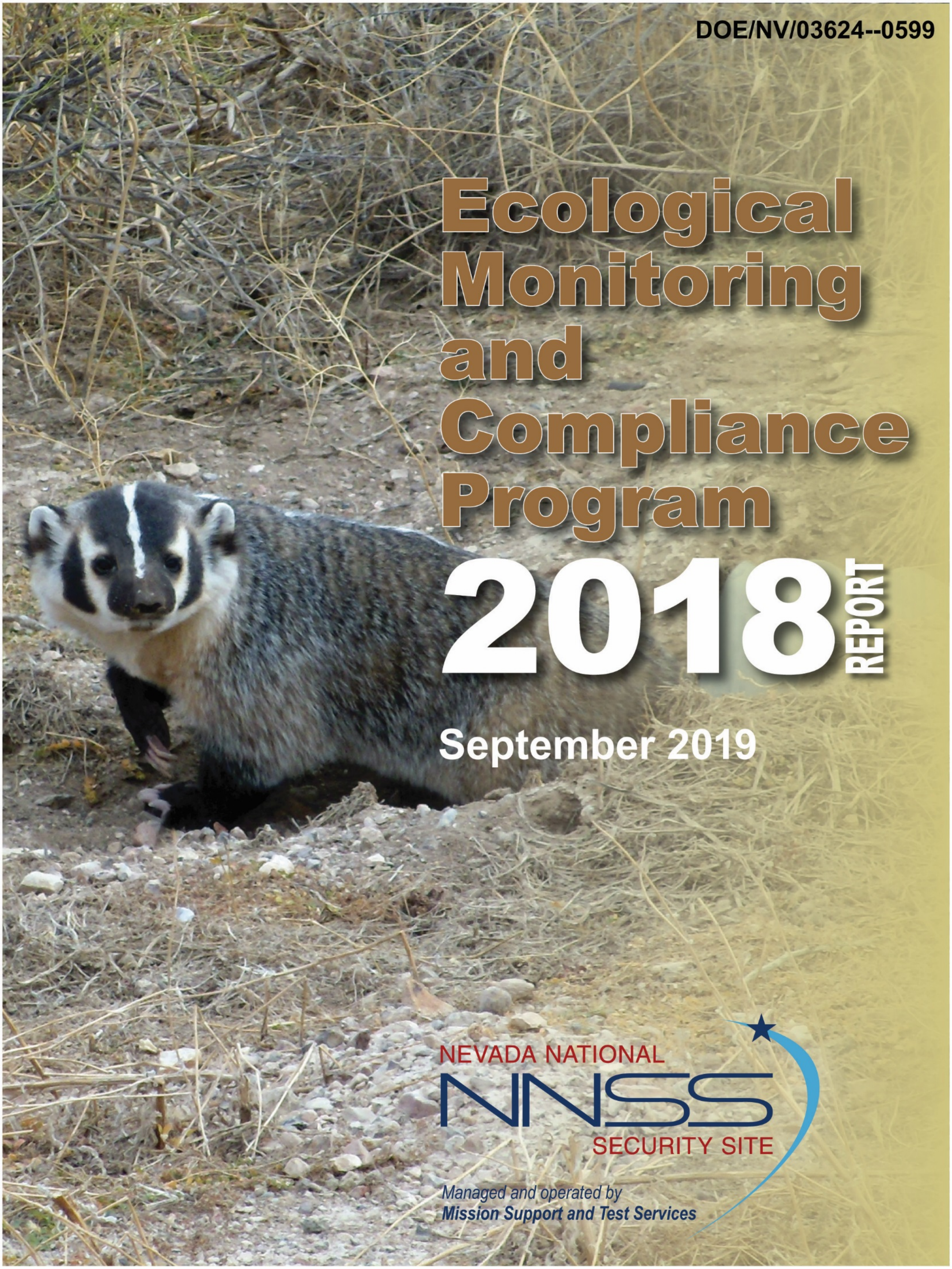

DOE/NV/03624--0599

Ecological Monitoring and Compliance Program

2018 REPORT

September 2019

NEVADA NATIONAL SECURITY SITE

NNSS

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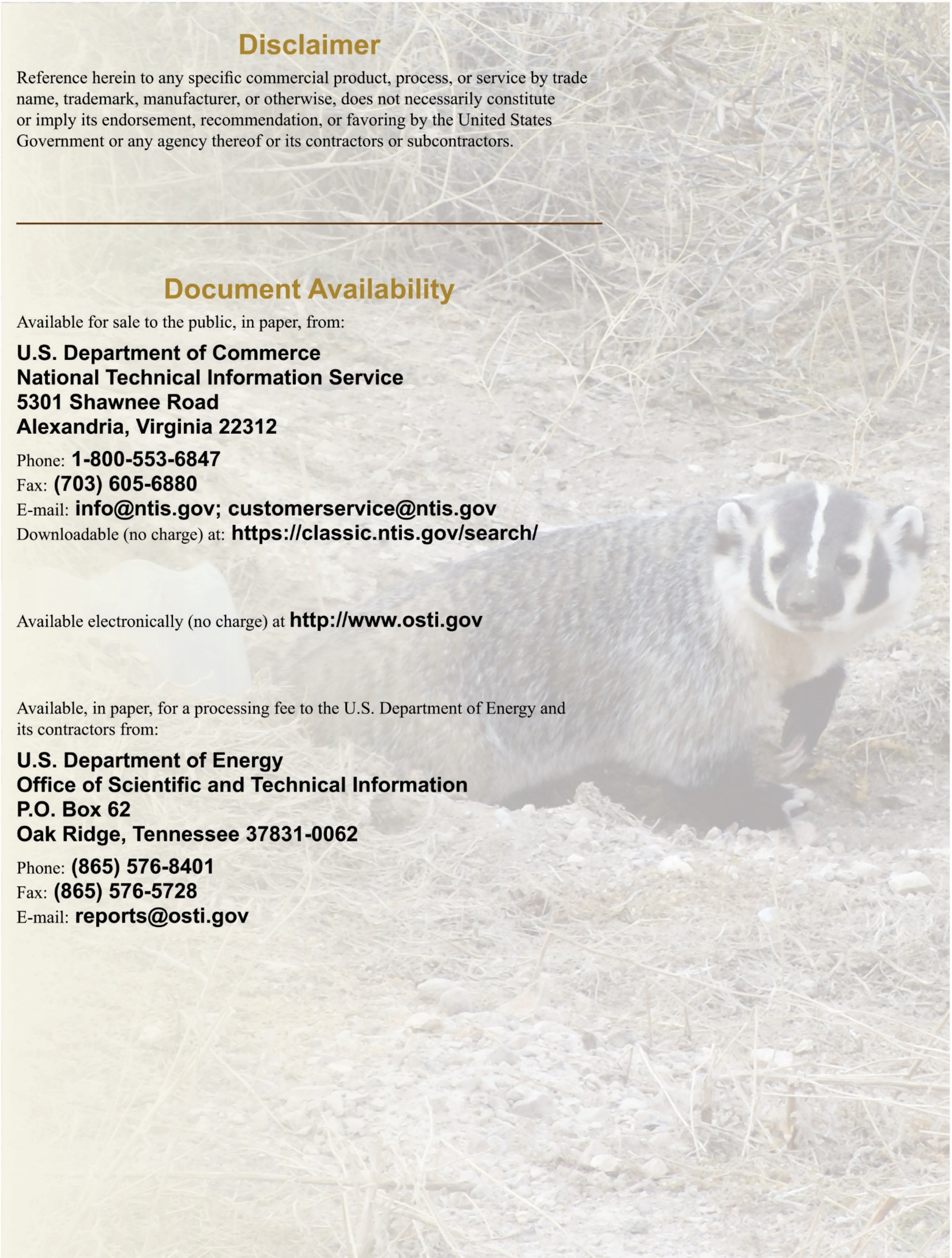

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Ecological Monitoring and Compliance Program 2018 REPORT

Derek B. Hall and
Jeanette A. Perry

September 2019

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P.O. Box 98518
Las Vegas, Nevada 89193-8518

By:
Mission Support and Test Services LLC
Ecological and Environmental Monitoring
P.O. Box 98521
Las Vegas, Nevada 89193-8521

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EXECUTIVE SUMMARY

The Ecological Monitoring and Compliance Program (EMAC), funded through the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO), monitors the ecosystem of the Nevada National Security Site (NNSS) and ensures compliance with laws and regulations pertaining to NNSS biota. This report summarizes the program's activities conducted by Mission Support and Test Services, LLC (MSTS), during calendar year 2018. Program activities included (a) biological surveys at proposed activity sites, (b) desert tortoise compliance, (c) ecosystem monitoring, (d) sensitive plant species monitoring, (e) sensitive and protected/regulated animal monitoring, and (f) habitat restoration monitoring. During 2018, most applicable laws, regulations, and permit requirements were met (see Section 3.1 for exception), enabling EMAC to achieve its intended goals and objectives.

Sensitive and protected/regulated species of the NNSS include 41 plants, 1 mollusk, 2 reptiles, 241 birds, and 23 mammals. These species are protected, regulated, or considered sensitive according to state or federal regulations and natural resource agencies and organizations. The desert tortoise (*Gopherus agassizii*) is the only species on the NNSS protected under the *Endangered Species Act*, and is listed as threatened. Biological surveys for the presence of sensitive and protected/regulated species and important biological resources on which they depend were conducted for 29 projects. A total of 311.3 hectares (ha) were surveyed for these projects. Some of the sensitive and protected/regulated species and important biological resources found included desert tortoise burrows, burrowing owls (*Athene cunicularia*) and several potential burrowing owl sites, several bat species, Joshua trees (*Yucca brevifolia*), Mojave yucca (*Yucca schidigera*), pine trees and many cactus species. MSTS provided written summary reports to project managers of survey findings and mitigation recommendations, where applicable.

Thirty-three projects occurring within the range of the desert tortoise were reviewed during 2018. Three were determined likely to adversely affect the desert tortoise, one was determined not likely to adversely affect the desert tortoise and the remaining 29 were determined to have no effects to the desert tortoise. Two projects disturbed desert tortoise habitat totaling 6.0 ha. No tortoises were observed, harmed or reported during any of the projects. There were 34 sightings of desert tortoises on roads on the NNSS with 31 of the tortoises determined to be in harm's way and moved off the road. Although no tortoises were reported to be hit by vehicles on the NNSS, one juvenile tortoise was killed by vehicular collision on the southbound on-ramp to the US Highway 95, the on-ramp used when exiting the NNSS. Field work concluded for the resident adult tortoise road study in the fall. Juvenile tortoises continued to be monitored as part of a collaborative effort to study survival of translocated animals.

From 1978 to 2018, there has been an average of 10.5 wildland fires per year on the NNSS with an average of about 98.0 ha burned per fire. During 2018, five wildland fires occurred on the NNSS. The largest occurred in Area 19 in late July and was caused by lightning. It burned approximately 1,012 ha in pinyon pine/Utah juniper/sagebrush (*Pinus monophylla/Juniperus osteosperma/Artemisia tridentata*) habitat. Another large fire caused by a power pole break burned about 458 ha in Mid Valley (Area 16) in blackbrush (*Coleogyne ramosissima*) habitat. A small fire (17 ha) occurred in late July in Area 30, likely due to lightning. The other two wildland fires were small (<0.4 ha) and were extinguished by NNSS Fire and Rescue personnel or carefully monitored until they burned out.

Wildlife use at nine natural water sources, one well pond, five water troughs, and four radiologically contaminated sumps, was documented using motion-activated cameras. Field surveys for sensitive plants were conducted for the Cane Spring suncup (*Camissonia megalantha*), Clokey's buckwheat (*Eriogonum heermannii* var. *clokeyi*), Inyo hulsea (*Hulsea vestita* ssp. *Inyoensis*), and Death Valley beardtongue (*Penstemon fruticiformis* var. *amargosae*).

Surveys of sensitive and protected/regulated animals in 2018 focused on birds, bats, feral horses (*Equus caballus*), mule deer (*Odocoileus hemionus*), desert bighorn sheep (*Ovis canadensis nelsoni*), and mountain lions (*Puma concolor*). Additional information is presented about bird mortalities, *Migratory Bird Treaty Act* compliance, nuisance animals and their control, and increasing populations of feral burros (*Equus asinus*) and pronghorn antelope (*Antilocapra americana*).

A new bird species, the western screech owl (*Otus kennicottii*), was observed in 2018, making a total of 245 confirmed bird species known to occur on the NNSS. Eleven golden eagle (*Aquila chrysaetos*) sightings were documented during winter raptor surveys; nine on the Yucca Flat route during the January and February surveys and two on the southern NNSS route during the January survey. This is by far the most golden eagle sightings documented on winter surveys yet. The red-tailed hawk (*Buteo jamaicensis*) was the most common species detected on both routes, comprising nearly three-fourths of all raptor sightings. Common ravens were more prevalent on the southern NNSS route than the Yucca Flat route, with most sightings observed around the Mercury Sewage Lagoon. Results from the last five years of winter raptor surveys are also presented.

Feral horse distribution was similar this year to last year with concentrated activity around Camp 17 Pond and Gold Meadows Spring especially during the hot, dry summer months. A total of 40 individuals were identified in at least 5 different bands and at least 5 foals and 6 juveniles were observed. Mule deer abundance measured with standardized deer surveys was the lowest recorded since 2006. Twelve radio-collared desert bighorn sheep were monitored during 2018 until their collars dropped or stopped working. Overall, radio-collared sheep ranged over Shoshone Mountain, Yucca Mountain, Bare Mountain, Thirsty Canyon, Black Mountain, and Quartz Mountain. Rams typically ranged over larger areas than females. A total of 13 marked sheep (9 of 14 from 2016 captures and 4 of 5 still alive from 2015 captures) were documented with motion-activated cameras in the Shoshone Mountain, Yucca Mountain, Fortymile Canyon area.

A total of 64 mountain lion images (i.e., photographs or video clips) were taken during 188,465 camera hours at 7 of 27 sites sampled. An additional 9,109 images of at least 39 species other than mountain lions were also documented. A minimum of three individuals (adult male and adult female with cub) were known to occur on the NNSS in 2018.

A quantitative vegetation assessment was conducted on the revegetated cover cap at Corrective Action Unit (CAU) 110, U-3ax/bl, and a qualitative assessment was conducted at CAU 111, “92-Acre Site.” Visual assessments were also conducted at Double Tracks, Clean Slate I, II, and II sites to assist in guiding future revegetation efforts at Clean Slate II and III.

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ACRONYMS AND ABBREVIATIONS

α	statistical significance level
ac	acre(s)
APHIS	Animal and Plant Health Inspection Service
APP	Avian Protection Plan
CAU	Corrective Action Unit
cm	centimeter(s)
DOE	U.S. Department of Energy
DOE/NV	U.S. Department of Energy, Nevada Operations Office
EGIS	Ecological Geographic Information System
ELU	Ecological Landform Unit
EM	Environmental Monitor
EMAC	Ecological Monitoring and Compliance Program
EO	Executive Order
FWS	U.S. Fish and Wildlife Service
g	gram(s)
GIS	Geographic Information System
GPS	Global Positioning System
ha	hectare(s)
ICR	San Diego Zoo Institute for Conservation Research
JTGP	Joshua Tree Genome Project
kg	kilogram(s)
km	kilometer(s)
LANL	Los Alamos National Laboratory
m	meter(s)
MBTA	Migratory Bird Treaty Act
MCL	midline carapace length
mm	millimeter(s)
MOU	Memorandum of Understanding
MSTS	Mission Support and Test Services, LLC
n	Sample Size
NAC	Nevada Administrative Code
NAD	North American Datum

NDOW	Nevada Department of Wildlife
NNHP	Nevada Natural Heritage Program
NNPS	Nevada Native Plant Society
NNSA/NFO	U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office
NNSS	Nevada National Security Site
NOAA	National Oceanic and Atmospheric Administration
NTTR	Nevada Test and Training Range
NWRC	National Wildlife Research Center
p	probability
pCi/L	picocuries per liter
sd	standard deviation
spp.	species
TCS	tortoise clearance survey
UGTA	Underground Test Area
USACE	U.S. Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
VHF	very high frequency

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1.0 INTRODUCTION

In accordance with U.S. Department of Energy (DOE) Order DOE O 231.1B, "Environment, Safety, and Health Reporting," the Office of the Assistant Manager for Environmental Management of the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO) requires ecological monitoring and biological compliance support for activities and programs conducted at the Nevada National Security Site (NNSS). Mission Support and Test Services, LLC (MSTS) is the Management and Operations contractor for the NNSS. MSTS Ecological and Environmental Monitoring has implemented the Ecological Monitoring and Compliance Program (EMAC) to provide the aforementioned biological compliance support and ecological monitoring. EMAC is designed to ensure compliance with applicable laws and regulations, delineate and define NNSS ecosystems, and provide ecological information that can be used to predict and evaluate the potential impacts of proposed projects and programs on those ecosystems. During 2018, all applicable laws and regulations were followed, and most of the permit requirements were met (see Section 3.1 for exception), enabling EMAC to achieve its intended goals and objectives.

This report summarizes the EMAC activities conducted by MSTS during calendar year 2018. For purposes of this report, MSTS will be referred to when discussing work accomplished by NNSS biologists. Monitoring tasks during 2018 included six program areas: (a) biological surveys, (b) desert tortoise compliance, (c) ecosystem monitoring, (d) sensitive plant monitoring, (e) sensitive and protected/regulated animal monitoring, and (f) habitat restoration monitoring. The following sections of this report describe work performed under these six areas.

2.0 BIOLOGICAL SURVEYS

Biological surveys are performed at project sites where land-disturbing activities are proposed. The goal is to minimize adverse effects of land disturbance on sensitive and protected/regulated plant and animal species (Table 2-1), their associated habitat, and other important biological resources. Sensitive species are defined as species that are at risk of extinction or serious decline or whose long-term viability has been identified as a concern. They include species on the Nevada Natural Heritage Program (NNHP) At-Risk Plant and Animal Tracking List (NNHP 2019). Protected/regulated species are those that are protected or regulated by federal or state law. Many species are both sensitive and protected/regulated (Table 2-1). Important biological resources include cover sites, nest or burrow sites, roost sites, or water sources important to sensitive species. Survey reports document species and resources found and provide mitigation recommendations.

2.1 SITES SURVEYED AND SENSITIVE AND PROTECTED/REGULATED SPECIES OBSERVED

In 2018, biological surveys were conducted for 29 projects on the NNSS (Figure 2-1 and Table 2-2). Scientists surveys a total of 311.3 hectares (ha) for the projects (Table 2-2). The surveyed area included the project area and a buffer area extending 10-50 meters (m) beyond the project area. Twenty projects were within the range of the threatened desert tortoise (*Gopherus agassizii*) (see Section 3.0). Although within the range of the desert, several of these projects did not have the potential to disturb tortoise habitat. Two projects were within the Frenchman Flat desert tortoise exclusion zone (an area identified as having no tortoise presence), five projects were within buildings and one project was within a fenced area. Sensitive and protected/regulated wildlife species and important biological resources found during the surveys included tortoise burrows (one adult tortoise burrow was active with burrowing owls [*Athene cunicularia*] and one inactive burrow was excavated by a juvenile tortoise); several potential and active burrowing owl sites; several predator burrows which can be utilized by tortoises and other wildlife; several bird nests and species; ungulate sign (pronghorn antelope [*Antilocapra Americana*], burro [*Equus asinus*], horse [*Equus caballus*] and mule deer [*Odocoileus hemionus*]); one live bat (*Myotis* spp.) and bat sign; yucca plants (Joshua tree [*Yucca brevifolia*] and Mojave yucca [*Yucca schidigera*]); singleleaf pinyon (*Pinus monophylla*); and many cactus species (see Table 2-2 for resources listed by project). Scientists communicated with ground crews and provided written summary reports to project managers of survey findings and mitigation recommendations when applicable (Table 2-2).

2.2 POTENTIAL HABITAT DISTURBANCE

Surveys are conducted for all activities that have the potential to disturb habitat. These surveys are required in undisturbed habitat, whenever vegetation has re-colonized old disturbances, and/or sensitive or protected/regulated species may occur in the area. For example, desert tortoises may move through project areas and may be concealed under vegetation during activities where heavy equipment is used. Biological and tortoise clearance surveys are conducted to ensure desert tortoises are not in harm's way. Burrowing owls frequently inhabit burrows, buried pipes with exposed openings, and culverts at disturbed sites. Surveys are conducted to ensure burrowing owl adults, eggs, and nestlings are not harmed.

During vegetation mapping surveys of the NNSS, delineated areas of homogeneous plant and wildlife communities were identified and referred to as Ecological Landform Units (ELUs) (Ostler et al. 2000). These ELUs were evaluated for importance with the intent that comparable ELUs would respond similarly to land management practices. This concept was later applied to categorizing groupings of ELUs into important habitat types as follow: *Pristine Habitat* (having few human-made disturbances), *Unique Habitat* (containing uncommon biological resources such as a natural wetland), *Sensitive Habitat*

Table 2-1. List of sensitive and protected/regulated species known to occur on or adjacent to the NNSS.

Plant Species	Common Names	Status[a]
Moss Species		
Entosthodon planoconvexus	Planoconvex cordmoss	S, H
Flowering Plant Species		
Arctomecon merriamii	White bearpoppy	S, M
Astragalus beatleyae	Beatley's milkvetch	S, H
Astragalus funereus	Black woollypod	S, H
Astragalus oophorus var. *clokeyanus*	Clokey eggvetch	S, W
Camissonia (Chylismia) megalantha	Cane Spring suncup	S, M
Cymopterus ripleyi var. *saniculoides*	Sanicle biscuitroot	S, M
Eriogonum concinnum	Darin buckwheat	S, M
Eriogonum heermannii var. *clokeyi*	Clokey buckwheat	S, W
Frasera pahutensis	Pahute green gentian	S, M
Galium hilendiae ssp. *kingstonense*	Kingston Mountains bedstraw	S, H
Grusonia pulchella	Sand cholla	S, CY, E
Hulsea vestita ssp. *inyoensis*	Inyo hulsea	S, W
Ivesia arizonica var. *saxosa*	Rock purpusia	S, H
Penstemon fruticiformis ssp. *amargosae*	Death Valley beardtongue	S, H
Penstemon pahutensis	Pahute Mesa beardtongue	S, W
Phacelia beatleyae	Beatley scorpionflower	S, M
Phacelia filiae	Clarke phacelia	S, M
Phacelia mustelina	Weasel phacelia	S, Ma
Sclerocactus polyancistrus	Redspined fishhook cactus	S, CY, Ma
Agavaceae	Yucca (3 species), Agave (1 species)	CY
Cactaceae	Cacti (17 species)	CY
Juniperus osteosperma	Utah juniper	CY
Pinus monophylla	Single-leaf pinyon	CY

Table 2-1. List of sensitive and protected/regulated species known to occur on or adjacent to the NNSS (continued).

Animal Species	Common Name	Status[a]
Mollusk Species		
Pyrgulopsis turbatrix	Southeast Nevada pyrg	S, IA
Reptile Species		
Plestiodon gilberti rubricaudatus	Western red-tailed skink	S, IA
Gopherus agassizii	Desert tortoise	LT, S, NPT, A
Bird Species[b]		
Accipiter gentilis	Northern goshawk	S, NPS, A
Alectoris chukar	Chukar	G, IA
Aquila chrysaetos	Golden eagle	EA, NP, A
Asio flammeus	Short-eared owl	S, A
Asio otus	Long-eared owl	S, A
Callipepla gambelii	Gambel's quail	G, IA
Coccyzus americanus	Western yellow-billed cuckoo	LT, S, NPS, IA
Corvus brachyrhynchos	American crow	G, IA
Falco peregrinus	Peregrine falcon	S, NPE, A
Haliaeetus leucocephalus	Bald eagle	EA, S, NPE, A
Ixobrychus exillis hesperis	Western least bittern	S, NP, IA
Lanius ludovicianus	Loggerhead shrike	NPS, A
Melanerpes lewis	Lewis woodpecker	S, IA
Oreoscoptes montanus	Sage thrasher	NPS, IA
Riparia riparia	Bank swallow	S, IA
Spinus pinus	Pine siskin	S, IA
Spizella breweri	Brewer's sparrow	NPS, IA
Toxostoma lecontei	LeConte's thrasher	S, NP, IA
Mammal Species		
Antilocapra Americana	Pronghorn antelope	G, A
Antrozous pallidus	Pallid bat	NP, A
Cervus elaphus	Rocky Mountain elk	G, IA
Corynorhinus townsendii	Townsend's big-eared bat	S, NPS, A
Equus asinus	Burro	H&B, A

Table 2-1. List of sensitive and protected/regulated species known to occur on or adjacent to the NNSS (continued).

Animal Species	Common Name	Status[a]
Equus caballus	Horse	H&B, A
Euderma maculatum	Spotted bat	S, NPT, A
Lasionycteris noctivagans	Silver-haired bat	S, A
Lasiurus blossevillii	Western red bat	S, NPS, A
Lasiurus cinereus	Hoary bat	S, A
Lynx rufus	Bobcat	F, IA
Microdipodops megacephalus	Dark kangaroo mouse	NP, A
Microdipodops pallidus	Pale kangaroo mouse	S, NP, A
Myotis thysanodes	Fringed myotis	S, NP, A
Ovis canadensis nelson	Desert bighorn sheep	G, A
Odocoileus hemionus	Mule deer	G, A
Puma concolor	Mountain lion	G, A
Sorex tenellus	Inyo shrew	S, IA
Sylvilagus audubonii	Audubon's cottontail	G, IA
Sylvilagus nuttallii	Nuttall's cottontail	G, IA
Tadarida brasiliensis	Brazilian free-tailed bat	NP, A
Urocyon cinereoargenteus	Gray fox	F, IA
Vulpes macrotis	Kit fox	F, IA

[a] **Status Codes for Column 3**

Endangered Species Act, U.S. Fish and Wildlife Service

LT	Listed Threatened

U.S. Department of Interior

H&B	Protected under *Wild Free Roaming Horses and Burros Act*
EA	Protected under *Bald and Golden Eagle Act*

State of Nevada – Animals

S	Nevada Natural Heritage Program – At-Risk Plant and Animal Tracking List
NPE	Nevada Protected-Endangered, species protected under Nevada Administrative Code (NAC) 503
NPT	Nevada Protected-Threatened, species protected under NAC 503
NPS	Nevada Protected-Sensitive, species protected under NAC 503
NP	Nevada Protected, species protected under NAC 503
G	Regulated as game species under NAC 503
F	Regulated as fur bearer species under NAC 503

Table 2-1. List of sensitive and protected/regulated species known to occur on or adjacent to the NNSS (continued).

State of Nevada – Plants	
S	Nevada Natural Heritage Program (NNHP) – At-Risk Plant and Animal Tracking List
CY	Protected as a cactus, yucca, or Christmas tree from unauthorized collection on public lands
NNSS Sensitive Plant Ranking	
E	Evaluate
H	High
M	Moderate
W	Watch
Ma	Marginal
Long-term Animal Monitoring Status for the NNSS	
A	Active
IA	Inactive

[b] All bird species on the NNSS are protected by the *Migratory Bird Treaty Act* except for chukar, Gambel's quail, English house sparrow (*Passer domesticus*), Rock dove (*Columba livia*), Eurasian collared dove (*Streptopelia decaocto*) and European starling (*Sturnus vulgaris*). Most bird species are also protected by NAC503.

Sources used: NNHP 2019, Nevada Native Plant Society (NNPS) 2019, NAC 2019, U.S. Fish and Wildlife Service (FWS) 2019

(containing vegetation associations that recover very slowly from direct disturbance or are susceptible to erosion), and *Diverse Habitat* (having high plant species diversity) (U.S. Department of Energy, Nevada Operations Office [DOE/NV] 1998).

Two projects occurred in areas designated as *Sensitive Habitat*: 18-09 and 18-20 (Figure 2-1, Table 2-2). The total area disturbed (ha) of important habitat types tracked since 1999 comprises 9.46 (*Pristine*), 17.46 (*Unique*), 379.51 (*Sensitive*), and 87.05 (*Diverse*). Projects in 2018 disturbed a total of 21.4 ha of undisturbed land (Table 2-2). Projects utilize previously disturbed areas as well as existing roads as much as possible to minimize the disturbance of habitat.

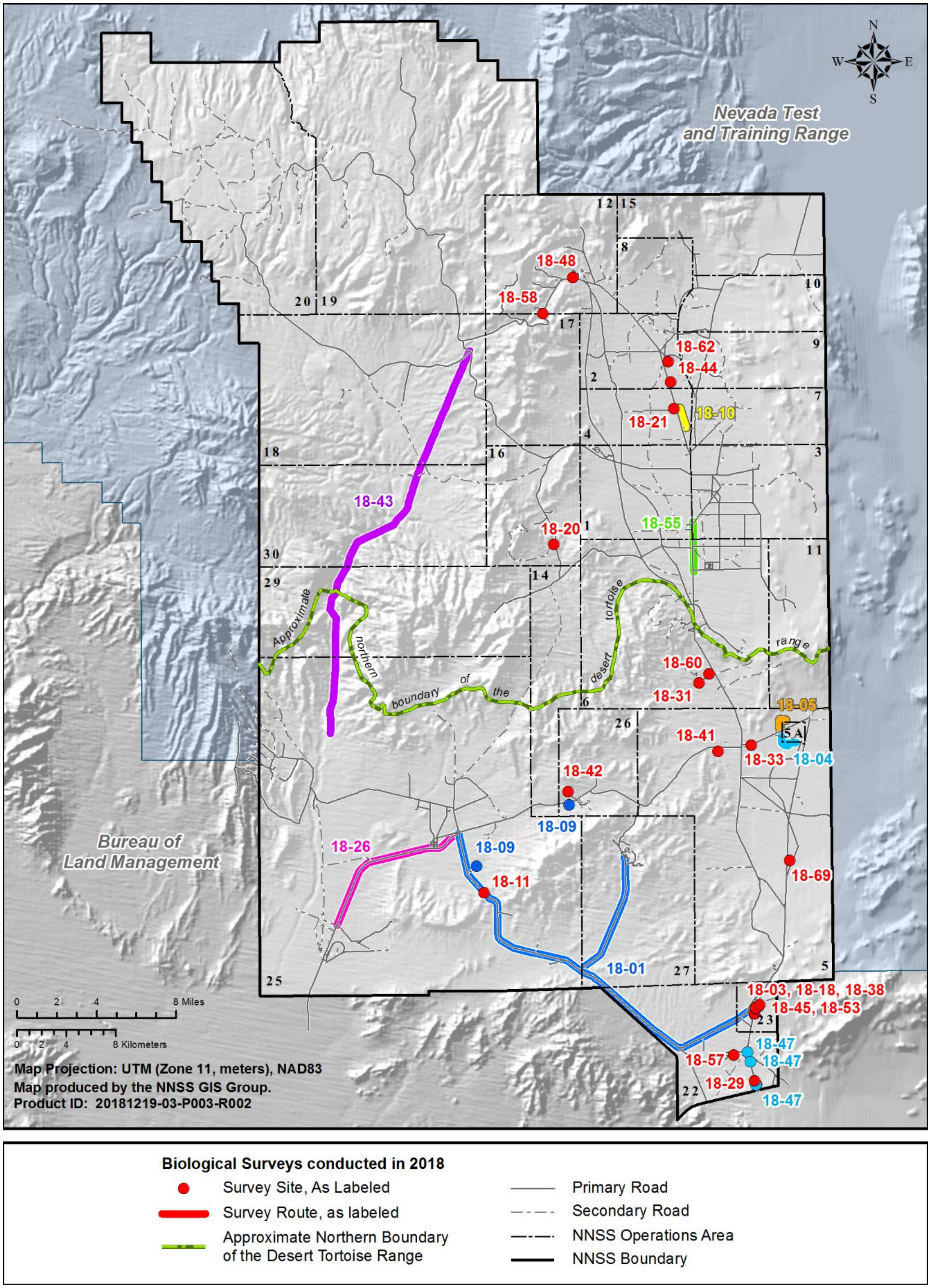

Figure 2-1. Biological surveys conducted in 2018. Project 18-09 had two surveyed locations and 18-47 had three.

Table 2-2. Summary of biological surveys conducted on the NNSS during 2018.

Project No.	Project Name	Important Species/Resources Found	Area Surveyed (ha)	Project area in Undisturbed Habitat (ha)	Mitigation Recommendations
18-01	Grading JAF and 27-01 Road Shoulders	Yucca, cacti, antelope and burro sign, predator burrows, tortoise burrows, roosting owl	131.10	0	TCS[a], EM[b], avoid flagged resources
18-03 (17-03)	Fire Station 1 Solar Demonstration Expansion Areas	Yucca, cacti, antelope sign	1.40	0	TCS[a], EM[b], leave natural wash in tact
18-04 (17-40)[c]	Relocation of water line in Area 5	Cacti, antelope sign, predator burrow, flycatcher	9.90	7.0	Pre-activity survey, avoid cacti if possible
18-05	RWMC Expansion Phase I	Predator burrows, juvenile tortoise burrow, cacti, yucca, inactive bird nest	42.00	10.7	Formal consultation, TCS[a], EM[b], pre-activity survey for area outside tortoise habitat
18-09	Test Bed South Phase I	Tortoise burrow, predator burrows, yucca, cacti	4.61	3.0	Formal consultation, TCS[a], EM[b], pre-activity survey for area outside tortoise habitat
18-10	THOR Corridor	Potential burrowing owl sites, kit fox sign	4.37	0	Pre-activity survey, avoid flagged exposed pipes
18-11	Exposed Optic Line JAF	Predator burrow	0.105	0	TCS[a], avoid flagged predator burrow
18-18	Bowling Alley Demolition	Pair of yellow-headed blackbirds, bat guano	NA	NA	Pre-activity survey for buildings
18-20	Earth Wind and Fire	Yucca, cacti, mule deer sign	0.17	0.4[d]	Pre-activity survey
18-21	BEEF Parking Lot and 4-04	None	4.70	0	Pre-activity survey
18-26	Lathrop Well Road Mowing	Cacti, antelope sign, predator burrows, 1 tortoise burrow (tortoise burrow and 1 predator burrow were active with burrowing owls)	20.50	0	TCS[a], EM[b], avoid flagged resources
18-29	Removal and Disposal Building 22-1111	Live bat, bat guano	NA	NA	Pre-activity survey for buildings
18-31	DAF Parking Lot Extension	Yucca, cacti	0.32	0	TCS[a]
18-33[c]	Frenchman Flat Transformer Replacement	None	1.27	0	Pre-activity survey
18-38	Tent 23-424 Removal	Dead baby bird (possibly raven), owl pellet	NA	NA	Pre-activity survey for buildings
18-41	Smoke Pots Area 5	Yucca, cacti	0.65	0	Informal consultation, TCS[a], EM[b], avoid flagged resources
18-42	Rocket Launcher Retrieval	Bird nest	NA	NA	Pre-activity survey for buildings, remove inactive nest
18-43 (17-12)	Power Pole Vegetation Abatement	Burro and horse sign, piece of old tortoise carcass, owl pellets, bobcat sign, red tailed hawk, bird nests	12.51	0	Formal consultation, TCS[a], EM[b], pre-activity survey for areas outside tortoise habitat
18-44	DAG 2	None	0.25	0.3	Pre-activity survey
18-45	Demolition 23-23	None	NA	NA	Pre-activity survey for buildings

Table 2-3. Summary of biological surveys conducted on the NNSS during 2018 (continued).

