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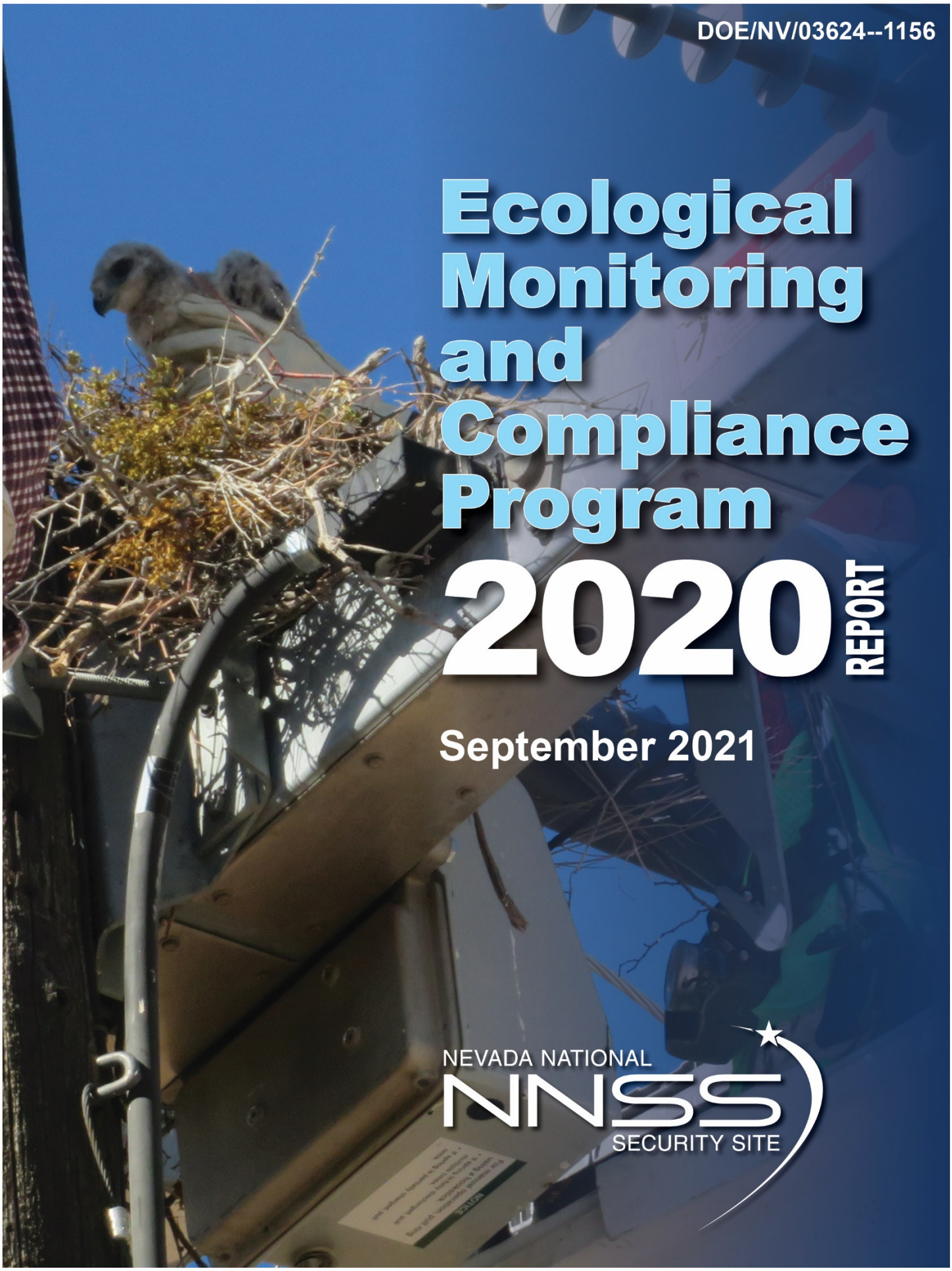

Ecological Monitoring and Compliance Program 2020 REPORT

September 2021

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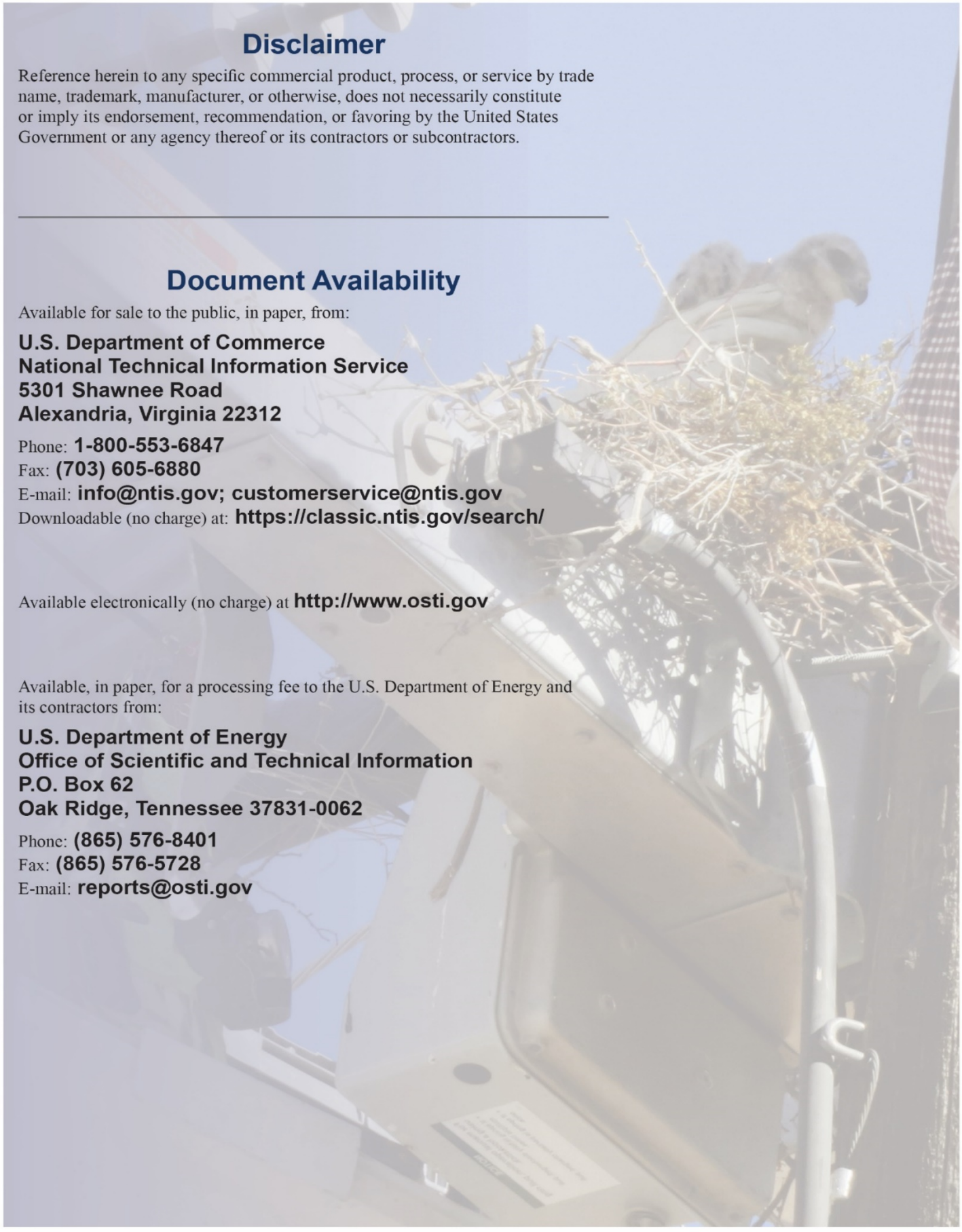

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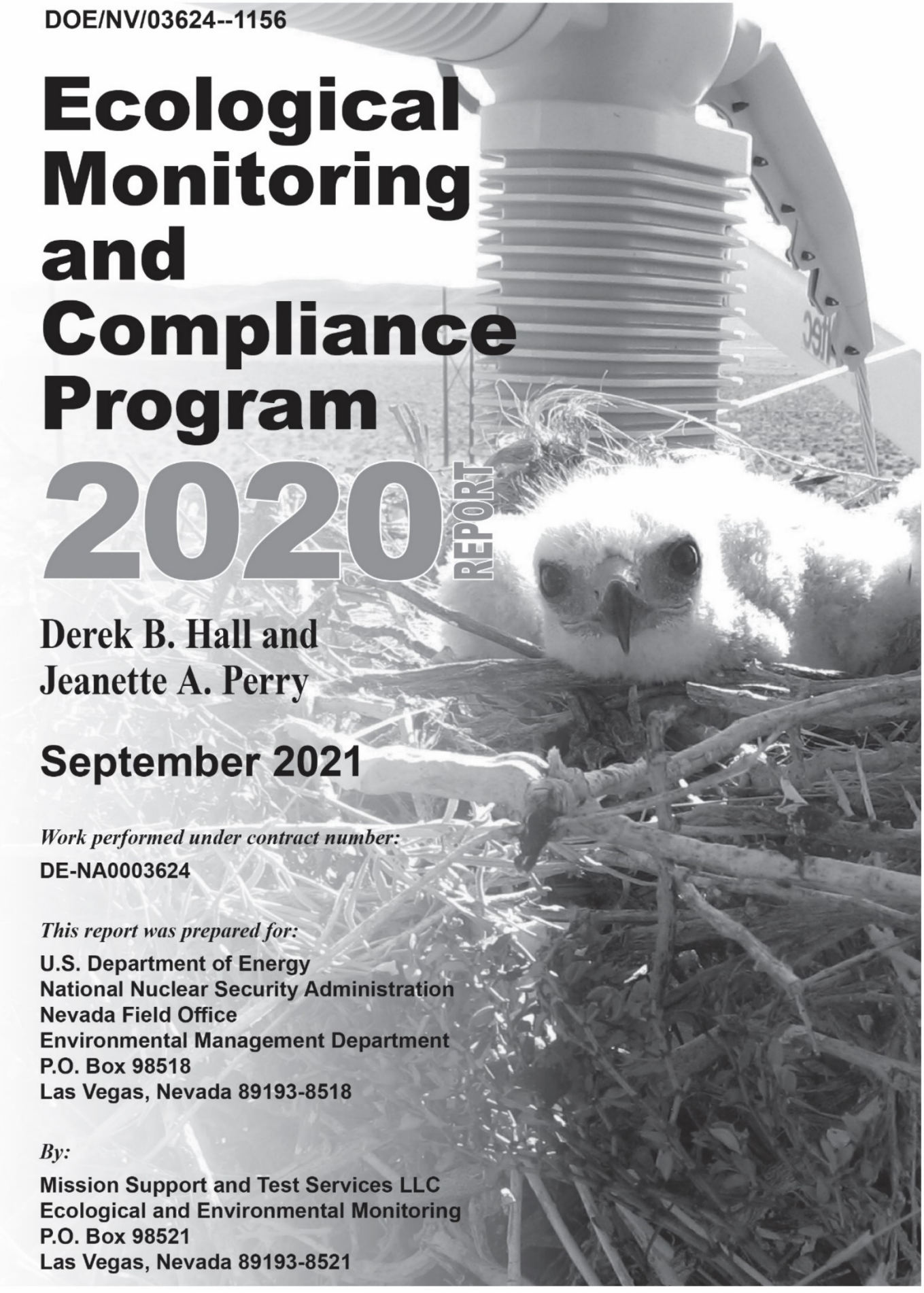

