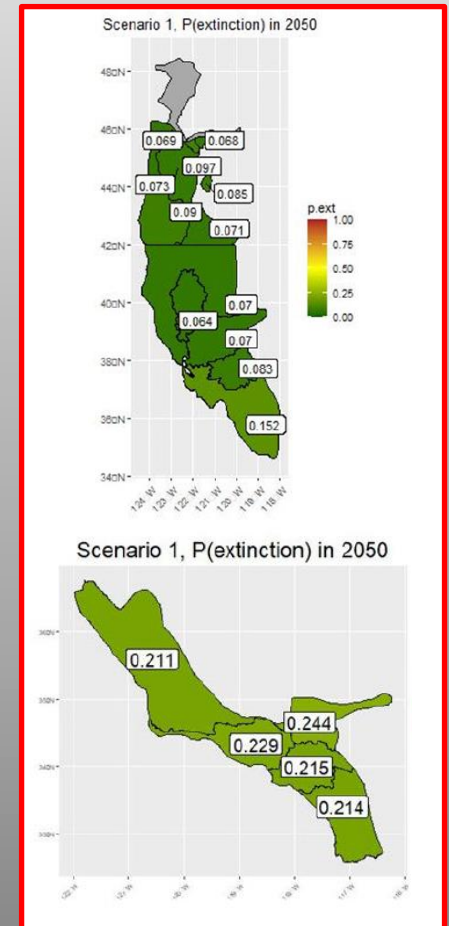
U.S. Fish and Wildlife Service

Version 1.1

April 2023



Threat	Scenario 1 (RCP 8.5)	Scenario 2 (RCP 4.5)
Land conversion	Ceiling type density function mimicking wetland loss by State under RCP 8.5/SSP 5	Ceiling type density function mimicking wetland loss by State under RCP 4.5/SSP 2
Drought	Drought frequency under RCP 8.5; annualized rates of moderate and extreme drought within analysis units, with impacts to survival of all age classes and to the proportion of breeding females, after 4+ years of moderate drought, 1, 2, or 3 years of severe drought, or a combination	Drought frequency under RCP 4.5; annualized rates of moderate and extreme drought within analysis units (0.87 of RCP 8.5 rates of increase), with impacts to survival of all age classes and to the proportion of breeding females, after 4+ years of moderate drought, 1, 2, or 3 years of severe drought, or a combination
Bullfrog presence	Bullfrog spread based on continuation of rate of change over last 17 years across analysis units, with impacts to survival of hatchlings and small juveniles	Bullfrog spread based on continuation of rate of change over last 17 years across analysis units, with impacts to survival of hatchlings and small juveniles



The Importance of DoD lands to Biodiversity Conservation (T & E species and ecosystems)

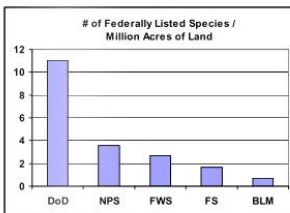


Threatened and Endangered Species on Department of Defense Lands



Background

The U.S. Fish and Wildlife Service (FWS) and National Oceanic and Atmospheric Administration (NOAA) Fisheries have the lead for guiding implementation of the Endangered Species Act (ESA); however, the ESA states that all Federal agencies are responsible for conserving threatened and endangered (T&E) species as part of their normal activities. Department of Defense (DoD) agencies play a vital role in the conservation of many rare plant and animal species. DoD manages approximately 29 million acres on about 425 major military installations throughout the United States. Access limitations due to security and safety concerns have sheltered many military lands from development pressures and large-scale habitat loss. As a result, some of the finest remaining examples of rare wildlife habitats are found within these lands. In fact, there are more T&E species per acre on DoD lands than for any other federal public land management agency, as shown in the following figure:



KEY: DoD - Department of Defense, NPS - National Park Service, FWS - Fish and Wildlife Service, FS - Forest Service, BLM - Bureau of Land Management

Currently, the DoD is responsible for 320 T&E species on 252 separate installations. These installations are located in different ecosystems, and require different needs for both species protection and military training. Through open communication and cooperation, FWS has collaborated to establish successful partnerships with DoD and its associated military services. These partnerships have enabled the military to carry out its mission on its bases, while ensuring the continued use of sound science in the conservation and protection of threatened and endangered species.

DoD T&E Expenditures

Each fiscal year (FY), the services are required to file a report with the FWS outlining T&E species expenditures. These

data summarize the costs of managing for T&E species and include such actions as species surveys, monitoring, research, and on-the-ground conservation efforts. The FWS reports the expenditures of all agencies to Congress. This fact sheet provides a summary of DoD reported expenditures from FY1991-FY2004.

The numbers of T&E species as of May 2004, affected installations, and individual service T&E expenditures from FY1991 to FY2004 are:

Service	# of Species ¹	# of Installations ²	Expenditures FY91-FY04
Air Force	76	43	\$ 105,147,019
Army	173	96	\$ 177,820,470
Marine Corps	56	15	\$ 35,798,765
Navy	138	98	\$ 55,971,671
Total	320	252	\$ 374,737,925

¹ Many species are managed by more than one service.
² # of installations refers only to those installations with at least one federally listed T&E species.

The top five most invested species from FY1991 to FY2004 for all DoD are:

- Red-cockaded Woodpecker \$67.4 million
- Desert Tortoise \$29.6 million
- San Clemente Loggerhead Shrike \$17.3 million
- Mexican Spotted Owl \$16.4 million
- Black-capped Vireo \$13.5 million

The species most invested in from FY1991 to FY2004 per service is:

- Air Force, Desert Tortoise \$15.9 million
- Army, Red-cockaded Woodpecker \$50.3 million
- Marine Corps, Least Bell's Vireo \$4.0 million
- Navy, San Clemente Loggerhead Shrike \$17.3 million



The Desert Tortoise, *Gopherus agassizii*, is a federally listed threatened species found on 11 DoD installations.

Federal Lands and Endangered Species: The Role of Military and Other Federal Lands in Sustaining Biodiversity

BRUCE A. STEIN, CAMERON SCOTT, AND NANCY BENTON

The US government has multiple responsibilities for the protection of endangered species, many of them stemming from its role as the nation's largest landowner. To explore how endangered and imperiled species are distributed across the federal estate, we carried out a geographic information system (GIS)-based analysis using natural heritage species occurrence data. In this 10-year update of a previous analysis, we found that the Department of Defense and the USDA Forest Service harbor more species with formal status under the Endangered Species Act (ESA) than other US agencies. The densities of ESA status species and imperiled species are at least three times higher on military lands—2.92 and 3.27, respectively, per 100,000 hectares—than on any other agency's lands. Defense installations in Hawaii are especially significant; more than one-third of all ESA status species on military lands are Hawaiian. These findings highlight the continued importance of public lands for the survival of America's plant and animal species.

Keywords: endangered species, biodiversity, federal lands, Department of Defense, natural heritage

The federal government owns more than 264 million hectares (ha) across the United States, representing nearly one-third (29%) of the nation's land area, and one-fifth (21%) just in the lower 48 states. These lands span a wide array of ecosystems, from frozen tundra in the north to subtropical hardwood hammocks in southern Florida. In turn, these habitats support diverse assemblages of native wildlife, including many that are rare or have suffered serious declines. Such rare or declining species are of particular scientific and conservation interest because of their heightened risk of extinction.

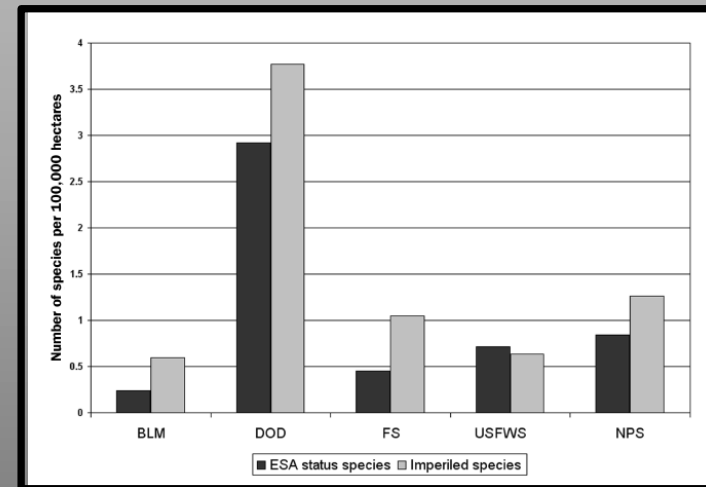
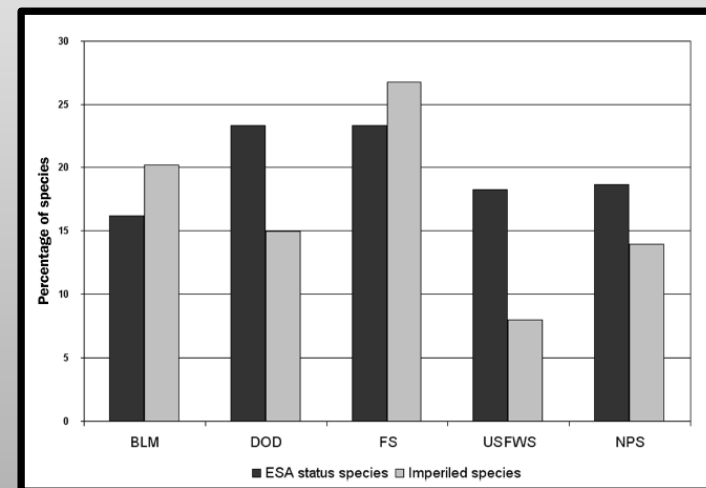
The Endangered Species Act (ESA) of 1973 represents a formal expression of the American people's concern about the loss of plant and animal species to extinction. The federal government has dual responsibilities under this act. Administration and enforcement of the act's provisions are federal obligations of the US Fish and Wildlife Service (USFWS) within the Department of the Interior and the National Marine Fisheries Service (NMFS) within the Department of Commerce. A second area of responsibility relates to the federal government's role as the nation's largest landowner and manager, with broad responsibilities for managing the resources under its control. The mandates of federal agencies vary widely; consequently, land-management objectives range from a focus on protection and preservation, as is the case with the National Park Service (NPS), to multiple uses of the land,

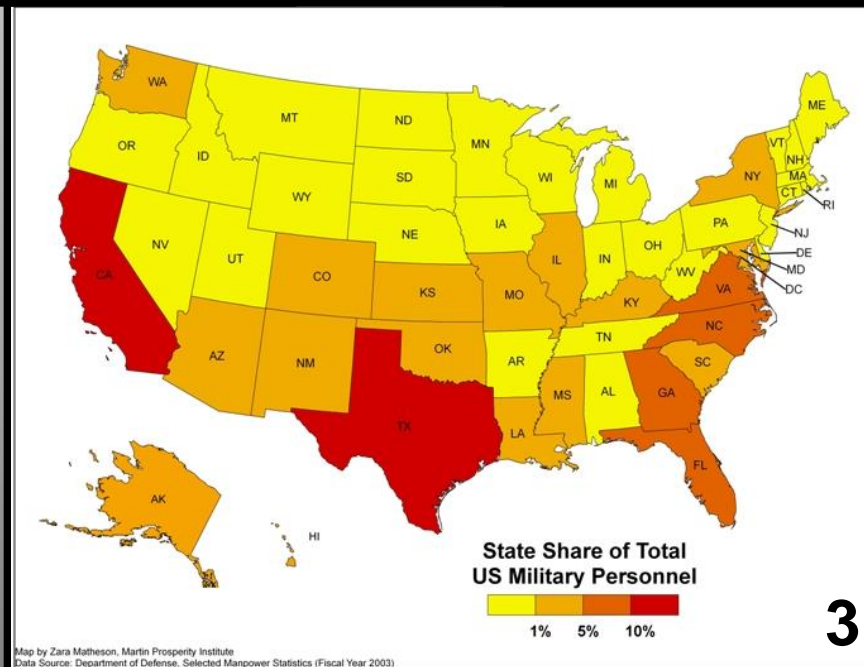
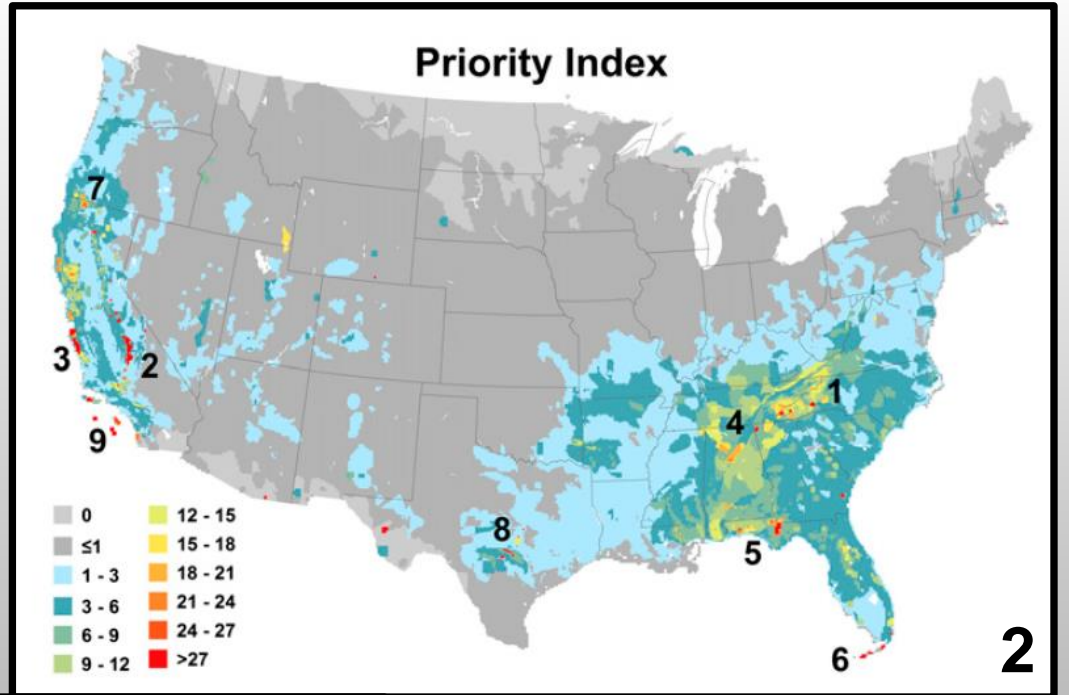
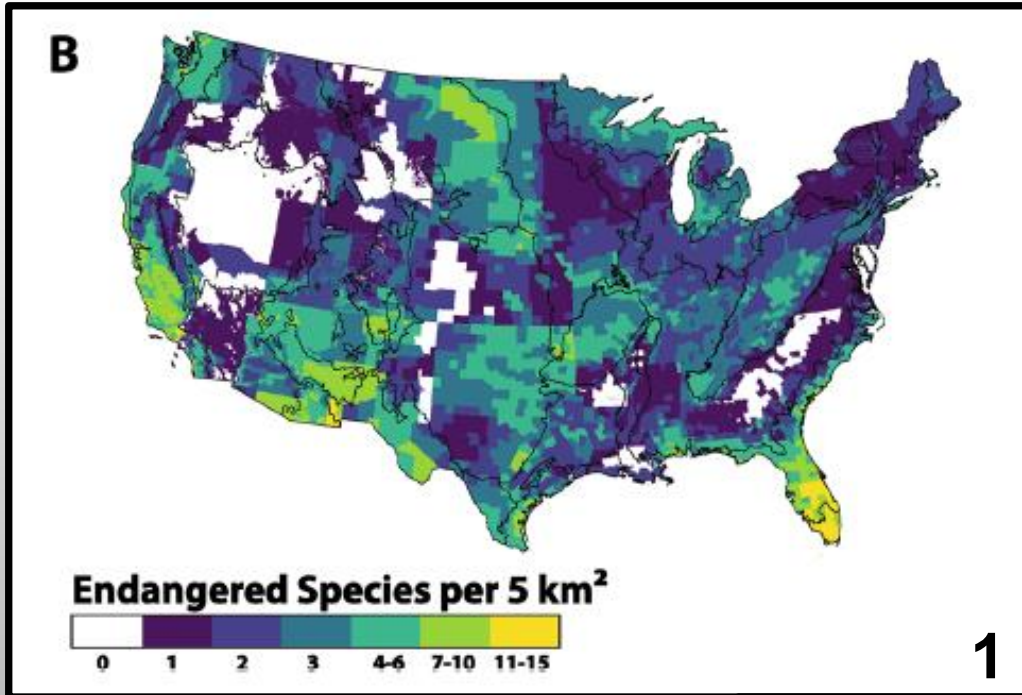
including resource extraction, as with the USDA Forest Service and the Bureau of Land Management (BLM).