Project No.	Project Name	Important Species/Resources Found	Area Surveyed (ha)	Project area in Undisturbed Habitat (ha)	Mitigation Recommendations
18-47	Security Signs	Yucca, cacti	0.055	0	TCS[a]
18-48	Area 12 Trailer Disposal	3 inactive bird nests, bat guano, bird scat	NA	NA	Pre-activity survey for buildings, remove all inactive nests
18-53	Mercury Demo Phase II	Dead bat *Myotis* spp., bat guano, cacti, antelope sign	2.86	0	Pre-activity survey for buildings
18-55	U1a Water System Upgrade	Yucca, cacti, antelope sign, predator burrows, horned larks	66.00	Project in progress	Pre-activity survey, utilized right-of-way corridor and existing roads
18-57	Parking Lot 22-1	Burro sign, cacti	0.37	0	TCS[a]
18-58	Power Pole Replacements Area 12	Pinyon pine and deer sign	0.25	0	Pre-activity survey
18-60	DAF Flood Channel	Yucca, cacti, kit fox sign at culverts	0.40	0	TCS[a]
18-62	Fence Area 2	Cacti, potential burrowing owl sites	0.65	0	Pre-activity survey
18-69	Borrow Pit Area 5	Antelope and burro sign, cacti, predator burrows	6.90	0	TCS[a]
		Total	**311.34**	**21.4**	

[a]Tortoise Clearance Survey
[b]Environmental Monitor
[c]Within a tortoise exclusion zone
[d]Post-activity survey revealed habitat disturbance exceeded surveyed area

3.0 DESERT TORTOISE COMPLIANCE

Desert tortoises occur within the southern one-third of the NNSS. This species is listed as threatened under the *Endangered Species Act*. In December 1995, NNSA/NFO completed consultation with the U.S. Fish and Wildlife Service (FWS) concerning the effects of NNSA/NFO activities, as described in the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE/NV 1996), on the desert tortoise. NNSA/NFO received a final Biological Opinion (Opinion) from the FWS in August 1996 (FWS 1996). On July 2, 2008, NNSA/NFO provided the FWS with a Biological Assessment of anticipated activities on the NNSS for the next 10 years and entered into formal consultation with the FWS to obtain a new Opinion for the NNSS. NNSA/NFO received the final Opinion on February 12, 2009 (FWS 2009). This Opinion covers the anticipated activities at the NNSS through 2019.

In August 2018, MSTS biologists provided FWS with a draft Biological Assessment which covers anticipated NNSS activities in tortoise habitat through 2029 and worked with FWS to finalize the Biological Assessment. In March 2019, NNSA/NFO entered formal consultation with FWS and provided FWS with the final Biological Assessment. NNSA/NFO awaits the completion of this formal consultation with FWS in order to obtain a new Opinion which is anticipated to be complete by September 2019.

The Desert Tortoise Compliance task of EMAC implements the terms and conditions of the 2009 Opinion, documents compliance actions taken by NNSA/NFO, and assists NNSA/NFO in FWS consultations. All terms and conditions listed in the Opinion were implemented by MSTS staff biologists in 2018, including (a) conducting 100% coverage tortoise clearance surveys (TCS) at project sites within 24 hours from the start of project construction, (b) ensuring that project managers have an environmental monitor (EM) on site during site clearing and heavy equipment operation, (c) developing effects analysis for proposed disturbances to append to the Opinion, and (d) preparing an annual compliance report for NNSA/NFO submittal to the FWS.

3.1 PROJECT SURVEYS AND COMPLIANCE DOCUMENTATION

In 2018, 33 projects occurring within the range of the desert tortoise were reviewed by biologists. Projects were placed in one of three categories based on biological review: likely to adversely affect the desert tortoise, not likely to adversely affect the desert tortoise or no effects to the desert tortoise. Three projects were determined likely to adversely affect the desert tortoise: 18-05, 18-09 and 18-43. One project was determined not likely to adversely affect the desert tortoise: 18-41. The remaining 29 projects were determined to have no effects to the desert tortoise based on the location of the projects within developed areas, previously disturbed areas and/or creating minimal land disturbances. Details of the biological review for each project can be found in the FWS Annual Report for 2018.

Full coverage tortoise clearance surveys for project areas plus a buffer zone (additional 10-50 meters beyond project area) were required and completed for three projects; 18-05, 18-09, and 18-43 (Table 3-1 and Figure 3-1). Full coverage tortoise clearance surveys were conducted within twenty-four hours of project start time, typically hours before surface-disturbing activities. Pre-activity surveys (one-hundred-percent coverage, meandering transects or building surveys) were conducted on an additional eighteen projects as biologists deemed prudent (Table 3-1 and Figure 3-1). No desert tortoises were observed or reported injured or killed during projects in 2018.

Post activity surveys were completed on eight of the projects to ensure construction activities remained within the surveyed area and to quantify the amount of tortoise habitat disturbed (Table 3-1). All projects remained within surveyed boundaries with the exception of one incident during project 18-09, Test Bed

Table 3-1. Summary of biological surveys conducted within the range of the desert tortoise on the NNSS during 2018.

Project No.	Project Name	Compliance Activities	Tortoise Habitat Disturbed (ha)
18-01	Grading JAF and 27-01 Road Shoulders	Pre-activity Survey (100% coverage), Post Activity Survey	0
18-03 (17-03)	Fire Station 1 Solar Demonstration Expansion Areas	Pre-activity Survey (100% coverage)	0
18-04 (17-40)	Relocation of Water Line Area 5	Pre-activity Survey (meandering transects), Post Activity Survey	0
18-05	RWMC Expansion Phase I	Tortoise Clearance Survey, Post Activity Survey	3.08
18-09	Test Bed South Phase I	Tortoise Clearance Survey, Post Activity Survey	2.95
18-11	Exposed Optic Line JAF	Pre-activity Survey (100% coverage)	0
18-18	Bowling Alley Demolition	Pre-activity Survey (Buildings)	0
18-26	Lathrop Well Road Mowing	Pre-activity Survey (100% coverage), Post Activity Survey	0
18-29	Removal and Disposal Building 22-1111	Pre-activity Survey (Buildings)	0
18-31	DAF Parking Lot Extension	Pre-activity Survey (100% coverage)	0
18-33	Frenchman Flat Transformer Replacement	Pre-activity Survey (Buildings)	0
18-38	Tent 23-424 Removal	Pre-activity Survey (Buildings)	0
18-41	Smoke Pots Area 5	Pre-activity Survey (100% coverage), Post Activity Survey	0
18-42	Rocket Launcher Removal	Pre-activity Survey (Buildings)	0
18-43 (17-12)	Power Pole Vegetation Abatement	Tortoise Clearance Survey, Post Activity Survey	0
18-45	Demolition 23-23	Pre-activity Survey (Buildings)	0
18-47	Security Signs	Pre-activity Survey (100% coverage)	0
18-53	Mercury Demo Phase II	Pre-activity Survey (Buildings)	0
18-57	Parking Lot 22-1	Pre-activity Survey (100% coverage)	0
18-60	DAF Flood Channel	Pre-activity Survey (100% coverage)	0
18-69	Borrow Pit Area 5	Pre-activity Survey (100% coverage), Post Activity Survey	0
		Total	**6.03**

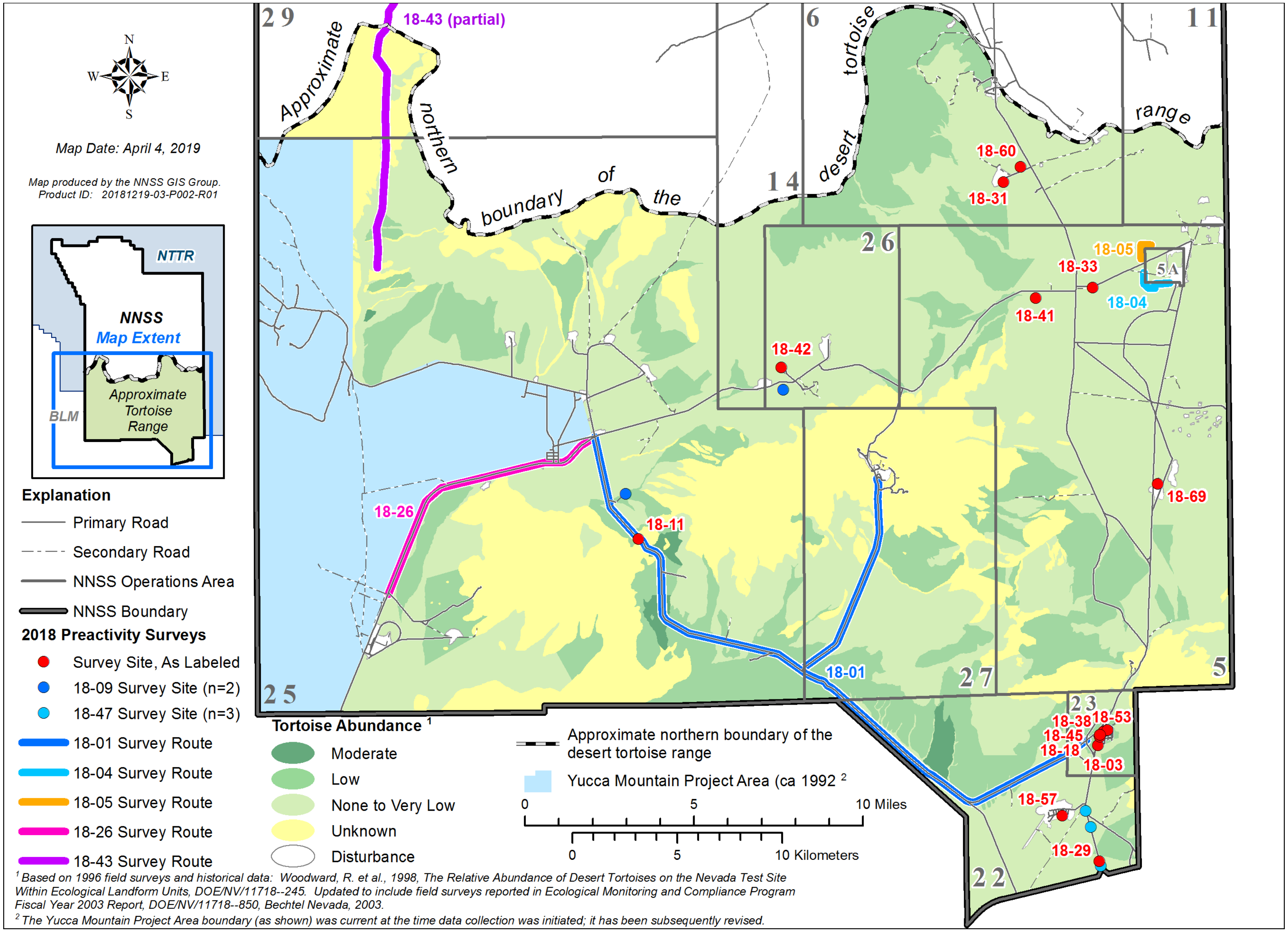

Figure 3-1. Biological surveys conducted within the range of the desert tortoise in 2018.

South Phase I. Phase I of this project involved the clearing of two separate areas. One of the areas was previously disturbed next to a substation and was determined to not be tortoise habitat. This area was staked with lath and 100-percent coverage surveys were completed by biologists. The area to be graded was 0.57 ha. Surveys were completed in August and included the project area plus a buffer zone. No tortoise sign was observed. The area was graded on August 20th, 2018. On November 27th, 2018, biologists were informed an additional 0.26 ha was graded during the project due to a miscommunication between the construction supervisor and an operator. A post-activity survey revealed the additional area that was cleared was within the surveyed buffer area and not viable tortoise habitat. This incident has been addressed with all personnel involved with the project. In order to avoid future incidents, project personnel and biologists have agreed all project boundaries will be staked every 50 feet with five foot lath.

Two projects disturbed tortoise habitat: 18-05 disturbed 3.08 ha and 18-09 disturbed 2.95 ha (Table 3-1). Both projects were appended to the Opinion and received concurrence from FWS for tortoise habitat disturbance.

In January 2019, the annual report summarizing tortoise compliance activities conducted on the NNSS from January 1 through December 31, 2018 was submitted to the FWS. This report, required under the Opinion, contains (a) the location and size of land disturbances that occurred within the range of the desert tortoise; (b) the number of desert tortoises injured, killed, or removed from project sites; (c) a map showing the location of all tortoises sighted on or near roads as well as vehicular mortalities; and (d) a summary of construction mitigation and monitoring efforts.

Compliance with the Opinion ensures the desert tortoise is protected on the NNSS and the cumulative impacts on this species are minimized (DOE/NV 1998). In the Opinion, the FWS determined the "incidental take" ("take" means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct, and "incidental take" is a take that results from activities that are otherwise lawful) of tortoises on the NNSS and the cumulative acreage of tortoise habitat disturbed on the NNSS are parameters that should be measured and monitored annually. In 2017, the threshold level established by the FWS for moving tortoises observed on NNSS roads out of harm's way was exceeded (Table 3-2). As the limit of incidental take under the Roads category was approached in June 2017, NNSA/NFO received concurrence from FWS to continue moving tortoises off roads when in harm's way. The take limit set by FWS for the 10-year term of the Opinion is 125 and the actual amount of take is currently 184 (Table 3-2).

There were 34 reported desert tortoise roadside sightings during 2018 (Figure 3-2). Thirty-one of the encountered tortoises were determined to be in harm's way and moved off the road (Figure 3-2) in accordance with Service-approved tortoise handling procedures. One noteworthy observation was a hatchling observed crossing Mercury Highway in Area 5 (Figure 3-3). The hatchling was moved safely off the road in the direction it was moving and reported to biologists.

One road mortality was reported just outside the NNSS boundary and was likely the cause of NNSS personnel end-of-the-day traffic leaving the site. A juvenile tortoise was reported hit by a vehicle on May 14th on the southbound on-ramp to the US Highway 95y (Figure 3-2). The report was investigated but could not be confirmed with a carcass. Although the mortality was not covered under the action area in the Opinion, it was likely the cause of activities on the NNSS. A new tortoise road sign was installed before the southbound exit to increase employee awareness (Figure 3-2) and a site-wide desert tortoise awareness announcement was posted and emailed to employees. The road mortality was reported to FWS as well as Nevada Department of Transportation.

Table 3-2. Cumulative incidental take (2009–2018) and maximum allowed take for NNSA/NFO programs.

Program	Number of Hectares Impacted (maximum allowed)	Number of Tortoises Anticipated to be Incidentally Taken (maximum allowed)	
		Killed/Injured	Other
Defense	2.27 (202)	0 (1)	0 (10)
Waste Management	3.08 (40)	0 (1)	0 (2)
Environmental Restoration	0 (4)	0 (1)	0 (2)
Non-Defense R&D	2.95 (607)	0 (2)	0 (35)
Work for Others	14.50 (202)	0 (1)	0 (10)
Infrastructure Development	4.01 (40)	0 (1)	1 (10)
Roads	0 (0)	12 (15)[a]	184 (125)[b]
Totals	**26.81 (1,095)**	**12 (22)**	**185 (194)**

[a]No more than 4 desert tortoises killed on roads during any calendar year and no more than 15 killed on roads during the term of the Opinion.
[b]Take limit was exceeded during calendar year 2017. Requested concurrence to continue moving tortoises off roads when in harm's way was authorized by the Service on June 5, 2017.

3.1.1 Mitigation for Loss of Tortoise Habitat

Mitigation for the loss of tortoise habitat is required under Term and Condition 3c of the Opinion. This term and condition as amended in November 2013, requires NNSA/NFO to perform one of three mitigation options: (a) prepay funds into the Desert Tortoise Mitigation Fund (now the Mojave Desert Tortoise Sub-Account) for projects under the Work-for-Others Program, (b) apply the accrued costs to implement FWS-approved conservation studies on the NNSS as earned mitigation for the future loss of tortoise habitat by non-Work-for-Others projects, or c) prepay mitigation funds into the Desert Tortoise Mitigation Fund, then revegetate disturbed habitat following specified criteria; once the revegetation is successful, the money paid for mitigation will be refunded. Accrued costs for 2018 are applied at a level equal to the rate of $885 per acre (ac) of disturbance.

Two projects were required to pay mitigation fees based on the projects' permanent disturbance of desert tortoise habitat. Project 18-05, under the Waste Management Program, is an ongoing project. The project disturbed 7.61 ac (3.08 ha) in 2018 but has the potential to disturb 82 ac over the duration of the project. $72,570 (82 ac x $885/ac) has been deducted from accrued funds from Service-approved conservation programs. Project 18-09, under the Nondefense Research and Development Program, is an ongoing project as well. In 2018, the project disturbed 7.29 ac (2.95 ha). The project has the potential to disturb 46.5 ac over the duration of the project. $41,153 (46.5 ac x $885/ac) has been deducted from accrued funds.

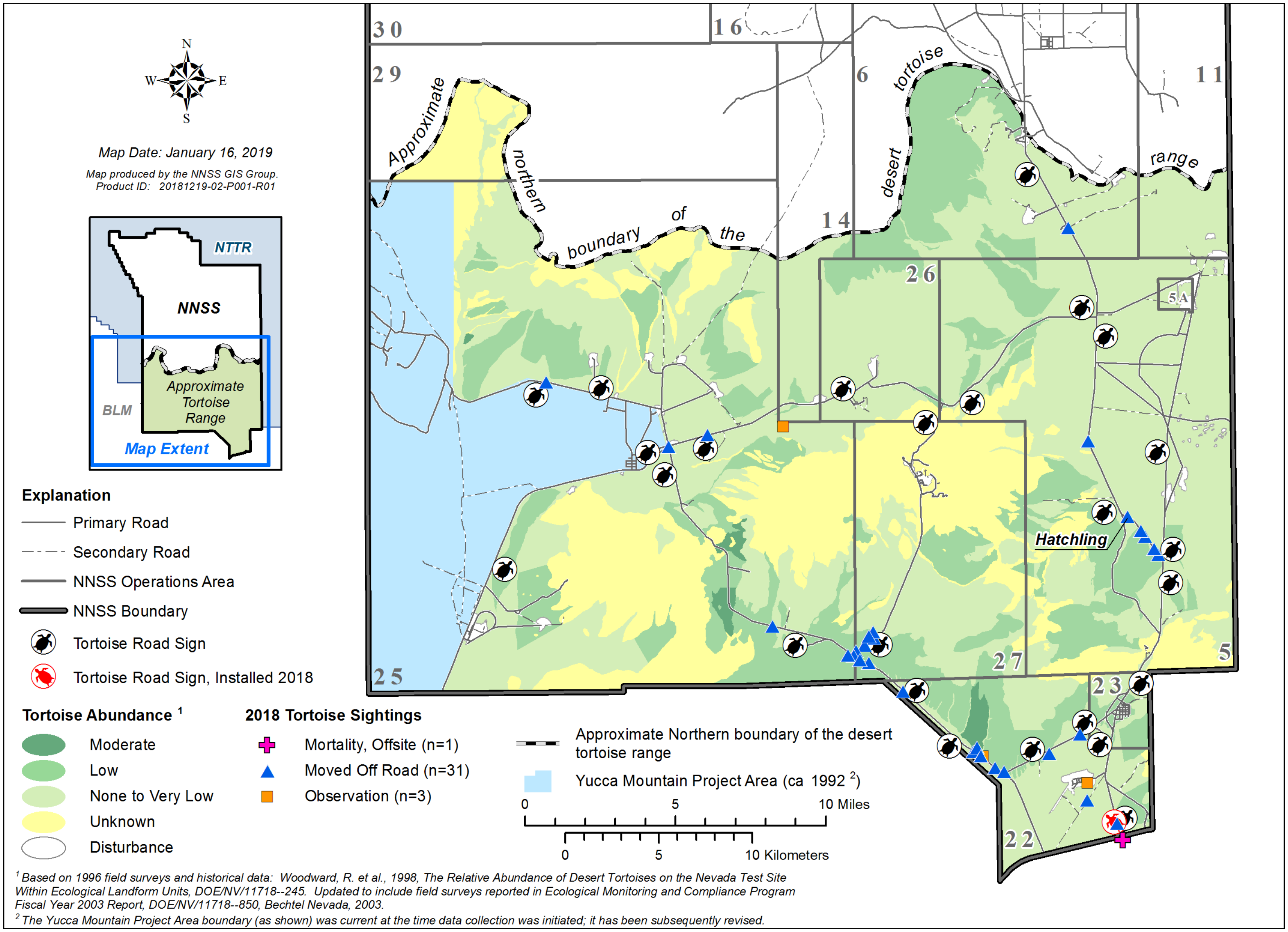

Figure 3-2. Locations of tortoise roadside sightings, including tortoises moved off roads, one tortoise road mortality, and locations of tortoise caution road signs.

Figure 3-3. Hatchling tortoise moved off Mercury Highway (Area 5).

(Photo by D.B. Hall September 5, 2018).

3.2 CONSERVATION RECOMMENDATIONS

Two desert tortoise conservation research studies have been approved by the FWS and are being implemented by MSTS biologists; the desert tortoise road study and the juvenile translocation study. The following is a synopsis of activities conducted for each of these projects.

3.2.1 Road Study

Per the Opinion, NNSA/NFO developed a desert tortoise study which focuses on collecting fine-scale patterns of roadside habitat use by the desert tortoise for application in the future development and implementation of management practices in order to minimize road mortalities on the NNSS (FWS 2009).

Results from prior desert tortoise surveys and historical roadside observation/mortality data were analyzed using a Geographic Information System (GIS) to identify areas with higher densities of desert tortoises and areas that may be at higher risk for tortoise mortalities caused by vehicles along NNSS roads. This analysis suggested the need for a better understanding of desert tortoise activity near roads with high desert tortoise use and the effects of the zone of depression (up to 0.4 km from road edges) on tortoise abundance (Boarman and Sazaki 2006).

Desert tortoises may be drawn to roads to forage and drink, especially after summer rains when water collects in depressions on or along roads, thus creating a short-term source of drinking water that may be critical to their survival. Further, roadside vegetation is typically more succulent than non-roadside vegetation due to a water-harvesting effect and stimulated plant growth from roadside maintenance activities such as mowing or blading. In addition, while some efforts to model desert tortoise habitat in the Mojave Desert have been made (Weinstein 1989, Andersen et al. 2000, Nussear et al. 2009), knowledge about fine-scale patterns of habitat use is still lacking.

This research project was appended to the Opinion in April 2012 and implemented in May 2012. The main objectives of this study are to (1) determine fine-scale patterns of habitat use of desert tortoises found near roads on the NNSS, and (2) assess the risk of desert tortoise road mortality on the NNSS. A secondary objective is to assess the health and condition of desert tortoises on the northern periphery of their range. FWS originally approved a handling take limit of twenty adult tortoises for the project and later approved the sample size increase to thirty adult tortoises. Field work for the study came to completion in September 2018.

Starting in the 2012 tortoise active season (March through October), adult tortoises observed on or near NNSS roads were affixed with very high frequency (VHF) transmitters and Global Positioning System (GPS) data loggers to be included in the study. Eleven resident tortoises were included in the study in 2012. An additional seven tortoises were included in the study in 2013 and one tortoise (GOAG13) died from possible predation. Six additional tortoises were added to the study in 2014 with one tortoise (GOAG8) found dead, flipped on its back, with the assumption it was not able to right itself. In 2015, an additional six tortoises were affixed with transmitters and GPS loggers, making a total of 30 tortoises included in the study. One tortoise (GOAG29) was found dead from possible predation in 2015. Gender of the study animals were 12 females, 17 males, and one unknown with ambiguous features. Table 3-3 contains information about each tortoise included in the road study. Tortoises were tracked via radio telemetry on a weekly basis during the active season (March-October) and at least monthly through hibernation (November-February) for a duration of at least two years. GPS loggers recorded a coordinate location every 15, 30, or 60 minutes. The average length of time each tortoise was included in the study was 3.4 years (Table 3-3).

In 2018, six tortoises continued to be tracked and affixed with GPS loggers. Health assessments were conducted on the animals in the spring and GPS loggers were replaced every 4 weeks on each animal through the active season. Transmitters and GPS loggers were removed from the animals by September 2018, when field work came to a completion (Figure 3-4). Health assessments were completed and new paper tags adhered to the animals when their transmitters were removed for future identification.

3.2.1.1 Preliminary Results

Out of the 30 tortoises included in the study, three died and one (GOAG10) was not outfitted with a GPS logger, but was monitored by weekly VHF tracking. The three dead tortoises and GOAG10 were not included in the following preliminary analysis. A fourth tortoise, GOAG 27, was also removed from preliminary analysis due to its misrepresentation of typical tortoise behavior. This tortoise was first observed in the town of Mercury at a gas station and had to be relocated outside the developed area, still well within the boundaries of the NNSS. The tortoise’s movement patterns post-relocation were not consistent with a resident tortoise, rather a translocated tortoise (i.e. large linear movements, not utilizing burrows, pacing tortoise fencing along roadways, etc.).

Table 3-3. Status of tortoises included in the desert tortoise road study and the number of recorded road crossing events (MCL = midline carapace length in millimeters [mm]).

Tortoise ID	Sex	Time Included in Study (Years)	Size MCL (mm)	Status	Number of Paved Road Crossing Events
GOAG 1	F	3.42	285	Transmitter Removed	6
GOAG 2	F	3.39	233	Transmitter Removed	1
GOAG 3	M	3.35	288	Transmitter Removed	0
GOAG 4	F	4.42	257	Transmitter Removed	23
GOAG 5	F	3.36	243	Transmitter Removed	0
GOAG 6	M	3.35	227	Transmitter Removed	0
GOAG 7	F	3.28	238	Transmitter Removed	0
GOAG 8	F	2.26	258	Dead, Flipped	NA
GOAG 9	F	4.26	251	Transmitter Removed	23
GOAG10	M	3.20	230	Transmitter Removed	No GPS Data Collected
GOAG11	M	4.02	257	Transmitter Removed	40
GOAG12	F	3.49	277	Transmitter Removed	15
GOAG13	M	0.12	206	Dead, Suspect Predation	NA
GOAG14	F	3.37	214	Transmitter Removed	13
GOAG15	M	4.07	280	Transmitter Removed	18
GOAG16	M	4.01	307	Transmitter Removed	21
GOAG17	M	3.14	282	Transmitter Removed	10
GOAG18	M	3.08	277	Transmitter Removed	0
GOAG19	F	3.38	232	Transmitter Removed	0
GOAG20	U	3.30	180	Transmitter Removed	Not Calculated
GOAG21	M	3.26	286	Transmitter Removed	18
GOAG22	M	3.51	215	Transmitter Removed	6
GOAG23	M	3.05	258	Transmitter Removed	4
GOAG24	M	2.97	268	Transmitter Removed	0
GOAG25	M	3.49	241	Transmitter Removed	18
GOAG26	F	3.38	212	Transmitter Removed	0
GOAG27	M	3.32	250	Transmitter Removed	Not Included in Analysis
GOAG28	M	3.17	215	Transmitter Removed	0
GOAG29	F	0.05	255	Dead, Suspect Predation	NA
GOAG30	M	2.95	279	Transmitter Removed	44

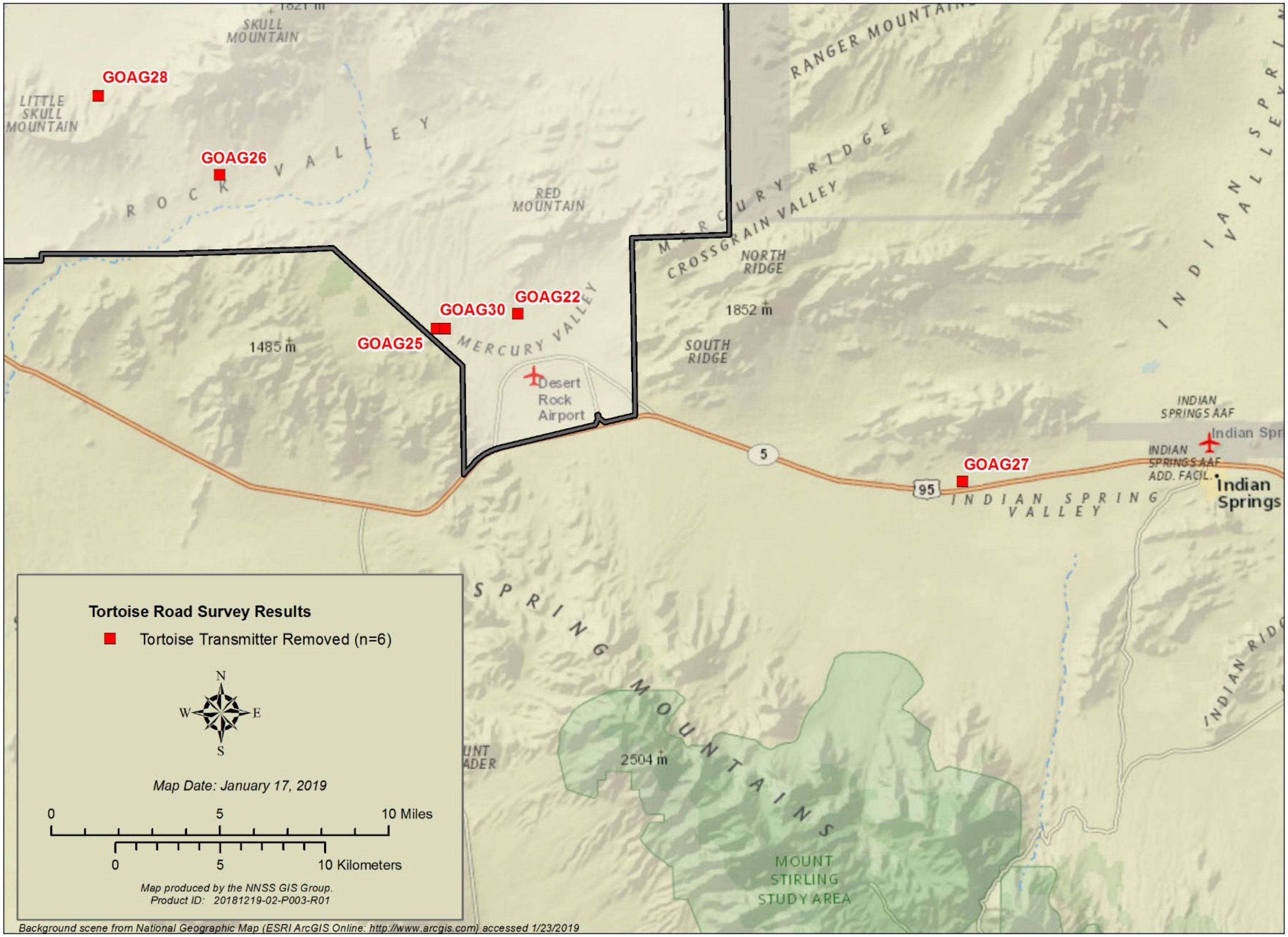

Figure 3-4. Locations of six tortoises monitored during 2018 at the time their transmitters were removed, Fall 2018.

3.2.1.2 Observational Behaviors

During tracking events, tortoises were observed spending 64% of their time underground, 19% of their time above ground and 17% of their time under vegetation. It is typical that tortoises spend most of their time underground, escaping hot or cold temperatures. When tortoises were observed above ground, foraging activity (i.e. eating or evidence of plant material on mouth) was observed during about half the tracking events (52%). Foraging events typically peaked from April through May, with the most foraging events documented in 2015 and 2016. When seeking underground refugia, tortoises were observed using soil burrows, caliche burrows, rock burrows (a burrow dug directly beneath a rock), rock shelters (typically a rock overhang), and culverts (Figure 3-5). Tortoises were observed more often in soil burrows than other types of refugia (Figure 3-5). Study animals utilized a variety of shrubs for shade and protection with four plant genera playing an important role: *Larrea*, *Coleogyne*, *Lycium* and *Ephedra* (Figure 3-6).

3.2.1.3 Road Crossing Events

The direct and indirect impacts roads have on the desert tortoise have long been identified as contributors to population declines. Increased traffic in tortoise habitat from construction projects and other human activities increase the likelihood of road kill tortoises (FWS, 2011). The NNSS averages 1.2 tortoise road kills a year (ranging from zero to three). In order to develop mitigation strategies to reduce road mortalities, a better understanding of road crossing events is needed. Peaden et al. (2017) defined a road crossing event as the movement path a tortoise made which crossed over a 10 m buffer on either side of the road, along with the width of the road. This accounts for GPS data recording errors as well as discrepancies with defining the width of the road (Peaden et al. 2017). The following preliminary analysis remains consistent with this definition but will likely be adjusted for future analysis to account for differences in GPS equipment.

A total of 260 road crossing events were recorded by 15 tortoises during the study. Nine tortoises were not documented to have crossed roads (Table 3-3). Only paved road crossing events were calculated. All road crossing events recorded during the study were successful, meaning no study tortoises were injured or killed while attempting to cross roads. The number of tortoises moved out of harm's way off NNSS roads is documented per the Opinion. Marked tortoises were moved 13 times off roads. Future analysis for road crossing events will include timing, topographic locations, road avoidance behaviors, and duration of events.

3.2.1.4 Road-effect Zone

The road-effect zone was defined by Forman in several of his studies as the total area affected by the installation and use of roads "over which ecological effects extend many times wider than the road" (Forman et al. 1997, Forman and Deblinger 1999, and Forman 2000). Results from many studies have supported the road-effect zone and have shown the effects extending out to 800 m from the road for the desert tortoise (Nicholson 1978, LaRue 1992, Boarman and Sazaki 2006, and Nafus et al. 2013). These studies were conducted by walking transects at different distances from the road to identify tortoise sign (i.e. scat, tracks, burrows, live/dead tortoises). Boarman and Sazaki (2006) found a statistically significant lower mean sign count (0.2/km) directly alongside of Highway 58 in California in comparison to 400, 800 and 1600 m from the road "suggesting that tortoise populations in [the] study area are depressed in a zone extending at least 400 m from roadways". Nicholson (1978) found tortoise populations become consistent after 800 m from the road and LaRue (1992) found a steady increase in tortoise sign from the road out to 305 m.

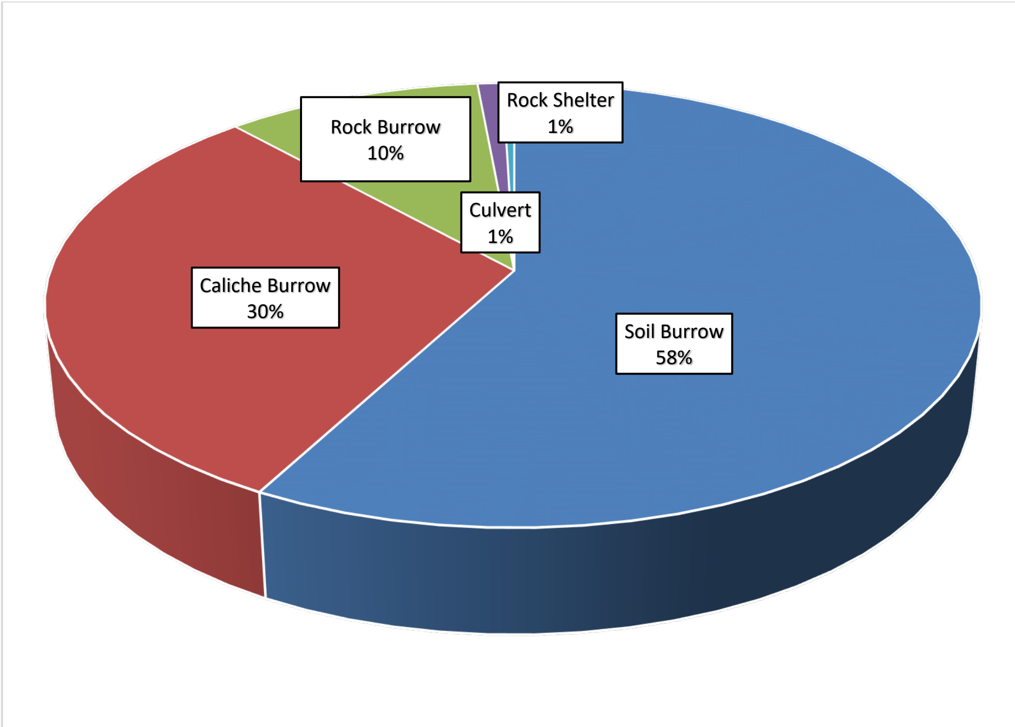

Figure 3-5. Percentage of observations by underground refugia type for 26 adult resident tortoises, May 2012 to October 2018.