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EXECUTIVE SUMMARY

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 2020. Program activities included (a) biological surveys at proposed activity sites, (b) desert tortoise compliance, (c) ecosystem monitoring, (d) sensitive and protected/regulated plant monitoring, (e) sensitive and protected/regulated animal monitoring, and (f) habitat restoration monitoring. During 2020, all applicable laws, regulations, and permit requirements were met, enabling EMAC to achieve its intended goals and objectives.

Sensitive and protected/regulated species of the NNSS include 43 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 34 projects. A total of 147.2 hectares (ha) were surveyed for these projects. The surveyed area included the project area and a buffer area extending 10-20 meters (m) beyond the project area. Some of the sensitive and protected/regulated species and important biological resources found during the surveys included several sensitive plant species (Cane Spring suncup [*Chylismia megalantha*], sand cholla [*Grusonia pulchella*], and Pahute Mesa beardtongue [*Penstemon pahutensis*]); western red-tailed skink habitat (*Plestiodon gilberti rubricaudatus*); birds, active nests, or nesting sites (chukar [*Alectoris chukar*]), red-tailed hawk [*Buteo jamaicensis*], Pinyon jay [*Gymnorhinus cyanocephalus*], and western burrowing owl [*Athene cunicularia hypugaea*]); predator burrows (coyote [*Canis latrans*] and kit fox [*Vulpes macrotis*]); ungulate sign (pronghorn antelope [*Antilocapra americana*], feral burro [*Equus asinus*], feral horse [*Equus caballus*] and mule deer [*Odocoileus hemionus*]); yucca plants (Joshua tree [*Yucca brevifolia*] and Mojave yucca [*Yucca schidigera*]); singleleaf pinyon (*Pinus monophylla*); and multiple cactus species. Scientists communicated with ground crews and provided written summary reports to project managers of survey findings and mitigation recommendations when applicable.

Seventeen surveys were completed by biologists within the range of the desert tortoise. No desert tortoises were observed or reported injured or killed during projects. A total of 9.9 ha of tortoise habitat was disturbed. All projects that were monitored within tortoise habitat remained within the surveyed project area.

There were 41 reported desert tortoise roadside sightings. Of the 41 tortoises, two were roadkills and one was a predation. Thirty-two tortoises were determined to be in harm's way and moved off the road in accordance with U.S. Fish and Wildlife-approved tortoise handling procedures.

Juvenile tortoises continued to be monitored as part of a collaborative effort to study survival of translocated animals. After 100 months post-release, 18 of the 60 juveniles were still alive (30.0% survival) which is comparable to an estimated 26.7% (16 of 60 alive) survival in a natural population. There is a much higher survival rate for males (40.0% [12 of 30]) compared to females (20.7% [6 of 29]) with most of the mortalities suspected as coyote and kit fox predation.

From 1978 to 2020, there has been an average of 10.2 wildland fires per year on the NNSS with an average of about 103.6 ha per fire. 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 [*Coleogyne ramosissima*] 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 were reported on the NNSS in 2020. The largest of these, named the Area 16 Fire, started in late July, from a lightning strike. It burned about 1,274 ha in Area 16 and Area 1, primarily in the Blackbrush-Nevada jointfir shrubland association. The other four fires were caused by lightning (one), electrocuted raptor (one), and manmade activities (two) but were all small, <0.1 ha in size. These fires were extinguished by NNSS Fire and Rescue personnel or carefully monitored until they burned out.

Wildlife use at nine natural water sources (six springs, three rock tanks) and ten constructed water sources (one well pond, five water troughs, and four radiologically contaminated sumps) was documented using motion-activated cameras.

The NNSS sensitive plant rankings were evaluated and updated based on each plant's overall distribution, abundance, and rarity. Evaluations for five candidate sensitive plant species continued with the addition of Clokey's cryptantha (*Cryptantha clokeyi*) and Lahontan beardtongue (*Penstemon palmeri* variety (var.) *macranthus*) to the NNSS sensitive plant monitoring program, the removal of Nye milkvetch (*Astragalus nyensis*) pending additional surveys, and the removal of two cactus species (Redspined fishhook cactus [*Sclerocactus polyancistrus*] and sand cholla). Long-term field monitoring surveys were conducted for Cane Spring suncup, Clarke phacelia (*Phacelia filiae*), Kingston Mountains bedstraw (*Galium hilendiae* ssp. *kingstonense*), Pahute Mesa beardtongue, Sanicle biscuitroot (*Cymopterus ripleyi* var. *saniculoides*), Weasel phacelia (*Phacelia mustelina*), and white bearpoppy (*Artctomecon merriamii*).

Surveys of sensitive and protected/regulated animals in 2020 focused on birds, bats, feral horses, mule deer, pronghorn antelope, 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.

A total of eight dead birds were documented on the NNSS in 2020. This is the lowest number of recorded mortalities since 2012. Five (4 red-tailed hawks and 1 common raven [*Corvus corax*]) were electrocuted, one prairie falcon (*Falco mexicanus*) and one unknown passerine were found dead from unknown causes, and one green-tailed towhee (*Pipilo chlorurus*) was euthanized after being severely injured from being stuck on a glue trap. No golden eagle (*Aquila chrysaetos*) deaths were recorded. A total of 87 power poles were retrofitted or reconfigured during 2020 using a variety of retrofits including installing insulator covers, conductor wire covers, and extending the length of the cross arm from 2.4 m to 3.0 m. Only three raptor species were detected during winter raptor surveys in 2020. No golden eagle sightings were documented during any of the surveys which is uncharacteristic. The red-tailed hawk was the most common species detected on both routes, comprising over 70% of all raptor sightings. A western burrowing owl was observed at a known burrow site during each survey in Yucca Flat. Common ravens were more prevalent on the southern route this year than in Yucca Flat with most of them observed near the Mercury Sewage Lagoons.

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 222 deer were observed during spotlight surveys, which equates to an average of 37.0 deer per survey night, almost double the number from 2019. Eight marked (six ewes, two rams) and at least five unmarked (two ewes, two rams, and one lamb) desert bighorn sheep were documented with camera traps at water sources in the Shoshone Mountain, Yucca Mountain, and Fortymile Canyon areas. Combined, a minimum of 13 sheep were documented at monitored water sources on the NNSS in 2020.

A total of 148 mountain lion images (i.e., photographs or video clips) were taken during 179,030 camera hours at 9 of 26 sites sampled. An additional 30,216 images of at least 81 species other than mountain lions were documented which represents the greatest species richness documented using camera traps in a given year. A minimum of four individual mountain lions (adult male and adult female with two subadults) were known to occur on the NNSS in 2020.

Habitat restoration activities conducted in 2020 included visually assessing the vegetation at the U-3ax/bl closure cover (Corrective Action Unit [CAU] 110) (Area 3 Radioactive Waste Management Site) and the "92-Acre Site" (CAU 111) (Area 5 Radioactive Waste Management Complex [RWMC]), preparing for the revegetation of CAU 577 East and West Cover Caps (Area 5 RWMC), and revegetating Cell 18 (Area 5 RWMC).

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ACRONYMS AND ABBREVIATIONS

APP	Avian Protection Plan
BCS	Body Condition Score
BEEF	Big Explosives Experimental Facility
CAU	Corrective Action Unit
cm	centimeter(s)
CUAS	Counter Unmanned Aerial System
DoD	Department of Defense
DOE	U.S. Department of Energy
DOE/NV	U.S. Department of Energy, Nevada Operations Office
DRA	Desert Rock Airport
DTM	Desert Tortoise Monitor
EGIS	Ecological Geographic Information System
ELU	Ecological Landform Unit
EMAC	Ecological Monitoring and Compliance Program
EMAD	Engine Maintenance, Assembly, and Disassembly Facility
EO	element occurrences
EODU	Explosive Ordnance Disposal Unit
ER	Environmental Restoration
ESA	Endangered Species Act
FWS	U.S. Fish and Wildlife Service
g	gram(s)
GIS	geographic information system
GOAG	desert tortoise
GPS	Global Positioning System
ha	hectare(s)
ICR	San Diego Zoo Institute for Conservation Research
JAF	Jackass Flats
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
NDNH	Nevada Division of Natural Heritage
NDOT	Nevada Department of Transportation
NDOW	Nevada Department of Wildlife
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
p	probability
pCi/L	picocuries per liter
PLS	pure live seed
PTT	platform transmitter terminal
r	correlation coefficient
RNCTEC	Radiological/Nuclear Countermeasures Test and Evaluation Complex
RWMC	Radioactive Waste Management Complex
sd	standard deviation
spp.	species
ssp.	subspecies
TCC	Test Cell C
TCS	tortoise clearance survey
UGTA	Underground Test Area
UNLV	University of Nevada Las Vegas
USDA	United States Department of Agriculture
USGS	U.S. Geological Survey
UST	underground storage tank
UTM	Universal Transverse Mercator
var.	variety

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 Mission and Infrastructure 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 2020, all applicable laws and regulations were followed, and the permit requirements were met, enabling EMAC to achieve its intended goals and objectives.

This report summarizes the EMAC activities conducted by MSTS during calendar year 2020. Monitoring tasks during 2020 included six program areas: (a) biological surveys, (b) desert tortoise compliance, (c) ecosystem monitoring, (d) sensitive and protected/regulated 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 program areas.