Despite these differences in objectives, all federal land-management agencies are obligated to comply with federal environmental laws and regulations such as the ESA. Thus, while considerable attention in recent years has rightfully focused on how to better protect endangered and threatened species on private lands, federal lands must play a key role in any national strategy for preserving the nation's rich array of wildlife species. Protection of threatened or endangered plant species under the ESA, for example, differs depending on whether the plant is found on federal property or on private property. The no-take provisions under the act, which prohibit landowners from causing harm to listed species, apply only to animals. Plant species on private lands are, in general, protected only where a federal action (e.g., regulatory permit) is involved. In contrast, listed plants occurring on federal lands receive full protection under the act.

What then is the scope of federal land management responsibilities for endangered species? Several previous

Bruce A. Stein (e-mail: bruce_stein@naturservice.org) is vice president and chief scientist. Cameron Scott is a conservation data analyst, and Nancy Benton is a project manager at Naturservice in Arlington, Virginia. © 2008 American Institute of Biological Sciences.





- 1) Clancy et al. (2020) Scientific Reports
- 2) Jenkins et al. (2015) PNAS
- 3) Florida. (2010) The Atlantic (Data: DoD)

Department of Defense Partners in Amphibians and Reptile Conservation (DoD PARC)



Department of Defense

Partners in Amphibian and Reptile Conservation



The U.S. Department of Defense Partners in Amphibian and Reptile Conservation (DoD PARC) network launched in 2009 to provide leadership, guidance, and support for the conservation and management of amphibians and reptiles on DoD lands in ways that help sustain the military's testing, training, and operational mission activities. DoD PARC is voluntary, proactive, and non-regulatory, and consists of over 550 military and civilian personnel. For the last 11 years, the network has served as a model of excellence for amphibian and reptile management and conservation on military lands, and we thank all who have contributed to our collective success.

How DoD PARC Benefits the Military Mission:

DoD PARC enhances military readiness by promoting healthy landscapes that support long-term testing and training requirements. In addition, the network increases the effectiveness of resource management on DoD lands through the development of proactive, science-based conservation and management strategies and tools.

DoD PARC increases communication and partnerships among the DoD community, facilitates collaborative implementation of guidance and problem solving, and saves money by sharing costs across the Military Services and with our non-DoD partners. The network helps to conserve the nation's biological heritage by developing partnerships that work across boundaries to help prevent species declines, which in turn helps DoD avoid mission restrictions and increases mission flexibility.

DoD PARC Program Goals:

- ◇ Provide sound, science-based strategies, tools, and information for managing amphibian and reptile populations that can be incorporated into existing natural resources and land management programs.
- ◇ Reduce or eliminate population declines of both common and at-risk species, thus helping preclude or minimize Endangered Species Act (ESA)-listings and critical habitat designations.
- ◇ Promote partnerships and collaborative efforts among the military community and external stakeholders to develop win-win outcomes that support military readiness and conservation.
- ◇ Promote awareness, involvement, communication, and coordination both within DoD and among national, regional, and local experts to achieve DoD mission and stewardship goals.



Rainbow Snake-J.D. Wilson



Blue-spotted Salamander-Robert Brodman



Eastern Box Turtle-David Burkwal



Green Anole-Paul Block



AMPHIBIANS AND REPTILES OF UNITED STATES DEPARTMENT OF DEFENSE INSTALLATIONS

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Abstract.—The U.S. Department of Defense (DoD) occupies approximately 10.1 million ha of land within the U.S. spanning most ecosystems contained therein. To date, no comprehensive agency-wide inventory of amphibian and reptile species has been compiled. We developed an amphibian and reptile species inventory for 415 DoD installations/sites and evaluated species diversity. The amphibian and reptile species confirmed present on DoD sites represent 66% of the total native species documented in the continental U.S. Snakes are the most widespread group found on DoD lands. Of the military services, Army sites have the greatest number of confirmed species, federally listed, state-listed, and At-risk species. There are 24 federally listed (threatened or endangered), 55 state-listed, and 70 At-risk species confirmed present on DoD sites. Thirty non-native and native transplant amphibian and reptile species/subspecies are also confirmed present on DoD sites. Lastly, we verified that approximately half of the military sites evaluated in this study have at least one venomous snake species confirmed present. Our study results assist directly with ongoing management and conservation of amphibian and reptile species on DoD lands and confirm military lands comprise a significant contribution to biodiversity conservation.

Key Words.—Endangered Species Act; Sikes Act; at-risk species; biodiversity; inventory; military; non-native; venomous

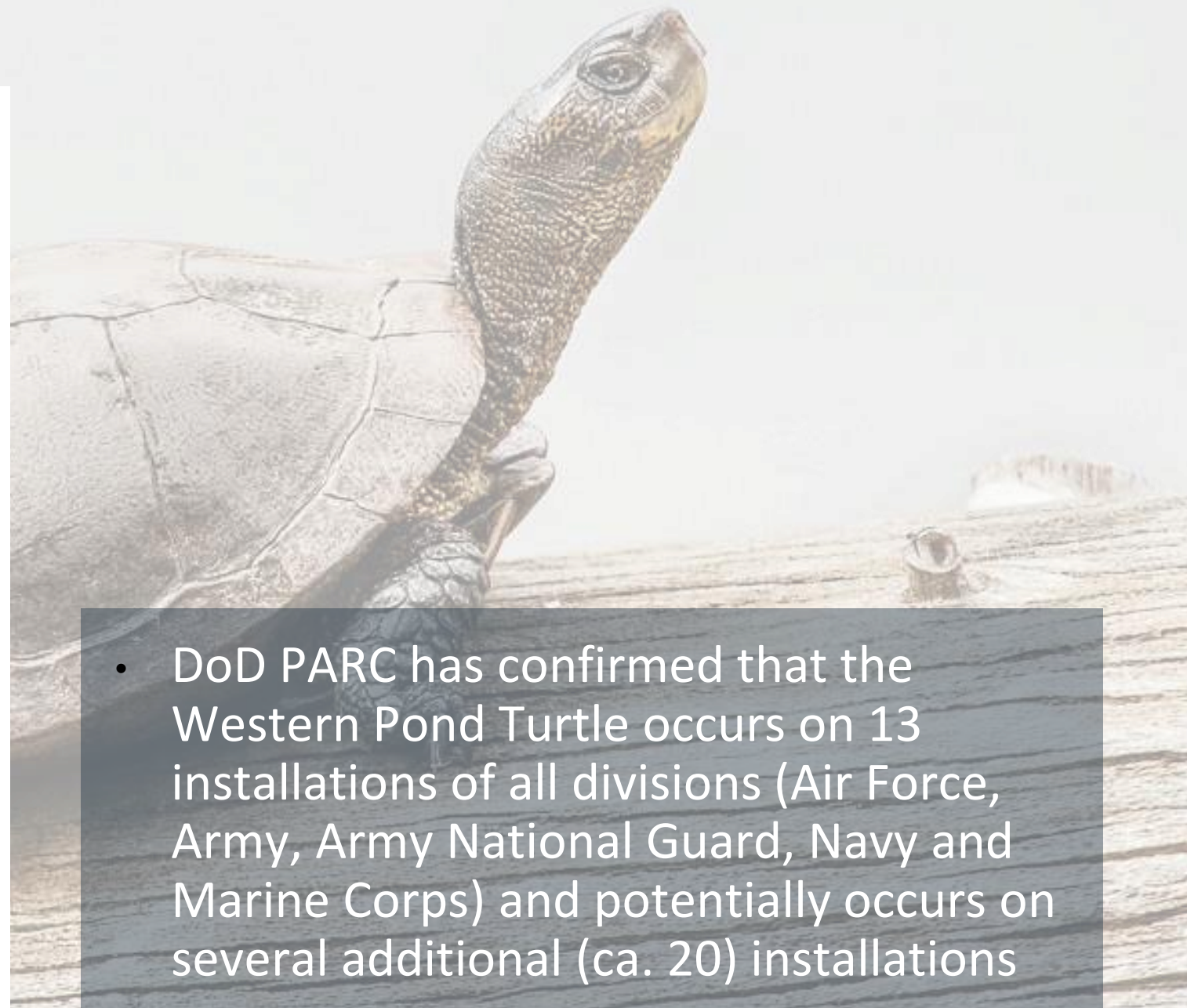
INTRODUCTION

The U.S. Department of Defense (DoD) manages approximately 10.1 million ha of land spanning a diversity of ecosystems. The primary purpose of these lands is to train military personnel and test weapons in support of national defense. Despite the constant and long-term use of military lands for this mission, several studies have documented the critical role these lands play in maintaining biodiversity (e.g., Groves et al. 2000; Stein et al. 2008; Aycrigg et al. 2015; Zentelis and Lindenmayer 2015). For example, DoD lands have the greatest density of Endangered Species Act (ESA)-status species and NatureServe (G1-G2)-impaired species of any federal land management agency (Stein et al. 2008; Aycrigg et al. 2015). Furthermore, even though DoD lands comprise only 5% of the total area of federal lands, they represent 82.6% of the diversity of ecological systems in the contiguous U.S. (Aycrigg et al. 2015). In fact, DoD lands contain the second-highest number of ecological systems of all federal land management agencies, second to the National Park System, which contains 27% more land area than the DoD (Aycrigg et al. 2015).

The DoD takes an ecosystem-based approach to natural resources management, which is implemented at installations using Integrated Natural Resource Management Plans (INRMPs). The Sikes Act (16 U.S. Code [U.S.C.] 670a–670o, 74 Stat. 1052), as amended,

requires DoD to prepare and implement INRMPs for installations that have been determined to have significant natural resources. The primary purpose of an INRMP is to create a single comprehensive ecosystem-based plan that ensures natural resources conservation measures and military operations are integrated and consistent with environmental stewardship, laws and regulations, and the military mission. The management and conservation of amphibians and reptiles on military lands is performed primarily through the implementation of specific management guidelines, protocols, and associated projects within INRMP for each installation.

The DoD strives to maintain healthy amphibian and reptile populations on their lands in support of military readiness because these species often surpass other vertebrate groups in terms of abundance, diversity, and biomass (Klemens 2000; Stuart et al. 2008; Vitt and Caldwell 2009; Ernst and Lovich 2009) and serve as indicators of environmental health (Hayes et al. 2006; Pounds et al. 2006; Johnson et al. 2007). The DoD has a network of subject matter experts in the field of herpetology (DoD Partners in Amphibian and Reptile Conservation) that distribute information and develop products that assist with meeting military mission goals, while promoting stewardship and conservation for amphibians and reptiles. The DoD is the first and only U.S. agency to date with a comprehensive Strategic Plan for Amphibians and Reptiles (Lovich et al. 2015), although species/habitat protection is not its primary



- DoD PARC has confirmed that the Western Pond Turtle occurs on 13 installations of all divisions (Air Force, Army, Army National Guard, Navy and Marine Corps) and potentially occurs on several additional (ca. 20) installations

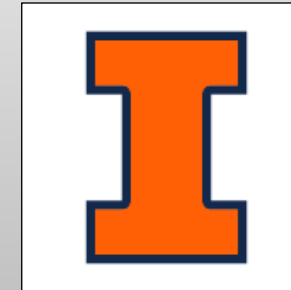
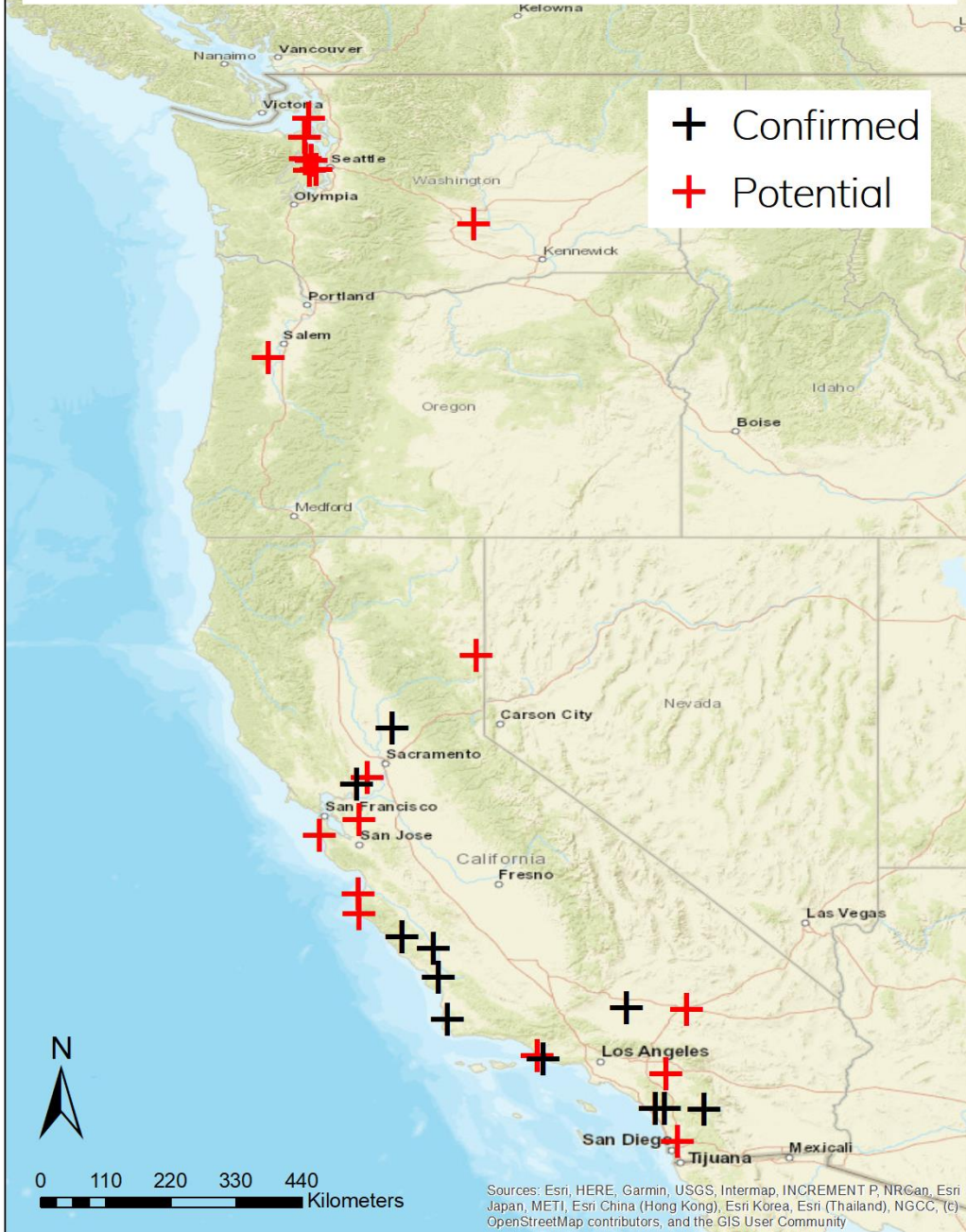
The DoD – SI Cooperative Agreement through the Chesapeake Watershed CESU

“A Rangewide Western Pond Turtle (*Actinemys* spp.) Status Assessment on Military Lands...”