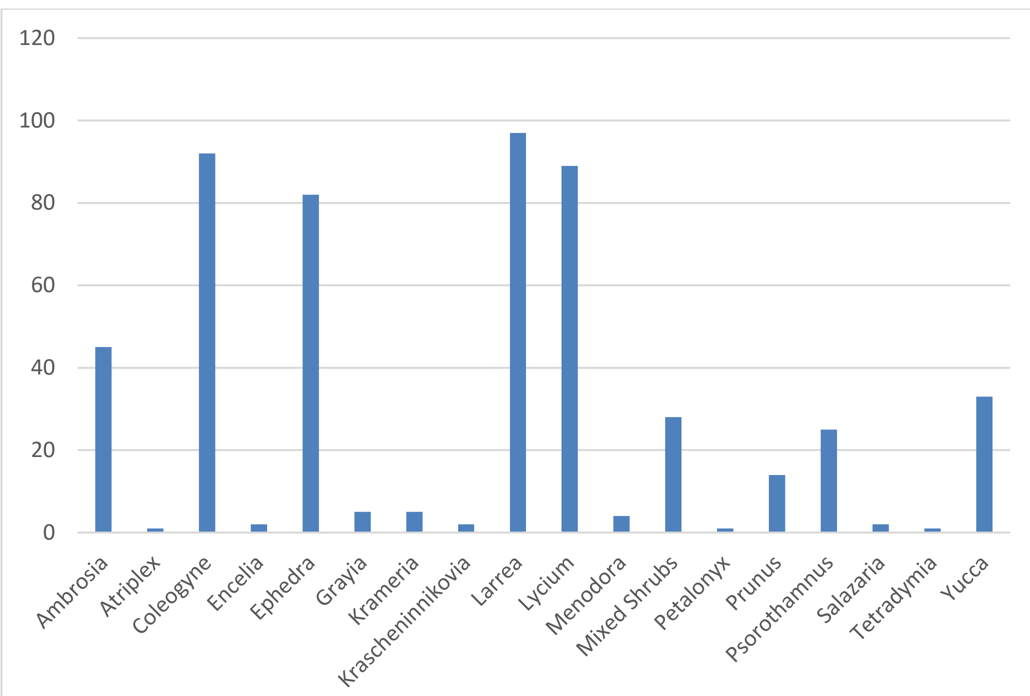

Figure 3-6. Number of times tortoises were observed under vegetation by plant genera, May 2012 to October 2018.

Previous studies have shown that the impacts of the installation of roads in tortoise habitat can extend outward beyond the footprint of the road, contributing to a decrease in tortoise abundance and activity (sign) in habitat close to the road (0-400 m). Our study creates an opportunity to explore the habitat use of tortoises who live near roads through their movement patterns. Using the assumption that decreased tortoise sign near roads is evidence of decreased habitat use, we hypothesize tortoises who live near paved roads spend a majority of their time further (>400 m) from roads.

There were 18 tortoises within our study whose home ranges overlapped a paved road. A total of 273,509 tortoise locations were recorded for these animals during the study either by VHF tracking or GPS logger. On average, data was collected on each tortoise for 3.4 years with a mean of 15,195 locations per tortoise (range 5,209-28,143).

The amount of time each tortoise spent near paved roads is summarized in Table 3-4 and Figure 3-7. This was calculated by summing the recorded tortoise locations within each interval (0-200 m, 201-400 m, 601-800 m, etc.) and dividing it by the total recorded tortoise locations for each animal. On average tortoises spent a majority of their time (37%) 201-400 m from paved roads (Figure 3-7; range 0.9-66.4%). Tortoises spent 23% of their time within 200 m of paved roads (range 0.6-68.1%). The trend shows a steady decrease in activity as the distance increases from the road (Figure 3-7). This could suggest the road-effect zone for paved roads on the NNSS may be minimal, as study animals spent most of their time near roads and all crossing attempts were successful.

There could be several reasons our movement pattern data is not supporting trends shown in previous studies. The first could be the amount of traffic on NNSS paved roads is low, ranging from 66 to 601 vehicle passes per day. Several of the previously mentioned studies included highways having well over 1,000 vehicle passes per day (Peaden et al. 2017, Nafus et al. 2013, and Boarman and Sazaki 2006). The 2013 study by Nafus et al. found that "tortoise sign had lower relative abundances at least 200 m from roads with the highest traffic volumes" with traffic volume ranging from less than one vehicle per day to 1,100. This trend will be analyzed with our study data in order to determine if it holds true with a lower maximum vehicle daily traffic limit (601/day).

The second could be that some previous studies focused on roads which were bound by tortoise exclusion fencing which restrict tortoises from crossing roads and establishing home ranges overlapping roads. Future analysis for our study may offer insight on the ongoing conflict between the negative and positive impacts that the installation of tortoise exclusion fencing has on the desert tortoise, especially for areas with low traffic volume.

3.2.2 Juvenile Translocation Study

In September 2012, 60 captive juvenile tortoises were translocated from the Desert Tortoise Conservation Center in Las Vegas to the southern edge of the NNSS in Area 22 to evaluate the survival of juvenile tortoises released in the wild. The NNSS provides one of the largest protected habitat areas in southern Nevada. The project is part of a long-term collaborative effort involving the FWS, MSTS, and the San Diego Zoo Institute for Conservation Research (ICR). Few studies have investigated translocated juvenile tortoise survival, so data obtained from this study will be valuable to assess translocation as a possible means of tortoise recovery.

Each tortoise was affixed with a VHF transmitter prior to release for post-release monitoring purposes. Regular monitoring of the animals occurred post-release from 2012 through 2018. During 2018, monitoring was conducted once in January and February, weekly in March and April, three times in May and June, twice in July and August, three times in September, weekly in October, twice in November and once in December. Additional monitoring was conducted in January 2019 to determine each tortoise's

Table 3-4. Percent of time study animals spent near roads. Highest percentages are bold type.

Tortoise ID	0-200m	201-400m	401-600m	601-800m	801-1000m	1001-1200m	1201-1400m	>1400m
GoAg01	23.2	15.2	**55.2**	4.0	2.5	0.0	0.0	0.0
GoAg02	6.5	**62.3**	11.5	18.0	0.7	0.5	0.3	0.0
GoAg04	**58.7**	33.2	7.6	0.4	0.0	0.0	0.0	0.0
GoAg06	30.2	**48.0**	19.4	2.5	0.0	0.0	0.0	0.0
GoAg09	27.2	**63.2**	9.6	0.0	0.0	0.0	0.0	0.0
GoAg11	11.7	**66.4**	16.7	4.7	0.5	0.0	0.0	0.0
GoAg12	45.1	**54.9**	0.0	0.0	0.0	0.0	0.0	0.0
GoAg14	42.5	**48.8**	8.7	0.0	0.0	0.0	0.0	0.0
GoAg15	10.3	**59.9**	25.9	3.8	0.0	0.0	0.0	0.0
GoAg16	6.8	16.1	**44.2**	23.1	8.2	1.5	0.0	0.0
GoAg17	24.6	**44.6**	28.8	2.0	0.1	0.0	0.0	0.0
GoAg18	24.2	**65.7**	10.2	0.0	0.0	0.0	0.0	0.0
GoAg19	0.6	**58.9**	40.4	0.1	0.0	0.0	0.0	0.0
GoAg20	**68.1**	31.6	0.3	0.0	0.0	0.0	0.0	0.0
GoAg21	2.6	2.3	11.8	**54.6**	21.6	6.4	0.8	0.0
GoAg22	7.8	11.7	**43.0**	14.5	2.5	3.4	10.7	6.4
GoAg23	0.9	0.9	8.6	8.8	15.3	**35.5**	12.7	17.5
GoAg25	14.9	**22.8**	8.7	8.4	9.2	9.8	9.2	16.9
GoAg26	2.5	1.1	7.5	11.1	**53.2**	6.8	0.1	17.5
GoAg30	24.5	**25.0**	13.8	24.5	8.0	4.2	0.0	0.0

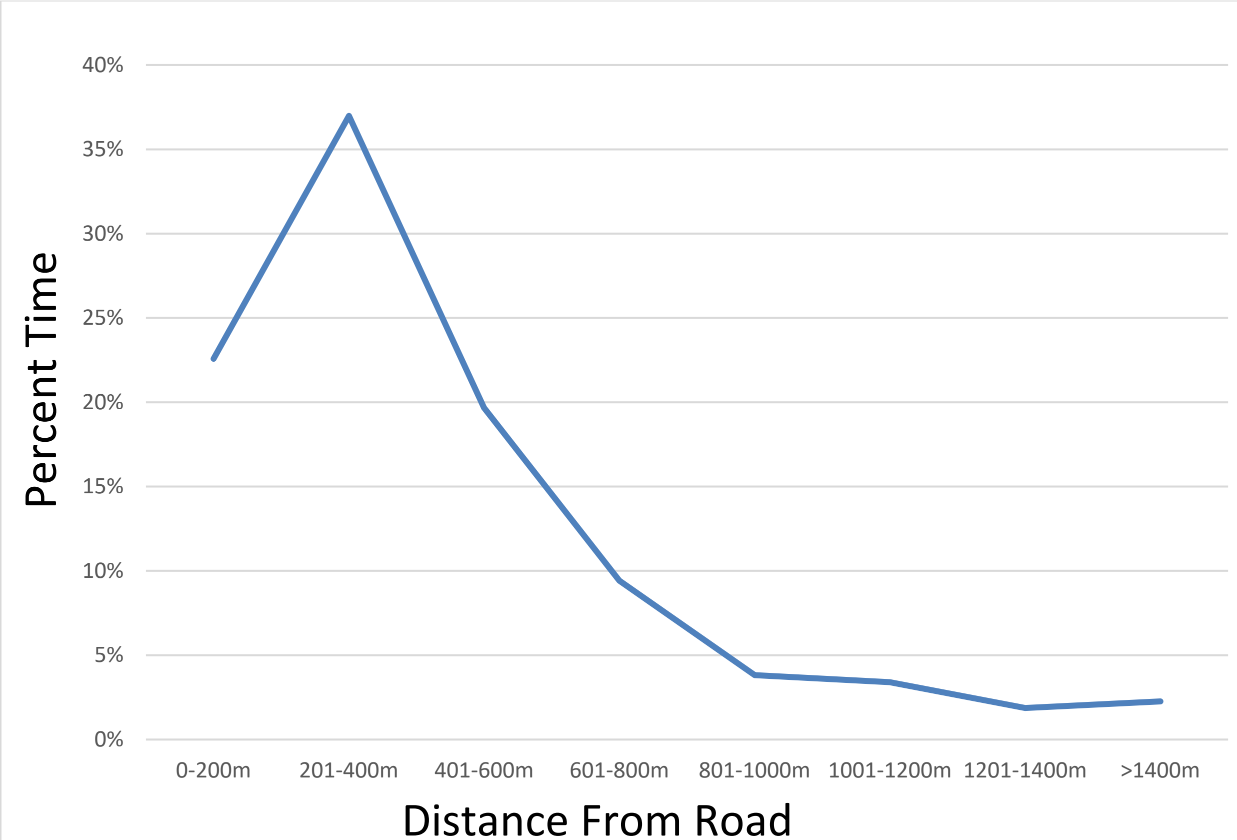

Figure 3-7. Average time study animals spent at different intervals from the road. Paved roads were at zero meters.

winter burrow. At the beginning of 2018, 27 of 60 (45%) tortoises were alive. Three tortoises died during 2018 (4009, 4037, 4050) leaving 24 of 60 (40%) alive at the end of 2018 (Table 3-5). Female 4009 was found on July 9, 2018, and died due to suspected exposure; Male 4037 was found on July 23, 2018, and died due to assumed predation; and Male 4050 was found on October 8, 2018, and died due to assumed predation. In late August, 4050 moved several kilometers (km) to the southeast and returned back near his release site in late September. He moved at least 8.1 km between August 20 and October 8. Whether this contributed to his death is unknown but he was found away from a burrow during most of this time. Figure 3-8 shows the release locations for all 60 translocated juveniles, the winter burrows for the surviving 24 tortoises, and the location of the dead tortoises.

After 76 months post-release, 24 of the 60 juveniles were still alive (40% survival). This is slightly higher but similar to an estimated 38% survival (23 of 60 tortoises alive) based on an annual survival rate of 0.85 that Turner et al. (1987) calculated in a natural population (Roy Averill-Murray, FWS, personal communication, February 7, 2017). There is a much higher survival rate for males (53% [16 of 30]) compared to females (28% [8 of 29]) with most of the mortalities suspected as coyote and kit fox predations. Given the importance of females surviving to adulthood to reproduce, this may be a critical life stage for females, and if female juveniles are not surviving to sexual maturity, this could lead to a decline in tortoise populations. The ratio of females to males for adults and particularly juveniles, as well as differential mortality between the sexes warrants further study in wild tortoise populations.

Table 3-5 contains information about the 27 juvenile tortoises monitored during 2018. On average, the distance between the release location and winter 2018-2019 burrow (i.e., the burrow a juvenile was in

Table 3-5. Mortality, sex, distance in meters (m) between release site and January 2019 burrow, distance between January 2018 burrow and January 2019 burrow, total distance between monitored locations (January 2018 to January 2019), and total number of burrows and new burrows occupied by 27 juvenile desert tortoises monitored during 2018 (* = Found dead during 2018, NA = Not Applicable).

Tortoise Number	Sex	Distance (m) Release to Winter 2018-19	Distance (m) Jan. 18 burrow to Jan. 19 burrow	Total Distance (m) between locations Winter 2018-19	Number of burrows used (New burrows)
4009*	Female	NA	NA	NA	NA
4010	Female	1227	64	1267	4 (3)
4014	Female	532	28	514	6 (3)
4030	Female	2377	105	2172	8 (5)
4039	Female	45	199	1249	7 (6)
4044	Female	216	29	1061	7 (4)
4045	Female	188	0	831	5 (3)
4046	Female	436	66	2475	9 (8)
4049	Female	1253	9	304	2 (1)
4004	Male	56	23	1263	7 (3)
4005	Male	241	18	1043	5 (4)
4007	Male	156	0	555	4 (1)
4011	Male	140	0	3752	6 (4)
4019	Male	343	0	2085	6 (4)
4024	Male	1320	613	3528	7 (6)
4025	Male	1127	52	975	7 (2)
4033	Male	125	0	719	2 (0)
4034	Male	215	55	1379	6 (3)
4036	Male	575	175	1899	7 (2)
4037*	Male	NA	NA	NA	NA
4038	Male	246	186	2554	5 (4)
4040	Male	585	121	1542	3 (2)
4041	Male	116	114	1058	7 (4)
4048	Male	253	254	3214	12 (7)
4050*	Male	NA	NA	NA	6 (5)
4053	Male	304	50	297	4 (2)
4055	Male	6251	194	1570	3 (2)
	Average	764	98	1554	5.5

during the first part of January 2019) was 764 m (range 45–6,251 m; standard deviation [sd] 1,295 m). Two-thirds (16 of 24) of the tortoises wintered in burrows within 100 m of their last year's winter burrow, and 21% (5 of 24) of them used the same winter burrow as the previous year.

The distance (m) between monitoring checks was calculated and is summarized in Table 3-5. This is not the total distance a tortoise moved during the year, but the summed distance between locations recorded during regular monitoring. It is important to note that movements tortoises made between monitoring checks were not recorded or measured. For females the average distance moved was 1,234 m, and for males 1,715 m. A two-tailed, t-test was used to determine if this difference was statistically significant at α (alpha level) = 0.05. It was not significant (p [probability] = 0.27).

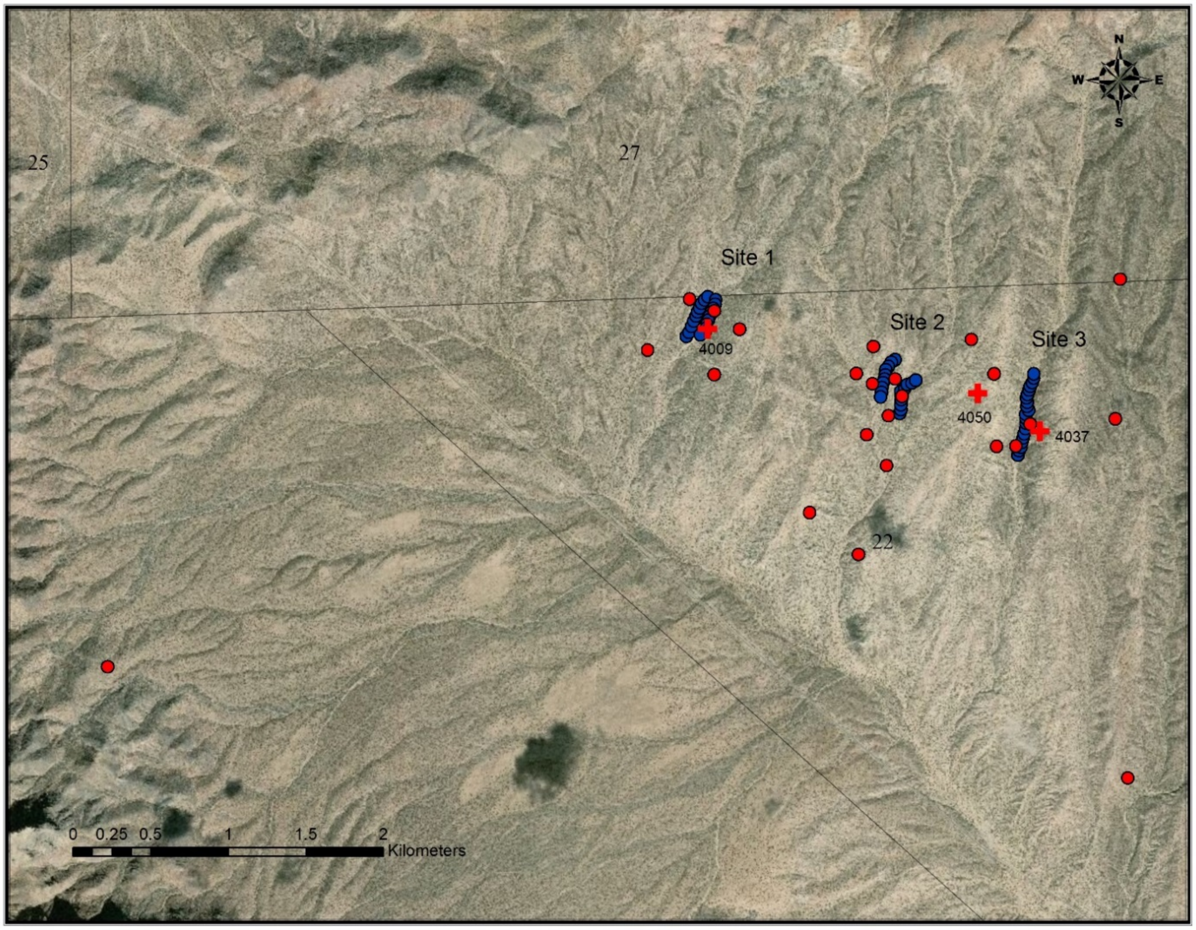

Figure 3-8. Release locations for 60 tortoises, September 2012 (blue dots, 20 at each site) and locations for 24 tortoises (red dots) January 2019. The red crosses are the locations of the dead tortoises (4009, 4037, and 4050).

During 2018, burrows were marked with unique numbers and data collected included Universal Transverse Mercator (UTM) coordinates (North American Datum [NAD] 83), burrow height, burrow width, burrow orientation, elevation, location, topographic position, vegetation cover and substrate. The number of unique burrows an individual used was calculated and is shown in Table 3-5. It is important to note that tortoise burrows were only documented during tracking checks, and therefore all burrows used may not have been documented. A total of 146 unique burrows were used by the 27 tortoises, and the number of new burrows marked and measured during 2018 was 88. The average height of burrows was 11.4 mm (range 7-28 mm; sd 4.1 mm) and average width of burrows was 22.8 mm (range 16-43 mm; sd 4.4 mm).

On average, tortoises used 5.8 unique burrows (range 2-12; sd = 2.2) (Table 3-5) with no significant difference between females (6.0 burrows) and males (5.8 burrows) ($p = 0.81$). One burrow (#12) was occupied by Female 4009 and Male 4034 on May 14, 2018. Timing of arrival at winter burrows differs between years (Table 3-6) and appears to be influenced by temperature and moisture. If enough moisture is received in the fall to cause plant germination and regrowth and temperatures are mild, tortoises continue to move around and forage into November (Hall et al. 2016).

Table 3-6. Percentage of tortoises at their winter burrow by October 1 and October 23 and the date by which all tortoises were at their winter burrows for the years 2014–2018.

Year	By October 1	By October 23	Date All Tortoises at Winter Burrow
2014	53	90	November 18
2015	4	37	November 23
2016	15	26	November 7
2017	41	89	November 6
2018	38	96	October 29

Observations made while tracking from January 2018 to January 2019 on the 27 surviving juvenile tortoises totaled 864. Figure 3-9 illustrates where tortoises were observed in relation to their burrow, in the open, or under vegetation. More than three-fourths of the observations were of tortoises either inside their burrows, in their burrow entrance, or on the burrow apron. The remaining one-fourth of the observations found tortoises in the open or under vegetation. Tortoises were found under 15 different vegetation species and under mixed shrub clumps. Figure 3-10 depicts the percentage of observations tortoises were found under vegetation by species. Most noteworthy is the dominance of blackbrush (*Coleogyne ramosissima*) and Nevada jointfir (*Ephedra nevadensis*) with more than one-half of observations of tortoises found under these two species. Mixed shrub clumps were also important. The "Other" category included creosote bush (*Larrea tridentata*) (2.8%), water jacket (*Lycium andersonii*) (2.1%), burrobrush (*Hymenoclea salsola*) (2.1%), shinyleaf sandpaper plant (*Petalonyx nitidus*) (2.1%), spiny hopsage (*Grayia spinosa*) (2.1%), turpentinebroom (*Thamnosma montana*) (2.1%), Mojave yucca (*Yucca schidigera*) (1.4%), and white bursage (*Ambrosia dumosa*), desert prince's plume (*Stanleya pinnata*), and woolly brickellbush (*Brickellia incana*) at <1% each.

For the 88 new burrows, tortoises used burrows on wash slopes nearly 60% of the time followed by burrows in wash bottoms, ridgetops and washlets (Figure 3-11). Vegetation cover at burrows was found at 92% of the burrows, suggesting this is an important factor in burrow selection for these juveniles (Figure 3-12). Mixed shrub clumps seemed to be the dominant cover followed by Nevada jointfir, pale desert thorn (*Lycium pallidum*), creosote bush, water jacket, and blackbrush (Figure 3-12). The other category was made up of spiny hopsage (5%), burrobrush (5%), littleleaf ratany (*Krameria erecta*) (1%), Shockley's goldenhead (*Acamptopappus shockleyi*) (1%), Mojave yucca (*Yucca schidigera*) (1%), winterfat (*Krascheninnikovia lanata*) (1%), Fremont's dalea (*Psorothamnus fremontii*) (1%), and red brome (*Bromus rubens*) (1%).

Gravel was the dominant substrate and was observed at nearly two-thirds of all new juvenile tortoise burrows (Figure 3-13), followed by gravel/cobble and gravel/sandy. Gravel is defined as rocks <2.5 centimeters (cm) in size, cobble as rocks between 2.5 and 12.7 cm, rock as >12.7 cm, and solid rock is bedrock. The other category is made up of gravel/rock (2%), gravel/caliche (1%), gravel/solid rock (1%), and sandy/cobble (1%). Combined categories such as gravel/sandy means that both were equal in abundance.

Evidence of foraging was documented on 25 of the 27 tortoises 89 times between March 5 and October 2, 2018, with one foraging peak in April (41 times) (Figure 3-14). The most common observed species eaten were desert globemallow (*Sphaeralcea ambigua*) (2.4%) and red brome (*Bromus rubens*) (2.4%) (Figure 3-15). Most (94%) of the time, it was not possible to identify what the tortoises had eaten. One tortoise (4010) was observed eating dried tortoise scat on May 21, 2018. Winter and spring precipitation was

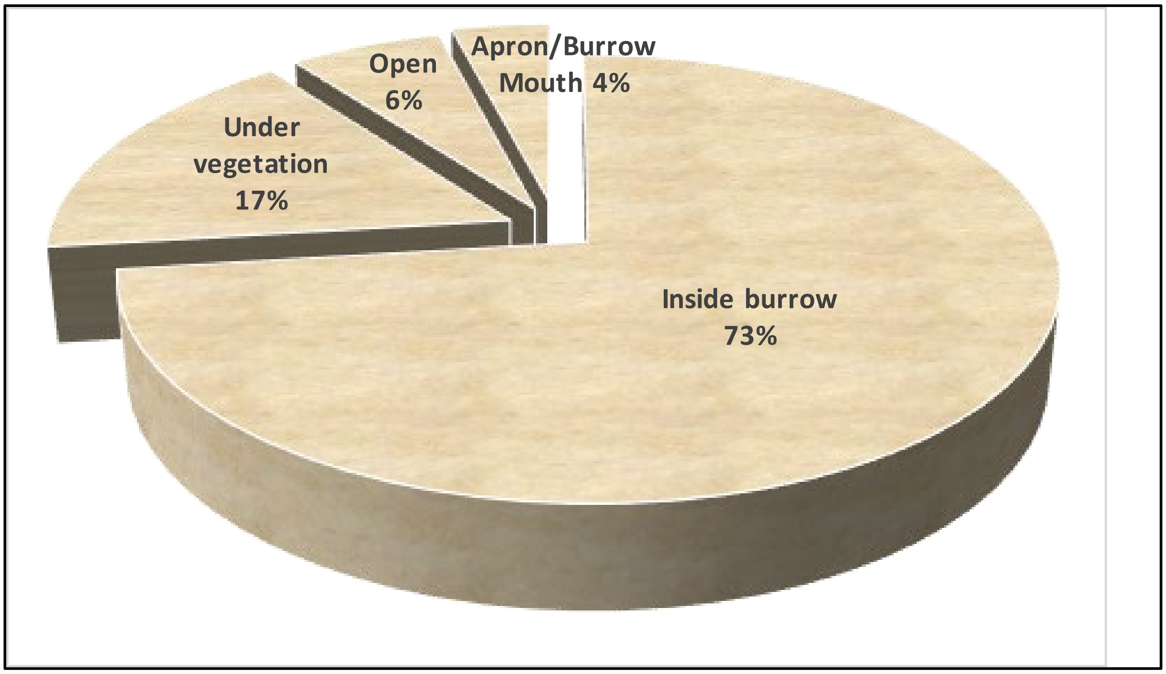

Figure 3-9. Percentage of observations (n=864) of 27 juvenile tortoises by location, January 2018–January 2019.

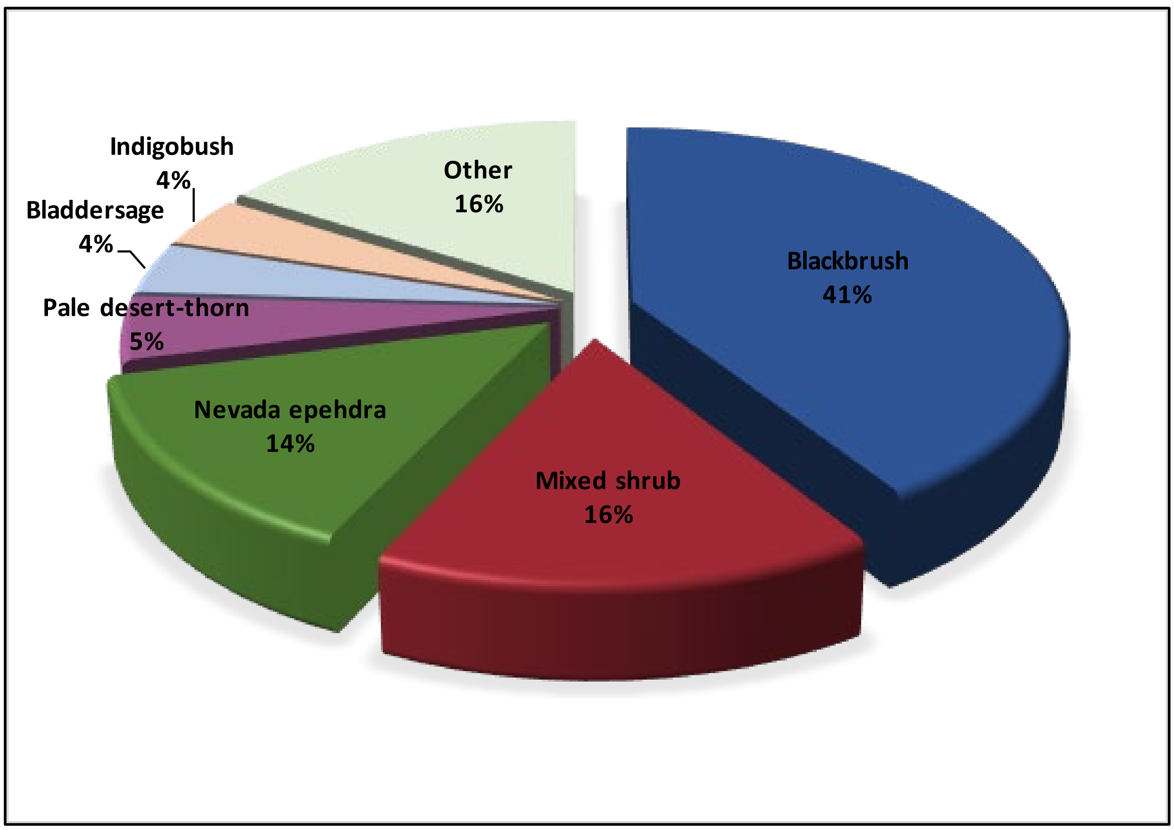

Figure 3-10. Percentage of observations (n=141) of 27 juvenile tortoises found under vegetation by species, January 2018–January 2019.

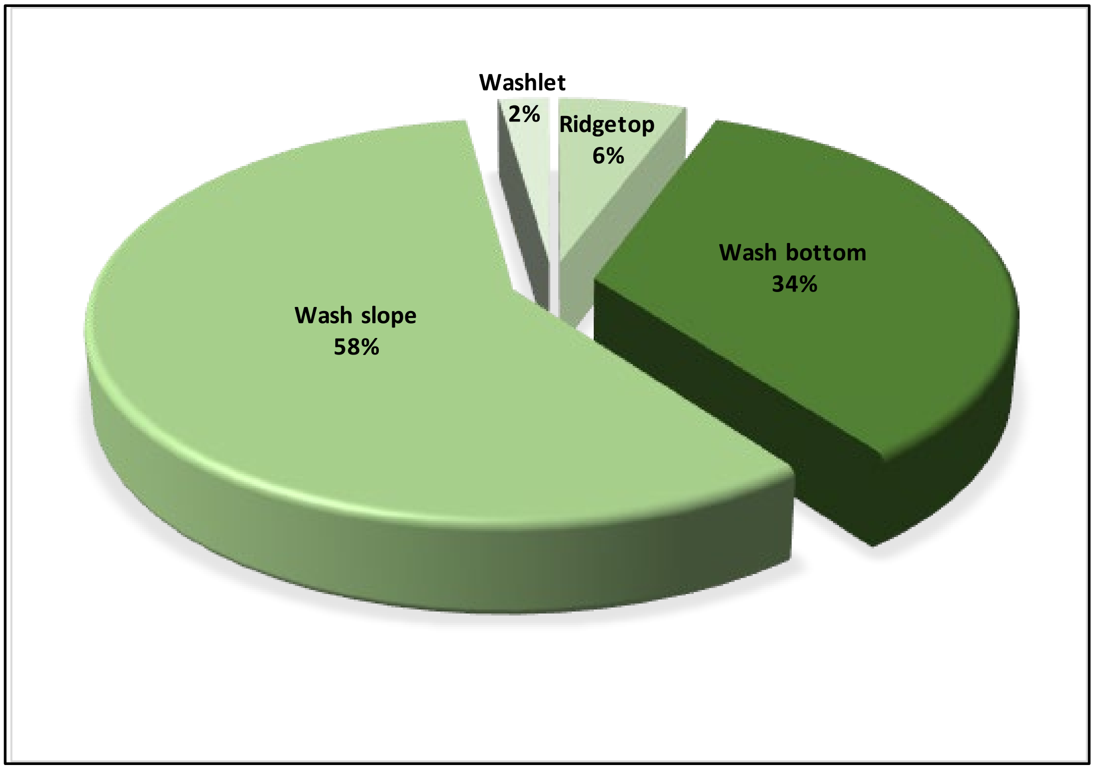

Figure 3-11. Percentage of juvenile tortoise burrows by topographic position, January 2018–January 2019 (n=88).

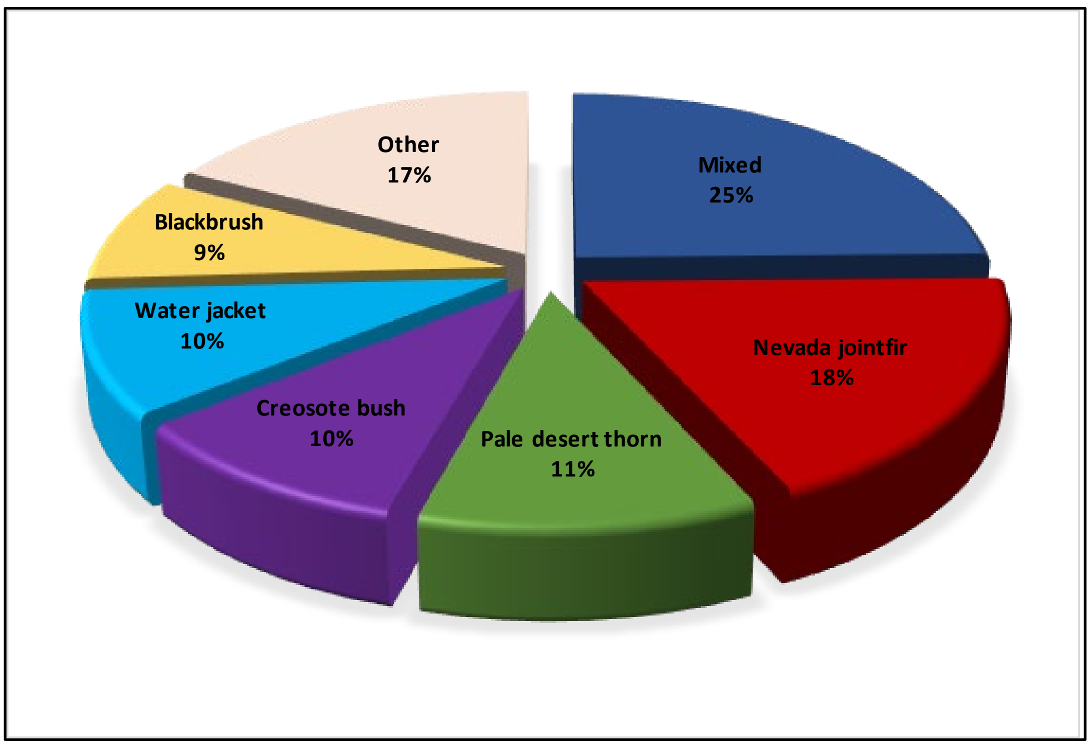

Figure 3-12. Percentage of juvenile tortoise burrows by vegetation cover at the burrow, January 2018–January 2019 (n=88).