2.0 BIOLOGICAL SURVEYS

Projects or activities involving land-disturbing activities on the NNSS are reviewed by biologists to determine if 1) sensitive and protected/regulated species occur within the project area 2) a biological survey is required to identify sensitive and protected/regulated species within the project area and/or 3) develop mitigation measures to protect impacted species, if required. Projects submit their scope of work for review prior to start of work through several different company processes including, but not limited to, National Environmental Policy Act checklists, Real Estate Operations Permits (parcels of land with specified activities or facilities designated to remain with that parcel), and/or MSTS documents.

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 Division of Natural Heritage (NDNH), formerly Nevada Natural Heritage Program, At-Risk Plant and Animal Tracking List (NDNH 2021). 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 2020, biological surveys were conducted for 34 projects on the NNSS (Figure 2-1, Table 2-2). Several projects had multiple survey locations, bringing the total number of surveys to 48 (Figure 2-1, Table 2-2). Scientists surveyed a total of 147.24 hectares (ha) for the projects (Table 2-2). The surveyed area included the project area and a buffer area extending 10-20 meters (m) beyond the project area. Twenty-one projects were within the range of the threatened desert tortoise (*Gopherus agassizii*), herein after *tortoise* (see Section 3.0). Several post-activity surveys were completed for projects that began prior to 2020: 18-07, 18-55, 18-66, 19-10, and 19-16 (Table 2-2). Sensitive and protected/regulated wildlife species and important biological resources found during the surveys included western burrowing owl sites (*Athene cunicularia hypugaea*); western red-tailed skink habitat (*Plestiodon gilberti rubricaudatus*); predator burrows (coyote [*Canis latrans*] and kit fox [*Vulpes macrotis*]); ungulate sign (pronghorn antelope [*Antilocapra americana*], feral burro [*Equus asinus*], and mule deer [*Odocoileus hemionus*]); two sensitive plant species (Cane Spring suncup [*Chylismia megalantha*] and Pahute Mesa beardtongue [*Penstemon pahutensis*]); yucca plants (Joshua tree [*Yucca brevifolia*] and Mojave yucca [*Yucca schidigera*]); singleleaf pinyon (*Pinus monophylla*); and multiple cactus species including one NDNH At-Risk cactus species (sand cholla [*Grusonia pulchella*]) (see Table 2-2 for resources listed by project). One unwanted invasive plant species, Sahara mustard (*Brassica tournefortii*), was found at project site 20-25 and removed. It has been found in this area before (see Figure 2-1 for project location). 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

Biological 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, tortoises may move through

Table 2-1. List of sensitive and protected/regulated species known to occur on 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
Chylismia megalantha	Cane Spring suncup	S, M
Cryptantha clokeyi	Clokey's cryptantha	S, E
Cymopterus ripleyi var. *saniculoides*	Sanicle biscuitroot	S, W
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
Hulsea vestita ssp. *inyoensis*	Inyo hulsea	S, W
Ivesia arizonica var. *saxosa*	Rock purpusia	S, H
Penstemon fruticiformis ssp. *amargosae*	Death Valley beardtongue	S, M
Penstemon pahutensis	Pahute Mesa beardtongue	S, W
Penstemon palmeri var. *macranthus*	Lahontan beardtongue	S, E
Phacelia beatleyae	Beatley scorpionflower	S, M
Phacelia filiae	Clarke phacelia	S, W
Phacelia mustelina	Weasel phacelia	S, W
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 the NNSS (continued).

Animal Species	Common Name	Status[a]
Mollusk Species		
Pyrgulopsis turbatrix	Southwest Nevada pyrg	S, A
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
Gymnorhinus cyanocephalus	Pinyon jay	S, NP, IA
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

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

Animal Species	Common Name	Status[a]
Equus asinus	Burro	H&B, 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 Division of Natural Heritage (NDNH) – At-Risk Plant and Animal Tracking
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

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

G	Regulated as game species under NAC 503
F	Regulated as fur bearer species under NAC 503
State of Nevada – Plants	
S	NDNH – 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	
H	High (high potential for NNSS populations to become at-risk in the future and/or is limited in range)
M	Moderate (moderate potential for NNSS populations to become at-risk in the
W	Watch (low potential for NNSS populations to become at-risk in the future)
E	Evaluate (status unknown)
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 under NAC503.

Sources used: NDNH 2021, NAC 2021, U.S. Fish and Wildlife Service (FWS) 2021

project areas and may be concealed under vegetation during activities where heavy equipment is used, and western burrowing owls frequently inhabit burrows, buried pipes with exposed openings, and culverts at disturbed sites. Biological surveys are completed to ensure sensitive or protected/regulated animal and plant species are not in harm's way.

Depending on the potential for sensitive and protected/regulated species to be within a project area, biologists conduct appropriate surveys for each land-disturbing activity prior to project start. A tortoise clearance survey is required within 24 hours before the start of a project when there is a possibility that a tortoise may be in the project area, adjacent land or wander into the project area during construction activities. A pre-activity survey is completed by walking meandering transects or the entire area and is required when there is no possibility of a tortoise being encountered during the project's activities but other sensitive and protected/regulated species may be encountered. A pre-activity survey for buildings is required prior to demolition of buildings, reactivation of decommissioned buildings, or relocation of trailers. The pre-activity survey for buildings also includes a survey for the outside of the building and the entire construction area. A post-activity survey is required for certain projects to determine the total amount of habitat disturbed and ensure the project followed all applicable biological compliance. Table 2-1 lists the type of surveys required for each project.

During vegetation mapping surveys of the NNSS, delineated areas of homogeneous plant 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* (containing vegetation associations that recover very slowly from direct disturbance or are susceptible to erosion), and

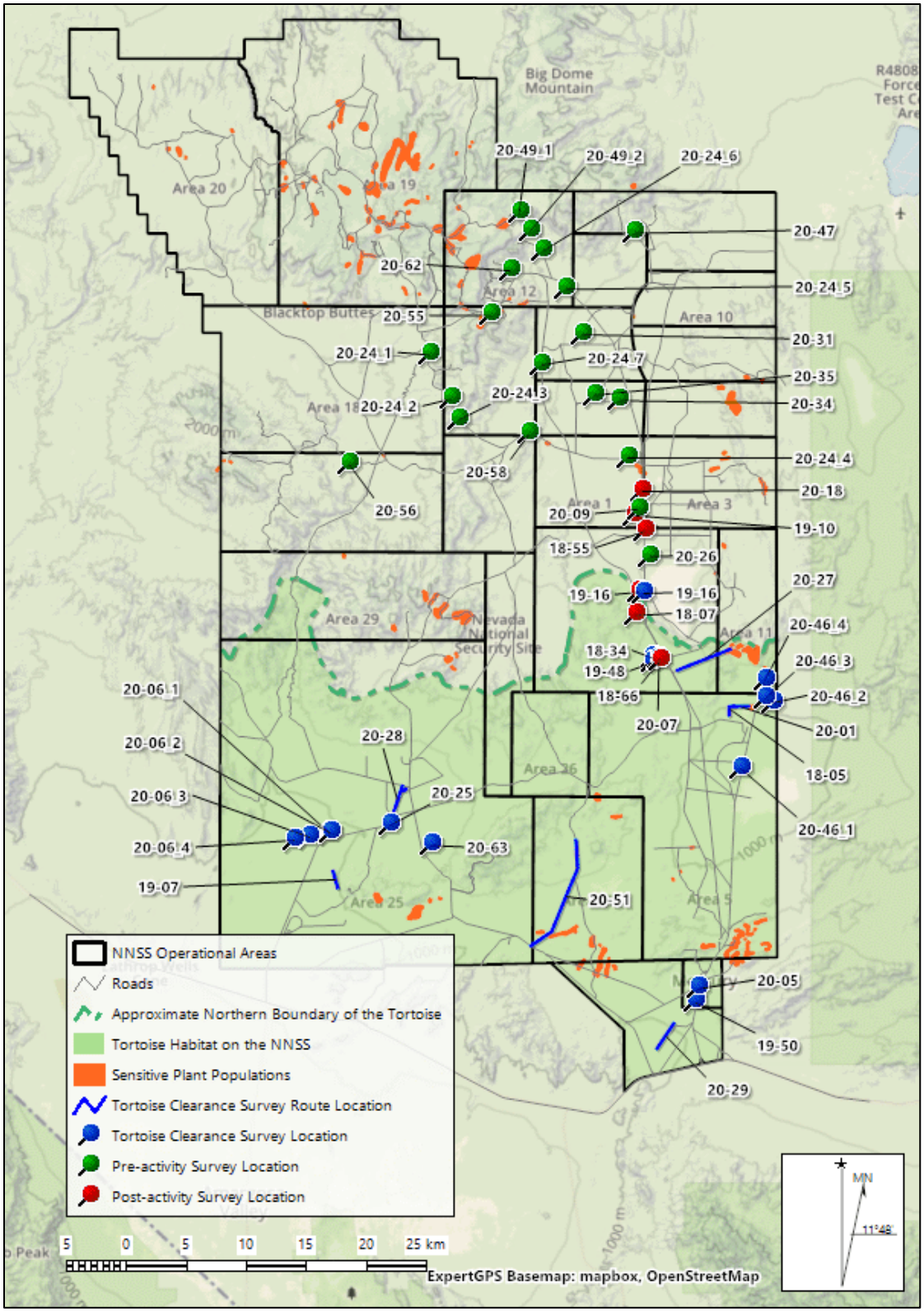

Figure 2-1. Biological surveys conducted in 2020. Project 20-06 had four locations, 20-24 had seven, 20-46 had four, and 20-49 had two. Project 19-16 had two separate surveys: tortoise clearance and post-activity.

Table 2-2. Summary of biological surveys conducted on the NNSS during 2020.