- **Inventory:** Maintain a comprehensive inventory of WPT populations across ranges.
- **Data Collection:** Gather updated biological data to support effective management.
- **Education:** Develop training resources for personnel engaged in WPT conservation.
- **Partnerships:** Collaborate with regional partners to strengthen conservation efforts.
- **Monitoring:** Form a working group for continuous monitoring and data sharing.



Military Lands with Western Pond Turtles




Monitoring Protocol Standards

DRAFT

USGS
science for a changing world

USGS Western Pond Turtle (*Emys marmorata*) Trapping Survey Protocol for the Southcoast Ecoregion

Survey Protocol, version 1



U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER



Northwest Fauna



A MONOGRAPH OF VERTEBRATE BIOLOGY

NUMBER 7 2012



Western Pond Turtle: Biology, Sampling Techniques, Inventory and Monitoring, Conservation, and Management

R. BRUCE BORG, HAZEL HILL, H. WELSH, JR., DAVID J. GERMANO,
DONALD T. AUSTON (EDITORS)

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THE SOCIETY FOR NORTHWESTERN VERTEBRATE BIOLOGY

**OBJECTIVE 1 – COLLATE
HISTORICAL DATA ON WPTS
FROM THE 13 MILITARY
INSTALLATIONS IN CALIFORNIA**

Objective 1 – Collate Historical Data on WPT

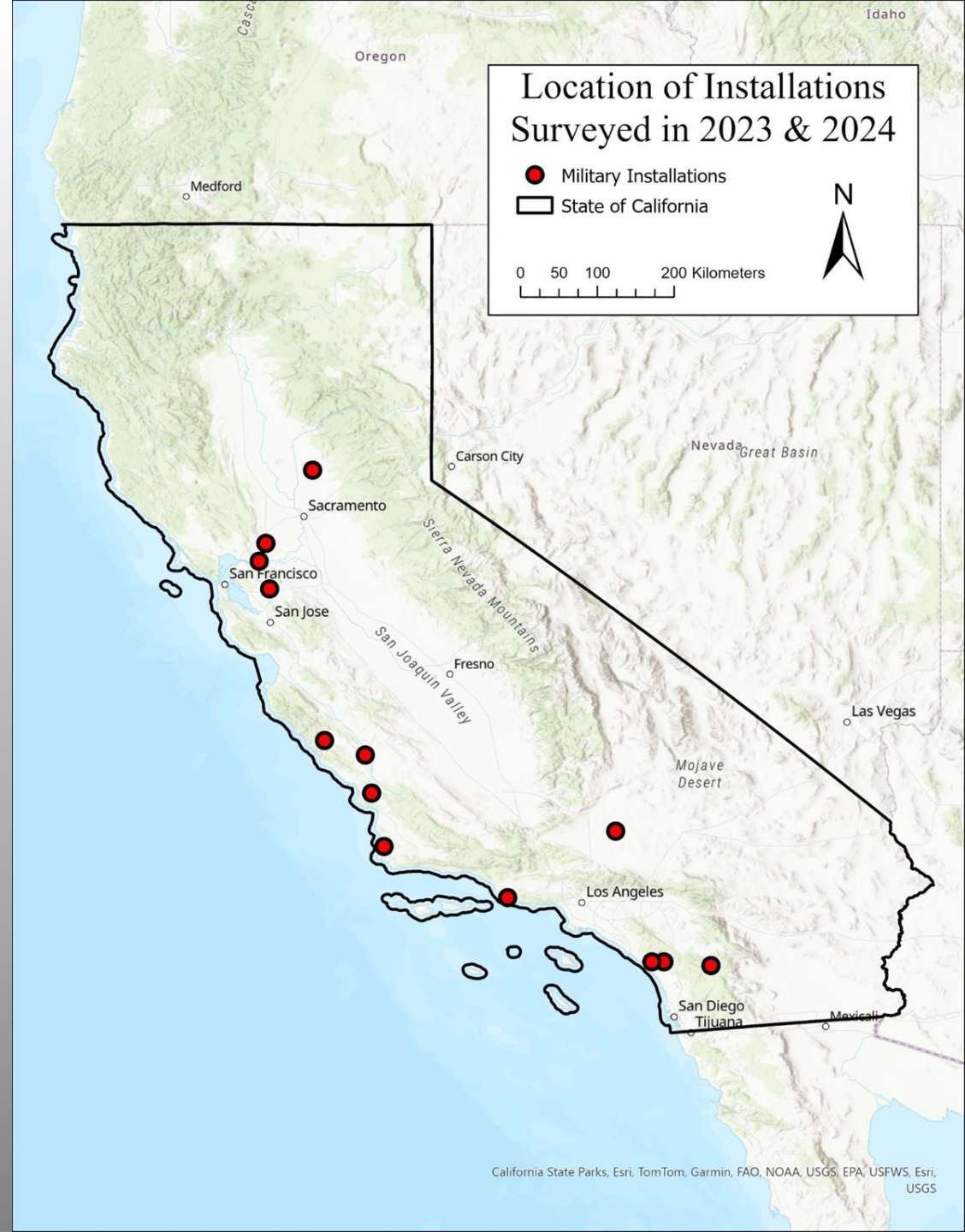
- Goal: Compile a comprehensive historical database for WPT at 13 military installations
- Methods: Database construction from historical records, highlighting gaps
- Field Manual: Standardized monitoring protocols for consistent data collection
- Training Program: Equip natural resource managers with field monitoring skills
- Long-Term Benefit: A shareable, standardized data resource for future WPT studies

Expected Outcomes - Objective 1

- Database Utility: Centralized repository for ongoing WPT monitoring and analysis
- Consistency in Monitoring: Field manual ensures uniform data across sites
- Enhanced Resource Management: Trained team for WPT surveys and monitoring
- Informed Management Decisions: Database insights guide targeted conservation
- Foundation for Future Research: Database supports long-term conservation efforts

Installations visited

Installation	2023	2024
Naval Weapons Station Fallbrook	2	1
Marine Corps Base Camp Pendleton	1	0
Remote Training Site Warner Springs	0	1
Naval Base Ventura County Point Mugu	1	1
Edwards Air Force Base	1	0
Vandenberg Space Force Base	1	1
Camp San Luis Obispo	1	0
Camp Roberts	1	1
Fort Hunter Liggett	2	2
Parks Reserve Forces Training Area	0	1
Military Ocean Terminal Concord	1	1
Travis Air Force Base	1	1
Beale Air Force Base	1	1



Initial Meetings with Resource Managers

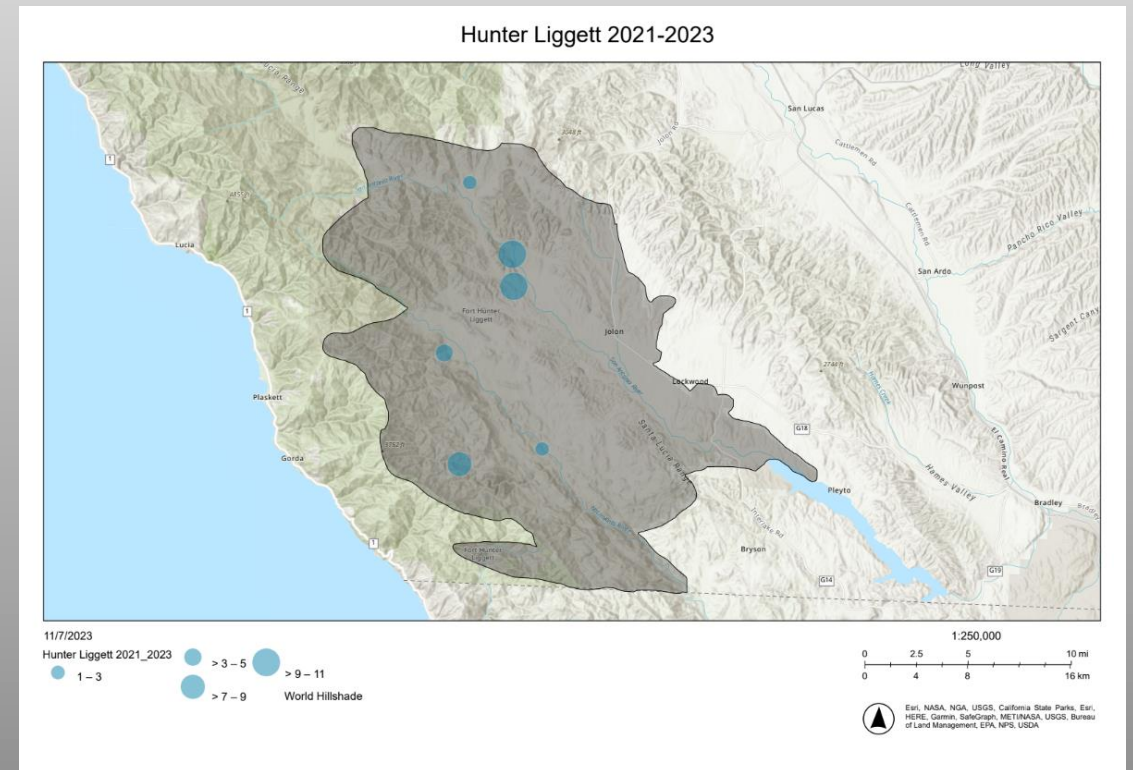
- Purpose: Assess existing data quality and depth at each installation
- Method: One-on-one meetings or group Zoom sessions with managers
- Focus: Determine if data is limited (e.g., turtle counts) or comprehensive
- Outcome: Insight into current WPT data, guiding database structure
- Benefit: Supports the development of a tailored monitoring strategy

Compile Data into Shareable Database

- Database Creation: Compile trapping, monitoring, and individual data
- Platform: Use FileMaker Pro initially, transfer to final database format
- Data Utility: Accessible for ongoing and future monitoring efforts
- Collaborators: Database available to military and research partners
- Goal: Create a lasting data repository to support WPT research

U.S. Army Fort Hunter Liggett (2021-2023)

Site	2021	2022	2023
Del Venturi	5	5	
Los Burros Creek		1	8
Milpitas		1	
Nacimiento River			1
San Antonio River			11
San Miguel Creek			5
Total (37)	5	7	25



Western Pond Turtle observations for thirteen military installations in California, from 1993 - 2023.

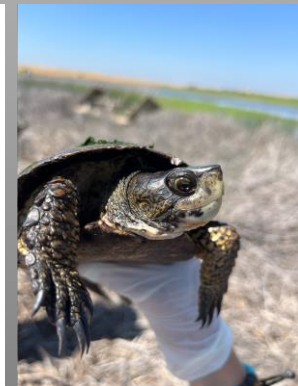
Year	Beale AFB	Travis AFB	MOTCO	Parks RFTA	Fort Hunter Liggett	Camp Roberts	Camp SLO	Edwards AFB	Vandenberg AFB	Point Mugu	MCB Camp Pendleton	NWSSB (Fallbrook)	RTS Warner Springs
1993-2000				4		3	29				770		
2001-2006				2			55						
2007	43						2			3 (3:0)			
2008	29						3			9 (7:2)	50 (30:18)		
2009							5			2 (2:0)			
2010	96 (48:26:22)						2			4 (2:2)	185 (100:67:18)		6 (3:2:0:1)
2011										1 (1:0)			
2012	46 (23:13:7)						2						
2013							4		16	5 (3:2)		54 (30:11:0:13)	
2014	166			1			2			10 (6:4)		17	2
2015	9 (7:2)						2			4 (1:3)			14 (3:6:1:4)
2016	124			8						1 (1:0)			5 (1:1:0:3)
2017	12	9		2						6 (1:4:0:1)			4
2018	67	6		3		2							2 (0:1:1)
2019	4 (2:2)		49	4				11 (7:2:2)					
2020	23 (2:12:2:6)			5				3 (0:0:1:2)		2 (2:0)			1 (1:0)
2021		10	32	6	5			9 (0:0:4:5)					3 (1:0:1:1)
2022			50	4	7 (1:2:0:4)			10 (2:3:0:5)			177 (88:67:22)	9 (2:5:2)	15 (3:6:3:3)
2023				18	25 (12:11:0:2)		3		104 (51:27:19:7)				2
Total	619	25	131	57	37	5	109	33	120	47	1182	80	54
Average	56.27	8.33	43.67	5.18	12.33	2.5	6.81	8.25	60	3.92	295.5	26.67	5.4
Range	4 - 166	6 - 10	32 - 50	1 - 18	5 - 25	2 - 3	1 - 29	3-11	16 - 104	1 - 10	50 - 185	9 - 54	1 - 15

Training Resource Staff on Protocols

- Training During Field Season: Teach staff monitoring techniques
- Topics Covered: Equipment use, data collection methods, measurements
- Customization: Tailor monitoring intensity to installation resources
- Goal: Establish structured protocols adaptable to each base's needs
- Outcome: Enable consistent, long-term monitoring by installation staff



- 50 aquatic traps
 - 24" Legler hoop
 - 18" Promar minnow
- 1-week trapping bouts
- Recorded body size, life stage, sex, reproductive status
- Individual notches



**OBJECTIVE 2 – DETERMINE
DETECTION AT THE 13
MILITARY INSTALLATIONS AND
CREATE A DETECTION
PROBABILITY TOOL**

Determine Detection

- Goal: Establish a detection probability tool for WPT
- Sampling: Conduct trapping sessions across 13 bases to assess WPT presence
- Detection Tool: Use environmental variables to optimize survey efficiency
- Future Application: Tool aids in cost-effective surveys at additional sites

Expected Outcomes - Objective 2

- Detection Tool Efficiency: Reduces logistical and financial survey costs
- Population Clustering: Detects spatial patterns for targeted management
- Scalable Model: Tool can be applied to additional sites for consistent results
- Enhanced Survey Focus: Enables better resource allocation for WPT surveys

Trapping Along Latitudinal Gradient

- Trapping Design: Use baited hoop and minnow traps in varied habitats
- Data Collection: Record GPS, habitat, and turtle metrics
- Survey Season: March-June, covering 4-5 wetlands per installation
- Marking and Measurements: Unique shell notch and standard morphometrics
- Additional Sampling: Disease swabs, blood samples, and photographs



Compile GIS and Weather Data for Covariates

- Landscape Data: Land cover, elevation, and road barriers
- Habitat Data: Vegetation and community data layers
- Weather Data: Temperature and precipitation from local stations
- Microhabitat Data: Canopy cover and substrate
- Goal: Support predictive modeling with comprehensive environmental data

Detection Analysis for Key Detection Factors

- Detection Complexity: Low-density, secretive species are hard to detect
- Optimal Conditions: Analysis helps identify favorable survey conditions
- Methodology: Mixed-effects regression models in R with survey covariates
- Modeling Tools: AICCMoavg to determine best model fit
- Outcome: Tailored conditions for maximizing survey success

Selected Variables for Detection Analyses

- Environmental, temporal, and categorical variables
- For analysis of Western Pond Turtle surveys conducted at 13 Military Installations
- With descriptions and units of measurement
- Variables that contain an asterisk had quadratic (squared) terms included in models.