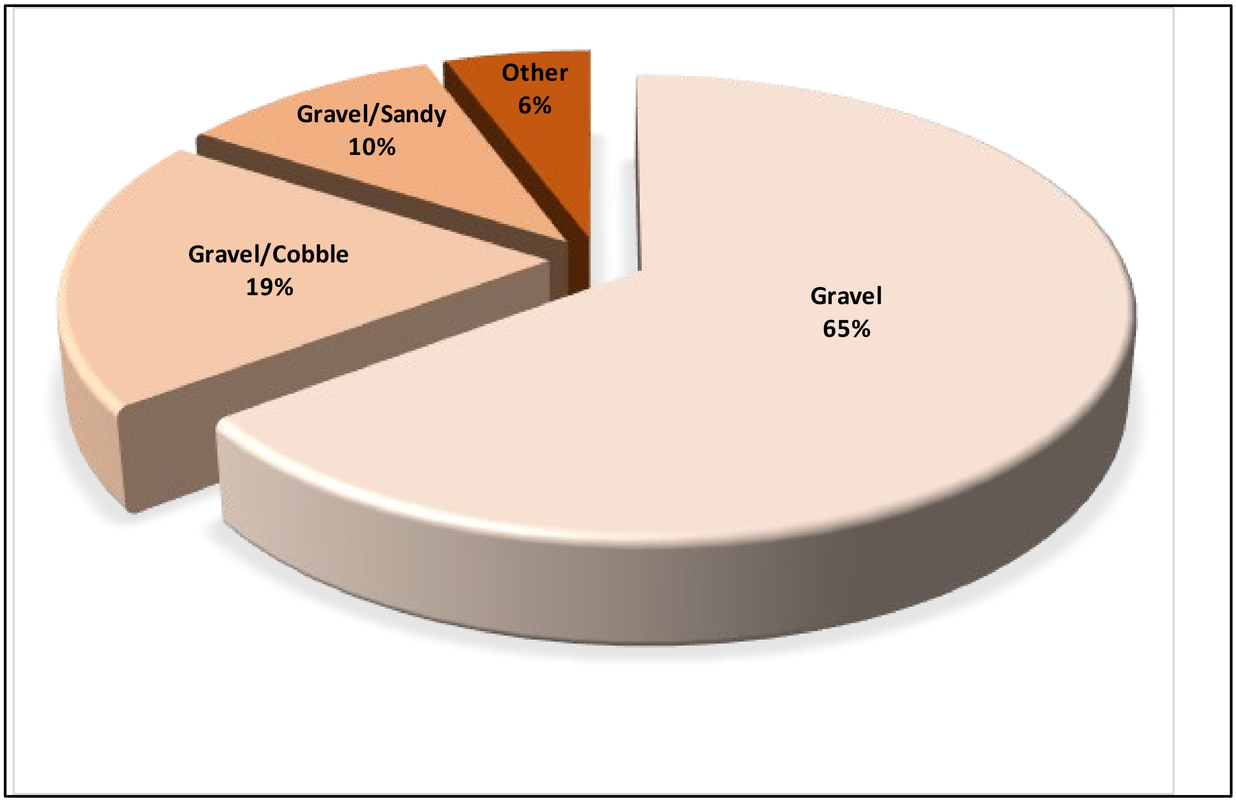

Figure 3-13. Percentage of juvenile tortoise burrows by substrate, January 2018–January 2019 (n=88).

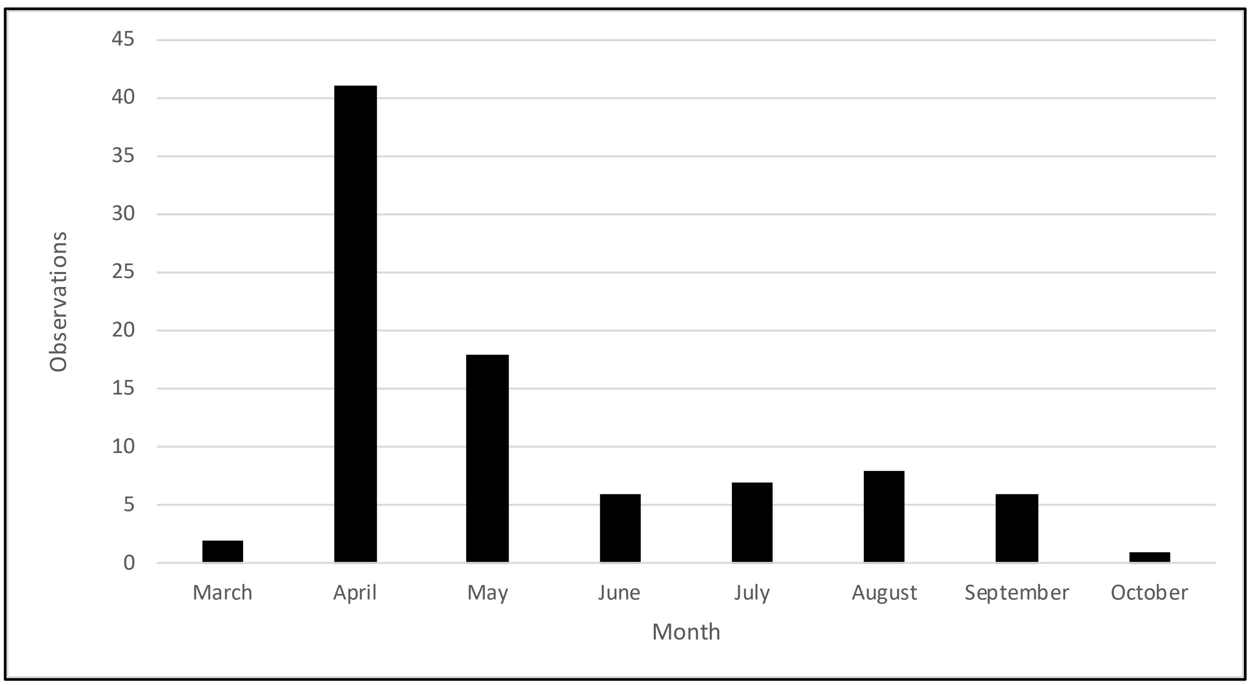

Figure 3-14. Number of times evidence of foraging was detected by month for 27 juvenile tortoises, January 2018–January 2019 (n = 89) (no evidence of foraging was detected in November, December, January, or February).

Figure 3-15. Male tortoise (#4055) eating red brome.

(Photo by D.B. Hall June 5, 2018).

about half of normal resulting in poor vegetation production during the spring green-up. Summer/fall precipitation was also below normal which resulted in reduced plant production. Some globemallow plants and a few other species grew new leaves in the fall but this green-up was highly localized.

Six-month transmitters were changed on three tortoises in the spring, and all transmitters were changed in the fall. All remaining tortoises in the fall were big enough to attach 12-month transmitters. During fall 2018, 25 tortoises were given a detailed health assessment including Male 4050 which was found dead on October 8, 2018. Tortoises were weighed, measured, and assigned a body condition score (1-3 = under condition, 4-6 = good condition, 7-9 = over condition) (Table 3-7). Tortoises were also assessed in spring 2018 (Table 3-7). Similar health assessments were performed pre-release in August and September 2012 (Table 3-7). This allows for comparison of growth rates, weight change and overall health and body condition score over time.

On average, the surviving 25 translocated juvenile desert tortoises increased 38 mm in MCL and 561 g in weight (without transmitters) from fall 2012 to fall 2018. Results from a two-tailed t-test showed there was no significant difference ($\alpha = 0.05$) in MCL growth between females (33 mm) and males (40 mm) ($p = 0.13$) or in weight gain between females (465 g) and males (607 g) ($p = 0.17$). Average growth in MCL from spring 2018 to fall 2018 was 5 mm with males growing significantly more (6 mm) than females (4 mm) ($p = 0.04$). Body condition scores indicated all tortoises were in good condition in 2018.

The main factor for survival appears to be gender with higher survival of males than females. This has been observed by other researchers as well (Melia Nafus, ICR, personal communication, December 4, 2014). Size, weight, overall health, and presence of *Mycoplasma* species (bacteria that causes upper

Table 3-7. Midline carapace length (MCL) (mm), weight without transmitters (g), and body condition score in Fall 2012, Spring 2018, and Fall 2018, including MCL growth and weight gain from Fall 2012 to Fall 2018 and MCL growth Spring 2018 to Fall 2018 (* = dead October 8, 2018).

Tortoise Number	Sex	Pre-release MCL (mm) (2012)	MCL (mm) (Spring 2018)	MCL (mm) (Fall 2018)	MCL Growth (mm) (2012-2018)	MCL Growth (mm) Spring 2018 to Fall 2018	Pre-release Weight (g) (2012)	Weight (g) (Fall 2018)	Weight gain (g) (2012-2018)	Pre-release Body Condition (2012)	Body Condition (Spring 2018)	Body Condition (Fall 2018)
4009	Female	138	141	DEAD	DEAD	DEAD	472	DEAD	DEAD	4	4	DEAD
4010	Female	142	167	172	30	5	590	1100	510	4	4	4
4014	Female	136	153	157	21	4	485	738	253	5	4	4
4030	Female	148	179	181	33	2	562	1200	638	4	5	4
4039	Female	117	150	154	37	4	315	785	470	5	4	4
4044	Female	146	168	173	27	5	484	1049	565	4	4.5	4
4045	Female	129	152	158	29	6	400	808	408	4	4.5	4.5
4046	Female	126	170	172	46	2	476	1021	545	4	4.5	4.5
4049	Female	106	135	140	34	5	238	570	332	4	4.5	4
4004	Male	117	143	150	33	7	303	648	345	4	4	4
4005	Male	140	164	170	30	6	564	1042	478	5	5	4.5
4007	Male	121	128	132	11	4	363	470	107	5	4	4
4011	Male	144	187	199	55	12	634	1400	766	4	5	5
4019	Male	150	198	202	52	4	654	1600	946	4	4.5	4
4024	Male	146	201	205	59	4	565	1500	935	5	4.5	4.5
4025	Male	127	162	166	39	4	357	938	581	5	4.5	4.5
4033	Male	126	139	142	16	3	430	592	162	4	4	4
4034	Male	128	162	170	42	8	407	1011	604	4	4	4
4036	Male	132	172	180	48	8	455	1100	645	4	4.5	4.5
4037	Male	105	117	DEAD	DEAD	DEAD	223	DEAD	DEAD	4	4	DEAD
4038	Male	132	190	202	70	12	457	1400	943	4	5	4.5
4040	Male	140	162	168	28	6	493	919	426	4	4	4.5
4041	Male	119	141	147	28	6	322	618	296	4	4	4
4048	Male	135	205	213	78	8	480	2100	1620	5	5	5
4050	Male	138	170	173*	35	3	502	1000*	498	4	4.5	5*
4053	Male	150	162	166	16	4	681	945	264	4	4.5	4
4055	Male	151	194	197	46	3	602	1300	698	4	4	4

respiratory disease in tortoises) do not seem to have any significant impact on survival. While it is impossible to determine if a tortoise was scavenged or preyed upon, a majority of dead tortoises have shown signs of being chewed on by mammalian predators. Given the presumed healthy status and low disease prevalence in the juveniles, it seems unlikely that they are dying and then being scavenged. This suggests that most of the mortality is due to predation. Coyote (*Canis latrans*) and kit fox (*Vulpes macrotis*) tracks have been observed on multiple occasions while conducting tortoise monitoring, and these canids appear to be the main predators predating study animals. To better understand the predator community and visitation frequency, a camera trap was set up at Site 2 for 140 days from March to August, 2017, and for 318 days between January and December, 2018, for a total of 458 days. Results showed eight coyote images which is about one every 57 days, five kit fox images which is about one every 92 days, six badger (*Taxidea taxus*) images which is about one every 76 days, and four bobcat (*Lynx rufus*) images which is about one every 115 days.

Why canid predation is higher on females than males is a question yet to be answered. Coyotes and kit foxes use olfaction as one of their dominant senses, therefore it is possible that females are giving off scent that makes them easier to detect. Another possibility is females spend more time aboveground or travel farther, thus making them more susceptible to predation. An analysis conducted on March to October observations from 2012-2017 showed that females actually spend more time in their burrows ($p = 0.01$) and less time in the open ($p = 0.02$) than males and that females and males travel similar distances ($p = 0.76$).

In order to help better understand the interaction between tortoises and their predators, oral, cloacal, and chin/forelimb swabs were collected from all 27 juvenile tortoises and 27 adult tortoises from the road study (10 females, 16 males, 1 unknown) during fall 2015. Additional samples were taken from 26 juveniles (18 males, 8 females) and 12 adults (9 males, 2 females, 1 unknown) during fall 2017. These samples were sent to Dr. Bruce Kimball at the Monell Chemical Senses Center in Philadelphia, Pennsylvania and analyzed using headspace gas chromatography/mass spectrometry to describe chemical signatures and detect any chemical differences between males and females as well as between adults and juveniles that might cause increased canid predation. Results revealed differences between female and male juveniles primarily in alkyl alcohols.

A preliminary field trial was conducted in September 2018, at the United States Department of Agriculture, Animal and Plant Health Inspection Service, National Wildlife Research Center (USDA-APHIS-NWRC), Millville Predator Research Facility in collaboration with Dr. Eric Gese (USDA-APHIS NWRC) and Dr. Kimball. Synthesized female and male tortoise scent and a control were presented to captive coyotes to determine if they showed any preference. Initial results showed no preference for the female, male, or control scent. Dr. Kimball is working on refining the female and male tortoise scent. Another trial at the Millville facility is being planned for 2019, as well as a field trial on the NNSS.

MSTS will continue monitoring the remaining juvenile study animals well into adulthood with adjustments to the monitoring schedule based on the animals' movement activities. Data analysis and publications will be a joint effort between NNSA/NFO and ICR.

3.2.3 USGS Rock Valley Study

The United States Geological Survey (USGS) in collaboration with FWS, ICR, and Penn State University completed their epidemiology study in the Rock Valley pens in September 2017. All translocated tortoises were removed from the three pens and transported back to Las Vegas. An MSTS biologist assisted in this effort.

As a result of this study, some mating of translocated individuals occurred and a few juvenile tortoises were observed within the pens. FWS considers these resident tortoises. MSTS biologists conducted full coverage surveys of all three pens to identify recent tortoise sign or live juvenile tortoises inside the pens. No active burrows were observed nor live tortoises. One nonviable tortoise egg was found on the surface under a shrub. Juvenile tortoises can be cryptic and difficult to observe during surveys. MSTS biologists will continue to monitor the pens for the next few active seasons in order to determine if live juvenile tortoises are present.

3.2.4 Coordination with Other Biologists and Wildlife Agencies

- In February 2018, an MSTS biologist attended the Desert Tortoise Council's 43rd annual meeting and symposium, and gave a presentation titled "Are Females Smellier than Males: Survival and Predation in Translocated Juvenile Desert Tortoises." This meeting was held in Las Vegas, Nevada, and included numerous presentations on desert tortoise biology, ecology, and recovery efforts.

- In February 2018, an MSTS biologist attended the annual meeting of the Nevada Chapter of The Wildlife Society in Reno, Nevada, and gave the aforementioned presentation on tortoises.

- Sent ticks collected from NNSS desert tortoises to Molly Bechtel at Northern Arizona University for testing and identification. They were identified as *Ornithodoros parkeri*, which is known to occur on the NNSS (Wills and Ostler, 2001). Ticks were analyzed for *Borrelia*, a genus of spirochete bacteria that causes Lyme disease, and all tested negative. This is particularly interesting because it is hypothesized that desert tortoises have an enzyme in their blood that kills *Borrelia*. If these ticks were feeding off tortoises, the *Borrelia* may have been killed by the enzymes in the tortoise blood.

4.0 ECOSYSTEM MONITORING

Biologists began comprehensive mapping of plant communities and wildlife habitat on the NNSS in 1996. Data were collected, describing selected biotic and abiotic habitat features within field mapping units called ecological landform units (ELUs). ELUs are landforms (Peterson 1981) with similar vegetation, soil, slope, and hydrology. Boundaries of the ELUs were defined using aerial photographs, satellite imagery, and field confirmation. ELUs are considered by site biologists to be the most feasible mapping unit by which sensitive plant and animal habitats can be described. In 2000 and 2001, topical reports describing the classification of vegetation types on the NNSS were published (Ostler et al. 2000, Wills and Ostler 2001). Ten vegetation alliances and 20 associations were reported to occur on the NNSS.

In addition to ELU mapping, ecosystem monitoring also entails monitoring a wide variety of terrestrial and aquatic habitats and non-sensitive and protected/regulated species. Efforts during 2018 focused on wildland fire fuels surveys, natural water source monitoring, and constructed water source monitoring, including contaminated sumps.

4.1 VEGETATION SURVEY FOR WILDLAND FIRE HAZARD ASSESSMENT

Wildland fires on the NNSS require considerable financial resources for fire suppression and mitigation. For example, costs for fire suppression on or near the NNSS can cost as much as $198 per ha (Hansen and Ostler 2004). Costs incurred from the Egg Point Fire in August 2002 (121 ha) were well over $1 million to replace 1 mile of burned power poles, and more than $200,000 for soil stabilization and revegetation of the burned area.

4.1.1 Wildland Fires in 2018

From 1978 to 2018, an average of 10.5 wildland fires per year and about 98.0 ha per fire have occurred on the NNSS. Most wildland fires are caused by lightning and do not occur randomly across the NNSS, but occur more often in particular vegetation types (e.g., blackbrush and pinyon pine/Utah juniper/sagebrush [*Pinus monophylla/Juniperus osteosperma/Artemisia* spp.] plant communities). These types have sufficient woody and fine-textured fuels that are conducive to ignition and spread of wildland fires. Once a site burns, it is much more likely to burn again because of the invasive annual plants that quickly colonize these areas (Brooks and Lusk 2008).

Five wildland fires occurred on the NNSS in 2018. The largest occurred in Area 19 in late July and was caused by lightning. It burned approximately 1,012 ha between Lambs Canyon and Kawich Canyon, north of the 19-01 Road in pinyon pine/Utah juniper/sagebrush habitat. Another large fire caused by a power pole break burned about 458 ha in Mid Valley (Area 16) in blackbrush habitat. This fire occurred in mid-April when moisture content in the vegetation was relatively high, contributing to limiting the fire's intensity. Had this fire occurred in the hot summer it would have been much larger and more severe. A small fire (17 ha) occurred in late July in Area 30, likely due to lightning. The other two wildland fires were small (<0.4 ha) and were extinguished by NNSS Fire and Rescue personnel or carefully monitored until they burned out.

4.1.2 Fuel Survey Methods

Beginning in 2004, and in response to a request from NNSS Fire and Rescue Department, surveys were initiated on the NNSS to identify wildland fire hazards. Vegetation surveys were conducted in April and May 2018 at sites located along and adjacent to major NNSS corridors to estimate the abundance of fuels produced by native and invasive plants. Climate and wildland fire-related information reported by other government agencies was also identified and summarized as part of the wildland fire hazards assessment. Survey findings and fuels assessment maps were compiled and reported to NNSS Fire and Rescue Department.

The abundance of fine-textured (grasses and herbs) and coarse-textured (woody) fuels were visually estimated on numerical scales using an 11-point potential scale: 0 to 5 (in 0.5 increments, where 0.0 is barren and 5.0 is near maximum biomass encountered on the NNSS). Details of the methodology used to conduct the spring survey for assessing wildland fire hazards on the NNSS are described in Hansen and Ostler (2004).

Photographs of sites typifying these different scale values are found in Appendix A of the *Ecological Monitoring and Compliance Program Calendar Year 2005 Report* (Bechtel Nevada 2006). Additionally, the numerical abundance rating for fine fuels at a site was added to the numerical abundance rating of woody fuels to derive a combined fuels rating for each site that ranged from 0 to 10 in one-half integer increments. The index ratings for fuels at survey sites were plotted on a GIS map and color-coded for abundance to indicate the wildland fire fuel hazards at various locations across the NNSS.

4.1.3 Fuel Survey Results

4.1.3.1 Climate

There are 17 rain gauges on the NNSS (Hansen and Ostler 2004) that have been used historically to measure precipitation. Data from these weather station gauges extends back more than 30 years (National Oceanic and Atmospheric Administration [NOAA] 2013). In the fall of 2011, most of the rain gauges on the NNSS were upgraded from weighing gauges to tipping-bucket style gauges with data transmitted directly to NOAA via telecommunications, rather than manually retrieving and processing the data (Hansen, personal communication, May 4, 2012). In most cases, the new gauges were relocated nearby to facilitate data collection. The changes were made to reduce costs, improve data reliability, and improve access time to the data after precipitation events. As a result of these modifications, only 14 rain gauges remain from the original gauge stations. The Cane Spring, Tippipah Spring, and Rock Valley gauge stations were decommissioned. The Jackass Flats gauge was moved to Port Gaston in Area 26. The Little Feller 2 gauge was moved from the eastern part of Area 18 to the northwestern corner of Area 18. Precipitation data collected in 2018 reflect the changes and attempt to match, as closely as possible, data collected historically. Mean values were recalculated to account for periods when gauges were not functional.

In order to assess whether the spring of the year would be relatively wet, normal, or dry, a simple measure of precipitation was needed. Precipitation during the months of December, January, February, March, and April was selected because of its simplicity and ease of calculation (Figure 4-1). While it is recognized that precipitation from other months is also important, as is the influence of temperature, winds, and relative humidity, precipitation during these months represents the period that most influences plant growth on the NNSS as observed along the

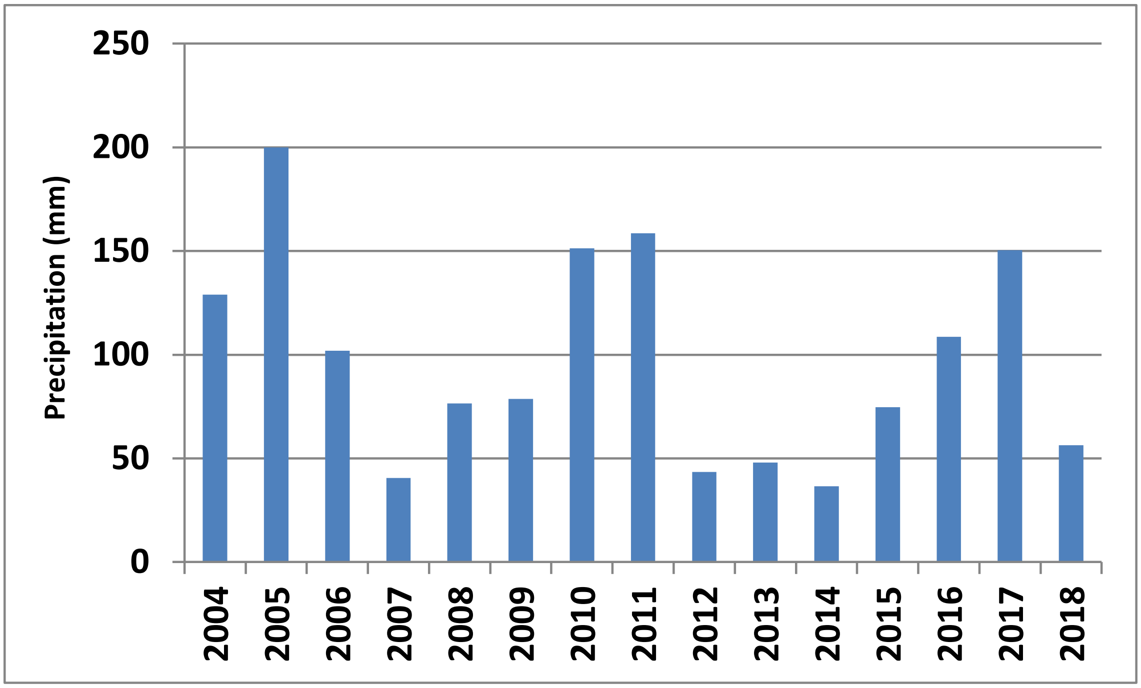

Figure 4-1. Average precipitation from December (previous year) through April for the years 2004 through 2018.

survey route. This period occurs before the beginning of the fire season in June so it allows one to make a prediction of the fuels that may be present. During the first 10 years of conducting fire fuel evaluations (2004-2013), the mean precipitation during these 5 months is correlated (R= 0.770) with our estimations of the combined fuel loads. During 2018, the average precipitation from the remaining 14 rain gauge stations on the NNSS during December–April was 56.3 millimeters (mm), which is about half the normal amount of 104.6 mm received on the NNSS.

4.1.3.2 Fuels

Due to the below-average precipitation received during winter/spring 2017-18, few annual grasses and forbs germinated and grew. Production of perennial herbaceous grasses and forbs was also limited.

The fine fuels index decreased in 2018 (1.83) compared to 2017 (2.38), and was the fifth lowest recorded since 2004 (Table 4-1). The fine fuels index reflected not only current year production but also standing dead crop from last year, particularly in areas of high red brome and cheatgrass (*Bromus tectorum*) production from 2017.

The woody fuels index value was the same (2.49) in 2018 as it was in 2017 (2.49) (Table 4-1). This was an average value in comparison to the other index values since 2004. Although new growth was limited by below-average precipitation, overall fuel load was similar to last year.

The combined index values (fine fuels plus woody fuels) for 2018 corresponds to the potential for fuels on the NNSS to support wildland fires once fuels are ignited. The higher the index, the greater the potential for wildland fires to spread. The NNSS average combined index value for fine fuels and woody fuels for 2018 was 4.32, which was the fifth lowest value recorded since 2004 (Table 4-1), suggesting below-normal fuels for the NNSS.

Table 4-1. Woody fuels, fine fuels, and combined fuels index values for 2004–2018.

Year	Average Woody Fuels Index	Average Fine Fuels Index	Average Combined Fuels Index
2004	2.75	2.13	4.88
2005	2.80	2.83	5.64
2006	2.80	2.46	5.26
2007	2.62	1.52	4.13
2008	2.59	2.23	4.81
2009	2.63	1.95	4.52
2010	2.61	2.27	4.89
2011	2.58	2.56	5.14
2012	2.43	1.75	4.17
2013	2.49	2.03	4.52
2014	2.44	1.39	3.83
2015	2.42	1.44	3.87
2016	2.43	2.67	5.10
2017	2.49	2.38	4.87
2018	2.49	1.83	4.32

The locations and results of the fine fuels, woody fuels and combined fuels surveys at 104 stations on the NNSS inspected during 2018 are shown in Figures 4-2, 4-3 and 4-4, respectively. The highest combined index values and thus the highest potential for wildland fires occurred in Fortymile Canyon and Mid Valley. High amounts of fine fuels were found in Fortymile Canyon, southeast Yucca Flat, and Mid Valley. Highest amounts of woody fuels are primarily found in the forested portions of Pahute Mesa.

Photographs were taken from permanent locations for all 104 sites during the past 14 years. Figure 4-5 shows photographs of Site 99 in Yucca Flat for the years 2015, 2016, 2017 and 2018. These photographs are valuable for many reasons, including providing a permanent record of previous site conditions, comparing site conditions among sites and years, and evaluating current year production with residual fuels from previous years.

Overall, the hazards of residual fuels contributing to wildland fires are below average for 2018 but still present a wildland fire risk. Once ignited, high ambient temperatures and high winds contribute to the spread of fire in areas where the abundance of fuels is sufficient to carry the flames of the fire. This is particularly acute in areas such as Fortymile Canyon that have burned previously and now consist of almost pure stands of cheatgrass and/or red brome. Rapid response by NNSS Fire and Rescue after fires are ignited is a key factor in minimizing wildland fire spread and severity.

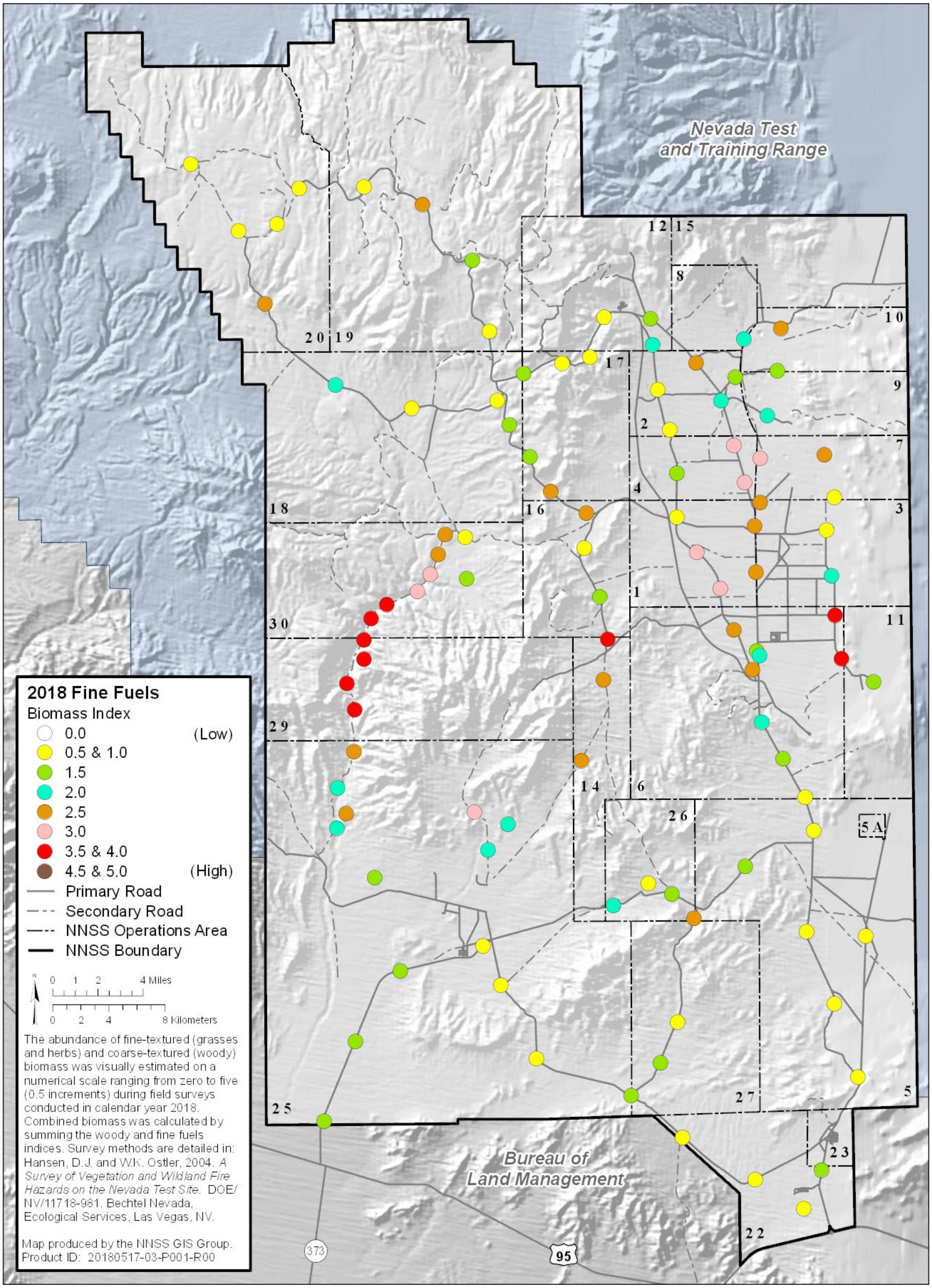

Figure 4-2. Index of fine fuels for 104 survey stations on the NNSS during 2018.

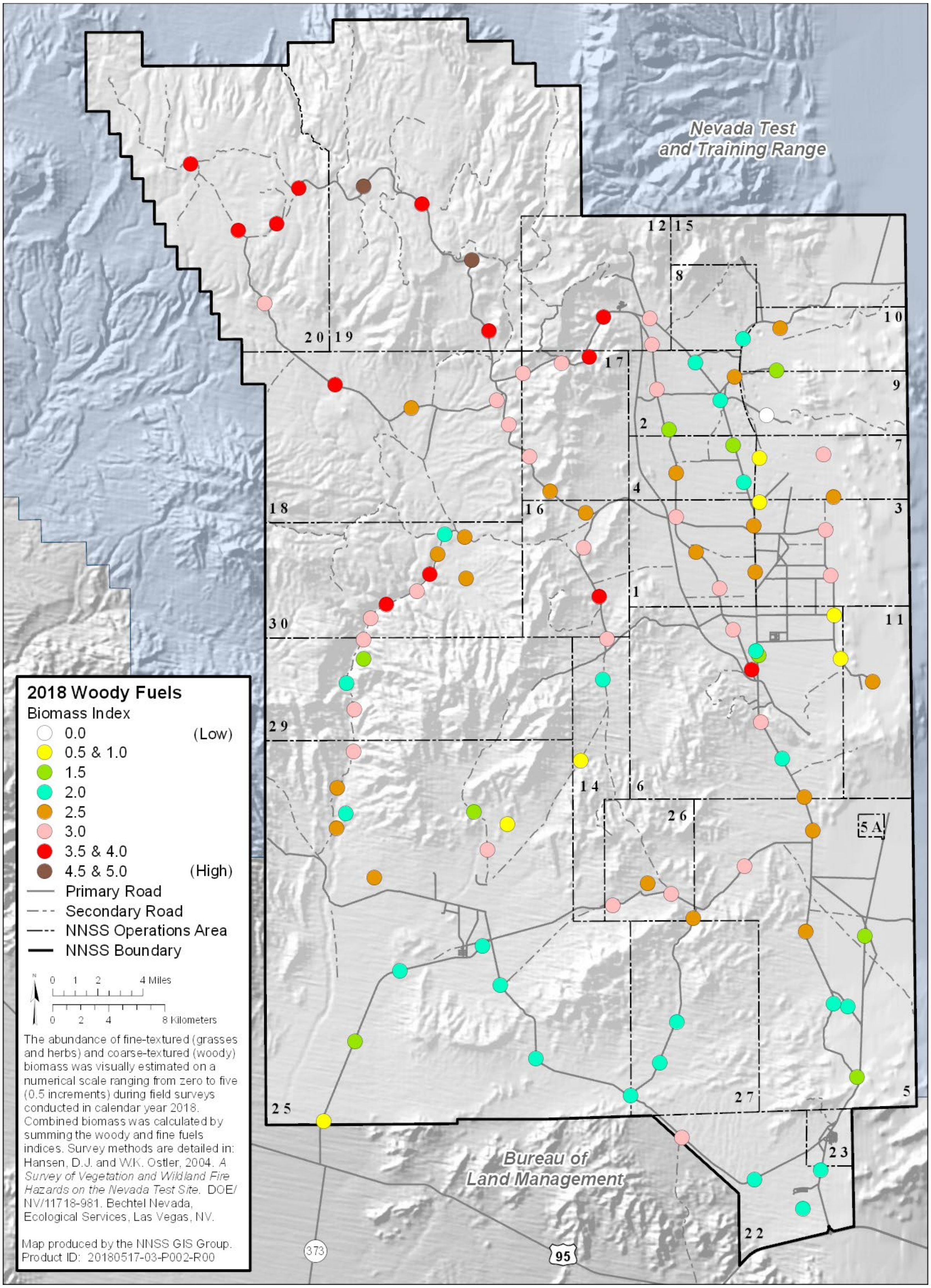

Figure 4-3. Index of woody fuels for 104 survey stations on the NNSS during 2018.