Project No.	Project Name	Important Species/Resources Found	Area Surveyed (ha)	Project area in Undisturbed Habitat (ha)	Mitigation Recommendations
18-05 [a]	RWMC Expansion (New Berm and Channel and small section in tortoise habitat in NW corner)	Predator burrows	3.79	1.05	Formal consultation, TCS [b], DTM [c]
18-07	CP Waterline Replacement	NA	NA [d]	0.10	Post-activity survey
18-34	DAF Substation Upgrade	Yucca, cacti (including 1 NDNH At-Risk cactus species), predator burrow	1.89	Project in Progress	TCS [b], DTM [c]
18-55	U1a Water System Upgrade	NA	NA [d]	17.20	Post-activity survey
18-66	DAF Utility Line	NA	NA [d]	1.80	Post-activity survey
19-07	Pole Replacements JF3	Cacti, roadkill rattlesnake	4.20	0	TCS [b], DTM [c], avian friendly poles
19-10	Air Supply Borehole	NA	NA [d]	0.50	Post-activity survey
19-16	Area 6 Tippipah Batch Plant	NA	NA [d]	5.10	TCS [b] and Post-activity survey
19-48	CUAS [e] Nodes	Cacti, Yucca	1.60	0.28	TCS [b], DTM [c]
19-50	Fiber Optic Poles Mercury Substation	Cacti, Yucca	0.57	0	TCS [b]
20-01	RWMC Expansion	Cacti, Yucca, antelope sign, predator burrow	6.71	1.34	Formal consultation, TCS [b], DTM [c]
20-05	Power and Fiber Optic Repairs Area 23	Cacti	0.33	0	TCS [b] (4 locations)
20-06	Area 25 Waterline Breaks	Cacti	1.31	0	TCS [b]
20-07	Area 6 New Trailers	Cacti, Yucca, cotton tail rabbit, predator burrows	0.85	0.20	TCS [b], DTM [c]
20-09	U1a Modernization Power Distribution	Yucca, cotton tail rabbit, antelope sign	6.50	Project in Progress	Pre-activity survey
20-18	Hawk Nest Relocation	Active red-tailed hawk nest	0.40	0	Post-activity survey
20-24	Crane Ops Sensors	Cacti, Yucca, horse sign	1.20	0	Pre-activity survey (7 locations)
20-25	Helipad Blading Area 25	Cacti, Sahara mustard (invasive plant species)	0.90	0	TCS [b]
20-26	U1a Communications	Antelope sign, coyote	2.90	Project in Progress	Pre-activity survey
20-27	Blading Area 11 EODU [f]	Cacti, Yucca, antelope sign, horned lizards, Mohave patch-nosed snake, 1 sensitive plant species	10.80	0	TCS [b] (included sensitive plant survey)
20-28	Blading 1st Street North	Cacti, Yucca, predator burrows	15.10	0	TCS [b]

Table 2-2. Summary of biological surveys conducted on the NNSS during 2020 (continued).

Project No.	Project Name	Important Species/Resources Found	Area Surveyed (ha)	Project area in Undisturbed Habitat (ha)	Mitigation Recommendations
20-29	Blading DRA [g]	Yucca, antelope sign, juvenile rattlesnake, horned lizard	19.60	0	TCS [b]
20-31	Area 2 Fire Break	Antelope and sign, predator burrows	7.20	0	Pre-activity survey
20-34	BEEF [h] Borrow Pits	None	1.60	0	Pre-activity survey
20-35	BEEF Small Fire Break Expansion	Yucca, burro sign	0.20	0	Pre-activity survey
20-46	Frenchman Flats Well Sites Cleanup	Antelope sign, 1 sensitive plant species, Yucca, cacti, predator burrow, burrowing owl sites	14.30	0	TCS [b] (4 locations)
20-47	Borehole U15	Yucca, potential skink habitat	0.70	0	Pre-activity survey
20-49	Communication Towers	Pine trees, cacti, chukar, pinyon jays	3.00	0.6	Pre-activity survey (2 locations)
20-51	Blading Road Shoulders 27-01 Road	Antelope sign	16.60	0	TCS [b], DTM [c]
20-55	Emergency FAJ Power Line Reroute	Pine trees, cacti, deer sign, chukar, 1 sensitive plant species	6.20	Project in Progress	Pre-activity survey
20-56	Area 18 Shooting Range	Ungulate sign (species not identified)	2.60	0.95	Pre-activity survey
20-58	Well 16D Waterline Repair	Yucca	0.09	0	Pre-activity survey
20-62	Area 12 Tunnels Construction Projects	Pine trees, cacti, deer sign	15.90	Project in Progress	Pre-activity survey
20-63	JAF [l] Substation	None	0.20	0	TCS [b]
		Total	**147.24**	**29.12**	

[a] Part of the project was in a tortoise exclusion zone identified in the 1996 Biological Opinion. These were areas designated as having such low tortoise presence they were exempt from the terms and conditions under the Biological Opinion and continued to remain in effect through August 26, 2019. As the zones were eliminated in 2019, all work outside the project area termed the "new berm and channel and small section in tortoise habitat in NW corner" is now covered under project 20-01.
[b] Tortoise Clearance Survey
[c] Desert Tortoise Monitor
[d] Post activity survey completed in 2020. Area surveyed during tortoise or pre-activity surveys was reported in previous years' EMAC reports.
[e] Counter Unmanned Aerial System
[f] Explosive Ordnance Disposal Unit
[g] Desert Rock Airport
[h] Big Explosives Experimental Facility
[l] Jackass Flats

Diverse Habitat (having high plant species diversity) (U.S. Department of Energy, Nevada Operations Office [DOE/NV] 1998).

Projects 20-49 and 20-56 disturbed 1.55 ha of *Pristine Habitat*, projects 18-07 and 19-16 disturbed 5.2 ha of *Sensitive Habitat*, and projects 18-66 and 20-07 disturbed 2.00 ha of habitat considered *Unique* and *Sensitive*. The total area disturbed (ha) of important habitat types tracked since 1999 comprises 11.01 (*Pristine*), 21.72 (*Unique*), 384.79 (*Sensitive*), and 87.05 (*Diverse*). Projects in 2020 disturbed a total of 29.12 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. Most notable was project 18-07, which was scheduled to disturb 6.07 ha, but instead utilized previously cleared areas, disturbing only 0.10 ha.

3.0 *DESERT TORTOISE COMPLIANCE*

Tortoises occur within the southern one-third of the NNSS. This species is listed as threatened under the Endangered Species Act (ESA). In December 1995, NNSA/NFO completed consultation with the 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 tortoise. NNSA/NFO received a Biological Opinion from FWS in August 1996 (FWS 1996). On July 2, 2008, NNSA/NFO provided FWS with a Biological Assessment of anticipated activities on the NNSS from 2009 through 2019. NNSA/NFO received the Programmatic Biological Opinion on February 12, 2009 (FWS 2009). On February 27, 2019, NNSA/NFO provided FWS with a Biological Assessment of anticipated activities on the NNSS from 2019 through 2029 and entered into formal consultation with FWS to obtain a new Biological Opinion. NNSA/NFO received the new Programmatic Biological Opinion (Opinion) on August 27, 2019 (FWS 2019).

The Desert Tortoise Compliance task of EMAC implements the protective measures of the 2019 Opinion, documents compliance actions taken by NNSA/NFO, and assists NNSA/NFO in FWS consultations. All protective measures listed in the Opinion were implemented by NNSS staff biologists in 2020, including (a) conducting 100% coverage TCS at project sites within 24 hours from the start of project construction, (b) ensuring projects have a DTM 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 FWS.

3.1 PROJECT SURVEYS AND COMPLIANCE DOCUMENTATION

Thirty-four projects occurring within the range of the tortoise were reviewed by biologists in 2020 and six projects in progress were carried over from previous years (Table 3-1). Projects are placed in one of three categories based on biological review: framework programmatic action (requires surveys and formal consultation with FWS), program-level action (requires surveys but no consultation with FWS), or no effects to the tortoise (surveys may still be required based on other important species in the project area). Once placed in one of the categories, required compliance activities are determined and completed (Table 3-1).

Seventeen tortoise clearance surveys were completed by biologists in 2020, with projects 20-06 and 20-46 having four survey locations each (Figure 2-1). No tortoises were observed or reported injured or killed during projects. Post-activity surveys confirm the amount of tortoise habitat disturbed for each project. All projects that were monitored within tortoise habitat remained within the surveyed area. This is determined by means of delineating the area of disturbance and constant communication between ground crews and biologists. A total of 9.87 ha of tortoise habitat was disturbed during 2020.

In January 2021, the annual report summarizing tortoise compliance activities conducted on the NNSS from January 1 through December 31, 2020 was submitted to FWS. This report, required under the Opinion, contains (a) the location and size of land disturbances that occurred within the range of the tortoise; (b) the number of tortoises injured, killed, or relocated off project sites; (c) a map showing the location of all tortoises sighted or relocated from on or near roads as well as vehicular mortalities; and (d) a summary of construction mitigation and monitoring efforts.

Table 3-1. Summary of projects within the range of the tortoise that were reviewed, compliance activities required, surveys completed, and amount of tortoise habitat disturbed in 2020 (TCS = Tortoise clearance survey, DTM = Desert tortoise monitor).

Project No.	Project Name	Description of Compliance Activity Required	TCS Completed During 2020	Tortoise Habitat Disturbed During 2020 (ha)
17-12 (18-43) [a]	Power Pole Weed Abatement	Formal Consultation, TCS, DTM		0
18-05 [a]	RWMC Expansion	Formal Consultation, TCS, DTM	✓	1.05
18-07 [a, b]	CP Water Line Replacement	Formal Consultation, TCS, DTM		0.10
18-09 [a]	Test Bed South	No Activities in 2020		0
18-34	DAF Substation Upgrade	TCS, DTM	✓	0
18-66 [a, b]	Area 6 Buried Utility Line	Formal Consultation, TCS, DTM		1.80
19-07	Pole Replacements JF3	TCS, DTM	✓	0
19-16 [a]	Area 6 Tippipah Batch Plant	Formal Consultation, TCS, DTM	✓	5.10
19-48	CUAS Nodes	TCS, DTM	✓	0.28
19-49	New Water Line 05A-32	None		0
19-50	Fiber Optic Poles Mercury Substation	TCS	✓	0
20-01	RWMC Westward Expansion	Formal Consultation, TCS, DTM	✓	1.34
20-02	Area 6 Bypass Valve	None		0
20-05	Power and Fiber Optic Repairs Area 23	TCS	✓	0
20-06	Area 25 Water Line Breaks	TCS	✓	0
20-07	Area 6 New Trailers	TCS, DTM	✓	0.20
20-08	Protective Force Training Complex Area 23	None		0
20-13	Drone Survey	None		0
20-15	TCC & EMAD Surveys	None		0
20-20	Seismic Monitoring Systems	None		0
20-21	Area 6 Erosion Repair	None		0
20-22	Area 6 Loading Pad	None		0
20-25	Helipad Blading Area 25	TCS	✓	0

Table 3-1. Summary of projects within the range of the tortoise that were reviewed, compliance activities required, surveys completed, and amount of tortoise habitat disturbed in 2020 (continued).