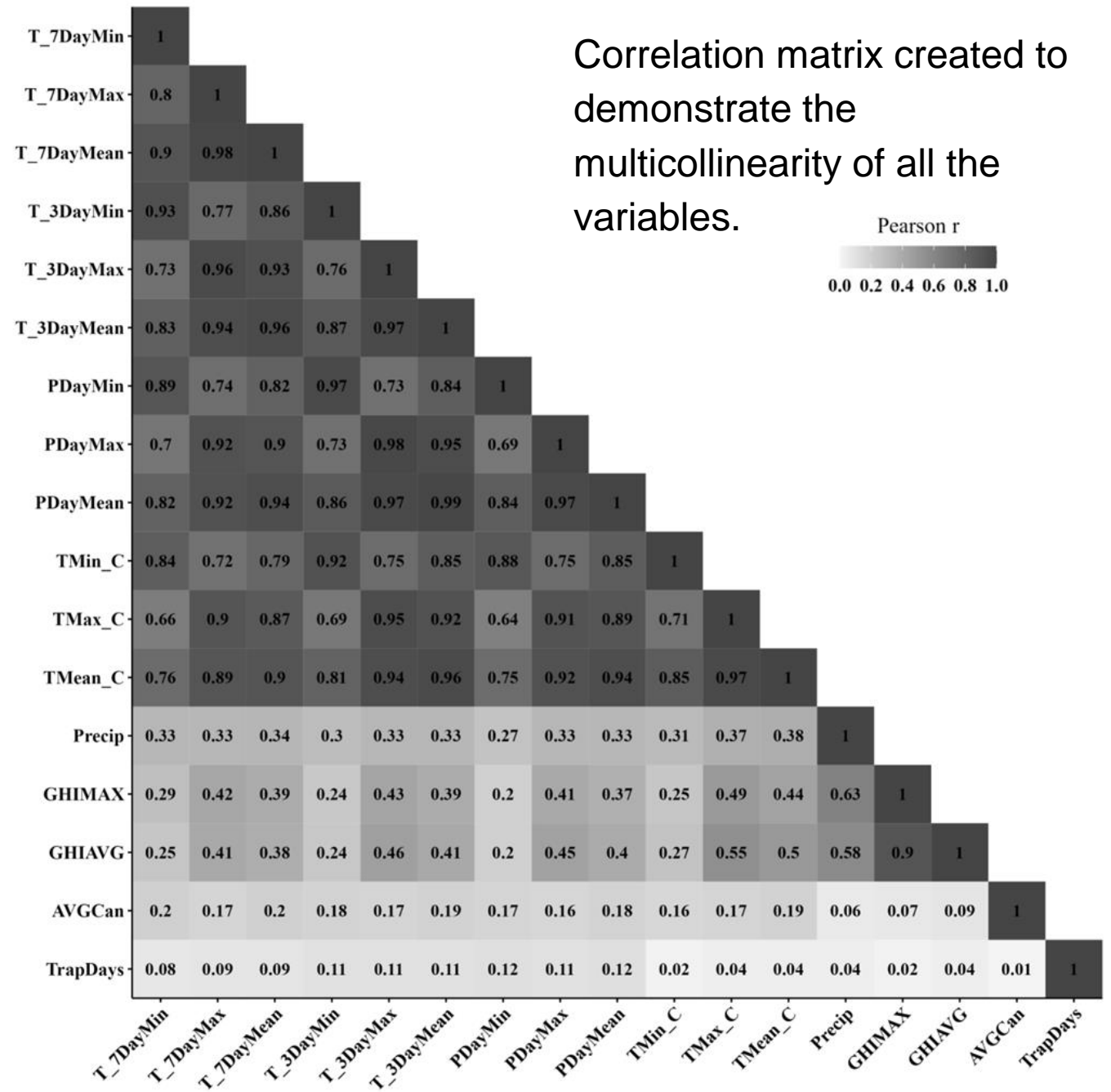
Variable	Description	Unit
D_ACTN	Presence or absence of a Western Pond Turtle in a trap	Binary
TrapDay	Day trap was checked	Count
Site	Military installation	Location
Substrate	Substrate composition where trap was placed	Type
AVGCan*	Average canopy cover	%
GHIMAX*	Daily maximum global horizon irradiance	W/m ²
GHIAVG*	Average global horizon irradiance	W/m ²
TMean_C*	Mean current day temperature	°C
TMax_C*	Maximum current day temperature	°C
TMin_C*	Minimum current daily temperature	°C
PDayMean*	Mean temperature for the previous day	°C
PDayMax*	Maximum temperature for the previous day	°C
PDayMin*	Minimum temperature for the previous day	°C
T_3DayMean*	Average minimum temperature for the previous three days	°C
T_3DayMax*	Average maximum temperature for the previous three days	°C
T_3DayMin*	Average mean temperature for the previous three days	°C
T_7DayMean*	Average mean temperature for the previous seven days	°C
T_7DayMax*	Average maximum temperature for the previous seven days	°C
T_7DayMin*	Average minimum temperature for the previous seven days	°C

Variables	VIF	Tolerance
AVGCan	1.071	0.934
TrapDays	1.306	0.766
PRECIP	1.446	0.692
GHIMAX	6.885	0.145
GHIAVG	7.764	0.129
TMin_C	49.392	0.020
PDayMin	51.210	0.020
T_7DayMin	56.472	0.018
T_3DayMin	165.971	0.006
TMax_C	193.134	0.005
PDayMax	230.575	0.004
TMean_C	353.575	0.003
T_7DayMax	378.934	0.003
PDayMean	446.849	0.002
T_7DayMean	621.553	0.002
T_3DayMax	872.185	0.001
T_3DayMean	1,475.000	0.001



Table of multicollinearity tests of all considered variables: Variance Inflation Factors (VIF) and Tolerance Levels.

Variables	VIF	Tolerance
AVGCan	1.041	0.960
TrapDays	1.067	0.937
GHIAVG	1.190	0.840
T_7DayMin	7.738	0.129
TMin_C	8.038	0.124
PDayMin	17.602	0.057
T_3DayMin	43.923	0.023



Models of Detection Factors

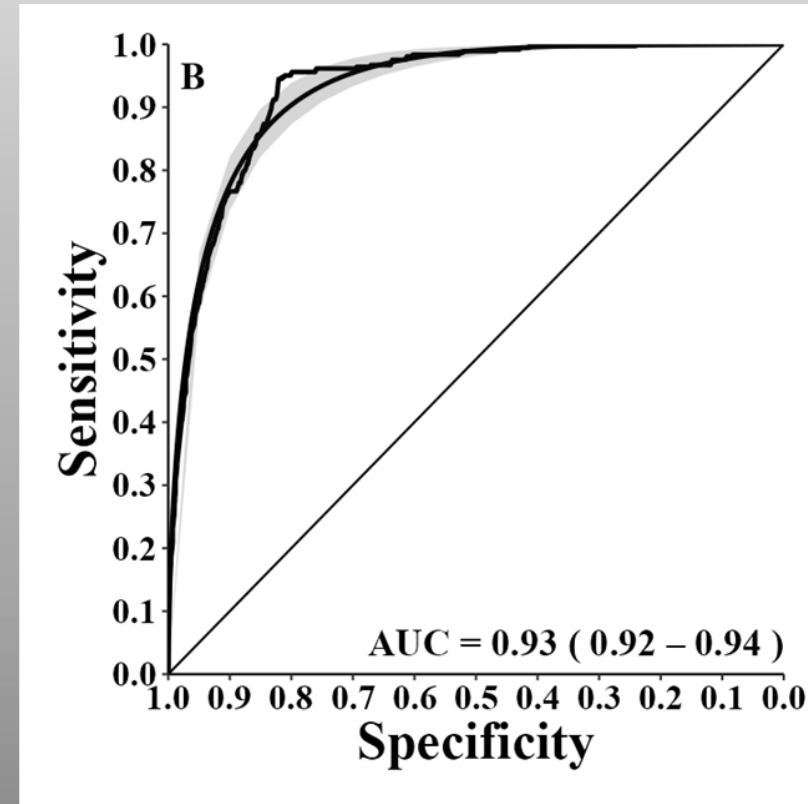
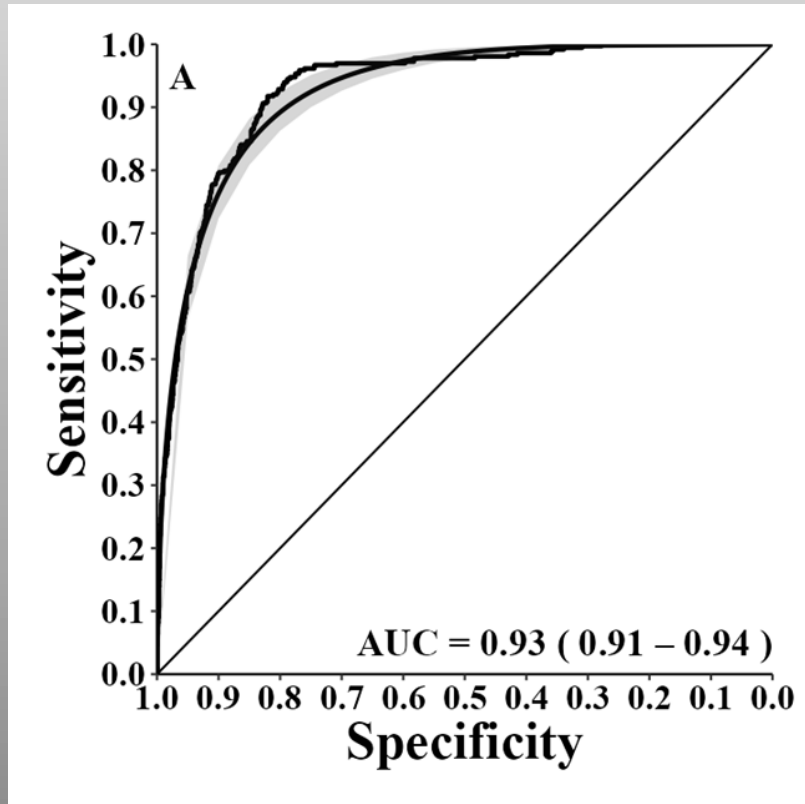
Model	Variables	Description
Global_Min	All Variables	Global additive
Null	Intercept	Intercept only
Trap_Day	TrapDay	Trap day
Trap_Location	Site, Substrate, AVGCan	Trap placement
Site + Trap_Day	Site, TrapDay	Military installation and trap day
Site	Site	Military installation
Site + 7_Day_Min	Site, T_7DayMin	Military installation and average seven day minimum temperature
Site + Prev_Day_Min	Site, PDayMin	Military installation and previous day minimum temperature
Previous 7_Day_Min	T_7DayMin	Average minimum seven day temperature
Day_of_Min	TMin_C	Minimum temperature of the day
Prev_Day_Min	PDayMin	Previous day minimum temperature
Solar	AVGCan, GHIAVG	Average canopy cover and average global horizontal irradiance
Site + Day_of_Min	Site, TMin_C	Military installation and minimum temperature of the day
Trap_Cover	AVGCan	Average canopy cover
Substrate	Substrate	Substrate type

Model Comparison: Akaike information criterion (AIC) results for the 15 binary mixed-effect logistic regressions for detection probability models. Data were collected from 3,675 trap events on the Western Pond Turtle across 13 Military installations in California.

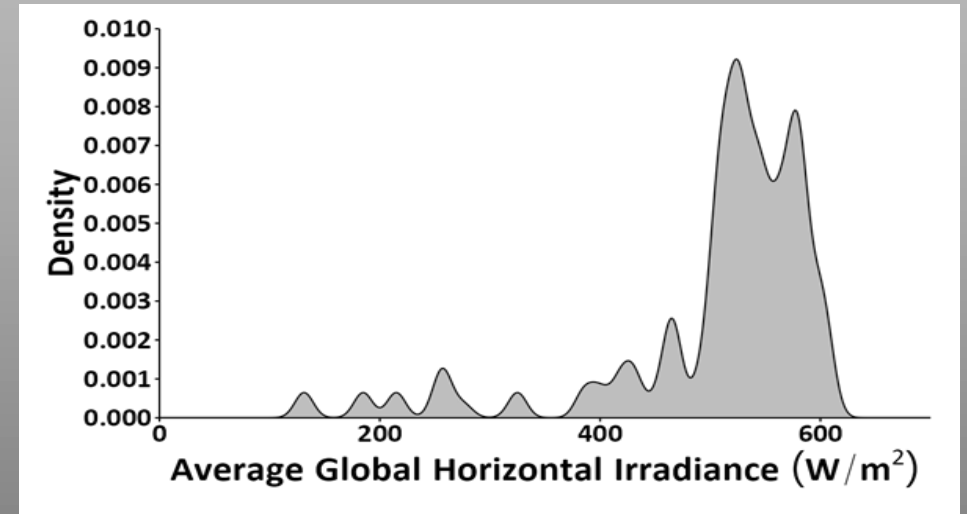
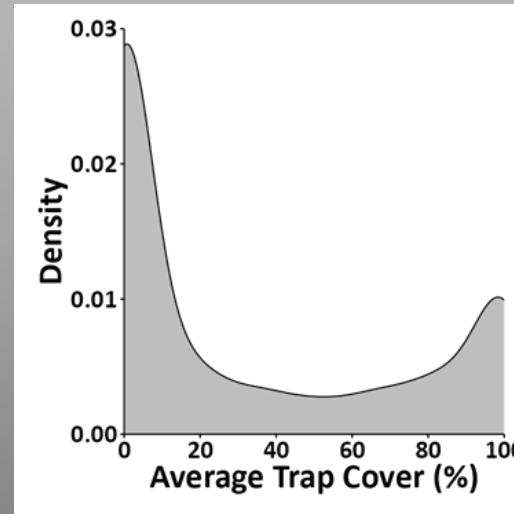
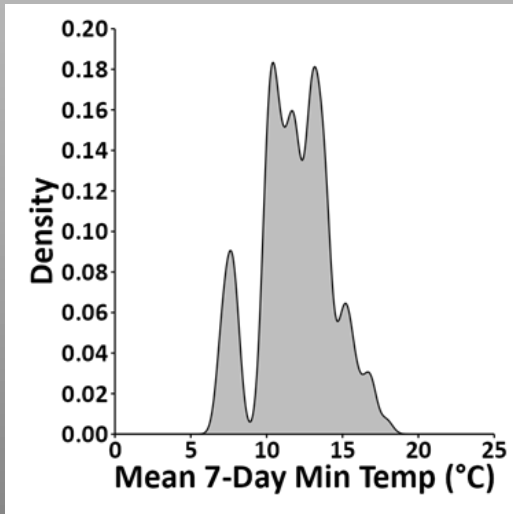
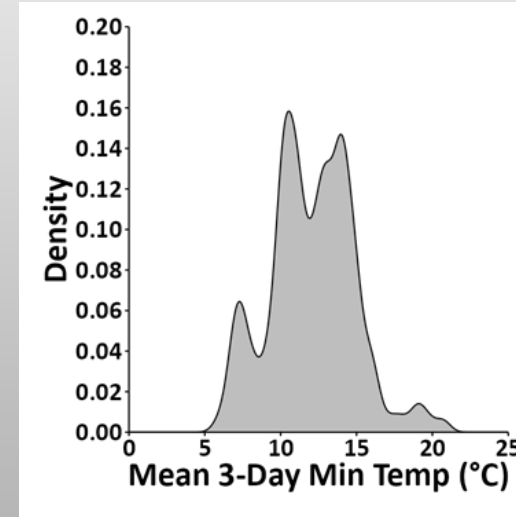
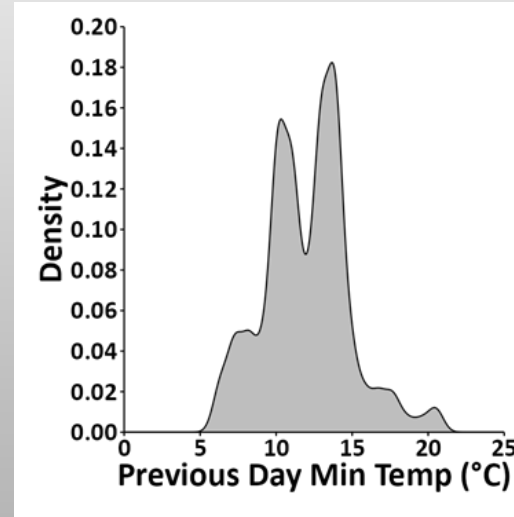
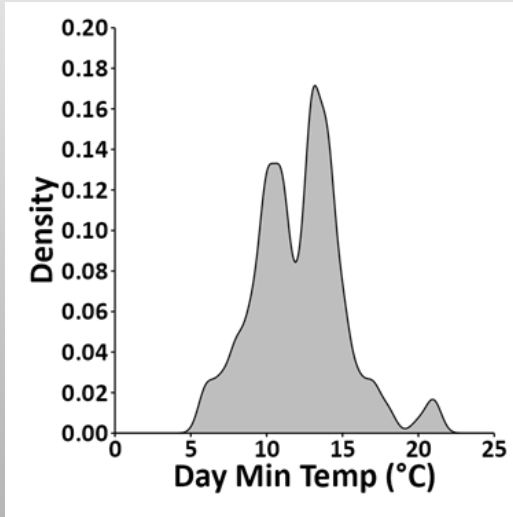
Rank	Modnames	K	LL	AICc	Δ AICc	wi	\sum wi	r ² m	r ² c
1	Global_Min	33	-984.69	2,035.99	0.00	0.88	0.88	0.29	0.53
2	Trap_Location	22	-998.17	2,040.62	4.63	0.09	0.97	0.26	0.52
3	Site + Trap_Day	15	-1,006.36	2,042.86	6.87	0.03	1.00	0.23	0.54
4	Site	14	-1,013.29	2,054.69	18.70	0.00	1.00	0.23	0.53
5	Site + 7_Day_Min	16	-1,012.17	2,056.50	20.51	0.00	1.00	0.23	0.53
6	Day_of_Min + Site	16	-1,012.88	2,057.92	21.93	0.00	1.00	0.23	0.53
7	Site + Prev_Day_Min	16	-1,013.05	2,058.25	22.26	0.00	1.00	0.23	0.53
8	Previous 7_Day_Min	4	-1,082.52	2,173.06	137.07	0.00	1.00	0.08	0.59
9	Prev_Day_Min	4	-1,090.28	2,188.57	152.58	0.00	1.00	0.04	0.59
10	Day_of_Min	4	-1,093.77	2,195.55	159.56	0.00	1.00	0.03	0.60
11	Trap_Day	3	-1,095.87	2,197.74	161.75	0.00	1.00	0.01	0.71
12	Solar	6	-1,094.92	2,201.86	165.87	0.00	1.00	0.02	0.64
13	Trap_Cover	4	-1,097.96	2,203.93	167.94	0.00	1.00	0.01	0.65
14	Substrate	8	-1,097.40	2,210.83	174.84	0.00	1.00	0.02	0.63
15	Null	2	-1,103.65	2,211.30	175.32	0.00	1.00	0.00	0.68