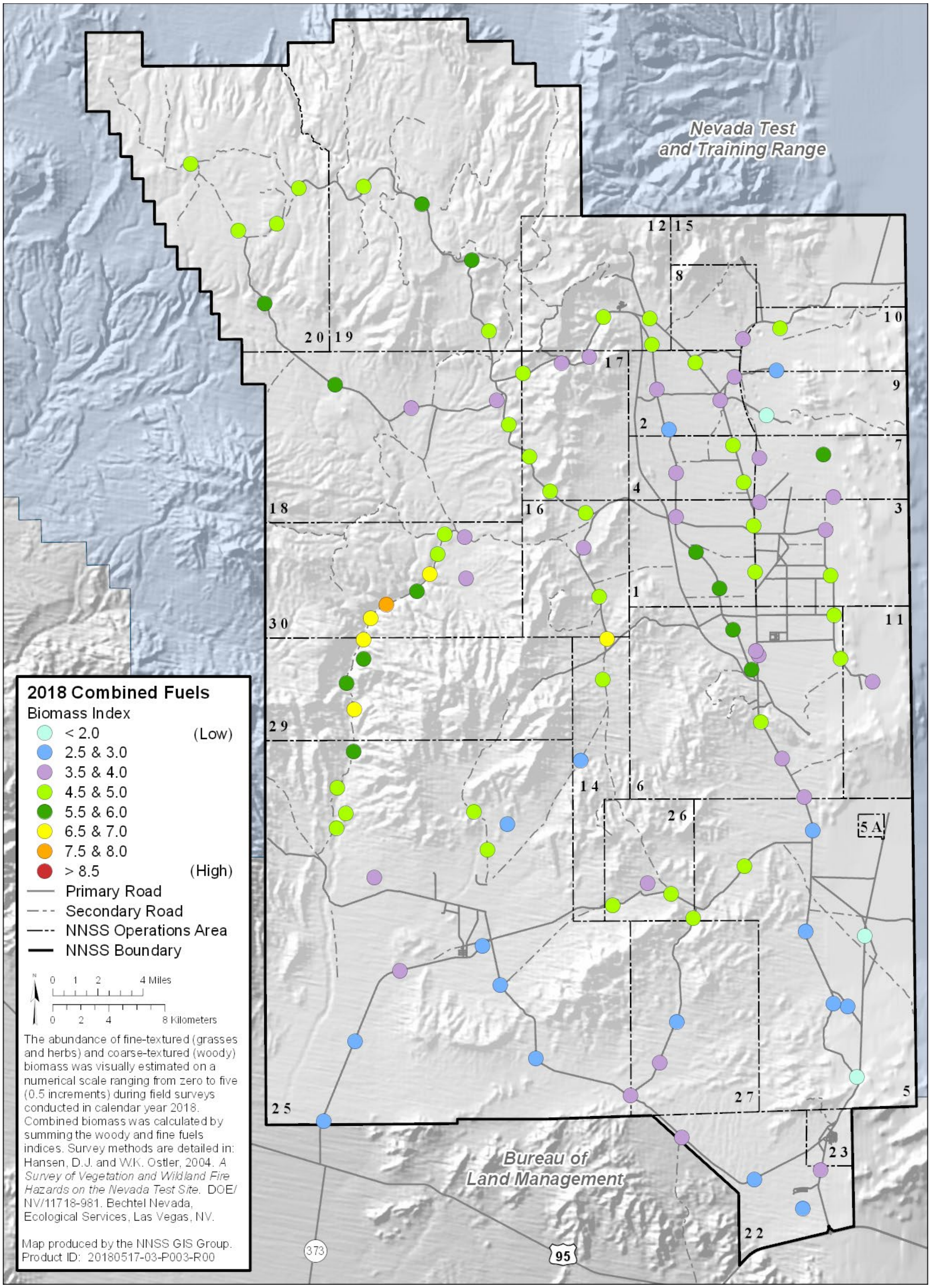

Figure 4-4. Index of combined fine fuels and woody fuels for 104 survey stations on the NNSS during 2018.

Figure 4-5. Site 99 on the west side of Yucca Flat in 2015, 2016, 2017 and 2018.

(Photos by W. K. Ostler, April 21, 2015 [top left]; April 20, 2016 [top right] and by J. Perry, April 26, 2017 [bottom left] and April 24, 2018 [bottom right])

4.2 INVASIVE PLANTS

The three most commonly observed invasive annual plants to colonize the NNSS are Arabian schismus (*Schismus arabicus*), found at low elevations; red brome, found at low to moderate elevations; and cheatgrass, found at middle to high elevations (Table 4-2).

Cheatgrass was the most common invasive plant occurring on 60% of the study sites. While it was predominantly found at middle to higher elevations it was also found at lower elevation sites as well. Red brome (43%) and redstem stork's bill (*Erodium cicutarium*) (46%) were also found on almost half of the sites sampled. Precipitation history (Figure 4-1, shown previously) is also important in determining the percent presence of species across the NNSS. During periods of low precipitation, most annual species have low percent presence (i.e., the number of sites in which the plant was observed to be present and growing). Percent presence is generally greatest during periods of high precipitation, and appears to be a good indication of germination. Higher percent presence is also expected to occur when regional storms provide precipitation to a greater number of operational areas across the NNSS. However, the responses of some species, both invasive and native species, suggest that other variables, such as the timing of precipitation or temperatures required for germination, may also be contributing to plant response both in terms of plant abundance and biomass produced.

Colonization by invasive species such as cheatgrass, red brome, and Arabian schismus increases the likelihood of future wildland fires because they provide abundant fine fuels that are more closely spaced than native vegetation. Blackbrush vegetation types appear to be the most vulnerable plant communities to fire, followed by pinyon pine/Utah juniper/sagebrush species vegetation types. Wildland fires are costly to control and to mitigate once they occur. Revegetation of severely burned areas can be very slow without reseeding or transplanting with native species and other rehabilitation efforts. Blackbrush, sagebrush, juniper and pinyon pine do not resprout following fires. Untreated areas become much more vulnerable to future fires once invasive species, rather than native species, colonize a burned area.

Growth of fine fuels produced by invasive, introduced annual species (especially cheatgrass and red brome) and other native annual species during 2018 was the fifth lowest since 2004. Similar to last year, germination and growth of fine fuels during 2018 was greatest at the middle elevations and on previously burned sites.

Table 4-2. Precipitation history and percent presence of key plant species contributing to fine fuels at surveyed sites.

Precipitation History	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Mean Precipitation (mm) (December–April)	129.0	199.9	101.9	40.6	76.5	78.7	151.4	158.5	43.4	48.0	36.6	74.7	108.7	150.4	56.3
Invasive Introduced Species															
Bromus rubens (red brome)	51.7	64.4	67.8	0	63.0	63.2	58.5	62.3	0	19.2	28.8	52.9	54.8	68.3	43.3
Bromus tectorum (cheatgrass)	40.3	54.0	60.7	0	59.2	66.0	67.0	79.2	17.0	70.2	61.5	36.5	69.2	79.8	59.6
Erodium cicutarium (redstem stork's bill)	5.2	6.2	24.6	0	21.3	27.4	33.0	42.4	0.9	37.5	33.7	25.0	43.3	47.1	46.2
Schismus arabicus (Arabian schismus)	4.7	2.8	5.2	0	11.4	9.4	3.8	11.3	0	9.6	6.7	10.6	15.4	15.4	21.1
Native Species															
Amsinckia tessellata (bristly fiddleneck)	34.0	62.0	16.1	0	63.0	48.1	67.9	63.2	1.8	41.3	26.0	47.1	66.4	54.8	50
Mentzelia albicaulis (whitestem blazingstar)	49.8	8.1	0	0	2.4	18.9	51.9	16.0	3.7	6.7	20.2	43.3	41.4	25.0	3.8
Chaenactis fremontii (pincushion flower)	27.0	8.0	0	0	1.4	11.3	13.2	0.5	0	6.7	2.9	7.7	32.7	38.5	12.5

4.3 REPTILE STUDIES

No formal trapping or roadkill studies took place in 2018. However, some opportunistic reptile observations were documented. The purpose of ongoing reptile sampling is to fill in data gaps for species that have not been documented recently or are rare on the NNSS.

Three ground snakes were found in buildings in Mercury. One was retrieved from inside a building and released outside, one was extracted from a glue trap and released, and one was found dead on a glue trap. A western banded gecko (*Coleonyx variegatus*) was found in a building and relocated outside. Two noteworthy observations include a glossy snake (*Arizona elegans*) road-kill found in Jackass Flats on April 12, 2018, and a juvenile king snake (*Lampropeltis getula*) found in Frenchman Flat on October 1, 2018.

4.4 NATURAL WATER SOURCE MONITORING

4.4.1 Existing Water Sources Monitored

Nine natural water sources (six springs, three rock tanks) were monitored with motion-activated cameras in 2018, primarily to document the presence of mountain lions (*Puma concolor*) and other wildlife (Figure 4-6). Results are found in Table 6-4 (see Section 6.6.1, Motion-Activated Cameras). General assessments were also made of each spring and surrounding area to document major disturbances or changes to these important water sources. Topopah Spring was nearly dry with just a small wet spot in the cave pool. Vegetation was heavily trampled primarily by burros at Twin Spring and there was a small perennial pool of standing water. Vegetation at Captain Jack Spring was pretty dense in the absence of wild horses using the perennial spring.

Captain Jack Spring (#12) had the most images (1,398) with 7 mammal and 4 bird species detected. Mule deer dominated with 1,262 images recorded. Only 2 common raven (*Corvus corax*) images were taken this year versus over 100 last year. South Pah Canyon Tanks (#15) was a close second with 1,345 images taken including 3 mammal, 5 bird, and 1 lizard species. Most noteworthy is the 1,060 images of pinyon jays (*Gymnorhinus cyanocephalus*) recorded mostly in September and November with 30-40 individuals in many photos (Figure 4-7). Twin Spring (#21) had 598 images of 7 mammal and 2 bird species. Chukar (*Alectoris chukar*) and burros dominated with 276 and 275 images, respectively.

Delirium Canyon Tanks (#5) had the highest species richness with 8 mammal and 6 bird species detected in 492 images, including the first detection of a spotted skunk (*Spilogale gracilis*) (Figure 4-8) with a camera trap on the NNSS. Desert bighorn sheep (*Ovis canadensis nelsoni*) dominated with 209 images. Gold Meadows Spring (#18) had 385 images, far fewer than last year (1,279), of 4 mammal and 2 bird species. Most of these were horses (195) and mule deer (139). A lot fewer pronghorn antelope images were recorded compared to last year (13 versus 173) and no elk (*Cervus elaphus*) were detected.

A total of 365 images were taken at Topopah Spring (#9) with most of these (298) being coyotes. Fortymile Canyon Tanks (#11) had 287 images of 6 mammal and 5 bird species including 152 images of desert bighorn sheep and 103 images of golden eagles (*Aquila chrysaetos*). The camera at Cottonwood Spring (#4) was not working consistently and only 42 images were recorded with mule deer dominating (35 images). Only nine images were taken at Cane Spring (#7) (mule deer [seven], bobcat [one], and coyote [one]).

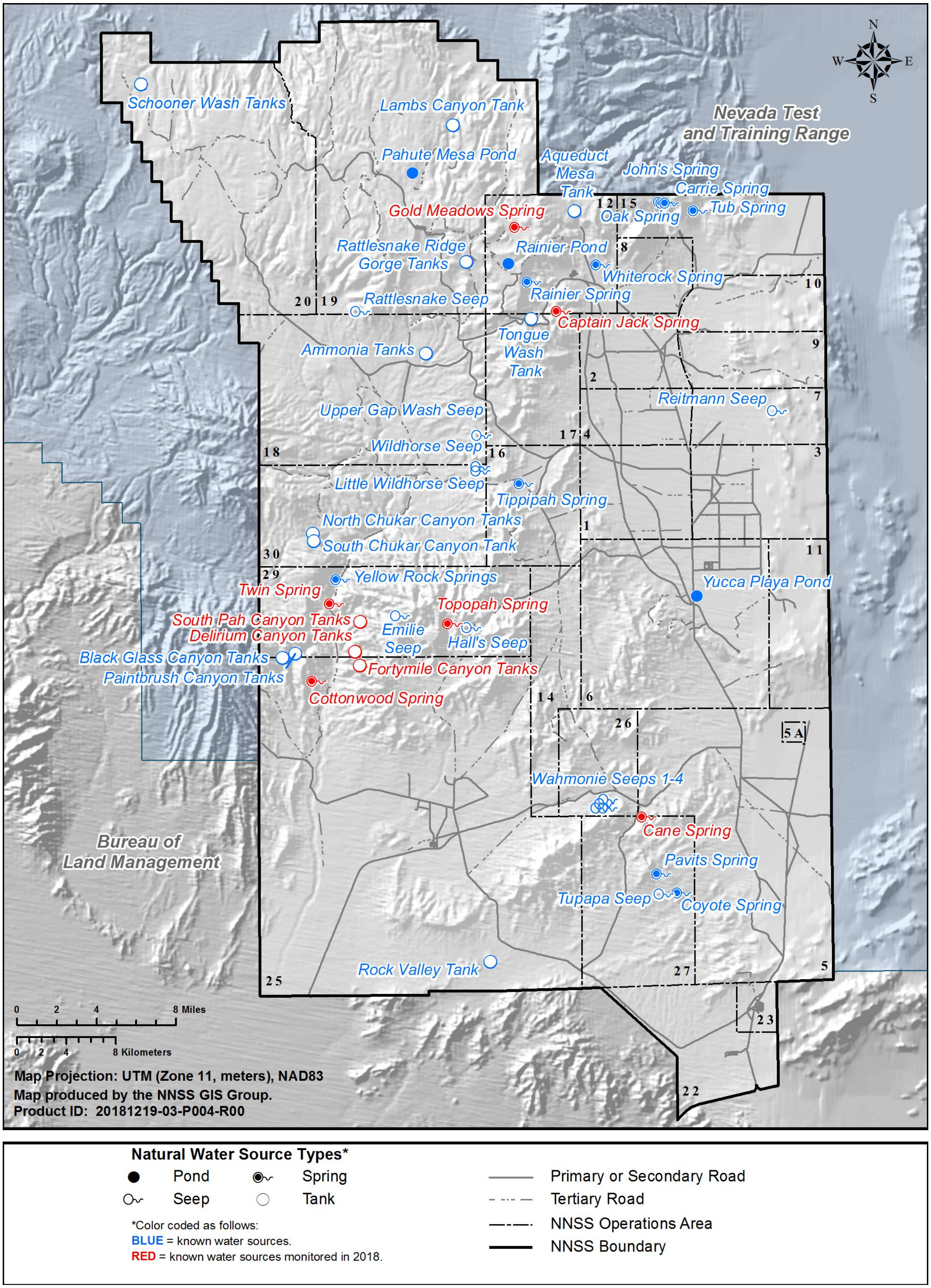

Figure 4-6. Natural water sources on the NNSS, including those monitored in 2018.

Figure 4-7. Flock of pinyon jays at South Pah Canyon Tanks (#15).

(Photo by motion-activated camera, August 31, 2018)

Figure 4-8. Spotted skunk at Delirium Canyon Tanks (#5).

(Photo by motion-activated camera, January 16, 2018)

4.5 CONSTRUCTED WATER SOURCE MONITORING

Ten constructed water sources were monitored with motion-activated cameras to document the presence of mountain lions and other wildlife during 2018. These included one well pond (Camp 17 Pond), five water troughs installed to mitigate the loss of well ponds, and four radiologically-contaminated sumps (Figure 4-9).

Camp 17 Pond (#6) had the greatest number of images (2,184) of any of the cameras in operation during 2018 with 17 species (5 mammal, 12 bird) being photographed (Table 6-4). Turkey vultures (*Cathartes aura*) (566 images), horses (541 images), and mule deer (528 images) were the dominant species. Of particular interest is the presence of an adult peregrine falcon (*Falco peregrinus*) (Figure 4-10) at the pond on June 15, 2018. This is the fourth record of this species on the NNSS and the first since 2004. Noteworthy observations include the detection of great blue herons (*Ardea herodias*) (29 images), great egrets (*Ardea alba*) (20 images) and American avocet (*Recurvirostra americana*) (1 image).

4.5.1 Mitigating Water Loss for Wildlife

Water conservation measures were implemented on the NNSS in 2012 at four sites: Area 6 Construction Yard (Area 6 Los Alamos National Laboratory [LANL] Pond), Well C1 Pond, Well 5B Pond, and J11 Pond. In order to conserve millions of gallons of water being lost to drainage and evaporation, pumping water to fill these ponds was stopped. Wildlife observation data gathered over several decades documented more than 100 species of wildlife using these artificial water sources. These included carnivores, ungulates, rabbits, bats, and dozens of species of waterfowl, passerines, and other birds.

The drying of these ponds resulted in the loss of valuable wildlife habitat, so water troughs were installed to help mitigate the loss. The water troughs were not meant to replace the well ponds as wildlife habitat, but were meant to provide at a minimum some supplemental water in areas with very limited perennial water sources and at sites where animals had become accustomed to finding water.

Water troughs were installed adjacent to the Area 6 LANL Pond and Well C1 Pond to mitigate the loss of these ponds, at Well 5A (Well 5C) to mitigate the loss of the Well 5B Pond, and at Cane Spring and Topopah Spring to mitigate the loss of the J11 Pond in Area 25. Motion-activated cameras were set up at each trough during the fall of 2012 and have been monitored since then to document wildlife use. These cameras were also added to the network of cameras used for monitoring mountain lions and results for 2018 are included in Table 6-4 (see Section 6.6.1, Motion-Activated Cameras).

Wildlife use at Well 5C trough (#24) was heavy (1,216 images) with at least 12 species (7 mammals and 5 birds) photographed. Bobcat (462 images), black-tailed jackrabbit (*Lepus californicus*) (268 images) and coyote (196 images) were the most commonly photographed species. Several photos show one of at least two individual bobcats lying in a depression near the trough waiting to ambush jackrabbits coming to drink. A few photos actually capture the chase and successful capture (Figures 4-11 and 4-12). Interactions between individual bobcats, between bobcats and coyotes, and between bobcats and badgers were also photographed.

Wildlife use at the Area 6 LANL Pond trough (#14) was moderate (193 images). Six species were detected including three mammals and three birds. Coyotes were photographed the most (72 images). Antelope continued to use this water source on a regular basis during the summer suggesting it is an important source of drinking water for them. Golden eagles were observed using this water source as well.

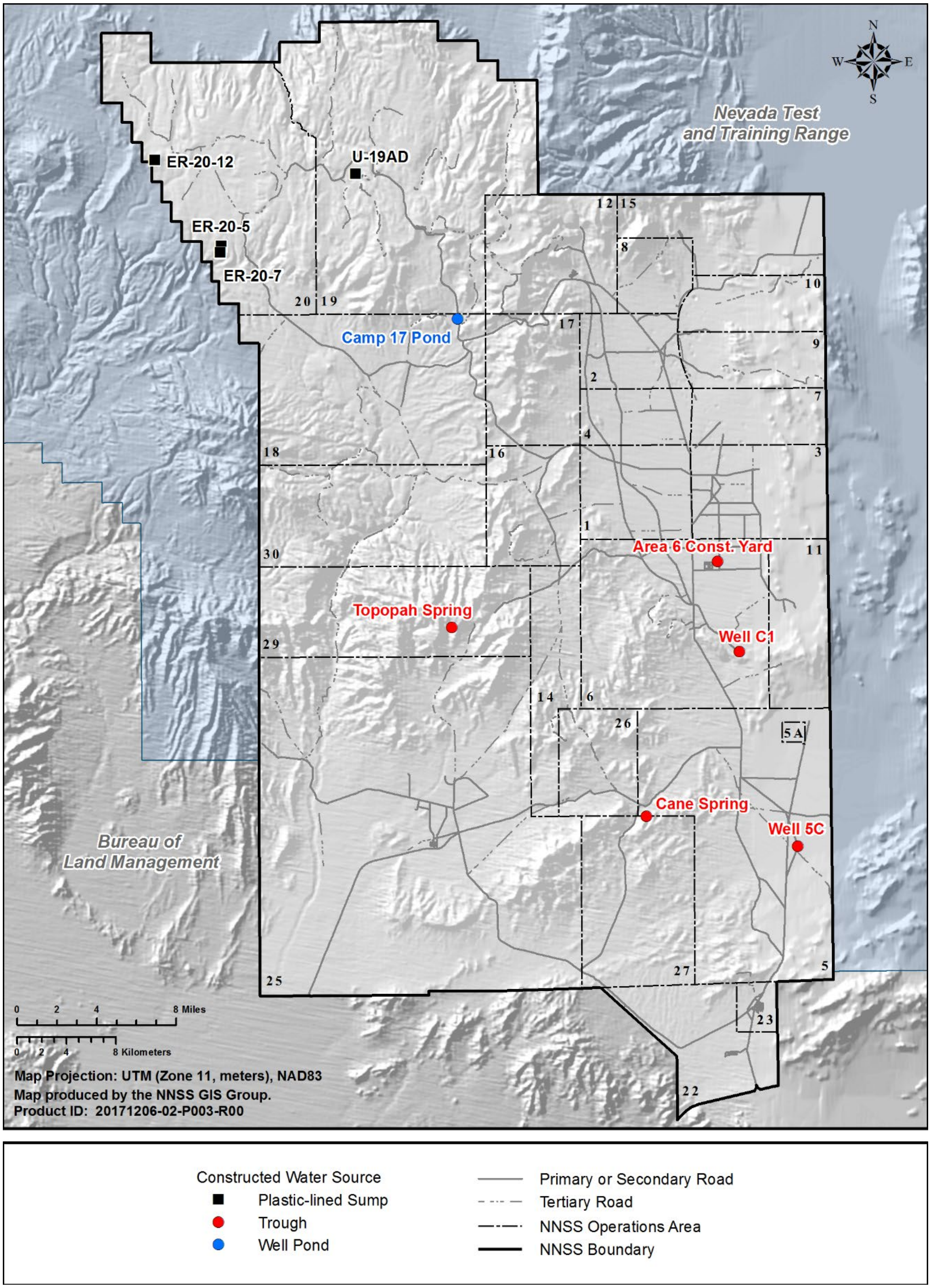

Figure 4-9. Constructed water sources monitored with motion-activated cameras for wildlife use during 2018.

Figure 4-10. Adult peregrine falcon at Camp 17 Pond (#6).

(Photo by motion-activated camera, June 15, 2018)

Use at Topopah Spring trough (#23) was light (99 images) with 95 images of mule deer and 4 of coyote. Use at Well C1 trough (#27) was also light (85 images) with 11 species (6 mammals and 5 birds) documented at the trough. Pronghorn antelope (24 images), coyote (23 images), and common raven (19 images) were the dominant species detected. Wildlife use at the Cane Spring trough (#26) was very light with only 12 images taken, 10 mourning dove (*Zenaida macroura*) and 2 mule deer photos.

The number of animal photographs taken at the Topopah Spring trough (99 images) was substantially less than at the spring (365 images) and species richness was higher at the spring than at the trough (6 versus 2). A similar pattern was observed at Cane Spring with more photos at the spring than at the trough (93 versus 12). Differences in use may be a preference for the natural setting at the springs versus using the artificial trough or water availability/accessibility or a combination of both.

In summary, several wildlife species use the water troughs, indicating the troughs are benefiting many wildlife species on the NNSS, especially certain bird species, ungulates, and coyotes. Waterfowl and shorebirds do not appear to use the troughs and undoubtedly have been negatively impacted by the removal of the well ponds. Although the water troughs did not replace the well ponds as a wildlife resource, they still attract and benefit a multitude of wildlife species, especially during the hot, dry summer.

Figure 4-11. Bobcat chasing a black-tailed jackrabbit at Well 5C Trough.

(Photo taken by motion-activated camera, August 26, 2018)

Figure 4-12. Bobcat with black-tailed jackrabbit at Well 5C Trough.

(Photo by motion-activated camera, September 7, 2018)

4.5.2 Monitoring Wildlife Use at Potentially Contaminated Water Sources

During 2018, motion-activated cameras were set up at four contaminated water sources which are sumps constructed to retain groundwater and drilling fluids from Underground Test Area (UGTA) wells during drilling, well development, and groundwater testing. The sumps included those located at UGTA wells ER 20-7, ER 20-5, U19ad, and ER 20-12 (Figure 4-9). The cameras were also added to the network of cameras used for mountain lion monitoring (see Section 6.6.1, Motion-Activated Cameras) (Table 6-4). Typically, discharge water and drilling fluids having ≥400,000 picocuries/liter (pCi/L) of tritium are diverted to plastic-lined sumps to evaporate; otherwise, they are diverted to unlined sumps. Inactive well sumps can also retain precipitation, which can become contaminated from accumulated sediments. The cameras were set up to document which wildlife species were using the sumps and their frequency of use to assess the potential off-site transport of radionuclides by wildlife as well as the potential impact to the wildlife themselves.

Like last year, of the four sumps, ER 20-7 (#13) had the highest use with 101 images representing 3 species; common raven (84 images), coyote (14 images), and mule deer (3 images). There are five, plastic-lined sumps at ER 20-5 (#2). A camera was set up at the sump in the northwest corner. Results showed light use with 20 images of black-tailed jackrabbits and 6 images of passerine birds. Wildlife use at the U19ad plastic-lined sump (#25) was minimal with 5 images of mule deer and 1 image of a turkey vulture (Figure 4-13). No animal images were taken at ER 20-12 SE Corner (#10) which was only operational for a short period.

Overall, wildlife use at the contaminated sumps was light during 2018. Nonetheless, important species are using them and are potentially up-taking radiological contaminants. Hunt-able species such as desert bighorn sheep, mule deer and mourning doves are a potential pathway of exposure to the general public. Protected birds such as turkey vultures and common ravens may also be impacted. UGTA sumps will continue to be monitored to determine their level of use by various wildlife species, calculate the potential dose someone eating contaminated wildlife may receive, and determine if the dose is harmful to the animal. More information about potential dose to humans and wildlife can be found in the annual Nevada National Security Site Environmental Reports (e.g., MSTS 2018) available at http://www.nnss.gov/docs/docs_LibraryPublications/2017%20NNSSER.pdf.

Figure 4-13. Three mule deer and a turkey vulture (in pond) at U19ad plastic-lined sump (#25).
(Photo by motion-activated camera, August 11, 2018)

4.6 COORDINATION WITH SCIENTISTS AND ECOSYSTEM MANAGEMENT AGENCIES

Site biologists interfaced with other scientists and ecosystem management agencies in 2018 for the following activities:

- Accompanied U.S. Forest Service personnel and took photos of their plots for the Interior West Forest Inventory and Analysis Program.
- Participated in multiple conference calls for the Mojave Seeds of Success Program and collected seven samples of white bursage leaves from around the NNSS for genetic testing.
- Participated in multiple conference calls for the DOE Invasive Species Working Group.
- Member of the Eastern Mojave Landscape Conservation Design Biodiversity team.

5.0 SENSITIVE PLANT MONITORING

The list of sensitive plants on the NNSS (see Table 2-1) is reviewed annually to ensure the appropriate species are included in the NNSS Sensitive Plant Monitoring Program. Taxonomy in the field of botany is constantly changing based on new information obtained on the relationship of plant species. In order to track these changes, MSTS biologists review several widely accepted sources (i.e. USDA PLANTS Database, Baldwin et al. 2001, and NNHP) as well as attend meetings with other botanists familiar with Nevada plants to stay updated on changes with family, genus or species names.

Over the years, a working list of over 850 plant species that have been identified on the NNSS has been developed. In 2018, this list was reviewed for updates with taxonomy and associated species codes (codes are represented by the first two letters of the genus combined with the first two letters of the species). Where applicable, plant names were updated with associated former synonyms. Additional fields to help with plant identification were added to the list as well (i.e. flower color, growth habit and bloom period).

5.1 SPECIES ACCOUNTS

5.1.1 Sand Cholla (*Grusonia [Opuntia] pulchella*)

While comparing the updated NNSS plant list to the NNHP At-Risk Plant and Animal Tracking List to identify species that have been elevated to sensitive status, a cactus species on the NNSS list, sand cholla (*Grusonia pulchella*), had been elevated to sensitive status. Sand cholla has been on the NNHP At-Risk Plant and Animal Tracking List for several years but was overlooked due to a recent change in genus. *Grusonia pulchella* was listed as being found on the NNSS under its former name, *Opuntia pulchella*. Sand cholla is found in Nevada, California, Arizona and Utah. According to its NNHP Rare Plant Fact Sheet, the cactus grows in "sand of dunes, dry-lake borders, river bottoms, washes, valleys, and plains in the desert" and is "dependent on sand dunes or deep sand in Nevada" (http://heritage.nv.gov/sites/default/files/atlas/opuntpulch.pdf). Systematic surveys for this species have not been conducted in Nevada nor on the NNSS.

Sand cholla was described by Beatley (1976) on the NNSS "below N face of Pahute Mesa (s. Gold Flat)" and elsewhere in Nye County "frequent in many areas of basin floors of Cactus Flat, Gold Flat, and Kawich Valley." Gold Flat is located along the northern boundary of Area 20 and into adjacent lands on the Nevada Test and Training Range (NTTR). Beatley (1976) described the species growing in association with saltbush and winterfat.

There are two specimen collections in the NNSS herbarium of sand cholla: one collected by Williams in 1978 from Cactus Flat (off the NNSS on the Nellis Air Force Range) and the other collected by Ostler in 1998 from Kawich Canyon (UTM NAD83; 565833mE, 4133604mN). The Kawich Canyon collection was documented as being located within the sagebrush-rabbitbrush vegetation alliance.

There are a total of 16 recorded species occurrences on the NNSS, including the collection from Kawich Canyon. These locations will be revisited to confirm the presence of this species and its habitat preference on the NNSS. Based on recorded observations of this species, it has been added to the list of sensitive plants on the NNSS and has been given an "evaluation" status. The threats and monitoring plan for the species will be determined after further evaluation and research.

5.1.2 Clokey's Cryptantha (*Cryptantha clokeyi*)

Another plant found on the NNSS list, Clokey's cryptantha (*Cryptantha clokeyi*), was added to the NNHP At-Risk Plant and Animal Tracking List in January 2019. Little information could be found on Clokey's cryptantha. The species was possibly found in 40-Mile Canyon near ledges located in the general area of 555466mE, 4087150mN (UTM NAD83). This area will be revisited and specimens collected for identification.

Previously known to be endemic to California, this species was found in Nevada in 2016 in Perlite Canyon, just east of Beatty. Four herbarium specimens were collected from Perlite Canyon, which is approximately 25 kilometers west of 40-Mile Canyon. The plants were collected from rhyolite formations with associated species basin big sagebrush (*Artemisia tridentata*), Stansbury cliffrose (*Purshia stansburiana*), desert bitterbrush (*P. glandulosa*), and several other species of *Cryptantha*. More information is needed on the occurrence of this species in Nevada and on the NNSS before adding it to the list of sensitive plants on the NNSS and the NNSS monitoring plan.

5.1.3 Clarke Phacelia (*Phacelia filiae*)

During the 2018 Nevada Rare Plant Workshop hosted by the Nevada Native Plant Society (NNPS), Anne Howald, a botanist with the California Native Plant Society revisited the question of the taxonomic differences between Clarke phacelia (*Phacelia filiae*) and Parish's phacelia (*Phacelia parishii*). The two species were determined to be distinct taxons based on Atwood et al. (2002) describing Clarke phacelia and the confirmation by Dr. Atwood in 2010 that specimens collected on the NNSS better match Clarke phacelia than Parish's phacelia. Dr. Howald examined seeds from specimens collected from the NNSS and from Pahrump Valley (off the NNSS) and determined the seeds were intermediate between the two species.

This reopens the question if the species should be separated into two distinct species and which species grows on the NNSS. Both Clarke and Parish's phacelia are considered sensitive and listed on the NNHP At-Risk Plant and Animal Tracking List. Survey and monitoring efforts will continue whether or not the taxonomy is resolved. Specimen collections will be scheduled during a good growing season to help resolve this taxonomic dilemma.

5.1.4 Joshua Tree (*Yucca brevifolia*)

The Joshua tree (*Yucca brevifolia*) was petitioned in 2015 to be listed under the Endangered Species Act. This petition was reconsidered in 2018. USFWS is currently in the process of determining if the Joshua tree is warranted for listing. The Joshua tree is a long-lived, slow growing agave that has long been an icon of the Mojave Desert. The petition cites several human threats to the Joshua tree including climate change, drought, pollution, invasive plants and changing fire regimes (Jones and Goldrick 2015).

The acceptance of the Joshua tree taxonomically split into two distinct species is growing; *Y. brevifolia* and *Y. jaegeriana*. The western Joshua tree (*Y. brevifolia*) is the taller of the two species and begins branching from higher up on the trunk than the eastern Joshua tree (*Y. jaegeriana*) (Lenz 2007). According to the geographical distribution map from Lenz (2007) as well as Yoder et al. (2013), the NNSS is within the *Y. brevifolia* distribution range. Hybridization of the two Joshua tree species occurs in Tikaboo Valley, which is approximately 45 kilometers east of the northwestern corner of the NNSS (Yoder et al. 2013).

The Joshua Tree Genome Project (JTGP) is working with local conservation organizations, federal agencies and teams of citizen scientists to expand research on the Joshua tree in order to assist FWS with future decisions on federal listings and develop a conservation plan. Their initial priorities are to develop a map of the current distribution of Joshua trees and assess population health (http://joshuatreegenome.org/mapping-JT-current/). MSTS biologists are assisting in this effort and providing the JTGP with data collected on Joshua trees on the NNSS including a distribution map from Ostler et al. (2000).

Further research is being discussed associated with climate change and hybridization. MSTS biologists will continue to provide support with research on the Joshua tree and its threats to assist FWS and JTGP with their conservation efforts.

5.2 LONG-TERM MONITORING

As part of the Adaptive Management Plan for Sensitive Plant Species (Bechtel Nevada 2001), the status of each sensitive plant is monitored periodically to ensure NNSS activities are not impacting the species. Field surveys are conducted to verify previously reported locations, to better define population boundaries, and to identify potential habitat for sensitive plant species known to occur on or adjacent to the NNSS. In 2018, several known plant populations were visited in order to familiarize new MSTS biologists with species identification and determine recent threats, if any, to the populations.

5.2.1 Cane Spring Suncup (*Camissonia [Chylismia] megalantha*)

The Cane Spring suncup (*Camissonia megalantha*) is in the evening primrose family which includes 18 genera and 655 species. The phylogeny within this family is routinely being updated with the release of new genetic information. The Cane Spring suncup has been widely accepted by botanists into the *Chylismia* genus, but has yet to be accepted by USDA. NNHP now accepts the change to *Chylismia megalantha*, but to maintain consistency with species codes for the NNSS list, the species will continue to be referred to as *Camissonia megalantha* until its genus change is accepted by USDA.