Project No.	Project Name	Description of Compliance Activity Required	Survey Completed During 2020	Tortoise Habitat Disturbed During 2020 (ha)
20-27	Blading Area 11 EODU	TCS	✓	0
20-28	Blading 1st Street North	TCS	✓	0
20-29	Blading DRA	TCS	✓	0
20-30	Demarcation	None		0
20-32	Port Gaston Weed Abatement	None		0
20-36	Cattle Guard Communications Mast	None		0
20-39	RNCTEC [e] Weed Abatement	None		0
20-41	UST-1 [f]	None		0
20-46	Frenchman Flats Well Sites Cleanup	TCS	✓	0
20-51	Blading Road Shoulders 27-01 Road	TCS, DTM	✓	0
20-52	USGS [g] Hydrologic Data Collection	None		0
20-53	CTOS [h]	None		0
20-54	SDRD [i] RSL [j]	None		0
20-57	Area 6 Emergency Egress Gate	None		0
20-59	Two Communication Buildings in Mercury	None		0
20-61	UGTA Project Well Sites Access Road Repairs	None		0
20-63	JAF Substation	TCS	✓	0
		Total		**9.87**

[a] Project carried over from previous year.
[b] Project came to completion in late 2019 with a post activity survey completed in 2020.
[c] Test Cell C
[d] Engine Maintenance, Assembly, and Disassembly Facility
[e] Radiological/Nuclear Countermeasures Test and Evaluation Complex
[f] underground storage tank
[g] U.S. Geological Survey
[h] Counter Terrorism Operations Support
[i] Site-Directed Research and Development
[j] Remote Sensing Laboratory

Compliance with the Opinion ensures the tortoise is protected on the NNSS and the cumulative impacts on this species are minimized. In the Opinion, 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. Although all detected incidental take events are reported under the Opinion, new parameters set by FWS in 2019 requires only large tortoises (>180 millimeters [mm]) be reported under the Opinion's incidental take limits. This is due to the low detection rate of small tortoises. Cumulative totals under the current Opinion reported in the FWS annual report are represented in Table 3-2. Cumulative totals tracked since 1992 are represented in Table 3-3.

There were 41 reported tortoise roadside observations and one observation on the northbound onramp of the I95 Highway, an area managed by Nevada Department of Transportation (NDOT) (Figure 3-2). The tortoise observed on the I95 Highway onramp was approximately 150 mm in length, moved off the road, and reported to NDOT. Of the 41 tortoises observed on NNSS roads, two were roadkills and one was a predation. The two roadkill tortoises were small (≤180mm); therefore, did not count as incidental take,

Table 3-2. Summary of tortoise habitat disturbance, tortoise habitat disturbance limits, incidental take of large tortoises (>180 mm), and anticipated number of incidental take of large tortoises under the current Opinion January 1, 2020 – December 31, 2020.

Program	Actual No. of Hectares Impacted (Limit Allowed)	No. of Tortoises Incidentally Taken (Maximum Allowed)	
		Non-injury or Non-mortality [a]	Detected Injury or Mortality
1) Continued Use of Existing Roads	NA	30 (350) [b]	0 (15) [c]
2) Defense	0.3 (202)	0 (10)	0 (2)
3) Waste Management	2.4 (101)	0 (10)	0 (2)
4) Environmental Restoration	0 (101)	0 (10)	0 (2)
5) Nondefense R&D [e]	0 (405)	0 (20)	0 (4)
6) Work-for-Others	0 (202)	0 (20)	0 (2)
7) Infrastructure	7.2 (202)	0 (20)	0 (4) [d]
Totals	**9.9 (1,213)**	**30 (440)**	**0 (31)**

[a] All tortoises observed in harm's way may be moved to a safe location
[b] No more than 35 non-injury or non-mortality tortoises in a given year.
[c] No more than 4 tortoises killed in a given year and no more than 15 killed during the term of the Opinion.
[d] No more than 2 tortoises killed in a given year and no more than 4 killed during the term of the Opinion.
[e] Research and Development

Table 3-3. Summary of disturbance of tortoise habitat, tortoise roadside observations, number of tortoises moved safely off the road during the roadside observations (Non-injury or Non-mortality Roadside Observations), and detected road mortalities (Detected Injury or Mortality) for all size classes 1992 – 2020.

Calendar Year	Hectares Disturbed	Total Roadside Observations	Non-injury or Non-mortality Roadside Observations [a]	Detected Injury or Mortality
1992-1996	57.4	Not documented	Not documented	2
1997	0.0	12	0	0
1998	0.0	3	3	1
1999	11.6	7	4	0
2000	2.5	7	7	0
2001	8.9	11	11	1
2002	6.3	3	3	0
2003	1.5	12	12	0
2004	9.1	17	17	3
2005	16.2	14	14	1
2006	5.5	35	14	1
2007	5.5	34	17	1
2008	2.6	19	19	0
2009	3.3	31	5	1
2010	1.8	22	13	2
2011	1.9	13	9	1
2012	6.2	19	18	1
2013	4.8	12	14	2
2014	2.2	16	17	0
2015	0.0	26	17	2
2016	0.1	36	19	1
2017	0.5	45	41	2
2018	6.0	34	31	0
2019	0.0	66	56	2
2020	9.9	41	32	2
Total	**163.7**	**843**	**747**	**26**

[a] All tortoises observed in harm's way may be moved to a safe location. If the tortoise is not in harm's way, it is allowed to move itself off the road, not counting towards incidental take.

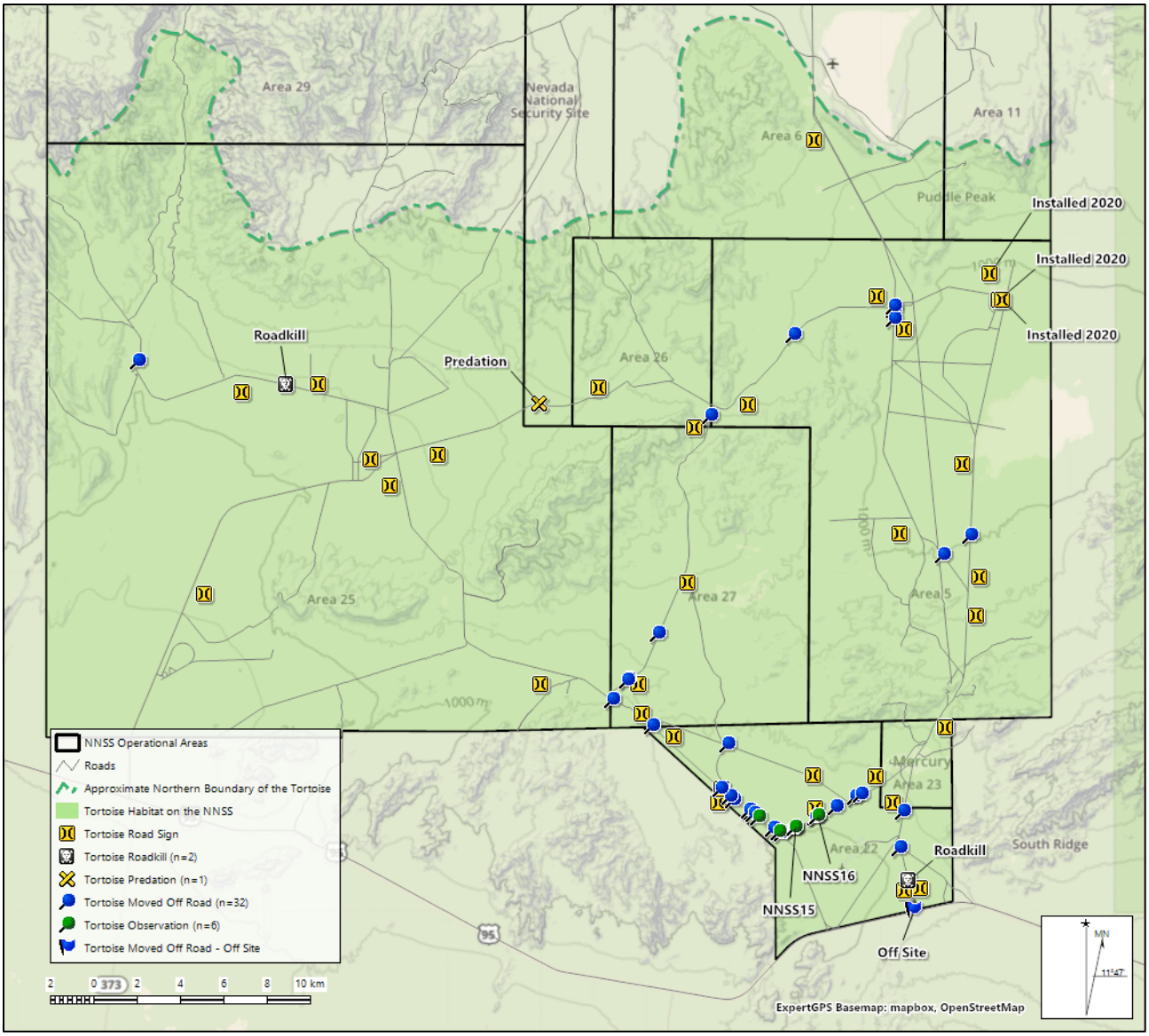

Figure 3-2. Locations of existing tortoise awareness road signs, new road signs installed in 2020, tortoise roadside observations (including tortoises moved off roads), two tortoise road mortalities, and one tortoise predation during 2020.

but were detected and reported to FWS. One of the tortoises was found hit by a vehicle but still alive. The tortoise was taken to Creature Comforts Animal Hospital in Las Vegas, Nevada, per FWS's recommendation, and later euthanized. The other tortoise was found dead upon arrival. The tortoise predation observation was an adult tortoise found dead on a road with predation wounds to its forelimbs, otherwise intact. Found at the end of December, it is possible the tortoise succumbed to its wounds or exposure to the elements.