Response operator curves (ROC): Global_Min and Trap Location detection model(s) for Western Pond Turtle across 13 Military Installations in California.

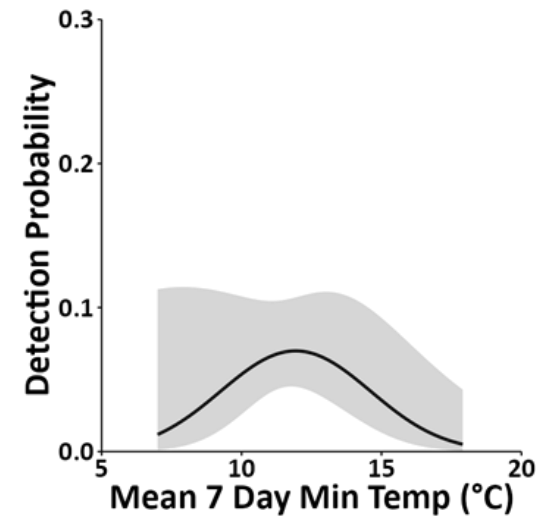
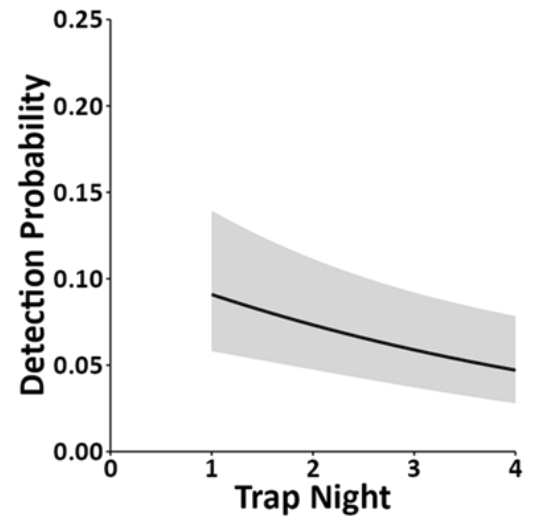
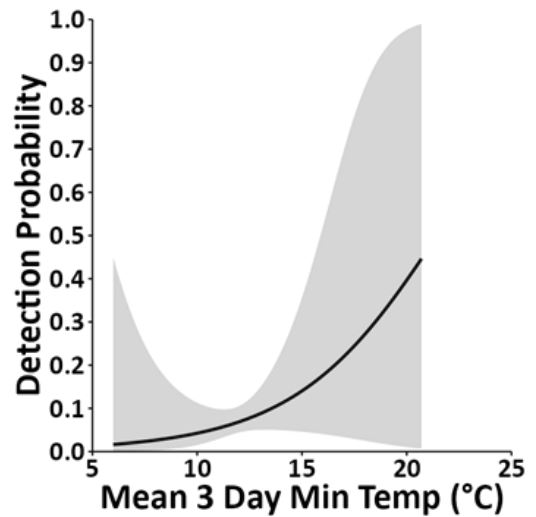
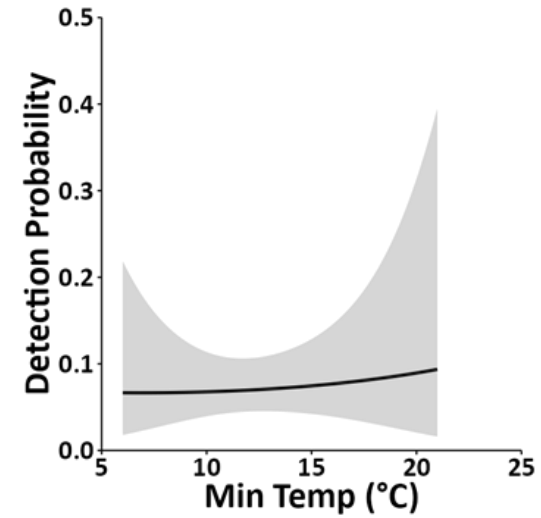
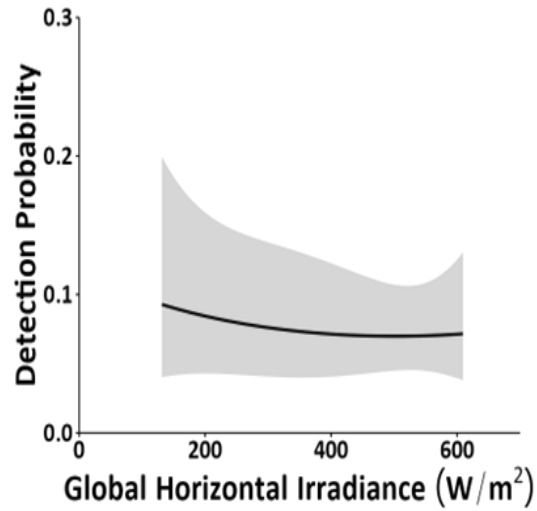
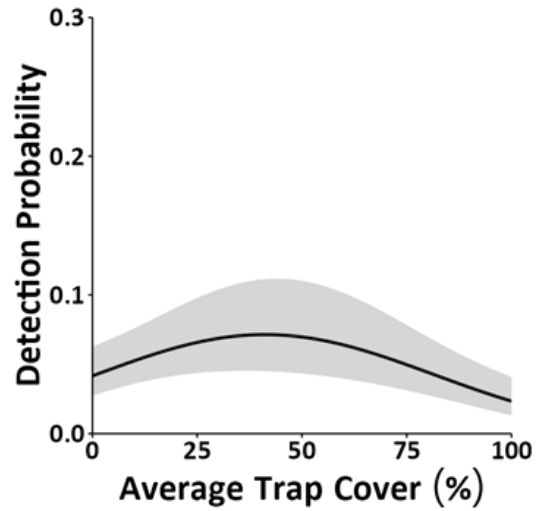
A = the Global_Min model (left), **B** = the Trap Location model (right).



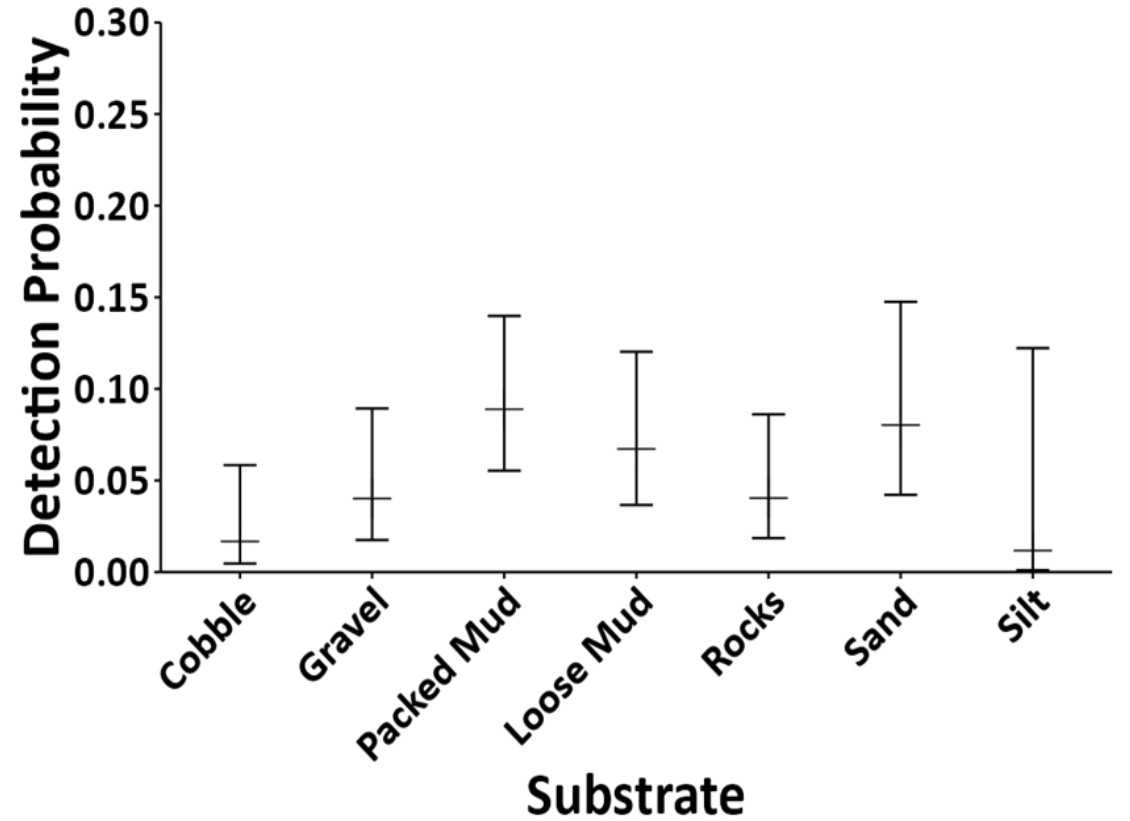
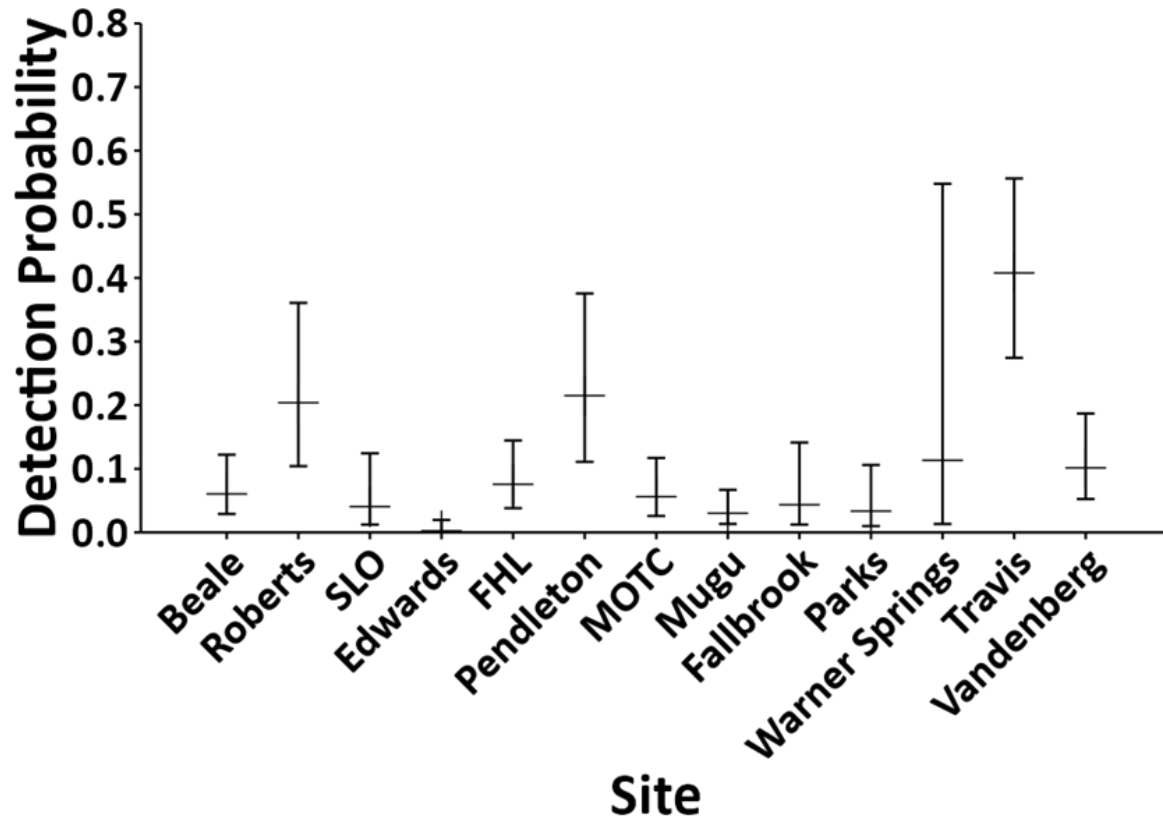
Density Plots



Detection Probability: the effects of environmental, temporal, and categorical co-variates on the detection probability of Western Pond Turtles from 3,675 trap events across 13 Military Installations in California.