Cane Spring suncup is endemic to Nevada, known from only Nye and Lincoln counties. The Cane Spring suncup is currently known from five areas on the NNSS: Cane Spring, French Peak, Slanted Butte, Little Skull Mountain and Orange Blossom Road. Shockley's evening primrose (*Camissonia heterochroma*) is similar to Cane Spring suncup but is smaller. Cane Spring suncup is an annual, which grows and typically blooms in the fall (August through October). This plant blooms during a season when other annuals are rare, making it prone to foraging with its large green foliage and large flowers.

Monitoring was scheduled during previous years (2013-2015) but all years were suboptimal growing seasons and no monitoring was completed. Systematic surveys for the plant were completed in the 1980s and 1990s. Opportunistic observations of the plant have been recorded since and monitoring appears to have last occurred in 2008 at the Orange Blossom Road population.

Four known Cane Spring suncup populations were visited in September 2018: Cane Spring, Slanted Butte, Little Skull Mountain and Orange Blossom Road. No plants were found at Slanted Butte, Little Skull Mountain or Orange Blossom Road. The areas were very dry with no annuals or forbs present. Approximately 20 plants were observed at the Cane Spring location: sixty percent were observed in flower, twenty percent with immature fruit, and twenty percent with mature fruit. One plant was foraged down to its stems but had new foliage growth from its base (Figure 5-1). It is typical for this species to regrow leaves after being foraged, but flowering may not occur. Another plant had evidence of insect predation (Figure 5-2). All other plants appeared to be healthy (Figure 5-3).

Figure 5-1. Evidence of herbivory on Cane Spring suncup at Cane Spring.

(Photo by J. Perry, September 13, 2018)

Figure 5-2. Evidence of insect damage on Cane Spring suncup at Cane Spring.

(Photo by J. Perry, September 13, 2018)

Figure 5-3. Healthy Cane Spring suncup plant at Cane Spring.

(Photo by J. Perry, September 13, 2018)

The Cane Spring area has a long history of human use and was used as a stage stop between Las Vegas and Beatty in the early 1900's. Wildlife are drawn to the area because of the perennial water and abundant plant growth. Historically, horses and burros were found using Cane Spring but no longer frequent the area. Rabbits and mule deer are the most common herbivores found around the spring. More recently the area has been used for training purposes and a trough was installed downstream from the spring. Although the dirt access road to the area has been gated, threats to the Cane Spring suncup continue to be trampling and wildlife foraging.

5.2.2 Clokey's Buckwheat (*Eriogonum heermannii var. clokeyi*)

Clokey's buckwheat (*Eriogonum heermannii var. clokeyi*) is a Nevada endemic perennial shrub restricted to limestone canyon walls. Its known locations include two areas in the western Spotted Range on the NNSS (Mercury Ridge and Red Mountain) and western areas of Clark county. There are ten varieties of *E. heermannii*. Five of them occur in Nevada with four identified on the NNSS and one identified just off the NNSS (northwestern Yucca Mountain). The best timing for surveys is from August through September, when it can be more easily identified with flowers.

Mercury Ridge was visited September 13th, 2018. Plants were locally abundant with no observable threats to the area. Approximately twenty percent of plants were observed in flower, twenty percent with immature or mature fruit, and sixty percent in senescence. Red Mountain was visited in October. Plants were not in bloom and were difficult to confirm as Clokey's buckwheat.

5.2.3 Inyo Hulsea (*Hulsea vestita ssp. inyoensis*)

Inyo hulsea (*Hulsea vestita ssp. inyoensis*) is a perennial forb in the Asteraceae (daisy) family. It is the only Hulsea subspecies found in Nevada and is otherwise distinguished from its relatives by its larger number of ray flowers, which are long and completely yellow. Threats to Inyo hulsea have greatly reduced with the absence of underground nuclear testing and its associated disturbances. Inyo hulsea grows well along road cuts, steep slopes and other disturbed areas. It continues to be considered a sensitive plant species due to its substrate requirements, which, on the NNSS, is restricted to light-colored volcanic substrates.

Inyo hulsea has been found at numerous locations in the northern areas of the NNSS: Rainier Mesa, Pahute Mesa, Belted range, Eleana range, Halfpint range, Cat Canyon and Oak Spring Butte. The Rainier Mesa population was visited on May 15th, 2018. Plants were observed with no obvious threats to the population. Twenty-five percent of the plants were in flower bud, twenty-five percent were in flower and fifty percent were immature plants. The Eleana range population was opportunistically observed in 2018 (see section 5.3.2).

5.2.4 Death Valley Beardtongue (*Penstemon fruticiformis var. amargosae*)

The Death Valley beardtongue (*Penstemon fruticiformis var. amargosae*) is known from one location on the NNSS in the Striped Hills on the southern boundary of Area 25, and was listed on the NNSS sensitive plant list in 2007. This area was visited on May 1st, 2018. Two populations in the area were visited and plants were found in boulder and rock cliff-washes near ridgelines in limestone substrate (Figure 5-4). Most plants were found in flower bud (65%) with a small amount (5%) flowering (Figure 5-5). The remaining plants (30%) were in vegetative status. There are no known threats to plant populations in this area from NNSS activities.

5.3 OPPORTUNISTIC ENCOUNTERS

During routine biological surveys, fuel surveys or other field work, opportunistic encounters of sensitive plant species are recorded.

5.3.1 Hilend's Bedstraw (*Galium hilendiae*)

A new population of Hilend's bedstraw (*Galium hilendiae*) was opportunistically found on June 7th, 2018, on the slopes of Yucca Mountain (UTM NAD83; 549435mE, 408777mN). The subspecies of the population is in question and the location will be revisited during an optimal growing season during its blooming time (late June-early July) to verify subspecies.

5.3.2 Inyo Hulsea (*Hulsea vestita ssp. inyoensis*)

Inyo hulsea has been observed during fuel surveys at survey point 143 (UTM NAD83; 572421, 4113223) in the Eleana population (Tongue Wash) consistently over the years with the latest observations in 2013 and 2017. It was observed again at this same location in 2018.

Figure 5-4. Death Valley beardtongue habitat.

(Photo by P. Hardesty, May 1, 2018)

Figure 5-5. Death Valley beardtongue in flower.

(Photo by P. Hardesty, May 1, 2018)

5.4 COORDINATION WITH OTHER SCIENTISTS

- In April 2018, an MSTS biologist attended the Nevada Rare Plant Workshop hosted by the Nevada NNPS in Reno, Nevada. The workshop allows botanists, government agencies and other interested parties to discuss conservation priority of rare native Nevada plants. Two sensitive plant ranking lists were discussed during the workshop: the Nevada Natural Heritage Program At-Risk Plant and Animal Tracking List and the Nevada Native Plant Society List.

- In 2018, MSTS biologists began attending the Nevada Native Plant Society Southern Chapter monthly meetings. The meetings host a network of botanists familiar with native Nevada plants. The meetings focus on current information and updates in Southern Nevada related to the status of important plant species, botany networking events and the need for collaboration between government agencies on plant research.

- MSTS biologists collected leaf and seed samples of Rock purpusia (*Ivesia arizonica* var. *saxosa*), a plant on the NNSS sensitive plant list, for the Department of Biology, University of Nevada, Reno to contribute to genetic research on rock purpusia varieties.

6.0 SENSITIVE AND PROTECTED/REGULATED ANIMAL MONITORING

The NNHP Animal and Plant At-Risk Tracking List (NNHP 2019); NAC 503, "Hunting, Fishing and Trapping; Miscellaneous Protective Measures" (NAC 2019); the FWS Endangered Species home page (FWS 2019); and other sources were reviewed to determine if any changes had been made to the status of animal species known to occur on the NNSS. The short-eared owl (*Asio flammeus*), long-eared owl (*Asio otus*), bank swallow (*Riparia riparia*), Lewis woodpecker (*Melanerpes lewis*), and pine siskin (*Spinus pinus*) were added as sensitive species. The ferruginous hawk (*Buteo regalis*) and phainopepla (*Phainopepla nitens*) were removed from the sensitive species list. Bendire's thrasher (*Toxostoma bendirei*) was also removed because it is not known to occur on the NNSS. The complete list with current designations is found in the Sensitive and Protected/Regulated Animal Species List (Table 2-1).

Surveys of sensitive and protected/regulated animals during 2018 focused on (a) birds, (b) bats (c) feral horses, (d) mule deer, (e) desert bighorn sheep, and (f) mountain lions. Information about other noteworthy wildlife observations, bird mortalities, and a summary of nuisance animals and their control on the NNSS is also presented.

6.1 BIRDS

Bird monitoring on the NNSS during 2018 focused on Migratory Bird Treaty Act (MBTA) Compliance, documenting bird mortalities, implementing the NNSS Avian Protection Plan, and conducting winter raptor surveys. Additionally, a new bird species, the western screech owl (Megascops *kennicottii*), was recorded (Figure 6-1). It was hit and killed by a vehicle on Buckboard Mesa Road (Area 20) on November 14, 2018. This makes a total of 245 confirmed bird species documented on the NNSS.

6.1.1 Migratory Bird Treaty Act Compliance

The MBTA is a federal law designed to protect most bird species. All but six birds known to occur on the NNSS are protected under the MBTA. Exceptions include the European starling (*Sturnus vulgaris*), English house sparrow (*Passer domesticus*), rock dove or pigeon (*Columba livia*), and the Eurasian collared dove (Federal Register, Volume 70, Number 49, March 15, 2005). The chukar and Gambel's quail (*Callipepla gambelii*) are also not protected under the MBTA but are regulated by Nevada state law as gamebirds. A change in the way the MBTA has been interpreted was written in a FWS Memorandum M-37050 on December 22, 2017. Up until now the MBTA has prohibited the intentional and incidental take of migratory birds. M-37050 changes that interpretation to state, "the Migratory Bird Treaty Act does not prohibit incidental take." The impacts of this change are not known at this time but will be addressed as more information becomes available.

Executive Order (EO) 13186 *Responsibilities of Federal Agencies to Protect Migratory Birds* directs federal agencies to develop a Memorandum of Understanding (MOU) and work with the FWS to promote the conservation of migratory bird populations. An MOU was signed by U.S. Department of Energy and FWS in September 2013 regarding implementation of EO 13186. This MOU is currently being updated.

Actions taken to comply with the MBTA and MOU during 2018 included the following: 1) conducted preactivity surveys for proposed projects before surface-disturbing work to avoid harming birds or their nests, 2) treated injured fledgling Say's phoebe (*Sayornis saya*) and returned it to its nest and moved a grounded sparrow out of harm's way, 3) installed bird guard, protective covers and other retrofits on power lines to reduce avian mortality, 4) received a Special Purpose Utility permit (MB60930C-1) from

Figure 6-1. Western screech owl, hit by a vehicle on Buckboard Mesa Road, Area 20.

(Photo by D. Hall, November 15, 2018)

FWS that allows for the removal of active bird nests in emergency situations and the possession and transporting of bird carcasses, and 5) reported dead/injured birds to FWS.

A greater roadrunner (*Geococcyx californianus*) nest containing one hatchling and two eggs was relocated on August 9, 2018. The original nest was inside a crane that had to be moved. After consulting with FWS, the nest was relocated to an adjacent piece of equipment and monitored for several hours. It was checked after the weekend and no birds were found, just a few eggshell fragments. It appeared that the nest was destroyed by avian predation, possibly by ravens in the area. Two other greater roadrunner nests were found in equipment this year but were left alone until the nest was empty or abandoned.

6.1.2 Bird Mortalities

Bird mortality is a measure of impacts that NNSA/NFO activities may have on protected bird species. NNSA/NFO activities that have affected birds typically have been of three types: collisions with buildings, electrocution from power lines, and vehicle mortalities. Other causes of death include predation and disease and in many instances the cause of death is unknown. Workers and biologists work together to observe and report mortalities.

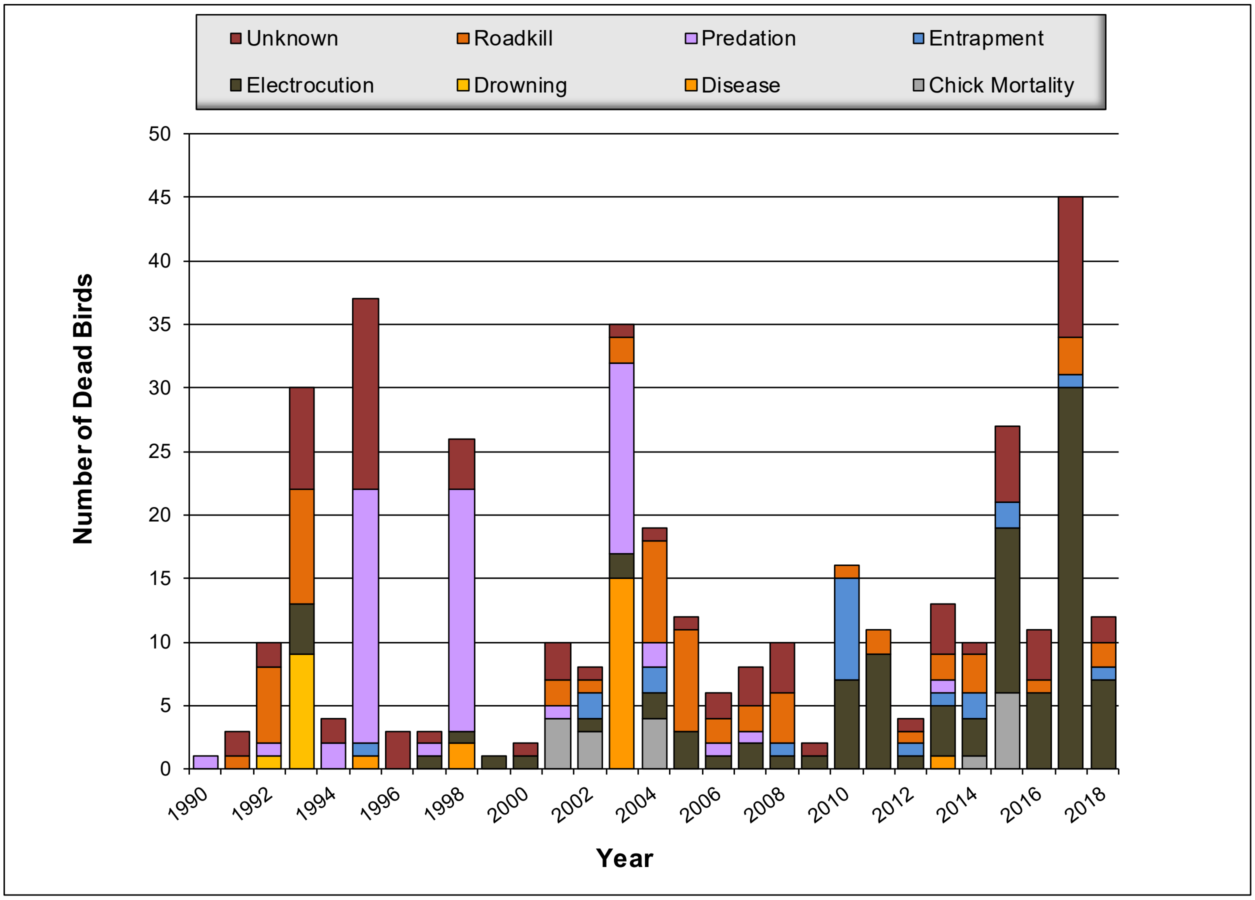

Figure 6-2. Records of reported bird deaths on the NNSS, 1990–2018.

Twelve birds were found dead on the NNSS in 2018 (Figure 6-2). Seven were electrocuted, including four golden eagles, one red-tailed hawk (*Buteo jamaicensis*), one great-horned owl (*Bubo virginianus*), and one greater roadrunner. Two birds were killed by vehicles. A golden eagle was injured by a vehicle and cared for by a raptor rehabilitator (Wild Wing Project) for about six months. Shortly before its planned release back to the NNSS, it got sick and died. Additionally, as mentioned earlier, a western screech owl was killed by a vehicle. A Wilson's warbler (*Wilsonia pusilla*) was extracted from a glue trap but died the next day. Two birds died of unknown causes including a red-tailed hawk found dead by the ATLAS facility in Yucca Flat (Area 6) and a great-horned owl that was found alive in Frenchman Flat but died later that day. It appeared to have some head trauma with unresponsive pupils and may have flown into a building. Bird mortalities were drastically reduced compared to last year, especially electrocutions. This may be due to reduced bird activity from the lack of precipitation and retrofitting numerous power poles to make them avian-friendly.

The golden eagle deaths were reported to FWS and the carcasses sent to the National Eagle Repository. Numerous poles were identified by MSTS biologists and the power group to install retrofits or reconfigure to make them avian friendly (Figure 6-3). A total of 95 poles were retrofitted during 2018 with additional poles planned to be retrofitted during 2019 when power can be shut off to important NNSS facilities. A variety of retrofits were made including installing insulator covers and extenders, perch deterrents, conductor wire covers, and fuse covers. We also conducted surveys at 142 pole sets to assess if they were avian-friendly and to look for bird carcasses. No dead birds were found and 15 (11%) were identified as not avian-friendly. These have been added to a list for future retrofit consideration.

Figure 6-3. Retrofitted pole with conductor wire covers, insulator covers, and extenders.

(Photo by D.B. Hall, April 5, 2017)

6.1.3 Implementing the NNSS Avian Protection Plan

The NNSS Avian Protection Plan (APP) was finalized during 2017. Its main purpose is to describe a program intended to reduce the operational and avian risks that result from avian interactions with electric transmission and distribution lines on the NNSS owned by NNSA/NFO as well as other non-electric sources of mortality (e.g., vehicle collisions, habitat disturbance).

At the end of each calendar year the APP should be reviewed and the following questions answered: 1) Is the reporting procedure effective at documenting avian mortalities, 2) Are reported mortalities/injuries addressed in a timely manner, 3) Are permit conditions being met, and 4) What mortality reduction measures were taken and are they effective. For 2018 answers to these questions are:

- The reporting procedure was effective at documenting avian mortalities. There is good communication between biologists, the power group, other NNSS workers and the Operations Command Center to report avian issues.
- Reported mortalities/injuries were addressed in a timely manner and were usually investigated the same day or within a few days.

- Currently, we have two federal permits and one state permit pertaining to birds on the NNSS. Federal permit MB008695-2 allows the taking of up to 10 mourning doves each year for radiological analysis and the salvage of dead migratory birds (except species listed under the Endangered Species Act). All permit conditions were met and an annual report summarizing 2018 activities was submitted to FWS. No mourning doves were taken and one great-horned owl specimen was salvaged for educational purposes. Federal permit MB60930C-1 is a "Special Purpose Utility Permit – Electric," and was issued November 6, 2018. This permit enables MSTS biologists to remove active nests at project sites in emergency situations and possess and transport carcasses of golden eagles and other bird species. All permit conditions were met and an annual report summarizing 2018 activities was submitted to FWS. This included entering all bird mortality injuries and mortalities into the Injury and Mortality Reporting system, a FWS electronic database. Nevada Department of Wildlife (NDOW) Scientific Collection Permit 261454 was renewed in December 2018 and allows for the salvage and possession of migratory birds and the sacrificing of mourning doves, chukar and gambel's quail. All permit conditions were met and an annual report summarizing 2018 activities was submitted to NDOW.

- Several mortality reduction measures were taken. These include the aforementioned retrofits on 95 power poles, identifying several poles for future retrofits, removing three inactive nests, surveying 311 ha at 29 project sites for active bird nests, and removing several dead rabbits and snakes from roads to reduce the potential for vehicle mortalities. These measures were effective at reducing avian mortalities.

6.1.4 Winter Raptor Surveys

Winter raptor surveys were initiated during 2014, in an effort to better understand wintering raptors on the NNSS and as a collaborative effort to provide data to the U.S. Army Corps of Engineers' (USACE) nationwide mid-winter bald eagle survey and NDOW's statewide monitoring effort. Surveys continued in 2018, and were conducted by driving a standard route to identify all raptors observed (i.e., eagles, hawks, owls, and vultures). Two official routes were established on the NNSS: Southern NNSS, Route #60 (83 km), and Yucca Flat, Route #61 (75 km) (Figure 6-4). Data including common name, UTM coordinates (NAD 83), time, activity, age class, and perpendicular distance from the road were recorded, and climatic data (i.e., temperature, wind speed, and cloud cover) were taken at the beginning and end of each survey. Surveys were conducted January 10 (Southern NNSS) and January 11 (Yucca Flat) to coincide with the national bald and golden eagle survey and on February 12 (Southern NNSS) and February 13 (Yucca Flat).

The intent is for these surveys to be conducted each year for numerous years to look at long-term trends in winter raptor occurrence on the NNSS. Much is known about raptors on the NNSS in the summer, but winter data are lacking. Winter data may be important to detect changes in species composition related to climate change. Data on common ravens and loggerhead shrikes (*Lanius ludovicianus*) were also recorded because ravens are known desert tortoise predators, and the loggerhead shrike is a sensitive species. The southern route is located primarily in the Mojave Desert portion of the NNSS while the Yucca Flat route is located in the transition zone between the Mojave Desert and Great Basin Desert. Detailed driving directions for each route are found in the 2016 EMAC report (Hall et al., 2017).

Results are found in Table 6-1. Eleven golden eagle sightings were documented during the surveys; five and four on the Yucca Flat route during the January and February surveys, respectively, and two on the southern NNSS route during the January survey. This is by far the most golden eagle sightings documented on winter surveys (Figure 6-5). The red-tailed hawk was the most common species detected on both routes, comprising nearly three-fourths of all raptor sightings (Table 6-1). Common ravens were more prevalent on the southern route this year than in Yucca Flat with most of them observed near the

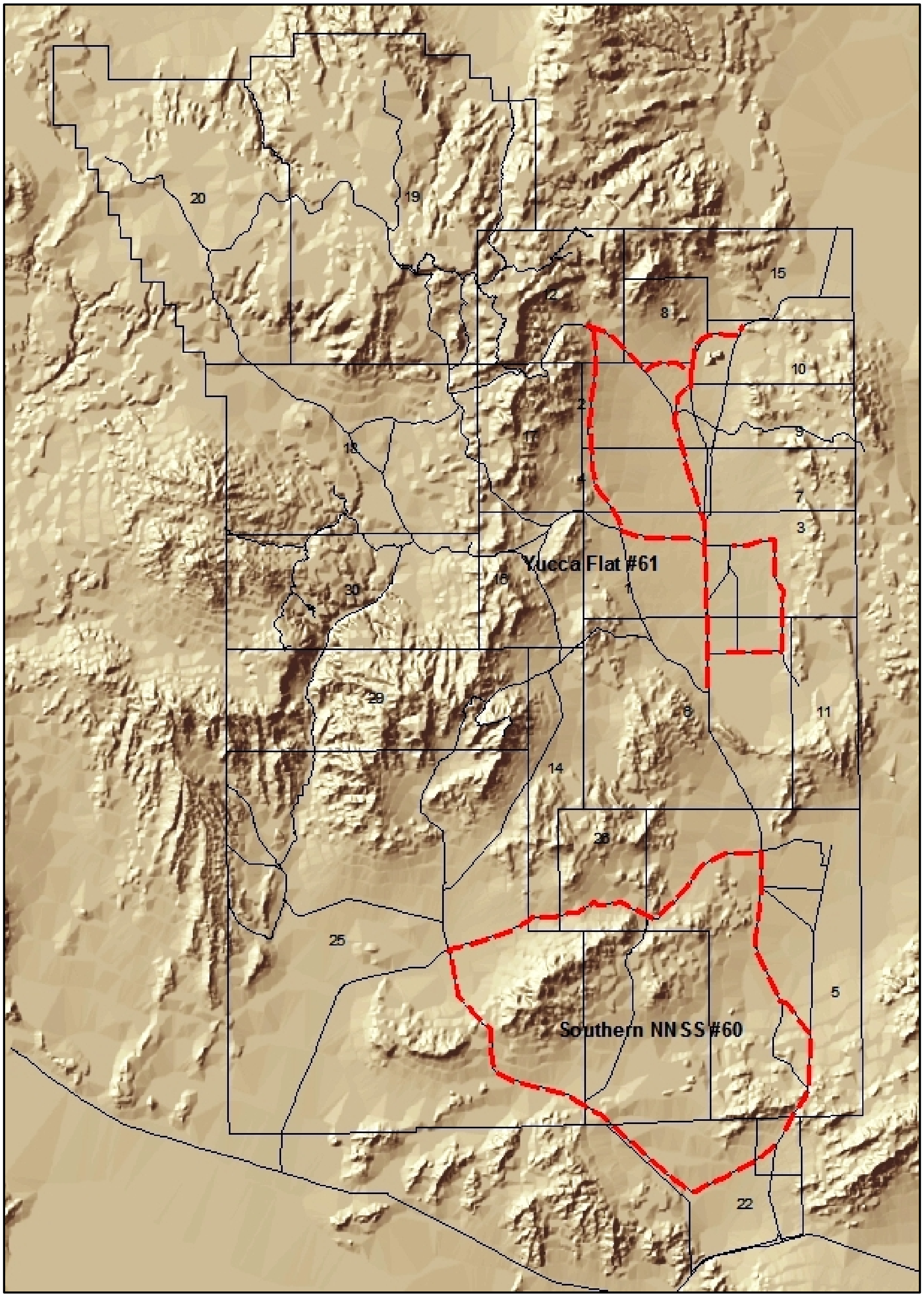

Figure 6-4. Winter raptor survey routes (red lines) on the NNSS.

Table 6-1. Results of winter 2018 raptor surveys on the NNSS.

Species	Southern NNSS (1/10/18)	Southern NNSS (2/12/18)	Yucca Flat (1/11/18)	Yucca Flat (2/13/18)
Golden Eagle (*Aquila chrysaetos*)	2	0	5	4
Red-tailed Hawk (*Buteo jamaicensis*)	15	10	10	6
Praire Falcon (*Falco mexicanus*)	0	0	1	1
American Kestrel (*Falco sparverius*)	0	0	1	0
Burrowing owl (*Athene cunicularia*)	0	0	0	1
Total Raptors	**17**	**10**	**17**	**12**
Common Raven (*Corvus corax*)	9	8	6	2
Loggerhead Shrike (*Lanius ludovicianus*)	0	0	0	0

Mercury Sewage Lagoons. Red-tailed hawk sightings were highly variable between routes and across years (Figure 6-5). Total number of winter raptor sightings in 2018 on both routes was the highest recorded since monitoring began in 2014 and were consistently higher on the Yucca Flat route than on the southern route (Figure 6-6). Data were entered into the Ecological Geographic Information System (EGIS) faunal database, and given to NDOW and the USACE for inclusion in their analyses.

6.2 BAT SURVEYS

Bat monitoring in 2018 consisted of removing dead bats from buildings and documenting the roost sites. Building 23-751 had multiple occurrences with one adult Brazilian free-tailed bat (*Tadarida brasiliensis*), three adult canyon bats (*Parastrellus hesperus*) (two female, one male), an adult female California myotis (*Myotis californicus*), and an adult unknown Myotis species found dead. An adult male California myotis or small-footed myotis (*M. ciliolabrum*) was found dead on a glue trap in Building 23-683, and a dead Myotis species was found in Dormitory B in Mercury. An adult female California myotis was found dead in a building at the Reactor Control Point (Area 25), and an adult female California or small-footed myotis was found dead in the machine shop at a facility in Area 27. Roost site locations at these buildings were entered in the EGIS faunal database.

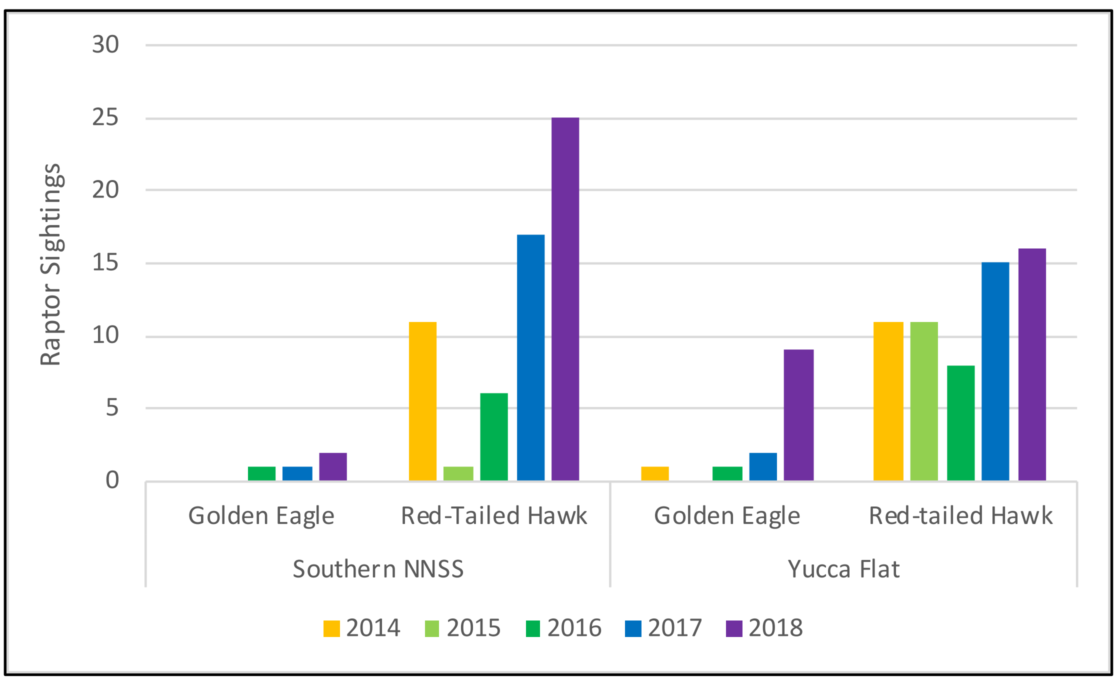

Figure 6-5. Number of golden eagle and red-tailed hawk sightings during winter raptor surveys on two routes from 2014–2018.

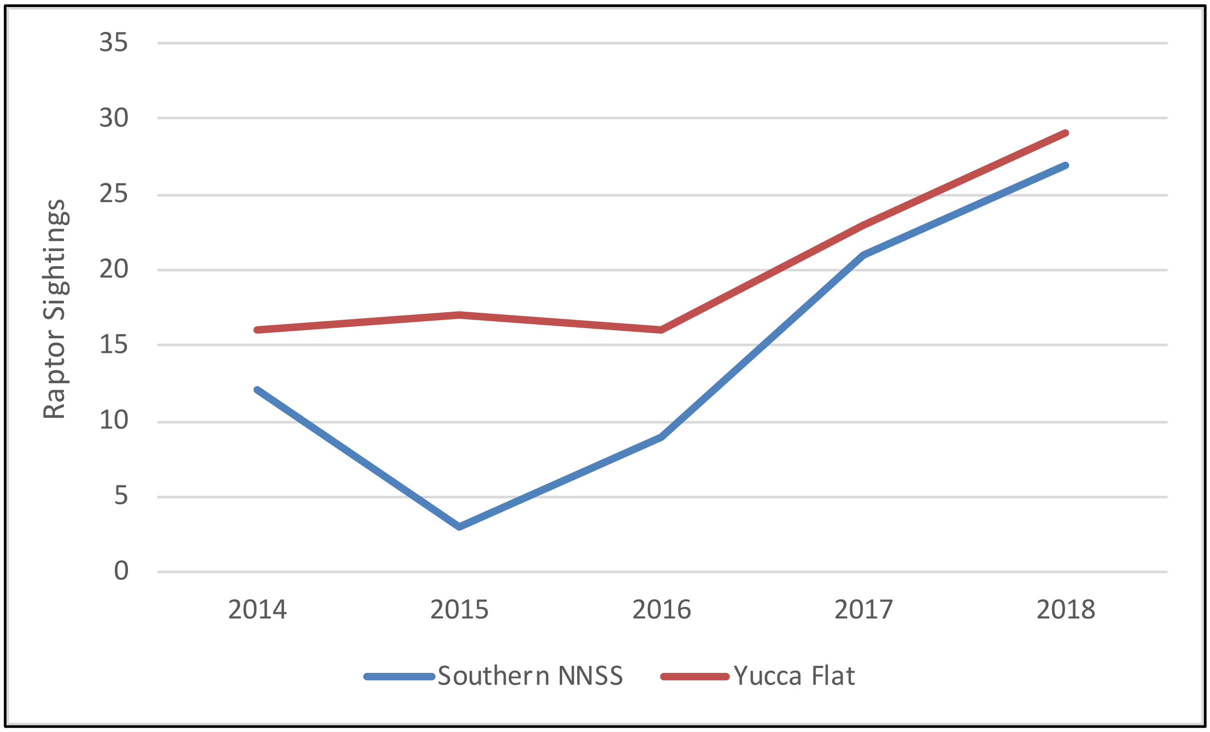

Figure 6-6. Number of winter raptor observations on the southern NNSS route and the Yucca Flat route (2014–2018).

6.3 FERAL HORSE SURVEYS

Monitoring was conducted in 2018 to determine the abundance and distribution of wild horses on the NNSS with survey routes, opportunistic sightings and camera traps (see Table 6-4 in Section 6.6.1 Motion-Activated Cameras). A previously-used, standard rubric for horse color, body features, body markings, facial marking and leg markings was used to identify and count individual horses. Surveys were conducted during the spring and summer at several locations including Camp 17 Pond, Airport Road, Pahute Mesa Road, and Gold Meadows (Figure 6-7). Biologists identified 40 individuals in at least five different bands; 16 females, 15 males, and nine of unknown sex (Patty Hardesty, MSTS, personal communication, March 18, 2019). The total includes six juveniles and five foals. In 2017, 24 individual horses were observed in four different bands including at least 3 foals. The increased number in 2018 is attributed to more intensive sampling and new individuals recruiting into the population.

Based on opportunistic sightings and camera results, horses were observed in the same areas as previous years. No horses were documented using Captain Jack Spring for the fifth consecutive year. Numerous horse photos were taken at Camp 17 Pond (541 images) and Gold Meadows Spring (195 images) (Table 6-4). These water sources are the core areas used by horses, especially during the hot, dry summer months.

Figure 6-7. Feral horses grazing in Gold Meadows.

(Photo by R. Carios, June 19, 2018)

6.4 MULE DEER

Initial studies of mule deer at the NNSS were conducted by Giles and Cooper (1985) from 1977 to 1982 when they performed mark and recapture studies on about 100 marked deer. They estimated the population to be about 1,500–2,000 deer. Spotlighting surveys for deer on the NNSS were conducted during 1989–1994, 1999–2000, and 2006-2018. In past years, the monitoring effort has emphasized estimating relative abundance and density but since 2016 survey efforts have focused solely on relative abundance.

6.4.1 Trends in Mule Deer Abundance

Mule deer abundance on the NNSS was measured by driving two standardized (59 km total length) road courses (Figure 6-8) to count and identify mule deer. One route (29 km) was centered around Rainier Mesa, and the second (30 km) was centered around the eastern portion of Pahute Mesa. Selection of the two routes was based on information from Giles and Cooper (1985) who determined there are two main deer herd components in these regions on the NNSS. Locations of mule deer were recorded with a Global Positioning System (GPS) unit from the road centerline. Perpendicular distance from the road to each deer group was measured with a laser range finder.