Thirty-two tortoises were determined to be in harm's way and moved off the road following FWS-approved protocol. Six of the tortoises observed were not handled. Eleven of the tortoises moved off roads were small (≤180 mm) and although were detected, did not count as incidental take. The smallest tortoise observation was approximately 76 mm in length and moved off the 27-01 Road late in the active season in November after a rainstorm (Figure 3-3, left). Twenty-one tortoises moved off roads were large (>180 mm) and were reported non-injury/non-mortality incidental take under the "Continued Use of Existing Roads" program under the Opinion. Of the 21 large tortoises that were moved off roads, two were previously marked tortoises (NNSS15 and 16) from the site's tortoise road study and three were able to be newly marked (NNSS61-63) as an ongoing mark-recapture study under the Opinion (Figure 3-3, right).

Figure 3-3. Small tortoise (left) moved off the 27-01 Road in November. Adult tortoise (right) with newly attached paper identification tag.

(Photos by J.A. Perry, November 3, 2020 [left] and June 8, 2020 [right]).

3.1.1 Mitigation for Loss of Tortoise Habitat

Prior to land-disturbing activities associated with any projects of the Work-for-Others program, the proponent shall pay remuneration fees to minimize effects from disturbance of tortoise habitat on the NNSS in accordance with FWS-approved instructions (FWS 2019). For land-disturbing activities that occur under all other programs (i.e., Defense, Waste Management, Environmental Restoration, Nondefense Research and Development and Infrastructure), NNSA/NFO will minimize effects from disturbance of tortoise habitat by funding and implementing FWS-approved conservation actions on the NNSS (FWS 2019). Remuneration fees are currently paid into the Mojave Desert Tortoise Sub-Account through the National Fish and Wildlife Foundation Chief Financial Officer for all Work-for-Others

projects at the rate of $923 per acre of disturbance. All other projects are able to utilize the NNSS's accrued funds from implementation of FWS-approved conservation studies. Deductions from the accrued funds are applied at a level equal to the rate of $923 per acre of disturbance.

Three projects were required to pay remuneration fees based on each project's permanent disturbance of tortoise habitat. Project 19-48, under the Defense program, disturbed 0.7 acres; therefore, $646 (0.7 acres x $923) was deducted from accrued funds. Project 20-07, under the Infrastructure program, disturbed 0.5 acres; therefore, $462 (0.5 acres x $923) was deducted from accrued funds. Project 20-01, the Radioactive Waste Management Complex (RWMC) Westward Expansion framework programmatic action, was appended to the Opinion on April 10, 2020 with the anticipated disturbance of 200 acres under the Waste Management program; therefore, $184,600 (200 acres x $923) was deducted from accrued funds.

3.2 CONSERVATION RECOMMENDATIONS

Biologists continue to increase tortoise awareness by updating and increasing tortoise signage throughout the NNSS. In response to a small tortoise roadkill found last year at the Area 5 RWMC, three new tortoise awareness signs were installed. The signs were placed at the three entrances to the facility (Figure 3-2). Biologists also began placing temporary signs on either side of the road at recent tortoise roadkill locations. Signs are left out for two weeks following a tortoise mortality to increase driver's awareness (Figure 3-4).

As a recommendation from FWS, MSTS biologists implemented a study in 2019 of tortoise exposure to radiological sources or fallout from nuclear testing by opportunistically testing tortoise carcasses found on the NNSS for radionuclides. Carcasses utilized for the study are selected from recent roadkills or found during the juvenile translocation study. No tortoise carcasses were tested in 2020.

Figure 3-4. Temporary tortoise awareness sign.

(Photo by J.A. Perry June 24, 2020).

There are currently five tortoise carcasses approved by FWS to be processed and tested: two roadkills, two study animals found dead during the juvenile translocation study, and one adult resident predation. MSTS biologists are collaborating with Los Alamos National Laboratory (LANL) on a study to determine radiation impacts on tortoises through scute sampling. The five tortoise carcasses will provide scute samples for the study and then be processed and tested for radionuclides.

Two tortoise conservation research studies have been approved by FWS and are being implemented by MSTS biologists; the tortoise road study and 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 tortoise study which focused on collecting fine-scale patterns of roadside habitat use by the tortoise for application in the future development and implementation of management practices in order to minimize road mortalities on the NNSS (FWS 2009).

The research project was appended to the Opinion in April 2012 and implemented in May 2012. The main objectives of this study were to (1) determine fine-scale patterns of habitat use of tortoises found near roads on the NNSS, and (2) assess the risk of tortoise road mortality on the NNSS. FWS originally approved a handling take limit of twenty adult tortoises for the project and later approved the sample size (n) increase to thirty adult tortoises. Field work for the study came to completion in September 2018. A draft topical report is in progress with several preliminary key findings:

- Male tortoises (n = 11) completed an average 32.8 (standard deviation [sd] = 38.5) paved road-crossing events as opposed to female tortoises (n = 8), which completed an average 6.8 (sd = 4.7) paved road-crossing events (two-sample, t-test, probability [p] = .052).
- During the study male tortoises (n = 15) on average moved 67.0 kilometers (km) per year (sd = 28.4 km) compared to female tortoises (n = 11) which moved 41.4 km per year (sd = 14.7 km, two-sample, t-test, p = .007).
- The percent of paved road-crossing events for nine female study animals peaked in May and June (Figure 3-5; 31% and 36%, respectively). This aligns with nesting season, which can begin in late spring and continue through early summer. The percent of paved road-crossing events for 11 male study animals peaked in August and September (Figure 3-5; 36% and 24%, respectively). This aligns with mating season.
- Tortoises whose home range intersected a road spent the majority of time (33.4%) 201-400 m from paved roads (Figure 3-6). Tortoises spent 0.5% of their time on paved roads (0-10 m) and 23.6% within 11-200 m of paved roads. The trend shows a steep increase in habitat use from 11 to 400 m, then a steady decrease as the distance increases from the road, becoming consistent after 800 m (Figure 3-6).
- Use of burrows on south-facing slopes dominated compared to burrows on west, east and north-facing slopes throughout the entire year (Figure 3-7).
- Twenty-two tortoises crossed roads a total of 1,206 times during the study. Roads had a range of traffic volume from zero to greater than 600 vehicle passes per day. Sample size varied for each road traffic volume category with two tortoises crossing high volume traffic roads (>600 vehicle passes/day) an average of 22.5 times (45 total, range = 4 – 41, sd = 26.2), 12 crossing intermediate volume traffic roads (80-140 vehicle passes/day) an average of 21.3 times (256 total, range = 1 – 49, sd = 13.9), three crossing low volume traffic roads (65-70 vehicle passes/day) an average of 85.7 times (257 total, range = 4 - 168, sd = 82), and 12 crossing very low volume

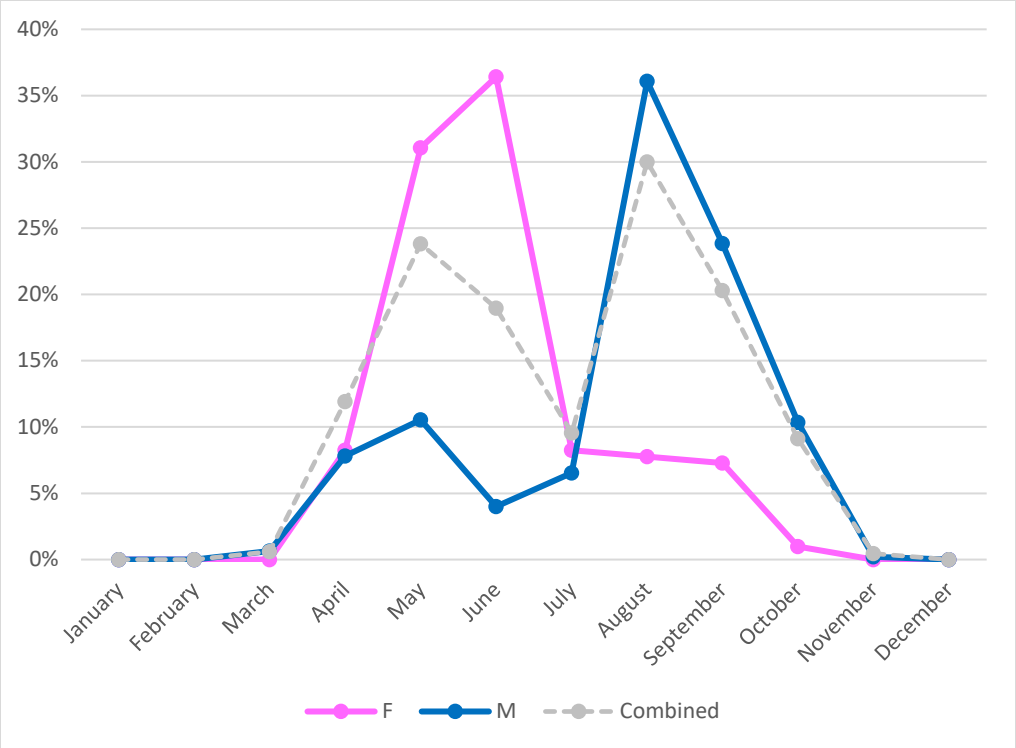

Figure 3-5. Percentage of combined paved road-crossing events by month for nine females (206 events), 11 males (474 events), and combined females, males, and one unknown sex (848 events). The tortoise active season is March through October, with nesting season beginning in spring and mating season in fall.

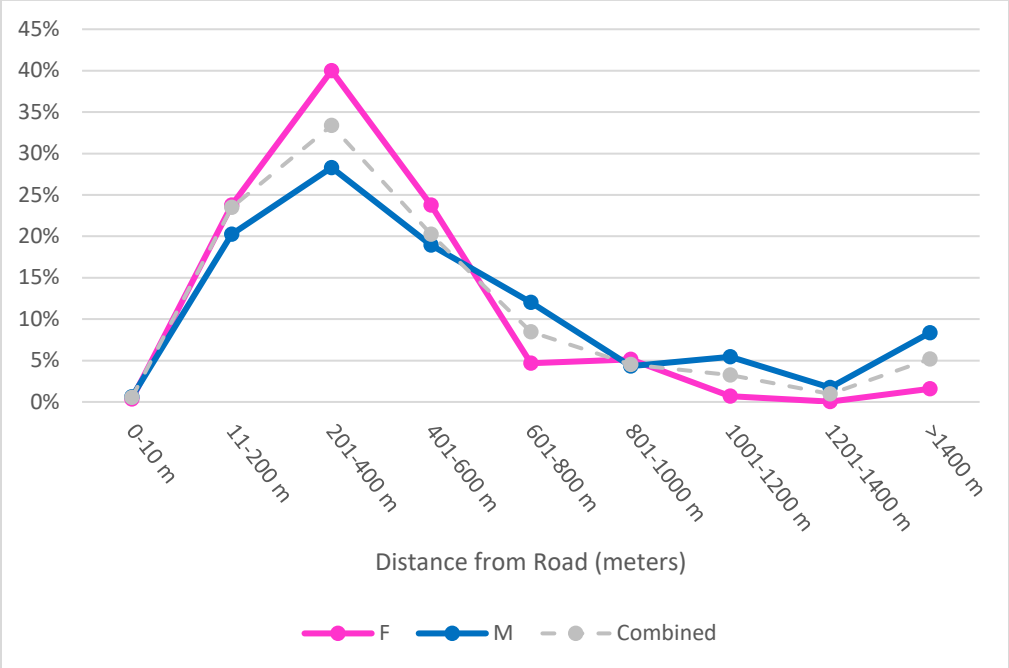

Figure 3-6. Percent time tortoises spent on (0-10 m), near (11-400 m), or far (401 to >1400 m) from paved roads for 11 females, 14 males, and combined females, males, and one unknown sex.