Categorical Variables



OBJECTIVE 3 – DETERMINE
ABUNDANCE, POPULATION
STRUCTURE, AND DEMOGRAPHY,
TO THE BEST EXTENT POSSIBLE, AT
13 MILITARY INSTALLATIONS

Objective 3 – Abundance & Demographic Structure

- Goal: Assess WPT and RES abundance and population demographics at 13 bases
- Data Collection: Record size, stage, and sex for demographic structure analysis
- Analysis Methods: CPUE, N-Mixture, and Capture/Mark/Recapture as data allows
- Staff Training: Installation staff to conduct extended surveys for richer data
- Demographic Insights: Skewed ratios or missing age groups signal threats

Expected Outcomes - Objective 3

- Population Robustness: Early indicators of population health and viability
- Demographic Red Flags: Detect issues like adult mortality or recruitment gaps
- Population Vulnerability: Initial estimates on population stability and risks
- Foundation for Monitoring: Basis for ongoing, data-driven conservation planning
- Management Guidance: Demographic insights shape targeted conservation actions

2023

- 50 aquatic traps
- 24" Legler hoop
- 18" Promar minnow
- 1-week trapping bouts
- Recorded body size, life stage, sex, reproductive status
- Individual notches



2024



- 25 aquatic traps
- Two trapping periods per week
- Mon-Wed, Wed-Fri
- Body size (+ annuli), life stage, sex, reproductive status
- Notches

Estimating Abundance

- Tiered Analysis: CPUE for low captures, N-Mixture for counts, CMR for recaptures
- Data Flexibility: Adapt methods based on capture rates and data richness
- CMR Limitations: Best for long-term monitoring with high recaptures
- Alternative Models: Presence or unmarked in R for flexible modeling
- Goal: Reliable abundance estimates based on available data

Capture Summary of 2023 and 2024 field season

Site	Traps	Hours	Species				Total	CPUE	WPT CPUE
			CHPI	GROU	TRSC	WPT			
Beale AFB	100	7,021.5	0	0	54	31	85	0.0121	0.0044
Camp Roberts	100	6,952.9	0	0	0	76	76	0.0109	0.0109
Camp San Luis Obispo	50	4,817.3	0	0	0	5	5	0.0010	0.0010
Edwards AFB	50	4,832.9	0	0	0	1	1	0.0002	0.0002
Fort Hunter Liggett	200	14,143.5	0	0	0	94	94	0.0066	0.0066
MCB Camp Pendleton	50	4,749.1	0	0	0	85	85	0.0179	0.0179
Military Ocean Terminal Concord	100	7,097.6	0	0	0	29	29	0.0041	0.0041
NAVBASE Point Mugu	100	6,843.6	0	0	0	14	14	0.0020	0.0020
NWS Seal Beach (Fallbrook)	150	11,890.3	0	0	0	10	10	0.0008	0.0008
Parks RFTA	50	2,353.3	0	0	0	5	5	0.0021	0.0021
RTS Warner Springs	25	1,784.4	0	0	0	3	3	0.0017	0.0017
Travis AFB	100	7,054.0	1	1	49	166	217	0.0308	0.0235
Vandenberg SFB	100	6,907.1	0	0	0	48	48	0.0069	0.0069
Total	1,175	86,447.7	1	1	103	567	672	0.0078	0.0066



Results

2023: 261

2024: 162

-Initial 119

-Recaps 43

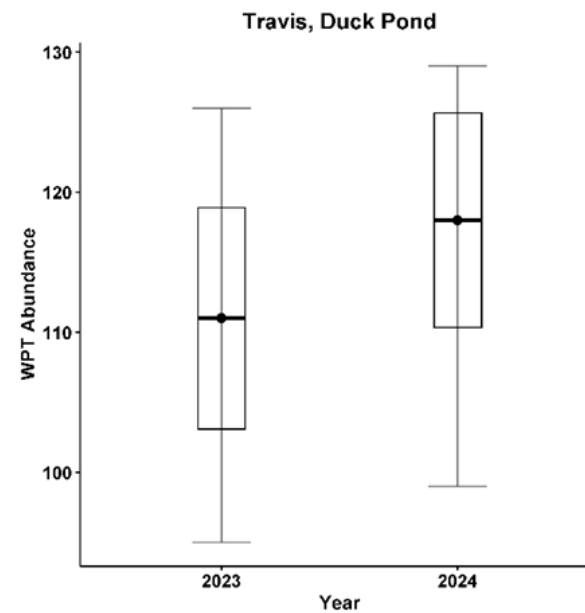
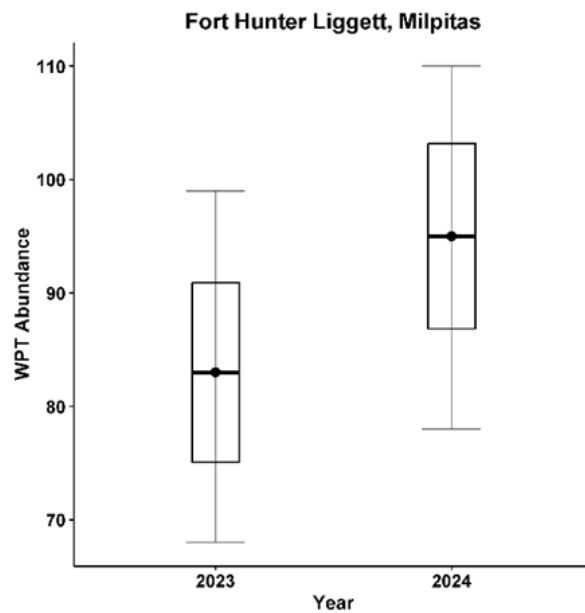
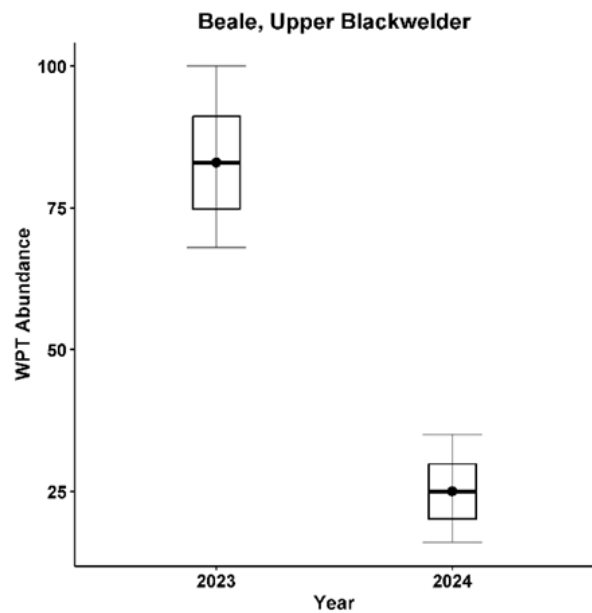
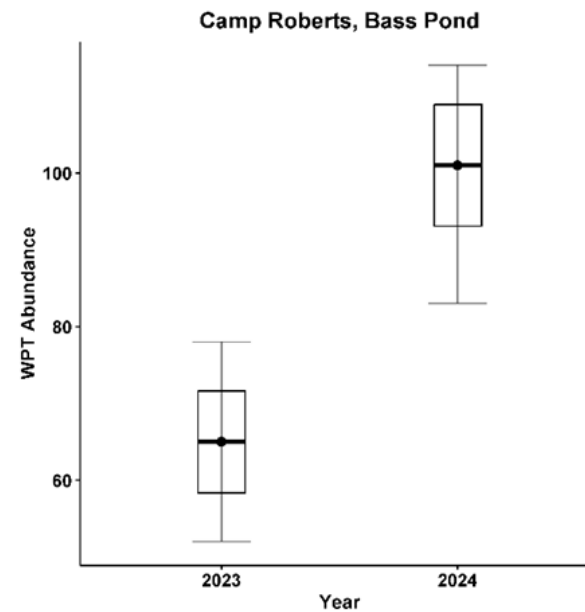
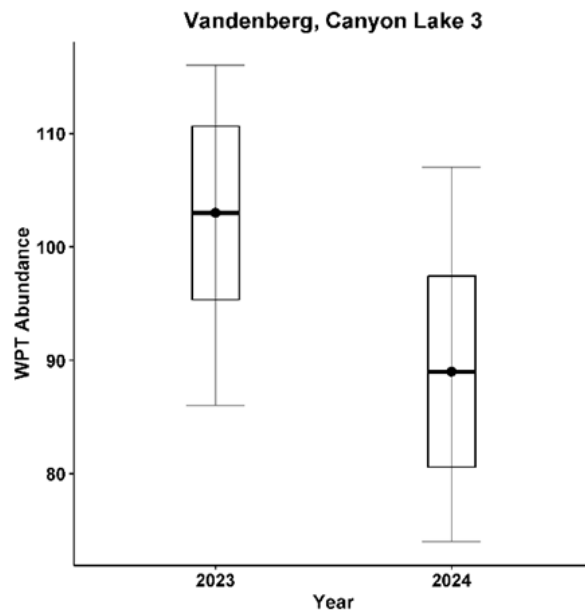
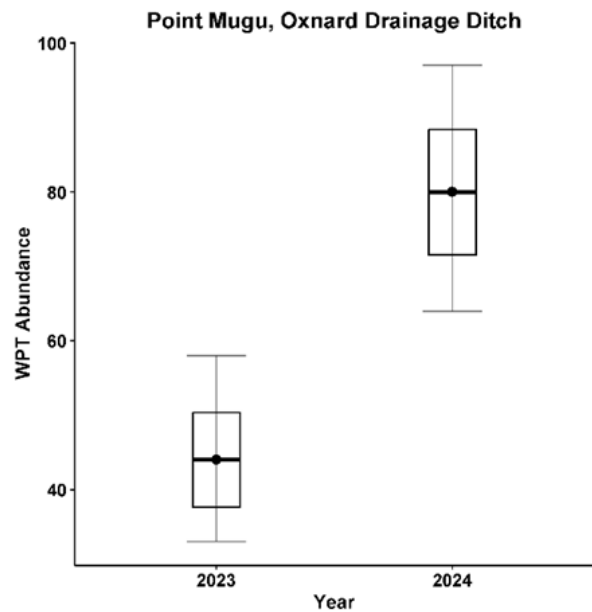
Total: 423

	2023	2024	Total
Fallbrook	9	0	9
Pendleton	45	X	45
Point Mugu	5	6	11
Edwards	1	X	1
Warner Springs	X	3	3
Vandenberg	26	19	45
SLO	4	X	4
Camp Roberts	34	19	53
Fort Hunter Liggett	43	20	63
Camp Parks	X	6	6
MOTCO	17	11	28
Travis	57	32	89
Beale	20	3	23



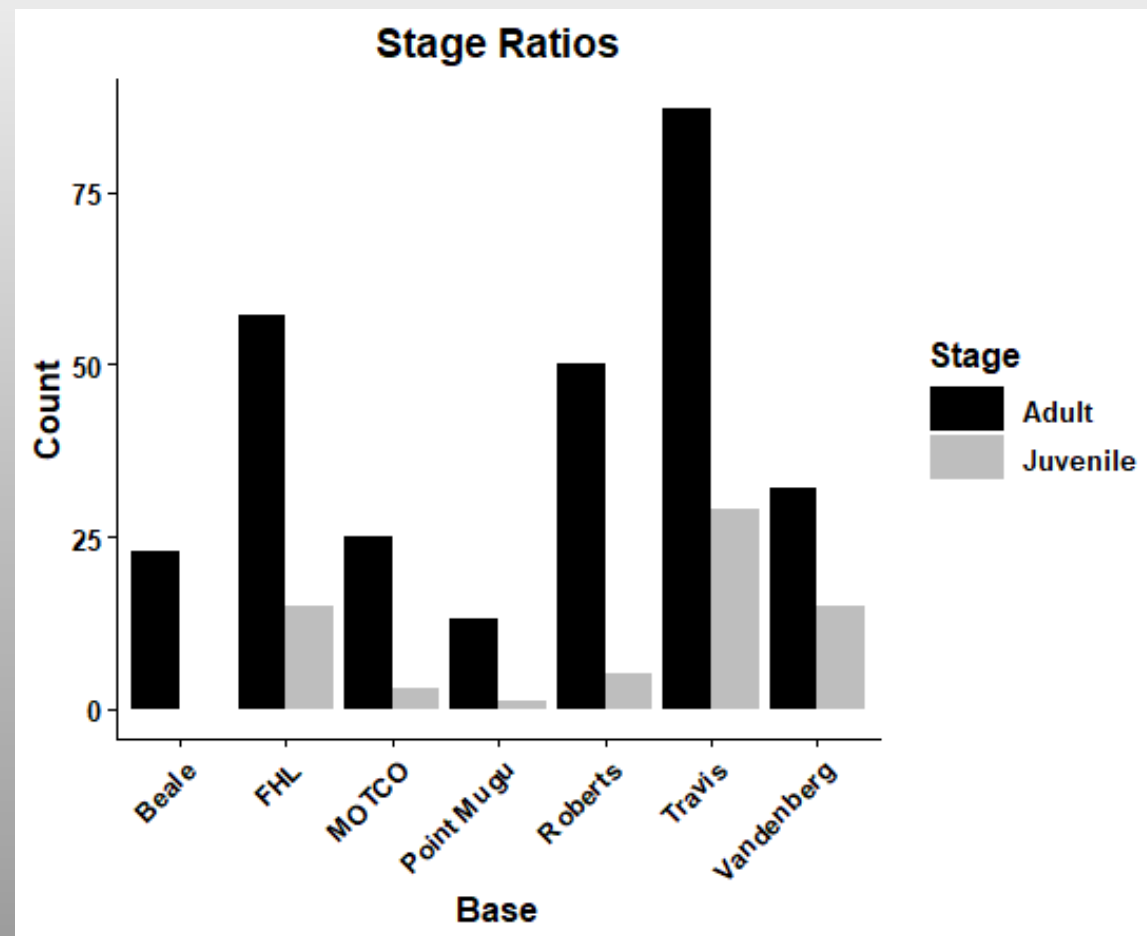
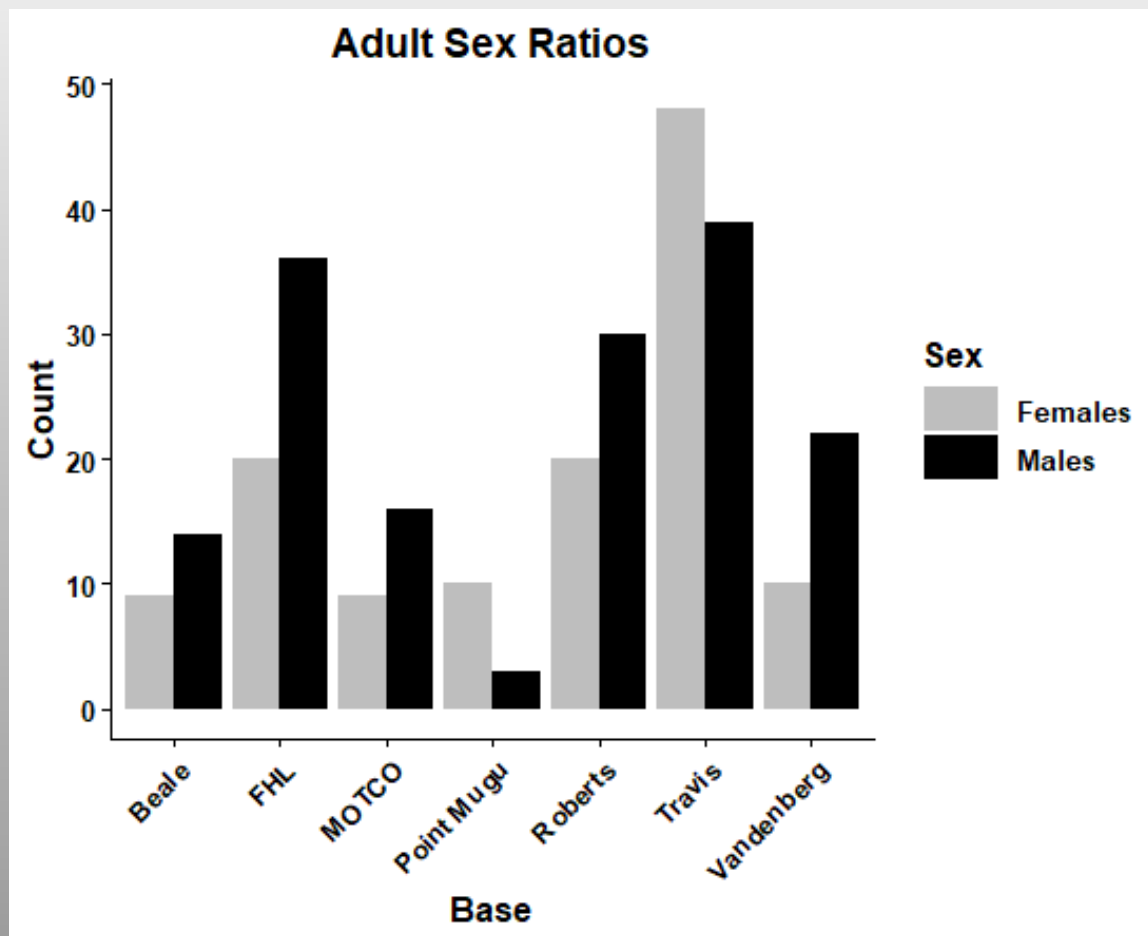
Base	Waterbody	Year	Est.	SE	Lower	Upper
Point Mugu	Oxnard Drainage	2023	44	6.4	33	58
		2024	80	8.4	64	97
Vandenberg SFB	Canyon Lake 3	2023	103	7.7	86	116
		2024	89	8.4	74	107
Camp Roberts	Bass Pond	2023	65	6.6	52	78
		2024	101	7.9	83	114
	Nacimiento River	2023	3	0.5	3	5
		2024	4	0.8	3	6
Fort Hunter Liggett	Lower Stoney	2023	2	0	2	2
	Reservoir	2024	1	0	1	1
	Lower Stoney Ponds	2023	35	5.1	26	46
		2024	88	8.4	72	105
	Milpitas	2023	83	7.9	68	99
		2024	95	8.2	78	110
Travis AFB	Duck Pond	2023	111	7.9	95	126
		2024	118	7.7	99	129
	North Gate	2023	42	5.8	31	54
		2024	89	8.4	72	105
Beale AFB	Upper Blackwelder	2023	83	8.2	68	100
		2024	25	4.8	16	35
MOTCO	Railroad Wetland	2023	86	8.2	70	102
		2024	75	8.2	60	92