During six surveys conducted September 17-19 and October 1-3, 2018, a total of 115 deer were observed on both routes combined, which equates to an average of 19 deer per night. This is lower than 2017 results with 149 deer observed and an average of 25 deer per night. On average, this is about 11 deer per

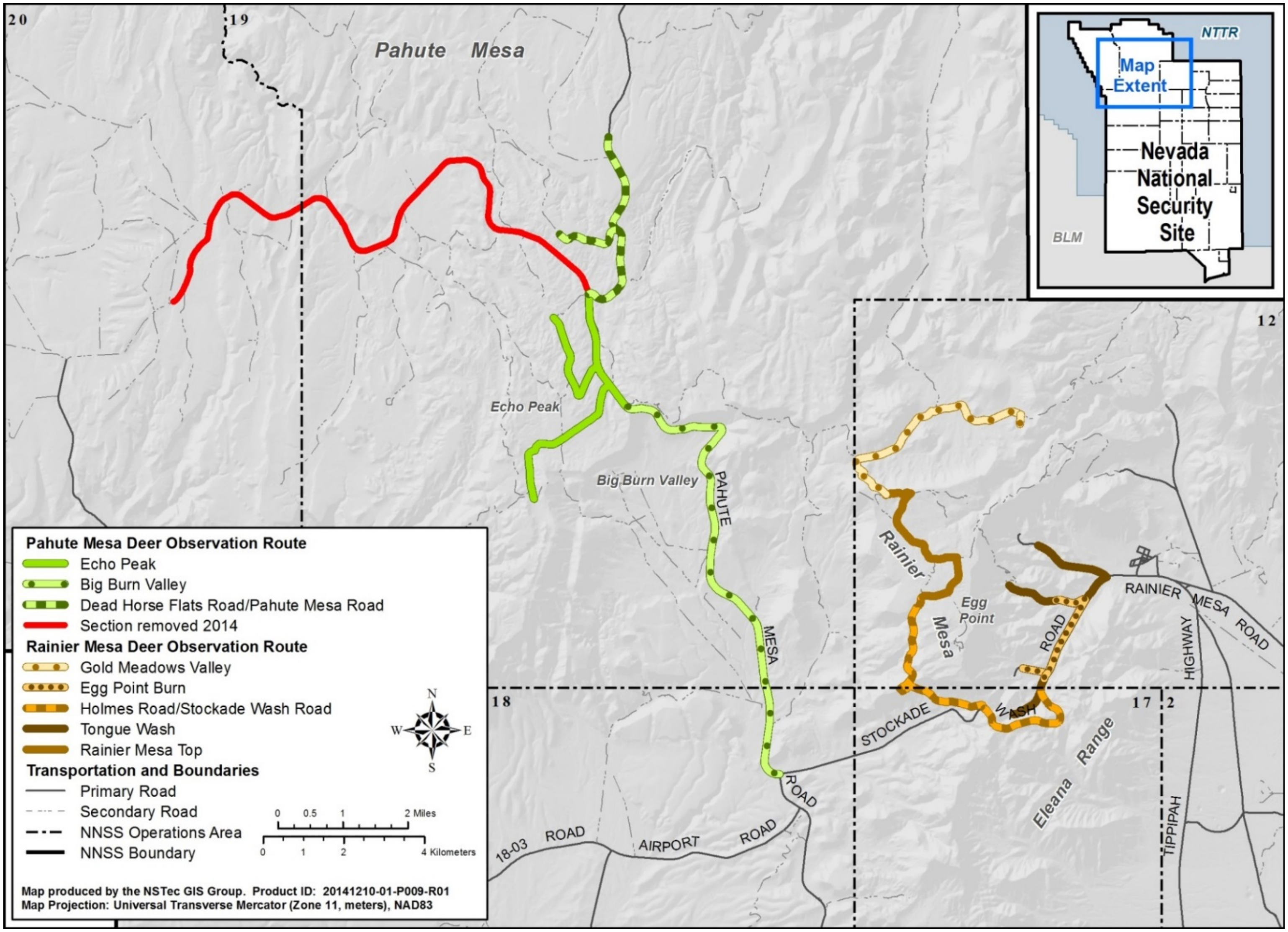

Figure 6-8. Road routes and sub-routes of two NNSS regions driven in 2018 to count deer and section removed due to road closure.

night lower than the long-term average since 1989 and the lowest since 2006. There has been a decreasing trend ($y = -2.3603x + 48.69$, $r^2 = 0.53$) the last 13 years with counts fluctuating widely (Figure 6-9). The trend for the entire study period (1989-2018, excluding 1995-1998 and 2001-2005) is nearly flat ($y = 0.0545x + 30.78$, $r^2 = 0.0018$). The standard deviation in 2018 for nightly counts was the lowest recorded since 2006 (Figure 6-9), and deer counts ranged from 10 to 27 deer per night. Specific causes for the fluctuation in deer numbers is unknown and requires further investigation.

Similar to last year, the number of deer per 10 km was higher on Rainier Mesa than Pahute Mesa in 2018 (Figure 6-10). A total of 55 deer groups were detected. Group size varied from 1 to 8 animals. Average group size was nearly equal between the Pahute Mesa and Rainier Mesa routes (1.8 and 2.3, respectively).

6.4.2 Sex and Fawn/Doe Ratios

The deer sex ratio (number of bucks per 100 does) decreased from 124 in 2017 to 105 in 2018, which is near the average of 109 (2006-2018) (Table 6-2). These sex ratios have varied greatly on the NNSS since 2006. Our values overall show some similarity to historical sex ratios noted by Giles and Cooper (1985), who attributed the higher number of males to a lack of hunting on the NNSS. Generally, deer populations in hunted areas in the western U.S. have significantly fewer males compared to females in the population than measured on the NNSS. The fawn/doe ratio (number of fawns per 100 does) in 2018 was 26 fawns per 100 does (Table 6-2) which is the same as in 2017 and very close to the average of 25 fawns per 100 does for the period 2006-2018. The third largest percentage of individuals unclassified to sex since 2006 was documented this year with nearly 24% of individuals unclassified. When deer are observed at long distances (150-200 m) from the vehicle, it can be difficult to determine if individuals are bucks, does, or fawns due to spotlight limitations.

6.4.3 Fall Distribution Surveys

A research study is anticipated to begin in November 2019 involving the capture and radio-collaring of 21 mule deer on the NNSS to better understand their habitat use and movements in support of studies regarding the potential radiological dose to the off-site public. In order to facilitate captures, spotlight surveys were conducted on November 19-20 to evaluate the distribution of mule deer at this time of year. The Rainier Mesa route (Figure 6-8) was surveyed on November 19. A total of 41 deer were observed (10 bucks, 15 does, 2 fawns, and 14 unknown), all of which were on the eastern slope of Rainier Mesa at lower elevations. The Pahute Mesa route (Figure 6-8) was surveyed on November 20. Three bucks were detected, all of which were found on the Echo Peak I road. These data will help determine the staging locations for the capture effort.

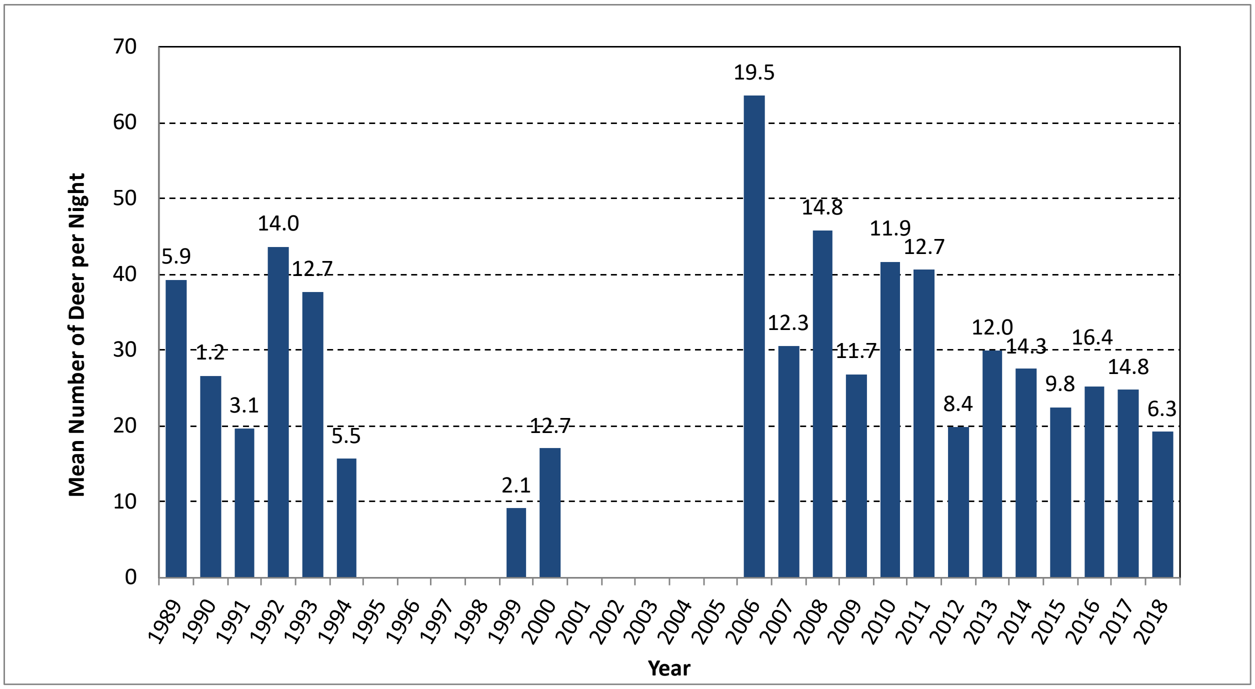

Figure 6-9. **Trends in total deer count per night from 1989 to 2018 on the NNSS (surveys were not conducted during 1995–1998 or 2001–2005). Standard deviation values above bars.**

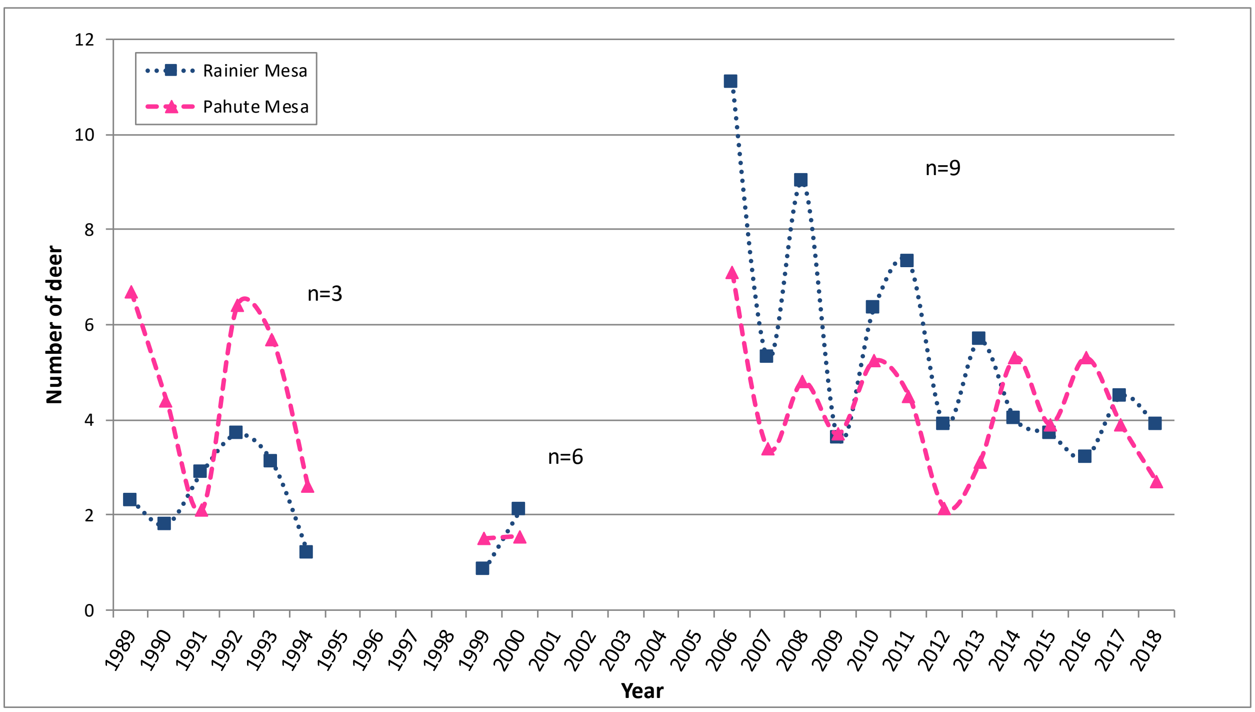

Figure 6-10. **Mean number of mule deer per 10 km per night, counted on two routes (n = number of survey nights; exceptions n = 12 for 2012, n = 8 for 2013, n = 6 for 2015–2018).**

Table 6-2. Mule deer classified by sex and age, with sex ratios, and fawn to doe ratios from 2006 to 2018 on the NNSS (12 survey nights for 2012, 8 for 2013, 6 for 2015–2018, 9 for all other years).

Year	Total Deer	Bucks	Does	Unclassified Sex	Bucks/100 does	Fawns	Fawns/100 does
2006	573	224	222	96	101	31	14
2007	275	148	68	59	218	0	0
2008	408	164	147	50	112	47	32
2009	242	98	102	35	96	7	7
2010	365	133	150	50	89	32	21
2011	477	189	184	67	103	37	19
2012	179	65	67	28	97	19	30
2013	243	106	68	38	156	31	45
2014	249	76	94	60	81	19	20
2015	135	33	58	19	57	25	43
2016	151	43	58	27	74	23	40
2017	149	52	42	44	124	11	26
2018	115	40	38	27	105	10	26

6.5 DESERT BIGHORN SHEEP

Prior to 2009, desert bighorn sheep (sheep) were rare visitors on the NNSS (Saethre 1994, Wills and Ostler 2001, Hall et al. 2017). Since 2009, numerous observations of sheep and sheep sign (i.e., scat, beds, and remains) have been detected with motion-activated cameras and during the mountain lion study, including the discovery of ewes and lambs in the Yucca Mountain/Fortymile Canyon area in 2011. These new data have expanded the known distribution of sheep on and near the NNSS and have prompted further study of these important animals including the capture, radio-collaring, and tracking of 21 individuals over the last four years. This study is being led by Kathy Longshore (USGS) with NDOW and MSTS as collaborators. Camera traps at water sources are also being used to monitor sheep on the NNSS.

6.5.1 Capture Results

Table 6-3 contains information on 21 sheep that were captured during November 2015 (n = 6, 5 radio-collared) and 2016 (n = 15, 13 radio-collared). Collars were programmed to record locations four times a day (1800, 0000, 0600, and 1200), except for the first five days of each month when hourly locations were recorded. This was done to better understand diel movement patterns. A total of 5,861 GPS locations were successfully recorded for the five radio-collared sheep from November 18, 2015 to May 1, 2016 (Figure 6-11).

During 2018, 12 radio-collared sheep (one ram died in April 2017) were tracked until their collars dropped off or the collars stopped functioning. Collars were programmed to drop off the sheep on May 1. However, the capture crew mistakenly failed to trim the excess collar material from collars on six of the sheep so the collars did not drop off as expected but remained on the sheep for varying lengths of time. By the end of 2018, nine collars had been retrieved with three still remaining on the animals. A total of 50,811 GPS locations were successfully recorded for the 13 radio-collared animals from November 30, 2016 through September 17, 2018 (Figure 6-11). Overall, radio-collared sheep ranged over Shoshone Mountain, Yucca Mountain, Bare Mountain, Thirsty Canyon, Black Mountain and Quartz Mountain.

Table 6-3. Desert bighorn sheep capture information for 2015 and 2016.

Collar ID	Sex	Age (years)	Capture date	Left Ear Tag	Right Ear Tag	Capture Location	Last known Location	Comments
686329	Male	3	11/17/2015	Yellow124	Blue/Green124	Southeast Shoshone Mountain	South Pah Canyon Tanks	Collar dropped 5/1/16; Photo 9/3/18
686326A	Male	U	11/17/2015	GreenJ	OrangeJ	Cottonwood Spring Area	Black Mountain	Collar dropped 5/1/16
No collar	Male	1.5	11/18/2015	OrangeD	BlueD	South Pah Canyon	South Pah Canyon Tanks	Too young for collar; Photo 12/30/18
686327A	Male	5	11/17/2015	Red121	Green121	Cottonwood Spring Area	North of Bare Mountain	Shot by hunter, fall 2016
686318	Female	U	11/17/2015	Blue125	Yellow125	Cottonwood Spring Area	Delirium Canyon Tanks	Collar dropped 5/1/16; Photo 7/12/18
686317	Female	3	11/17/2015	Green126	Orange126	Cottonwood Spring Area	Prow Pass Area	Collar dropped 5/1/16
686322	Male	4	11/28/2016	B -pink triangle	B -blue triangle	South Shoshone Mountain	Claim Canyon Pass	Collar dropped 8/6/18
686315	Female	2	11/29/2016	I -yellow triangle	I-green triangle	South Shoshone Mountain	East Shoshone Mountain	Collar dropped 5/25/18
686316	Female	2	11/29/2016	118-green square	118-red square	South Shoshone Mountain	Shoshone Mountain	Collar stopped 9/16/18, still attached 1/28/19
No collar	Male	0.8	11/29/2016	123-green square	123-yellow squ.	Shoshone Mountain	Fortymile Canyon Tanks	Too young for collar; Photo 8/9/18
No collar	Female	1	11/29/2016	A-green triangle	A-wht triangle	Shoshone Mountain	Delirium Canyon Tanks	Too young for collar; Found dead 8/22/18
686328	Male	3	11/29/2016	no tag	no tag	West Yucca Mountain	Hills west of Yucca Mountain	Collar stopped 9/17/18, still attached 1/31/19
686325	Male	5	11/29/2016	H-blue triangle	H-yellow triangle	West Yucca Mountain	Northwest of Claim Canyon Pass	Collar dropped 5/1/18
686324	Male	4	11/29/2016	F-white triangle	F-pink triangle	West Yucca Mountain	Black Glass Canyon	Collar dropped 9/15/18
686314	Female	>2	11/29/2016	G-pink triangle	G-yellow triangle	Shoshone Mountain	Vent Pass Area	Collar dropped 5/1/18
686319	Female	4	11/29/2016	120-blue square	120-green square	South Shoshone Mountain	Yucca Wash	Collar dropped 5/1/18
686313	Female	>2	11/29/2016	E-yellow triangle	E-green triangle	Shoshone Mountain	Vent Pass Area	Collar dropped 5/1/18
686320	Female	>2	11/29/2016	122-green square	122-yellow square	Shoshone Mountain	Vent Pass Area	Collar dropped 5/1/18
686323	Male	>5	11/29/2016	112-blue	112-yellow	Shoshone Mountain	North of Yellow Rock Spring	Died of natural causes, 4/6/17
686327	Male	3	11/29/2016	115-blue	115-yellow	West Yucca Mountain	East Pinnacle Ridge	Collar stopped 4/28/18
686326	Male	3.5	11/29/2016	116-blue	116-blue	Shoshone Mountain	East of Yellow Rock Springs	Collar stopped 9/16/18, still attached 1/28/19

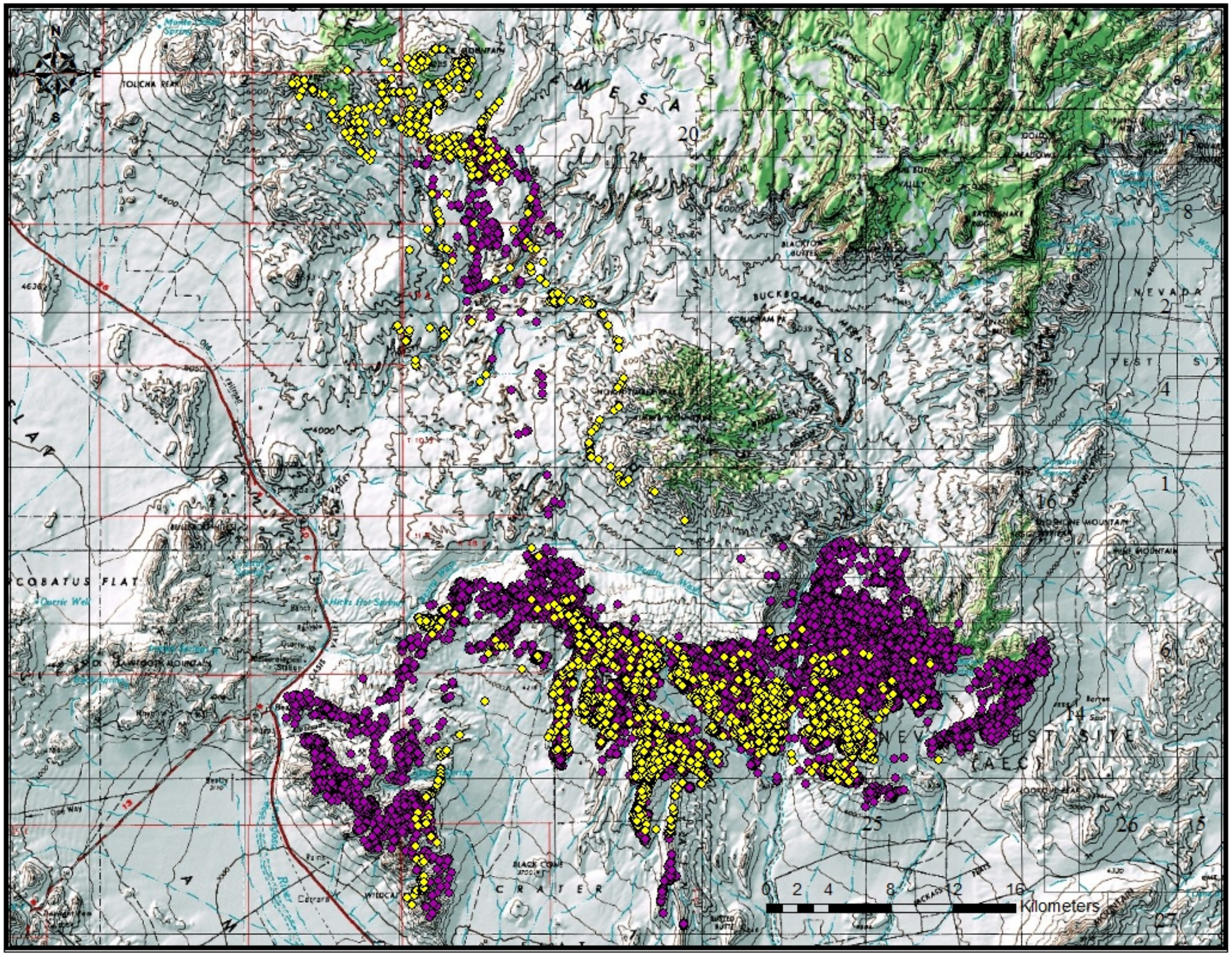

Figure 6-11. Locations from 18 radio-collared sheep, November 2015 to May 2018 (yellow dots = 2015 captures, purple dots = 2016 captures).

Rams typically ranged over larger areas than females. Two rams (686326A [2015 capture]; 686324 [2016 capture]) moved over 32 km to the north into Thirsty Canyon, Black Mountain and Quartz Mountain. Figures 6-12 and 6-13 show the locations of the six ewes captured in 2016 from November 30, 2016 to when the radio collars stopped working. All six ewes focused their activities around Yucca Mountain, Shoshone Mountain and Fortymile Canyon. Figures 6-14 and 6-15 show the locations of the seven rams from November 30, 2016 to when the radio collars stopped working. Rams 686322, 686323, 686326, and 686327 focused their activities around Yucca Mountain, Shoshone Mountain, and Fortymile Canyon similar to the ewes. Ram 686324 spent time north of the NNSS in Thirsty Canyon, south of Black Mountain in late August and September of 2017 and 2018. Rams 686325 and 686328 (Figure 6-16) focused their activities on Bare Mountain and the western portion of Yucca Mountain. A marked ewe (EweA) captured in 2016 that was too small for a collar was found dead near Delirium Canyon Tanks on August 22, 2018. It did not appear to have been killed by a mountain lion but cause of death is unknown. USGS is in the process of compiling the data and writing a final project summary report.

6.5.2 Camera Trap Results

During 2018, motion-activated cameras detected sheep at Delirium Canyon Tanks (209 images), South Pah Canyon Tanks (161 images), Fortymile Canyon Tanks (152 images), Cottonwood Spring (3 images), Topopah Spring (3 images), and Twin Spring (3 images) (Table 6-4).

Nine marked sheep were detected at Delirium Canyon Tanks including Ewe 686316 with lamb, Ewe 686319, EweA, Ewe 686314, Ewe 686313, Ewe 686320 with unmarked yearling ram, Ewe 686318-2015, Ram 123, Ram D-2015 as well as at least four unmarked ewes, two older lambs, and an unmarked ram.

Seven marked sheep were observed at South Pah Canyon Tanks including Ewe 686313, Ewe 686319, Ewe 686314, Ram 686329-2015, Ram 686328, Ram 686326, Ram D-2015, as well as at least three unmarked ewes, one lamb and an unmarked ram.

On March 4 a total of 15 sheep were photographed at Fortymile Canyon Tanks including 11 ewes (2 collared, 3 uncollared, 6 unknown) and 4 lambs. Other sheep photographed at this site were Ewe 686316, Ewe 686313, Ewe 686317-2015, Ewe 686320, Ram 686326, Ram 123, Ram 686329-2015 and 2 unmarked rams.

At Cottonwood Spring, three individual sheep were detected (Ewe 686318-2015, Ewe 686319, and an unmarked ewe). At Topopah Spring, an unknown ram was observed, and at Twin Spring an unknown ram was observed.

Similar to 2017, a total of 13 marked sheep (9 of 14 from 2016 captures and 4 of 5 still alive from 2015 captures) were documented with camera traps at water sources. This suggests that monitoring water sources in sheep habitat is a good technique for documenting marked sheep.

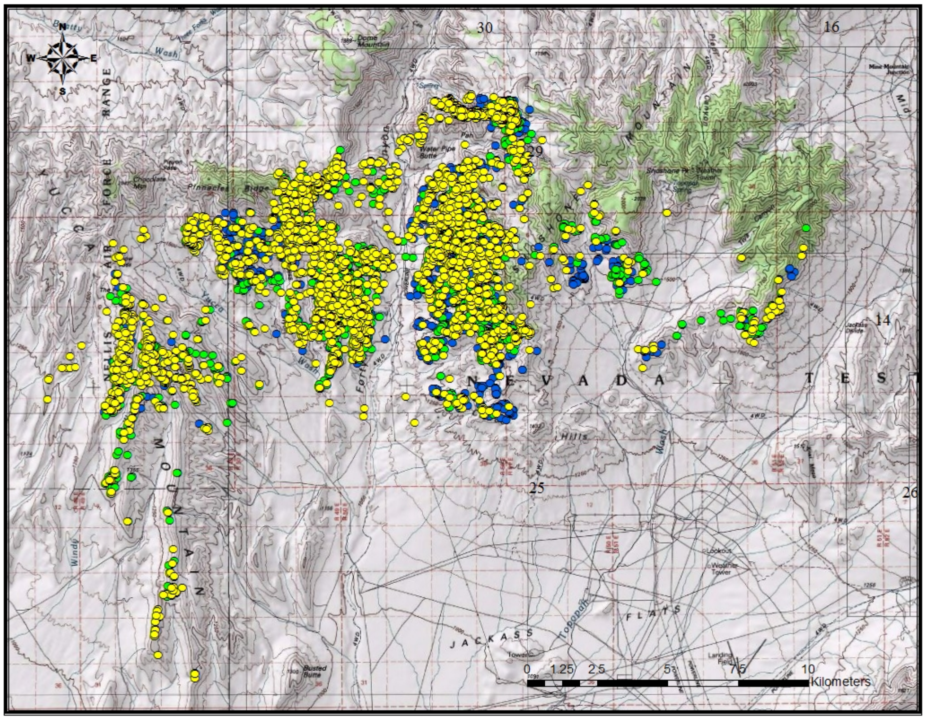

Figure 6-12. Locations of ewes 686313 (blue dots) (November 30, 2016 to May 1, 2018), 686315 (green dots) (November 30, 2016 to May 25, 2018), and 686316 (yellow dots) (November 30, 2016 to September 16, 2018).

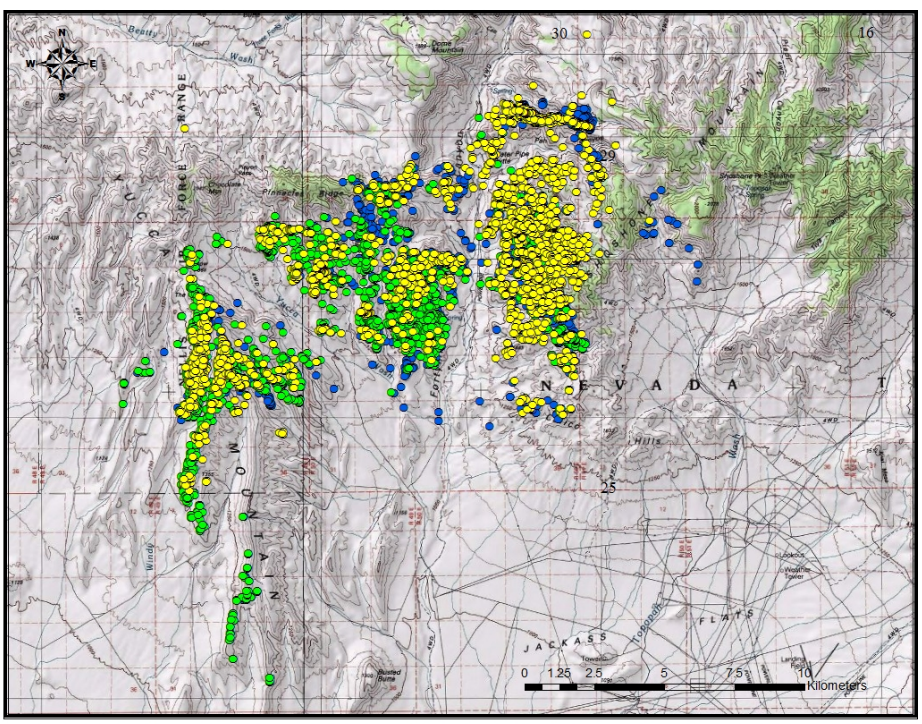

Figure 6-13. Locations of ewes 686314 (blue dots), 686319 (green dots) and 686320 (yellow dots) (November 30, 2016 to May 1, 2018).

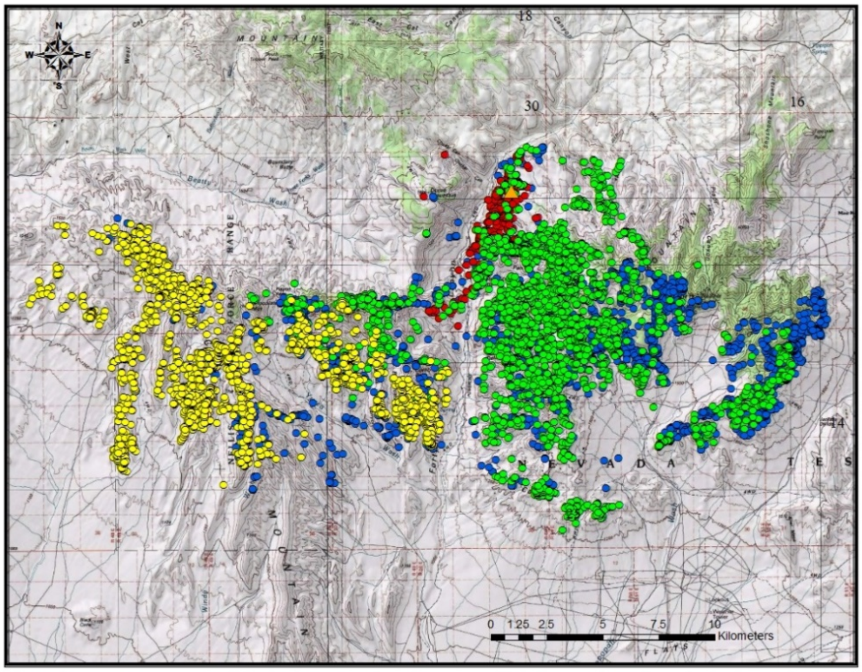

Figure 6-14. Locations of rams 686322 (blue dots) (November 30, 2016 to August 6, 2018), 686326 (green dots) (November 30, 2016 to September 16, 2018), 686327 (yellow dots) (November 30, 2016 to April 28, 2018), and 686323 (red dots) (November 30, 2016 to April 6, 2017); orange triangle = mortality location.

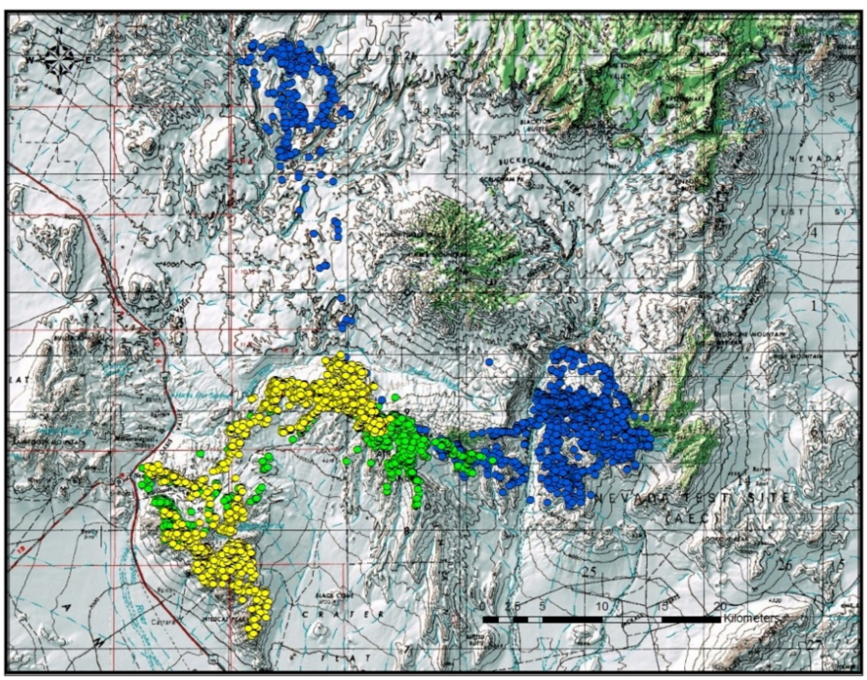

Figure 6-15. Locations of rams 686324 (blue dots) (November 30, 2016 to September 15, 2018), 686325 (green dots) (November 30, 2016 to May 1, 2018), and 686328 (yellow dots) (November 30, 2016 to September 17, 2018).

6.5.3 NTTR and Other Off-Site Captures

NNSS sheep captures were part of a larger collaborative effort among NDOW, USGS, NTTR, FWS, and NNSA/NFO to get valuable data on 1) the prevalence of pneumonia responsible for killing large numbers of bighorn sheep in southern Nevada, 2) metapopulation structure (how different herds are related) of sheep populations in southern Nevada, and 3) movements and habitat use of sheep in areas never studied before. On November 10, 2018, an MSTS biologist assisted in the capture and processing of 23 sheep in the Spotted Range just west of the NNSS. Samples were collected for disease and genetic testing. No captures occurred on the northern portion of NTTR, Bare Mountain or the Specter Range in 2018. On August 30, 2018, an MSTS biologist and NDOW biologist investigated the mortality of Ram25227 on the western slope of Quartz Mountain on NTTR. It appeared to have been killed by a mountain lion.