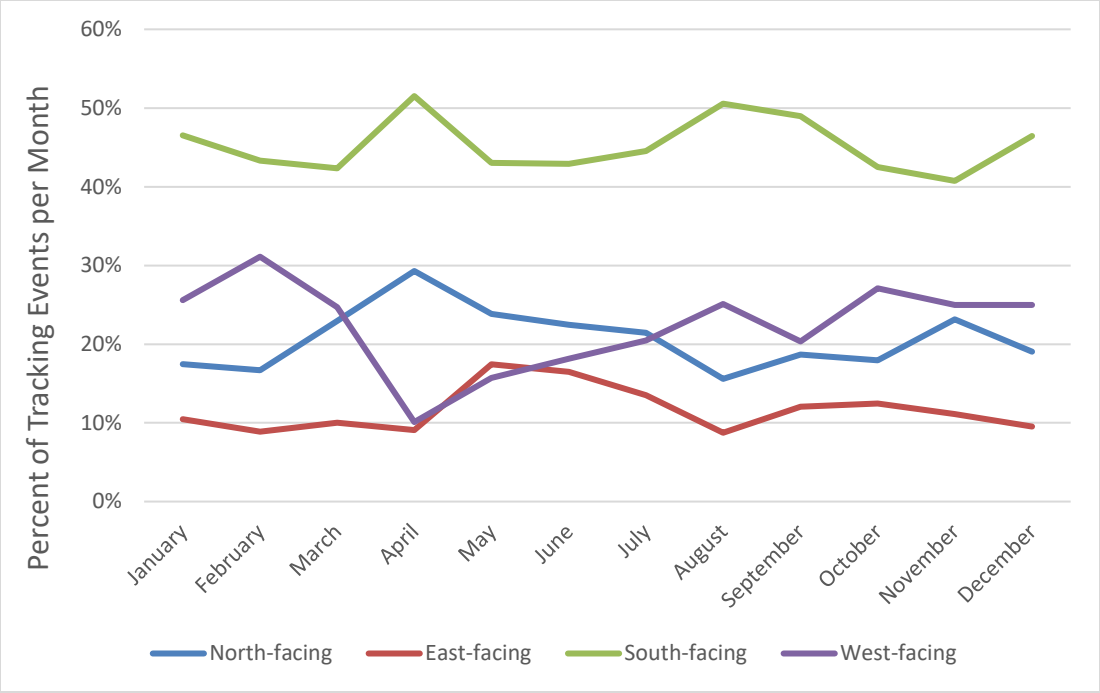

Figure 3-7. Percent of tracking events by month by aspect of burrow location when a tortoise was found in a burrow.

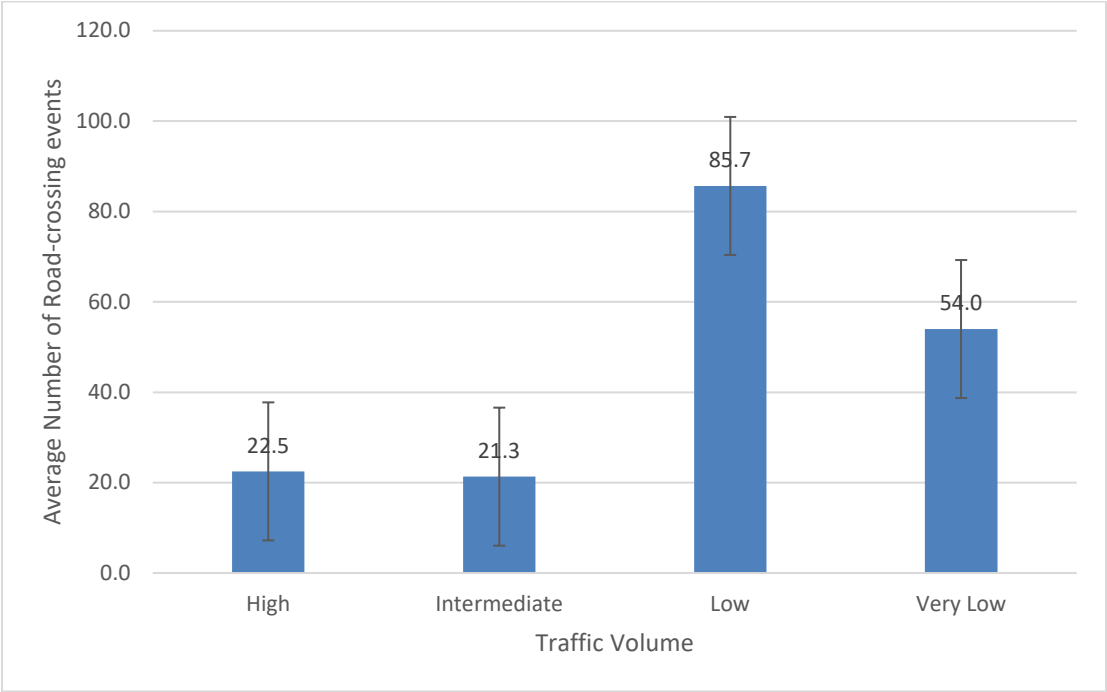

Figure 3-8. Average number of road-crossing events (completed and partial) by traffic volume category with standard error bars. High volume roads had greater than 600 vehicle passes per day, intermediate between 80-140, low 65-70, and very low less than 25.

traffic roads (<25 vehicle passes/day) an average of 54 times (648 total, range = 2 – 168, sd = 49.3). Some tortoises crossed different roads with different traffic volumes. Due to the small number of tortoises, road-crossing events were averaged by combining the high and intermediate categories (average 21.5 ± 14.7) and comparing it with the combined low and very low categories (average 60.3 ± 55.2) which revealed tortoises crossed higher traffic roads significantly less frequently than lower traffic roads (two-sample t-test, p = 0.018) (Figure 3-8). On the NNSS, traffic volume may play a role in the amount of times a tortoise chooses to cross a road.

Because the largest threat to the tortoise on the NNSS is the continued use of roads, research will continue on this topic. Biologists are currently implementing an opportunistic mark-recapture study to continue documentation and research on tortoises whose home ranges intersect NNSS roads. The study was approved by FWS and allows permitted biologists to attach identification numbers to tortoises when they are found and moved safely off NNSS roads (Figure 3-3, right). The objectives of the study are to (1) determine if tortoises moved safely off roads are repeat offenders, (2) identify trends in repeat offenders crossing roads, and (3) assist with collection of tortoise density data. Marking tortoises found on roads for future identification will provide information on population size and trends over time, which will assist in future conservation and management efforts (Pike et al 2005).

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 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 very high frequency transmitter prior to release for post-release monitoring purposes. Regular monitoring of the animals occurred post-release from 2012 through 2020. During 2020, monitoring occurred once in January and February, four times in March, three times in April, weekly in May, four times in June, twice in July, three times in August, weekly in September and October, three times in November, and once in December. Additional monitoring was conducted in early January 2021 to determine each tortoise's winter burrow. Once a tortoise was located, information such as date and time, elevation, Universal Transverse Mercator coordinates, position (i.e., in burrow and burrow number, under vegetation, in the open), habitat, substrate, activity, foraging evidence and species, temperature, cloud cover, and wind were recorded.

At the beginning of 2020, 24 tortoises were alive and by the end of 2020, 18 of the 60 tortoises (30.0%) (6 female, 12 male) were known or assumed to be alive (Table 3-4, Figure 3-9). Transmitters on two of these (males 4040 and 4041) failed but these tortoises were assumed to be alive with no evidence of attacks or transmitters with bite marks found. A male tortoise (4040) that went missing on October 14, 2019 was found on June 8, 2020, and a new transmitter was attached. It worked until mid-July when the signal was lost again. The tortoise had bite marks on the left and right marginal scutes which likely were from the predator attack that had removed the transmitter in October 2019. The transmitter for Male 4041 failed around the end of August. Subsequent searches failed to find these two missing tortoises and it is assumed that the batteries died on the transmitters. Searches during spring 2021 will be made to try and find these two missing tortoises and reattach working transmitters.

Six tortoises (2 females, 4 males) were found dead during 2020. Male 4024 was found dead on January 7th as an intact carcass and cause of death determined to be exposure. Female 4010 was found dead on

Table 3-4. Mortality, sex, distance in meters (m) between release site and January 2021 burrow, distance between January 2020 burrow and January 2021 burrow, total distance between monitored locations (January 2020 to January 2021), and total number of burrows and new burrows occupied by 24 juvenile desert tortoises monitored during 2020.