Estimated Abundance



Population Structure: Sex and Stage

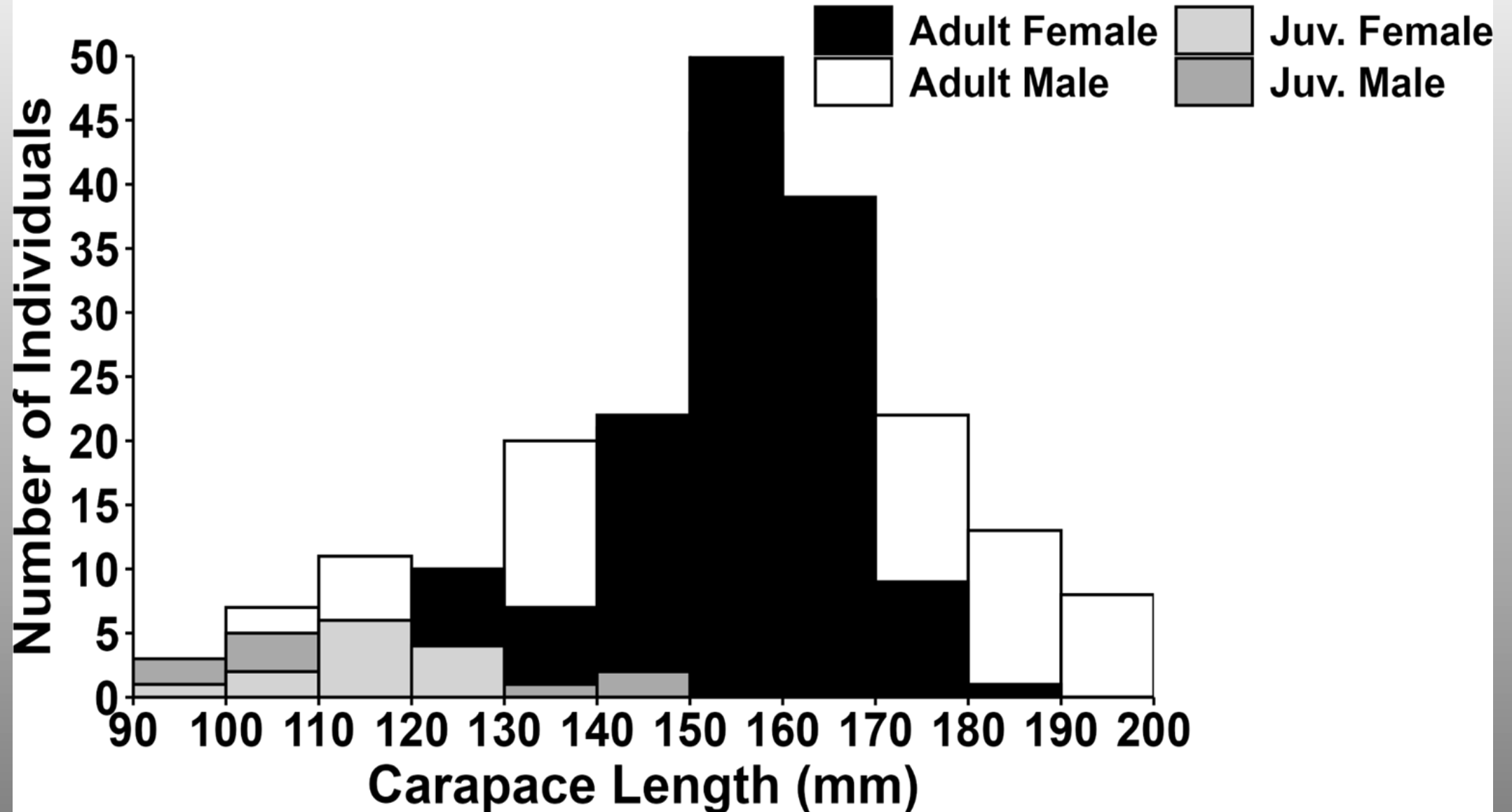
- Sex Ratios: Calculate adult and total sample ratios
- Stage Ratios: Mature vs. immature sizes
- Size Frequency Distribution: Bin morphometric data to analyze the size structure across demographics
- Allometric Growth Rates: Plot the relationship between different morphometric measurements
- Reproduction: Deduce reproductive success and age of sexual maturity
- Goal: Identify growth patterns and demographic structure



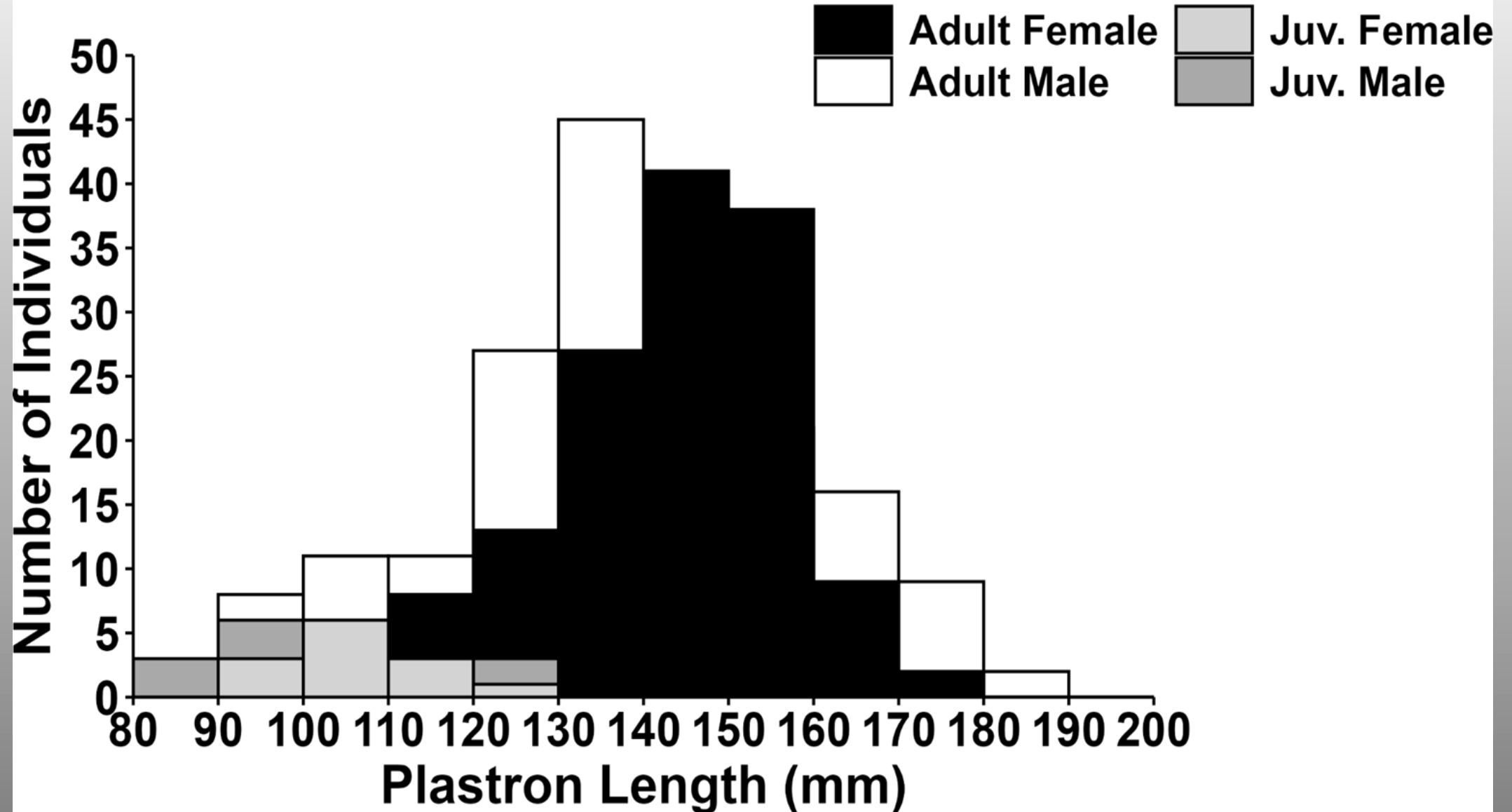
Base	<u>Overall Sex Ratios</u>			<u>Adult Sex Ratios</u>			<u>Stage Ratios</u>		
	Males	Females	p value	Males	Females	p value	Adults	Juveniles	p value
2023	131	92	0.010775	117	83	0.019397	202	59	1.71E-19
2024	67	65	0.930684	66	61	0.722787	127	35	1.85E-13
Overall	178	136	0.020534	163	125	0.029063	290	90	1.23E-25

Base	<u>Overall Sex Ratios</u>			<u>Adult Sex Ratios</u>			<u>Stage Ratios</u>		
	Males	Females	p.value	Males	Females	p.value	Adult	Juvenile	p.value
Travis	39	49	0.337399	39	48	0.391191	87	29	6.47E-08
Roberts	33	21	0.133674	30	20	0.202639	50	5	2.14E-10
Vandenberg	24	11	0.04096	22	10	0.050102	32	15	0.018624
FHL	38	24	0.097954	36	20	0.044047	57	15	6.54E-07
Beale	14	9	0.404873	14	9	0.404873	23	0	2.38E-07
MOTCO	16	9	0.229523	16	9	0.229523	25	3	2.74E-05
Point Mugu	3	10	0.092285	3	10	0.092285	13	1	0.001831

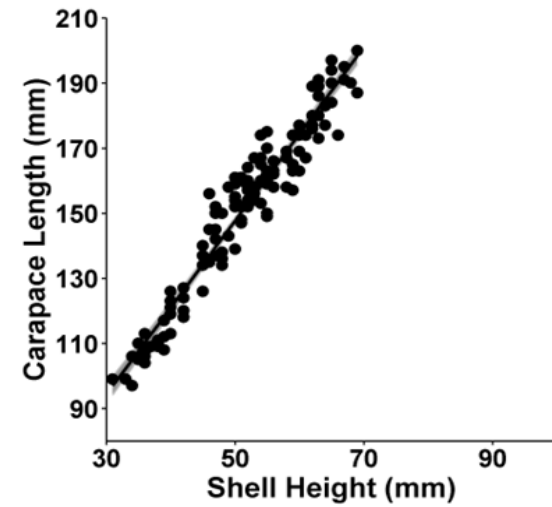
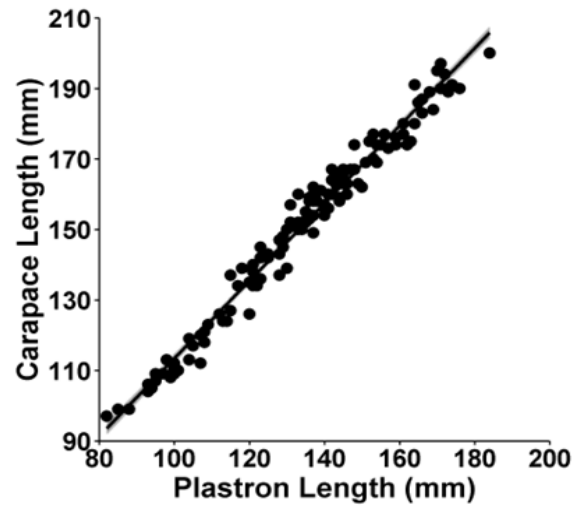
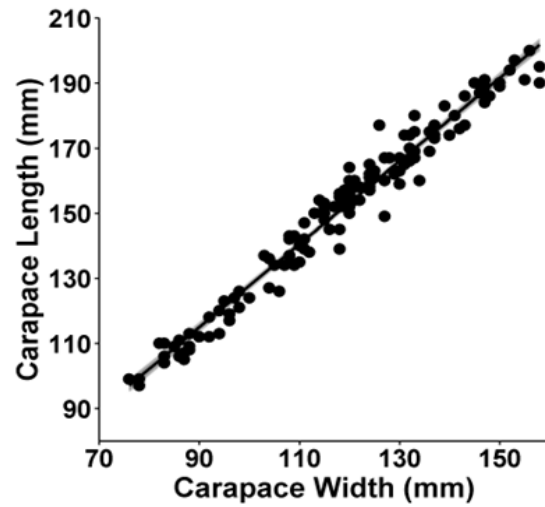
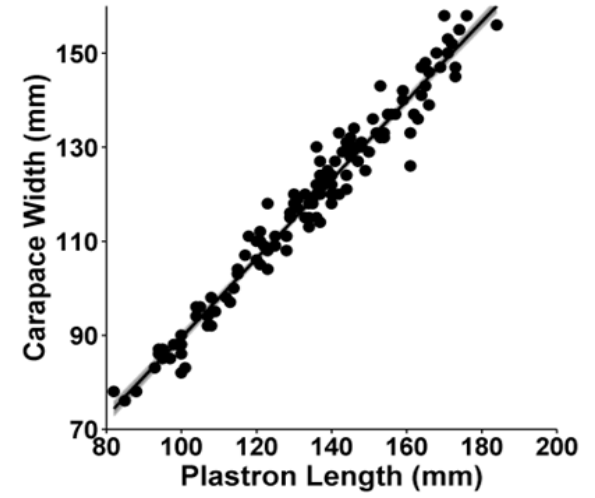
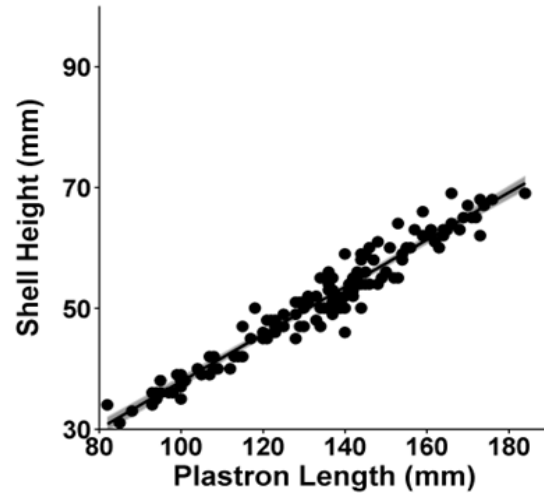
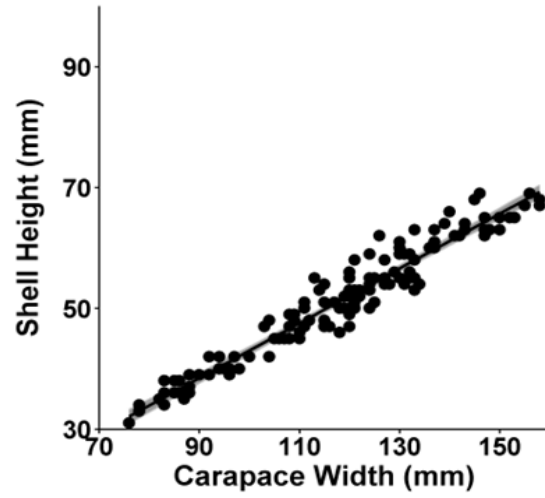
Size Frequency Plot: Carapace