Figure 6-16. Collared Ram 686328 (center-left) with ten other rams, hills west of Yucca Mountain.

(Photo taken January 31, 2019 by D.B. Hall)

6.6 MOUNTAIN LION MONITORING

6.6.1 Motion-Activated Cameras

Few data exist for mountain lion numbers and their distribution in southern Nevada, including the NNSS. Since 2006, site biologists have collaborated with Dr. Erin Boydston and Dr. Kathy Longshore, USGS research scientists, to use remote, motion-activated cameras to determine the distribution and abundance of mountain lions on the NNSS. Cameras used this way are referred to as camera traps. Remote, motion-activated cameras were used in 2018 at 27 sites (Figure 6-17 and Table 6-4). Sites were selected at locations with previous or new mountain lion sightings or sign, on roads or landform features that are potential movement corridors from one area to another, and in areas of good mule deer habitat (mule deer are a primary prey species for mountain lions). Some sites were also added based on other needs such as documenting the predator community in tortoise habitat or detecting animals at contaminated water sources or water troughs. The number of images reported is based on a 1-minute interval between images taken during a single episode. Some images reported herein were taken during late 2017 and early 2019 due to the accessibility and scheduling of camera trap visits.

A total of 64 mountain lion images (i.e., photographs or video clips) were taken during 188,465 camera hours across all sites (Figure 6-17 and Table 6-4). This equates to about 0.3 mountain lion images per 1,000 camera hours. Mountain lions were detected at 7 of the 27 sites, including 4 water sources, 2 canyons, and one road (Figure 6-17). Table 6-5 contains the camera trap results by month and location. Figure 6-18 depicts a mountain lion at Fortymile Canyon Tanks.

It is difficult to tell individual mountain lions apart from camera trap images and determine the exact number of mountain lions on the NNSS. At least three individuals (adult male, adult female with cub) were known to occur on the NNSS in 2018, compared to a minimum of four individuals in 2017, five individuals in 2016, three individuals in 2015 and four individuals in both 2014 and 2013.

In order to investigate temporal activity of mountain lions, camera detection data from all 13 years (2006–2018) were combined. Mountain lions were detected every month with peak occurrences during June, (n = 102), August (n = 102) and November (n = 135) (Figure 6-19). The number of images taken during summer and fall (June–November) (n = 528) accounted for nearly two-thirds of all images compared with the number of images taken during winter and spring (December–May) (n = 291) (Figure 6-19). Nearly three-fourths of mountain lion images were taken between 1700 to 0500 hours (Figure 6-20). From 2011 to 2018, nearly 1.6 times as many images were taken when it was dark (n = 387) compared with when it was light (n = 243).

A secondary objective of the camera surveys is to detect other species using these areas and thus to better define species distributions on the NNSS. A total of 9,109 images of at least 39 species other than mountain lions were taken during 188,465 camera hours across all sites (Table 6-4) which is about 48 images per 1,000 camera hours.

The most prevalent species photographed (25% of all images) was mule deer (2,281 images at 18 of 27 sites). Captain Jack Spring (1,262 images), Camp 17 Pond (528 images), and Gold Meadows Spring (139 images) are very important water sources for mule deer. Some of the rarer, more elusive species documented from camera surveys were desert bighorn sheep (see Section 6.5.2), bobcat (found at 9 of 27 sites), gray fox (found at 8 of 27 sites), golden eagle (found at 8 of 27 sites), and badger (found at 4 of 27 sites). A spotted skunk (*Spilogale gracilis*) was documented using the camera traps for the first time this year at Delirium Canyon Tanks. Noteworthy observations of some of the more common species include 857 images of coyotes at 18 of 27 sites and 519 images of common ravens at 9 of 27 sites. Greatest use and highest species richness was documented at water sources (both natural and constructed) especially

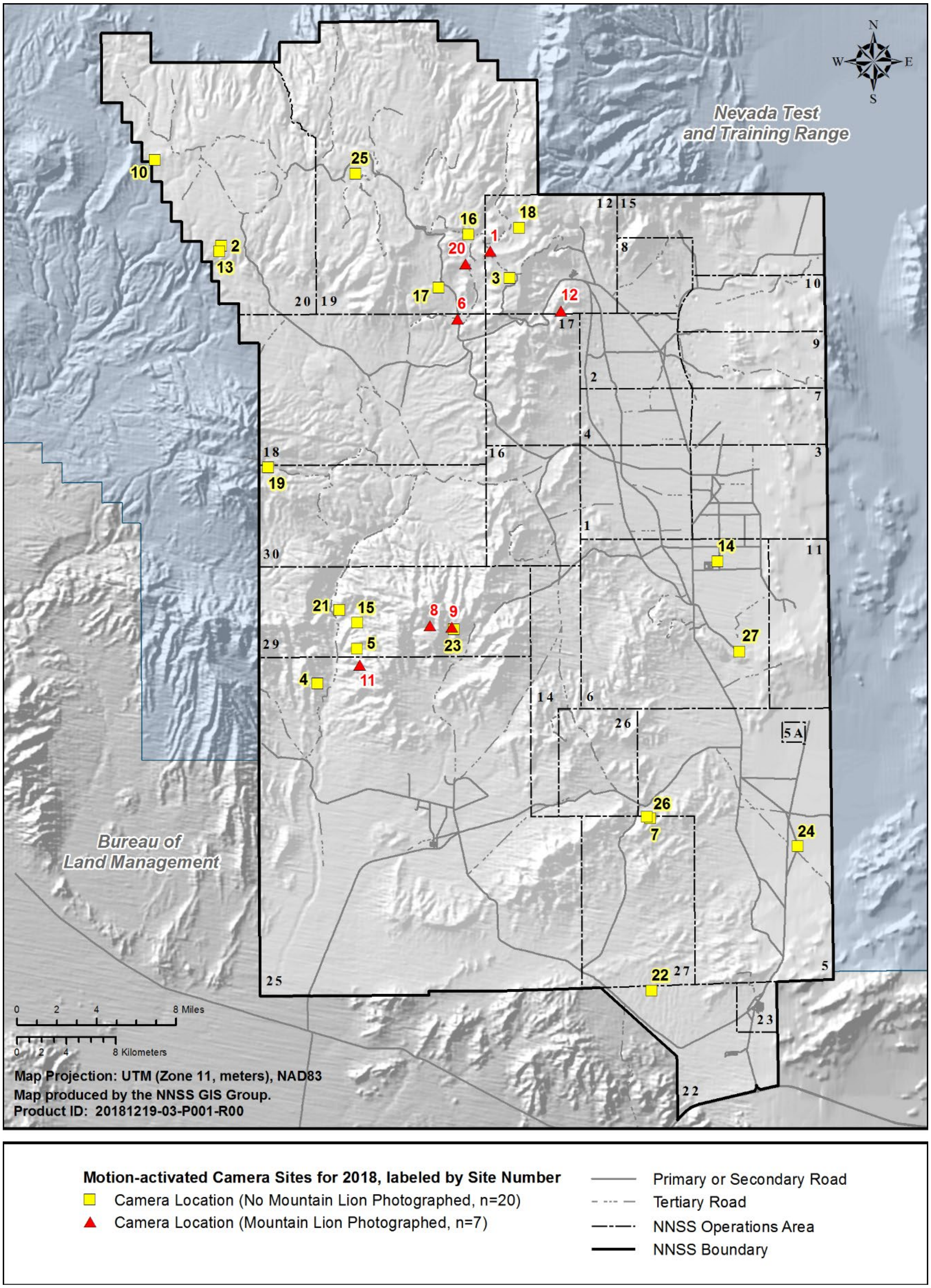

Figure 6-17. Locations of mountain lion photographic detections and camera traps on the NNSS during 2018.

Table 6-4. Results of mountain lion camera surveys during 2018 (a = camera hours not known for some time periods; b = Non-continuous operation due to camera problems, dead batteries, full memory cards, etc.).

Location (Site Number)	Dates Sampled	Camera Hours	Mountain Lion Images (Number of Images per 1,000 Camera Hours)	Other Observations (Number of Images)
Topopah Spring (#9)	12/20/17-12/19/18	8,739	33 (3.8)	Coyote (298), desert bighorn sheep (3), mule deer (46), chukar (15), mourning dove (3)
Captain Jack Spring (#12)	12/20/17-12/17/18[b]	6,724	14 (2.1)	Bobcat (4), gray fox (9), badger (1), coyote (111), mule deer (1,262), rock squirrel (1), golden eagle (5), chukar (1), common raven (2), jay (2)
Rattlesnake Ridge Gorge (#20)	12/19/17-12/18/18	8,736	7 (0.8)	Gray fox (2), badger (1), rock squirrel (1)
Camp 17 Pond (#6)	12/19/17-12/18/18	8,736	5 (0.6)	Coyote (50), mule deer (528), horse (541), black-tailed jackrabbit (1), golden eagle (25), peregrine falcon (2), Cooper's hawk (10), red-tailed hawk (141), turkey vulture (566), great blue heron (29), great egret (20), American avocet (1), chukar (3), common raven (264), ducks (2), jay (1)
West Topopah Spring (#8)	12/20/17-12/19/18[b]	5,981	3 (0.5)	Coyote (1)
12T-26, Rainier Mesa (#1)	12/19/17-12/18/18[b]	5,569	1 (0.2)	Mule deer (1)
Fortymile Canyon Tanks (#11)	1/4/18-1/22/19	9,215	1 (0.1)	Bobcat (1), gray fox (19), coyote (3), desert bighorn sheep (152), mule deer (2), golden eagle (103), chukar (1), great-horned owl (1), pinyon jay (3), common raven (2)
Gold Meadows Spring (#18)	12/19/17-12/18/18	8,736	0 (0.0)	Coyote (6), pronghorn antelope (13), mule deer (139), horse (195), golden eagle (29), common raven (3)

Table 6-4. Results of mountain lion camera surveys during 2018 (continued).

Location (Site Number)	Dates Sampled	Camera Hours	Mountain Lion Images (Number of Images per 1,000 Camera Hours)	Other Observations (Number of Images)
Dick Adams Cutoff Road, Rainier Mesa (#3)	12/19/17-12/18/18	8,736	0 (0.0)	Gray fox (3), mule deer (63), cliff chipmunk (1)
East 19-01 Road (#16)	12/14/16-12/19/17[b]	5,570	0 (0.0)	Mule deer (10)
Water Bottle Canyon (#17)	12/19/17-12/18/18	8,735	0 (0.0)	Mule deer (3)
East Cat Canyon (#19)	12/19/17-12/17/18[b]	8,170	0 (0.0)	Bobcat (1), coyote (3), mule deer (44)
Topopah Spring Trough (#23)	12/20/17-12/19/18[b]	8,739	0 (0.0)	Coyote (4), mule deer (95)
Area 22, Juvenile GOAG Site 2 (#22)	3/27/17-1/8/18[b]	3,445	0 (0.0)	Bobcat (4), coyote (3), kit fox (2), black-tailed jackrabbit (25), white-tailed antelope ground squirrel (1), western burrowing owl (1), horned lizard (1), zebra-tailed lizard (9), western whiptail lizard (2)
South Pah Canyon (#15)	1/4/18-1/22/19[b]	9,217	0 (0.0)	Gray fox (8), coyote (8), desert bighorn sheep (161), golden eagle (10), red-tailed hawk (2), chukar (21), mourning dove (63), pinyon jay (1,060), lizard (12)
Cottonwood Spring (#4)	1/4-6/15/18	3,880	0 (0.0)	Gray fox (1), coyote (2), desert bighorn sheep (3), mule deer (35), chukar (1)
Twin Spring (#21)	1/4/18-1/22/19[b]	3,664	0 (0.0)	Bobcat (1), gray fox (6), coyote (1), desert bighorn sheep (3), mule deer (33), burro (275), white-tailed antelope ground squirrel (2), chukar (276), mourning dove (1)
Delirium Canyon (#5)	1/4/18-1/22/19	9,217	0 (0.0)	Bobcat (12), gray fox (90), ring-tailed cat (31), coyote (61), spotted skunk (8), desert bighorn sheep (209), rock squirrel (1), bat (7), golden eagle (4), turkey vulture (28), chukar (22) mourning dove (13), common raven (5) hummingbird (1)

Table 6-4. Results of mountain lion camera surveys during 2018 (continued).

Location (Site Number)	Dates Sampled	Camera Hours	Mountain Lion Images (Number of Images per 1,000 Camera Hours)	Other Observations (Number of Images)
Cane Spring (#7)	12/20/17-12/17/18	8,695	0 (0.0)	Bobcat (1), coyote (1), mule deer (7)
Cane Spring Trough (#26)	12/20/17-12/17/18	8,695	0 (0.0)	Mule deer (2), mourning dove (10)
Well 5C Trough (#24)	12/20-12/26/17; 8/8-12/17/18	3,299	0 (0.0)	Bobcat (462), coyote (196), kit fox (13), badger (3), pronghorn antelope (4), burro (79), black-tailed jackrabbit (268), turkey vulture (1), greater roadrunner (3), common raven (92), western meadowlark (4), horned lark (91)
Area 6 LANL Pond Trough (#14)	12/20/17-12/17/18	8,684	0 (0.0)	Coyote (72), pronghorn antelope (22), black-tailed jackrabbit (23), golden eagle (9), turkey vulture (19), common raven (48)
Well C1 Pond Trough (#27)	12/20/17-12/17/18[b]	5,767	0 (0.0)	Bobcat (5), coyote (23), badger (1), pronghorn antelope (24), mule deer (3), black-tailed jackrabbit (1), golden eagle (4), Cooper's hawk (1), great-horned owl (3), turkey vulture (1), common raven (19)
ER 20-5 Plastic-lined Sump (#2)	12/19/17-12/18/18[b]	5,574	0 (0.0)	Black-tailed jackrabbit (20), passerine (6)
U19ad Plastic-lined Sump (#25)[a]	12/19/17-12/18/18[b]	5,590	0 (0.0)	Mule deer (5), turkey vulture (1)
ER 20-12 Plastic-lined Sump SE Corner (#10)	12/19/17-4/12/18[b]	1,618	0 (0.0)	None
ER 20-7 Plastic-lined Sump (#13)	12/19/17-12/18/18	8,734	0 (0.0)	Coyote (14), mule deer (3), common raven (84)

Table 6-5. Number of mountain lion images taken with camera traps by month and location (orange = number of mountain lion images; yellow = camera operational, no mountain lion images; green = camera not operational).

Camera Location (Site number)	Dec-17	Jan-18	Feb-18	Mar-18	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18
Topopah Spring (#9)			1	1								31	
Captain Jack Spring (#12)			5	4					5				
Rattlesnake Ridge Gorge (#20)	1			1	2		1	2					
Camp 17 Pond (#6)							2	1				2	
Canyon West of Topopah Spring (#8)				1	1	1							
12T-26, Rainier Mesa (#1)										1			
Fortymile Canyon Tanks (#11)					1								

Figure 6-18. Mountain lion at Fortymile Canyon Tanks.

(Photo taken April 11, 2018, by motion-activated camera)

during the summer and fall, which emphasizes the importance of these water sources for several wildlife species, particularly during the drier months.

6.6.2 Mountain Lion Telemetry Study

A collaborative effort between Kathy Longshore (USGS) and site biologists continued in 2018 to provide information to assess the risk of human encounters with mountain lions on the NNSS and determine what mountain lions eat and where they make their kills. This effort provides information about their natural history and ecology as well. Work in 2018 focused on writing and editing the final report summarizing the results of the telemetry study.

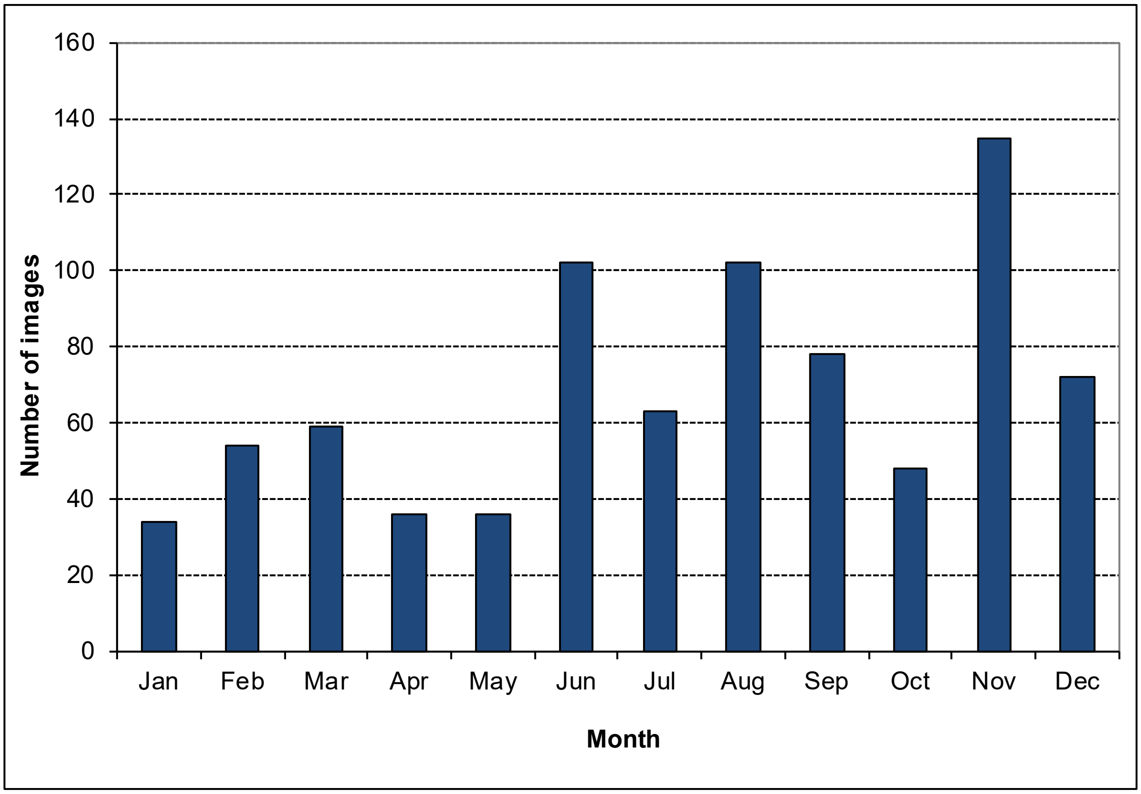

Figure 6-19. Number of mountain lion images by month for camera sites where mountain lions were detected from 2006 through 2018 (n = 819).

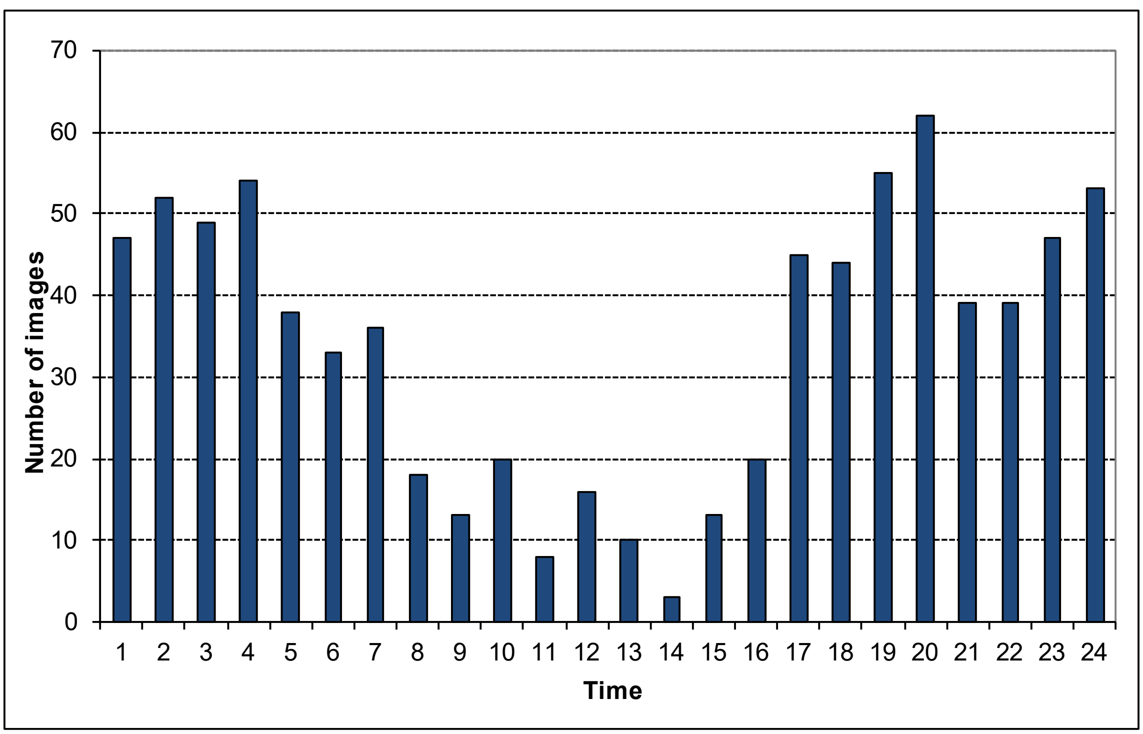

Figure 6-20. Number of mountain lion images by time of day (Pacific Standard Time) for camera sites where mountain lions were detected from 2006 through 2018 (n = 814).

6.7 RADIOLOGICAL SAMPLING

Sampling for radionuclides in game species (e.g., mule deer, pronghorn antelope) was performed in order to 1) determine uptake of radionuclides left over from previous nuclear testing on the NNSS, 2) estimate the potential dose to a human consuming a contaminated animal, and 3) estimate the dose to the animal. Sampling is to ensure dose limits, set to protect human and animal health, are not exceeded. These species are known to have large home ranges and are likely to leave the NNSS and move into areas where hunting is allowed. This is a potential pathway for humans to receive a dose from radionuclides found on the NNSS and must be accounted for.

In 2018, five samples were collected and analyzed, including one roadkill mule deer, three antelope (one roadkill, two predated) and one electrocuted bobcat. Muscle tissue was collected from all animals and water was distilled from the samples and submitted to a laboratory for tritium (^{3}H) analysis. The remaining tissue samples from all animals were submitted for Strontium-90 (^{90}Sr), Plutonium-238 (^{238}Pu), Plutonium-239+240 ($^{239+240}Pu$), Americium-241 (^{241}Am), and gamma spectroscopy analysis.

Man-made radionuclides were detected in an antelope killed by coyotes in Area 9. Doses from these concentrations are low and do not present a hazard to the animal or a person eating them. For a more detailed analysis of specific radionuclides and dose assessments see MSTS (2019).

6.8 NUISANCE AND POTENTIALLY DANGEROUS WILDLIFE

During 2018, NNSS biologists documented 62 calls regarding nuisance, injured, dead, or potentially dangerous wildlife in or around buildings, power lines, and work areas on the NNSS. Problem, injured, or dead animals included birds (27 calls), bats (10 calls), other mammals (18 calls), reptiles (6 calls, including 1 rattlesnake), and spiders (1 call). Mitigation measures taken typically involved relocating the animals away from people, instructing workers to leave the animal in place, or disposing of dead animals.

6.9 ELK, PRONGHORN ANTELOPE, AND WILD BURROS

Historic studies on the NNSS do not mention the presence of either Rocky Mountain elk or pronghorn antelope (Jorgensen and Hayward 1965; Collins et al. 1982). Likewise, horses but not burros were mentioned by Jorgensen and Hayward (1965). Collins et al. (1982) conducted a biologic overview of the Yucca Mountain area and found that individual burros were occasionally observed near Cane and Topopah springs and documented numerous burro droppings in the central section of Yucca Mountain along the major ridges and in the eastern side canyons. They did not see any animals and concluded that burros used this area in winter and spring when ephemeral water and succulent plants were present. Site characterization studies at Yucca Mountain in the late 1980s and 1990s rarely documented burros and elk and antelope were not documented at all.

Saethre (1994) reported that Rocky Mountain elk are resident outside the NNSS and rarely observed on the NNSS but did not document any specific sightings. Since 2009, there have been a few transient bull elk seen and photographed around Rainier Mesa and Pahute Mesa. Young bull elk are known to disperse from their natal range, and it is likely that the source population for the young bulls is to the north, possibly in the Groom or Kawich Range. During 2018, no elk were photographed or observed on the NNSS.

Over the last several years, pronghorn antelope appear to be increasing in number and expanding their range on the NNSS. During 2018, 63 images were taken of antelope at 4 sites (Table 6-4). Camera trap sites where antelope were documented included the Well C1 water trough (24 images), the Area 6 LANL Pond water trough (22 images), Gold Meadows Spring (13 images), and the Well 5C water trough (4 images). Antelope were regularly observed around Mercury, in Frenchman Flat and in Yucca Flat. There was a substantial decrease in the number of images this year compared to last year (63 versus 286) and group size was smaller compared to previous years. Monitoring will continue to track this trend.

In order to understand movements and habitat use of antelope on the NNSS, MSTS biologists plan to capture and radio-collar up to 21 antelope in November 2019, and track them for a three-year period. Of particular interest is the radiological burden of antelope and the potential dose to the off-site public if a contaminated animal moves off site and gets harvested and consumed.

Wild burros also appear to be increasing in number and expanding their range on the NNSS in recent years. A resident herd has been known to occupy Crater Flat, west of the NNSS for decades but sightings on the NNSS have been rare. During 2018, burros were documented with camera traps at Twin Spring (275 images) and the Well 5C trough (79 images) (Table 6-4). The area around Twin Spring was heavily disturbed from burro use. Burros or their sign (i.e., scat, tracks) were observed in Fortymile Canyon all the way north past Yellow Rock Springs, around Yucca Mountain (Midway Valley, Yucca Wash), in Jackass Flats, and in Rock Valley.

6.10 COORDINATION WITH BIOLOGISTS AND WILDLIFE AGENCIES

Site biologists interfaced with other biologists and wildlife agencies in 2018 for the following activities:

- Edited USGS final report on mountain lions on the NNSS.
- Attended Partners-in-Flight meeting in Las Vegas, Nevada on March 1, 2018.
- Assisted with a bird banding study at Moapa National Wildlife Refuge.
- Attended Nevada Bat Working Group Meeting and Bat Acoustics Workshop in Reno, Nevada, in December 2018.
- Participated in multiple conference calls for the DOE Migratory Bird Working Group.
- Became member of the Springsnail Conservation Team and drafted signatory page for NNSA/NFO to sign on to the Conservation Agreement for Springsnails in Nevada and Utah
- Provided a poster “10 Reasons why the NNSS is a National Ecological Treasure” to be displayed at the National Atomic Testing Museum and information for an update to the mountain lion exhibit.
- Assisted with mule deer trapping and radio-collaring effort with NDOW in the Toiyabe Mountains in April, 2018.

7.0 HABITAT RESTORATION MONITORING

MSTS biologists have conducted revegetation activities at disturbances on and off the NNSS in support of NNSA/NFO programs and continue to evaluate those efforts. Revegetation supports the intent of Executive Order EO 13112, "Invasive Species," to prevent the introduction and spread of non-native species and restore native species to disturbed sites. Revegetation also may qualify as mitigation for the loss of desert tortoise habitat under the current Opinion. Activities conducted in 2018 included quantitatively sampling the U-3ax/bl closure cover and establishing and sampling permanent transects at the reference area north of U-3ax/bl closure cover, visually assessing the vegetation at the "92-Acre Site" and Double Tracks cleanup site, and evaluating Clean Slate I, II, and III for potential revegetation efforts.

7.1 CORRECTIVE ACTION UNIT (CAU) 110, U-3AX/BL, CLOSURE COVER

Quantitative sampling occurred at the U-3ax/bl closure cover on July 31, 2018. Results were summarized in a report that was submitted to the MSTS Environmental Restoration group. Ten, 100-meter (m) long transects on the seeded portion of the cover were randomly selected and sampled on July 31, 2018. Plant cover and density were also sampled on three, 50-m long control transects on the non-seeded closure cover periphery. Additional transects were added to the reference area and ten, 100-m long transects were sampled on August 1, 2018. Optimal sampling time is May during peak plant production. Sampling this year was completed during the hot, dry summer when many plants had senesced, primarily the annuals. Some perennial plants had also gone dormant or lost leaf cover.

Plant cover was estimated using an ocular projection device which was placed at four-meter intervals along each transect. At each placement four ocular points were projected and the type of cover, i.e. rock, bare ground, litter, or plant species, intercepted by the points was recorded. A total of 100 points were sampled along each transect and percent cover was calculated by species and for bare ground, gravel/cobble, and litter. Plant density was estimated by placing a meter square quadrat at five-meter intervals along each transect and recording the number of plants, by species, found within the boundary of the quadrat. A total of 20 quadrats were placed along each transect. Plant density estimates were averaged over all quadrats and reported as number of plants per m^2.

Plant cover-Total plant cover on the closure cover this year was 12.2%. Two shrubs, shadscale saltbush (*Atriplex confertifolia*) and Nevada jointfir made up nearly all the plant cover with the annual, flatcrown buckwheat (*Eriogonum deflexum*), contributing a very small percentage. Invasive weed cover was not detected on the cover cap (Table 7-1).

Total plant cover on the reference site was 10.9% with most of that (10%) made up of eight shrub species. Nevada joinfir and spiny hopsage were the dominant species. One perennial grass, Indian ricegrass (*Achnatherum hymenoides*), contributed 0.9% cover, and no annual plants or invasive weeds were detected (Table 7-1).

Plant density-Plant density on the closure cover was 1.25 plants per m^2. Shrubs, mainly shadscale saltbush and Nevada jointfir, made up two-thirds of the density with flatcrown buckwheat making up nearly one-third of the density. Prickly Russian thistle (*Salsola tragus*) was found in low densities on the cover (Table 7-1).

Plant density on the reference area was 1.27 plants per m^2. Eight shrubs made up about 50% of the density, Indian ricegrass about 18%, and annual forbs about 32%. Saltlover (*Halogeton glomeratus*) was found in low densities on the reference area (Table 7-1). Although not quantified, cheatgrass and/or red brome occurred in over half of the quadrats.

Table 7-1. Plant cover and density data collected on the U-3ax/bl closure cover and reference area in 2018, and the revegetation standard.

		Plant Cover (%)			Plant Density (plants/m²)		
Plant		Cover Cap	Reference	Standard	Cover Cap	Reference	Standard
SHRUBS	Bud sagebrush		0.3			0.03	
	Fourwing saltbush		1.5		0.01	0.15	
	Nevada jointfir	2.5	3.0		0.35	0.13	
	Burrobrush		1.2			0.06	
	Shadscale saltbush	9.6	0.0		0.48		
	Spiny Hopsage		3.0			0.13	
	Shockleys goldenhead					0.01	
	Winterfat		0.2			0.03	
	Water jacket		0.8			0.10	
	Total Shrub	**12.1**	**10.0**	**7.0**	**0.84**	**0.64**	**0.45**
GRASSES	Indian ricegrass		0.9			0.23	
	Total Grass	**0.0**	**0.9**	**0.6**	**0.0**	**0.23**	**0.16**
FORBS	Birdnest buckwheat					0.01	
	Bristly fiddleneck					0.21	
	Flatcrown buckwheat	0.1			0.41	0.18	
	Total Forb	**0.1**	**0.0**	**0.0**	**0.41**	**0.40**	**.28**
TOTALS	**Total Plant***	**12.2**	**10.9**	**7.6**	**1.25**	**1.27**	**.89**
	Bare Ground	19.1	28.9				
	Gravel/Cobble	45.9	39.2				
	Litter	22.8	21.0				
INVASIVE WEEDS	Prickly Russian thistle				0.02		
	Saltlover					0.02	
	Total Invasive Plants	**0.0**	**0.0**		**0.02**	**0.02**	

Non-seeded Portion of Closure Cover-On the non-seeded portion of the closure cover, 0% plant cover and an average of 4 plants (flatcrown buckwheat) per m^2 was documented. Additionally, 10.9 invasive plants per m^2 (9 saltlover and 1.9 prickly Russian thistle) were documented.

Wildlife Usage-Several western whiptail (*Aspidoscelis tigris*) lizards and one black-tailed jackrabbit were observed on the closure cover. In some places, ants were abundant and very active on the surface. Several rodent burrows were observed but only a few of them appeared to be active. Rabbit pellets were only observed in 1% of the square meter quadrats. The only plant that appeared to be impacted by rabbit herbivory was winterfat and possibly desert globemallow. In comparison, several western whiptail lizards, a side-blotched lizard (*Uta stansburiana*), and one horned lizard (*Phrynosoma platyrhinos*) were observed on the reference area. Coyote scat was also documented in the reference area, and rabbit pellets were found in 20% of the square meter quadrats.

Summary-Plant cover and density is similar between the closure cover and the reference area suggesting that revegetation of the cover has been successful (Figure 7-1). Plant cover and density are well above the revegetation standard of 70% of the reference area (Table 7-1). The vegetative cover on the U-3ax/bl cover cap appears to be a stable plant community with persistent perennial shrubs.

Figure 7-1. U3ax/bl closure cover (top) and reference area (bottom).

(Photos taken July 31 (top) and August 1, 2018 (bottom) by D.B. Hall)

7.2 CAU 111, "92-ACRE SITE," CLOSURE COVERS

No quantitative sampling occurred at the 92-Acre Site in 2018. A visual assessment in July found very few perennial plants on any of the cover caps. There were about 20 large fourwing saltbush (*Atriplex canescens*) plants on the North South Cover. These plants were from the prior revegetation efforts that had survived the extensive rabbit herbivory before the site was fenced.

Overall the integrity of the cover caps was very good. Weed densities were low due to the lack of precipitation with saltlover and prickly Russian thistle being the most common species. No rabbits or fresh rabbit sign were observed. Light rodent burrowing activity was detected.

A bare area with no plant growth was observed near the tribal revegetation plots. This area was visually assessed in December. Although not conclusive, it is thought this area was a staging area for previous revegetation efforts and may be more heavily compacted than adjacent areas.

7.3 DOUBLE TRACKS

In December, an MSTS biologist visited the Double Tracks Cleanup Site and conducted a qualitative assessment of the plant community on the revegetated area. The site was revegetated in 1996 and last evaluated in 2007. Perennial plant cover and density were good. There were some bare areas where saltlover was abundant and there was some Russian thistle scattered throughout the area as well. There were several small washes and rivulets that had formed since the last visit, allowing for natural drainage across the site. Quantitative sampling of the cleanup site and the associated reference area is recommended.

7.4 CLEAN SLATE I, II, AND III

At the request of Navarro, Clean slate I, II, and III were visually assessed in December, 2018. Clean Slate I was cleaned up in 1997 but was not revegetated. Natural succession has filled in some of the bare areas, especially by the rhizomatous, spreading galleta grass (*Pleuraphis jamesii*). Bare areas that had not revegetated naturally were dominated by saltlover.

Clean-up efforts at Clean Slate II were completed in 2018. It was assessed to determine the feasibility of revegetating the staging areas and cleaned up sites inside the contamination area. Clean-up efforts at Clean Slate III are on-going with an anticipated completion date of August 2019. It was assessed to determine the feasibility of revegetation as well. A report was submitted to Navarro containing the results of the site visits and a proposed revegetation strategy for Clean Slates II and III.

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