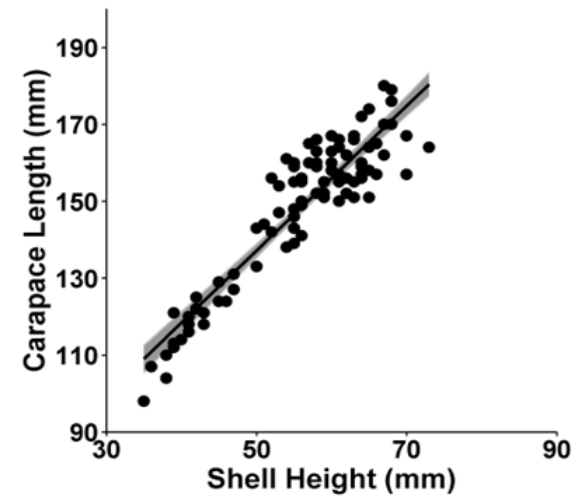
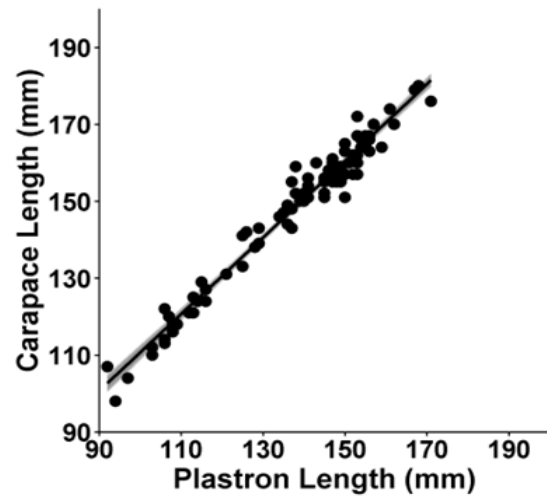
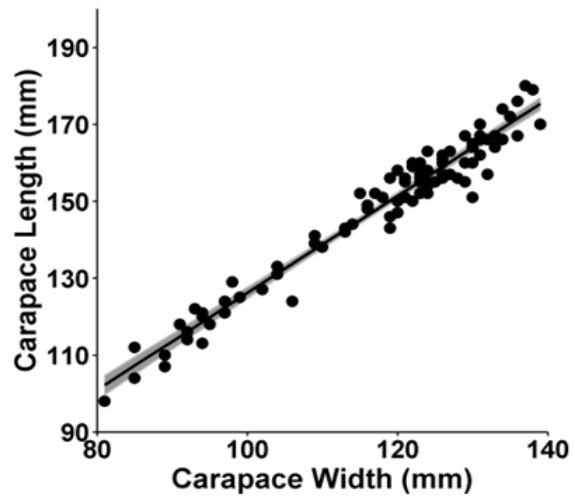
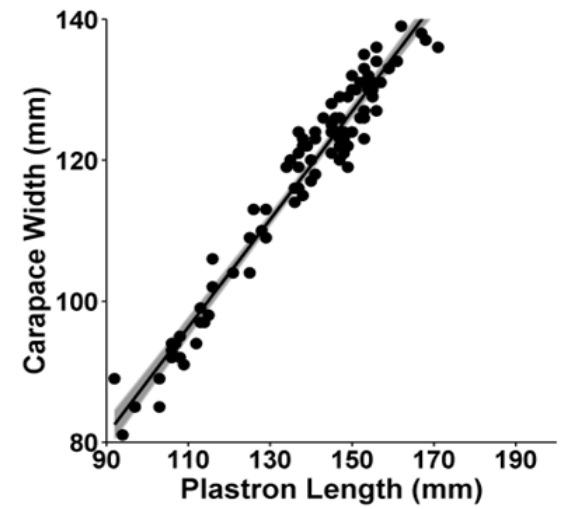
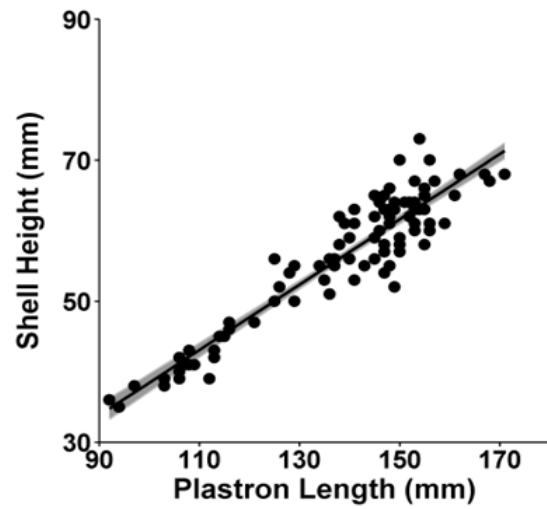
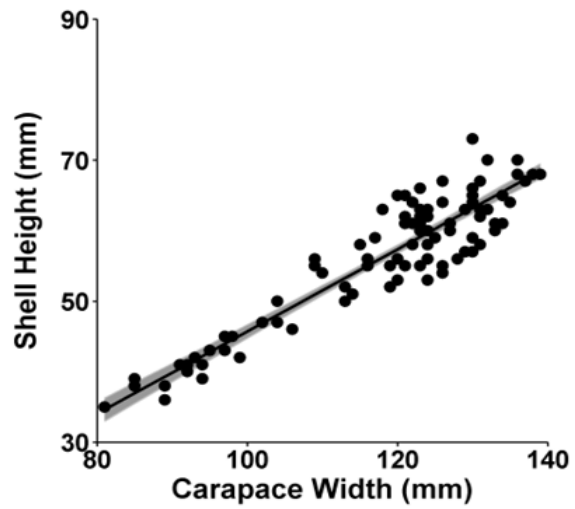
Size Frequency Plot: Plastron



Male Allometric Growth Rates



Female Allometric Growth Rates



Reproduction

- Mating and Nesting season
- Recruitment
- Palpated for eggs

Overall: 32%

April	Pendleton	0%
May	Point Mugu	85%
	Vandenberg	25%
	Camp Roberts	20%
June	MOTCO	40%
	Travis	38%
	Beale	0%
July	Fort Hunter Liggett	0%



**OBJECTIVE 4 – DISEASE
SURVEILLANCE AND
MONITORING**

Emydomyces

- Fungal Characteristics
 - Onygenalean fungi
 - Keratinophilic
- Epidemiology
 - Large host diversity
 - Many unknowns
 - Low wild prevalence in Illinois
 - High headstart prevalence



Emydomyces

- Fungal Characteristics
 - Onygenalean fungi
 - Keratinophilic
- Epidemiology
 - Large host diversity
 - Many unknowns
 - Low wild prevalence in Illinois
 - High headstart prevalence
- Conservation Concern
 - Do not release positive individuals



Emydid turtle Pathogens — Comparison Chart

TREATMENTS	EASTERN BOX	BLANDING'S	SPOTTED	WOOD	BOG
RANAVIRUS	HIGHLY SUSCEPTIBLE	UNKNOWN SUSCEPTIBILITY	UNKNOWN SUSCEPTIBILITY	UNKNOWN SUSCEPTIBILITY	UNKNOWN SUSCEPTIBILITY
HOST ADAPTED HERPES	TERRAPENE HERPESVIRUS 1	EMYDOIDEA HERPESVIRUS 1	EMYDID HERPESVIRUS	GLYPTEMYS HERPESVIRUS 2	GLYPTEMYS HERPESVIRUS 1
CANCER-CAUSING HERPES	TERRAPENE HERPESVIRUS 2	EMYDOIDEA HERPESVIRUS 2	UNKNOWN	UNKNOWN	UNKNOWN
OTHER HERPESVIRUS	TERRAPENE HERPESVIRUS 3	EMYDID HERPESVIRUS 1	EMYDID HERPESVIRUS 2	UNKNOWN	EMYDID HERPESVIRUS 2
HOST ADAPTED ADENOVIRUS	BOX TURTLE ADENOVIRUS	EMYDOIDEA ADENOVIRUS 1	UNKNOWN	UNKNOWN	UNKNOWN
OTHER ADENOVIRUSES	NOT DETECTED	SULAWESI ADENOVIRUS	UNKNOWN	UNKNOWN	UNKNOWN
MULTI-SPECIES ADENOVIRUS	BOX TURTLE ADENOVIRUS	BOX TURTLE ADENOVIRUS	UNKNOWN	UNKNOWN	UNKNOWN
MYCOPLASMA	EMYDID	EMYDID	EMYDID	UNKNOWN	UNKNOWN
EMYDOMYCES	LOW PREVALENCE	HIGH IMPACT	LIKELY SUSCEPTIBLE	LIKELY SUSCEPTIBLE	LIKELY SUSCEPTIBLE

Turtle Pathogens

HIGH THREAT

HOST
ADAPTED

UNKNOWN
SIGNIFICANCE

CANCER-
ASSOCIATED

ZOONOTIC



Materials and Methods – Pathogens and Health

- 2023
 - Combined oral-cloacal-shell swabs of all WPT
 - Emydomyces qPCR
- 2024
 - Combined oral-cloacal-shell swabs of all WPT and sliders
 - Emydomyces qPCR for all WPT
 - Multi-pathogen surveillance for all WPT and subset of sliders

Results – Pathogens and Health

- 2023
 - All WPT negative for Emydomyces (n=0/259; 95% CI: 0-1.4%)
- 2024
 - All WPT negative for Emydomyces (n=0/134; 95% CI: 2.7%)
 - Multi-pathogen surveillance: pending

Conclusion and Future Directions

- Long-Term Monitoring: Establish a lasting framework for WPT and RES
- Strategic Partnerships: Collaborate with DoD for conservation impact
- Database Maintenance: Share and update data with partners like Smithsonian
- Adaptive Management: Adjust strategies based on research outcomes
- Commitment to Conservation: Aim for sustained WPT and RES protection

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Thank you!

Questions?



Distinguishing Sex

- Chin
- Snout
- Ridges
- Tail length & girth
- Cloaca placement
- Plastron

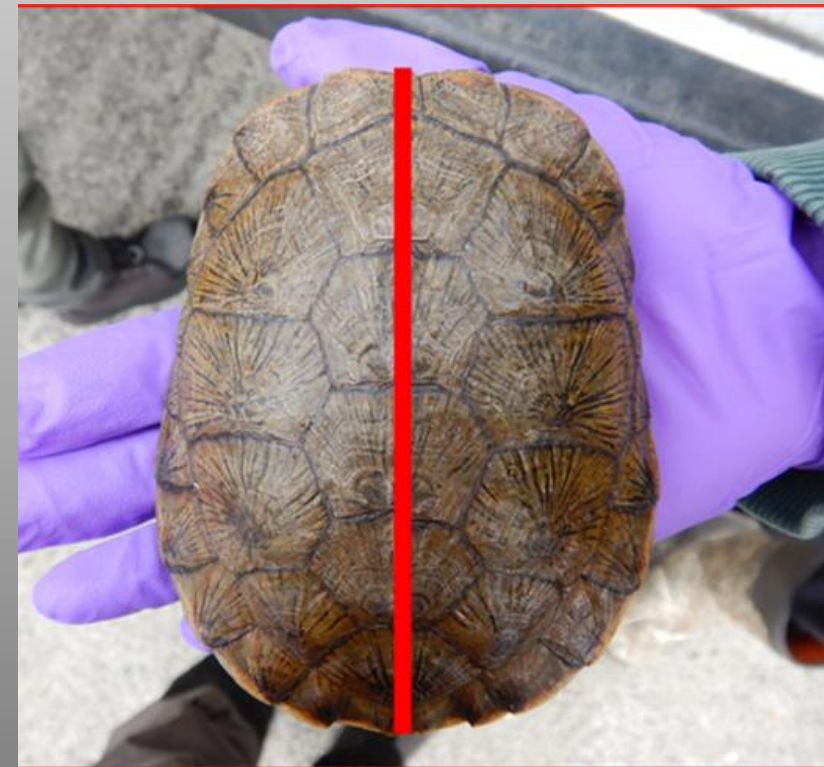
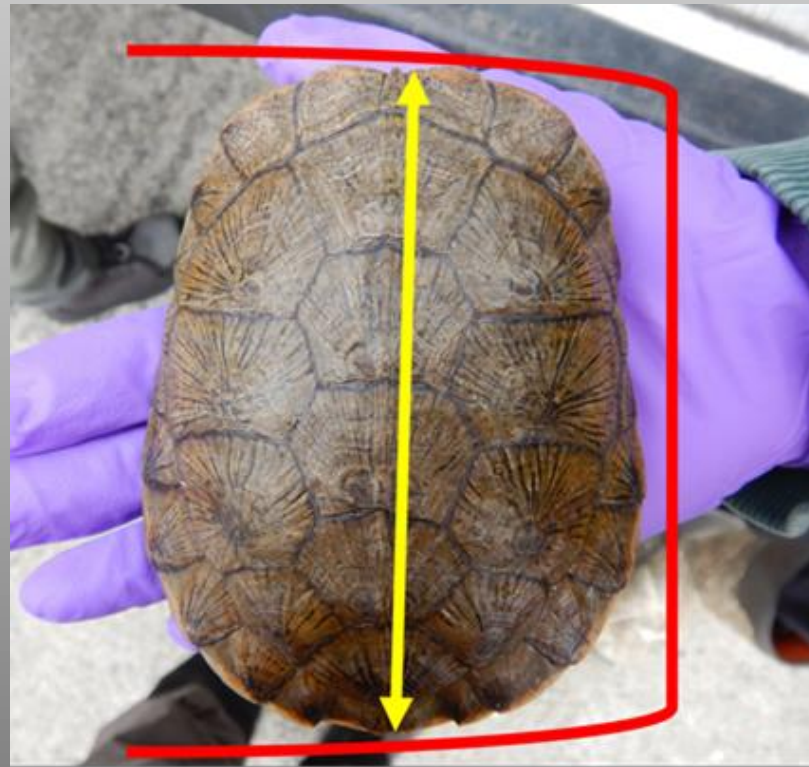


Distinguishing stage

- 2ndary sex characters
- 110 mm shell length



Morphometrics



Morphometrics