Tortoise Number	Sex	Distance (m) Release to January 2021 Burrow	Distance (m) between January 2020 and January 2021 Burrows	Total Distance (m) between locations (January 2020 to January 2021)	Number of Burrows Used (New Burrows)
4010[a]	Female	NA	NA	NA	NA
4014	Female	601	37	252	3 (0)
4030	Female	2551	84	1032	5 (3)
4039	Female	125	180	369	3 (1)
4044	Female	227	49	2389	5 (1)
4045	Female	188	0	1305	5 (2)
4046	Female	369	0	3876	10 (6)
4049[b]	Female	NA	NA	NA	NA
4004	Male	260	108	3296	9 (4)
4005	Male	8990	8784	10134	8 (6)
4007	Male	27	139	723	6 (1)
4011	Male	743	477	3960	8 (5)
4019[c]	Male	NA	NA	NA	5 (2)
4024[d]	Male	NA	NA	NA	NA
4025	Male	1101	64	1519	5 (2)
4033[e]	Male	NA	NA	NA	3 (2)
4034	Male	215	0	1474	7 (5)
4036	Male	631	117	3132	3 (1)
4038	Male	114	0	2840	4 (1)
4040[f]	Male	NA	NA	NA	NA
4041[g]	Male	NA	NA	NA	4 (1)
4048	Male	240	315	1589	6 (3)
4053	Male	274	0	313	3 (2)
4055[h]	Male	NA	NA	NA	NA
	Average	1041	647	2388	5.4

[a] Found dead on 4/20/20
[b] Assumed dead on 5/18/20
[c] Found dead on 10/12/20
[d] Found dead on 1/7/20
[e] Found dead on 9/28/20
[f] Found alive 6/8/20, transmitter failed mid-July
[g] Transmitter failed end of August
[h] Found dead on 5/4/20
NA = Not Applicable

April 20th in pieces and cause of death was assumed predation. Male 4055 was found dead as an intact carcass on May 4th and cause of death is unknown. The transmitter for Female 4049 was found with bite marks in it on May 18th and assumed to be dead by predation, although no sign of the carcass was found. There was disturbed vegetation and soil where the transmitter was found which suggested a predation event. Male 4033 was found dead on September 28th in pieces and cause of death was assumed predation. Male 4019 was found dead on October 12th in pieces and cause of death was assumed predation.

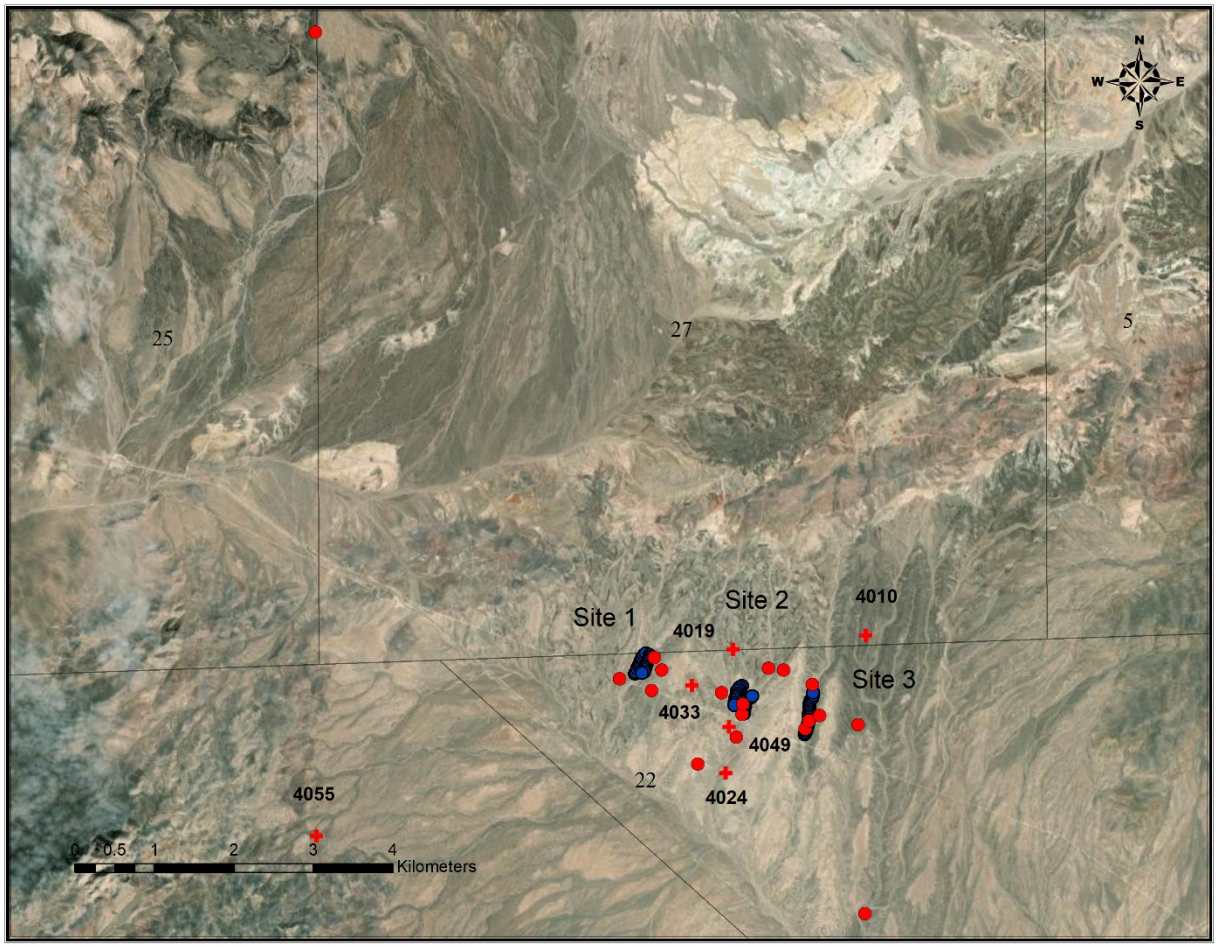

Figure 3-9. Release locations for 60 tortoises, September 2012 (blue dots, 20 at each site) and last known locations for 24 tortoises monitored during 2020 (red dot = living tortoise; red cross = dead tortoise with tortoise number in black text).

Our survival rate of 30.0% (18 of 60 alive) after eight years is a little higher but comparable to an estimated 26.7% (16 of 60 alive) survival based on an annual survival rate of 0.85 calculated for a natural population (Turner et al. 1987). There is a much higher survival rate for males (40.0% [12 of 30]) compared to females (20.7% [6 of 29]) with most of the mortalities suspected as coyote and kit fox predation. Given the importance of females surviving to adulthood to reproduce, this may be a critical life stage for females. If female juveniles are not surviving to sexual maturity, this could contribute to a decline in tortoise populations. Mulder et al. (2017) found that adult female fitness and integration following translocation was high which suggests that survival and integration and acceptance of translocated female tortoises into a natural population may be key to a successful translocation. The more females, resident or translocated, that survive the greater the fecundity which should result in population increases. Understanding differential mortality in both resident and translocated juvenile tortoises of both sexes warrants further study.

Table 3-4 contains information about the 24 juvenile tortoises monitored during 2020. On average, the distance between the release location and winter 2020-2021 burrow (i.e., the burrow a juvenile was in during the first part of January 2021) was 1,041 m (range = 27 - 8,990 m; sd = 2,206 m). On average, tortoises used winter burrows in 2021, 647 m away from their 2020 winter burrows. Over half (9 of 16) of the tortoises wintered in burrows within 100 m of their last year's winter burrow, and 31% (5 of 16) of

them used the same winter burrow as the previous year. The average distance moved between monitoring checks was 2,388 m (range = 252 - 10,134 m; sd = 2,411 m). This is not the total distance a tortoise moved during the year, but the summed distance between locations recorded during regular monitoring. Movements tortoises made between monitoring checks were not recorded or measured. Of particular interest was the nearly 9 km movement made by male 4005 from where he had been living for the past several years to his new home range on the lower slopes of Skull Mountain (Figure 3-9, red dot approximately 9 km northwest of Site 1). This is the longest documented movement in our study to date.

During 2020, 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 3-4. Tortoise burrows were only documented during tracking checks so it is likely that not all burrows used were documented. A total of 101 unique burrows were used with one burrow shared by male 4019 and female 4045 on August 17, 2020. The number of new burrows marked and measured during 2020 was 48. The average height of burrows was 10.6 mm (range = 8 - 22 mm; sd = 2.4 mm) and average width of burrows was 23.5 mm (range = 18 - 38 mm; sd = 4.8 mm). On average, tortoises used 5.4 unique burrows (range = 3-10; sd = 1.8) (Table 3-4). Timing of arrival at winter burrows differs between years (Table 3-5) 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). Precipitation during summer and fall was sparse, resulting in little food for tortoises to eat so tortoises tended to arrive at their winter burrows earlier than in wetter years.

Between early January 2020 and early January 2021, 669 observations were recorded. Tortoises were inside burrows 72% of the time and aboveground 28% of the time including under vegetation or a boulder (15%), in the open (10%), in the burrow mouth (2%), or on the burrow apron (1%) (Figure 3-10). Of the 97 observations under vegetation 42% were under blackbrush (*Coleogyne ramosissima*), 7% were under waterjacket (*Lycium andersonii*), 6% were under Nevada jointfir (*Ephedra nevadensis*), 6% were under Fremont's dalea (*Psorothamnus fremontii*), 19% were under mixed shrub species clumps, and the remaining 20% were under 10 other shrub species (Figure 3-11) including 4% burrobrush (*Hymenoclea salsola*), 3% pale desert thorn (*Lycium pallidum*), 3% spiny hopsage (*Grayia spinosa*), 2% creosote bush (*Larrea tridentata*), 1% white bursage (*Ambrosia dumosa*), 1% spiny menodora (*Menodora spinescens*), 1% fourwing saltbush (*Atriplex canescens*), 1% Virgin River brittlebush (*Encelia virginensis*), 1% Death Valley jointfir (*Ephedra funerea*), and 1% desert prince's plume (*Stanleya pinnata*).

For the 48 new burrows, tortoises used burrows on wash slopes over 70% of the time followed by burrows in wash bottoms (25%) and equally split between washlets (2%) and ridgetops (2%) (Figure 3-12). Vegetation cover at burrows was found at 98% of the burrows, suggesting this may be an important factor in burrow use for these juveniles. Creosote bush was the dominant cover followed by mixed shrub clumps, waterjacket, and pale desert thorn (Figure 3-13). White bursage (4%), blackbrush (4%), spiny hopsage (4%), Nevada jointfir (2%), desert prince's plume (2%), and one dead unknown shrub (2%) made up the other category.

Gravel was the dominant substrate at over 40% of all new juvenile tortoise burrows followed by cobble (19%), gravel/cobble (17%), sandy/gravel (10%), cobble/rock (10%), and rock (2%) (Figure 3-14). 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. Combined categories such as gravel/cobble means that both were equal in abundance.

Table 3-5. 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 2014–2020.

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
2019	13	78	December 12
2020	38	88	November 23

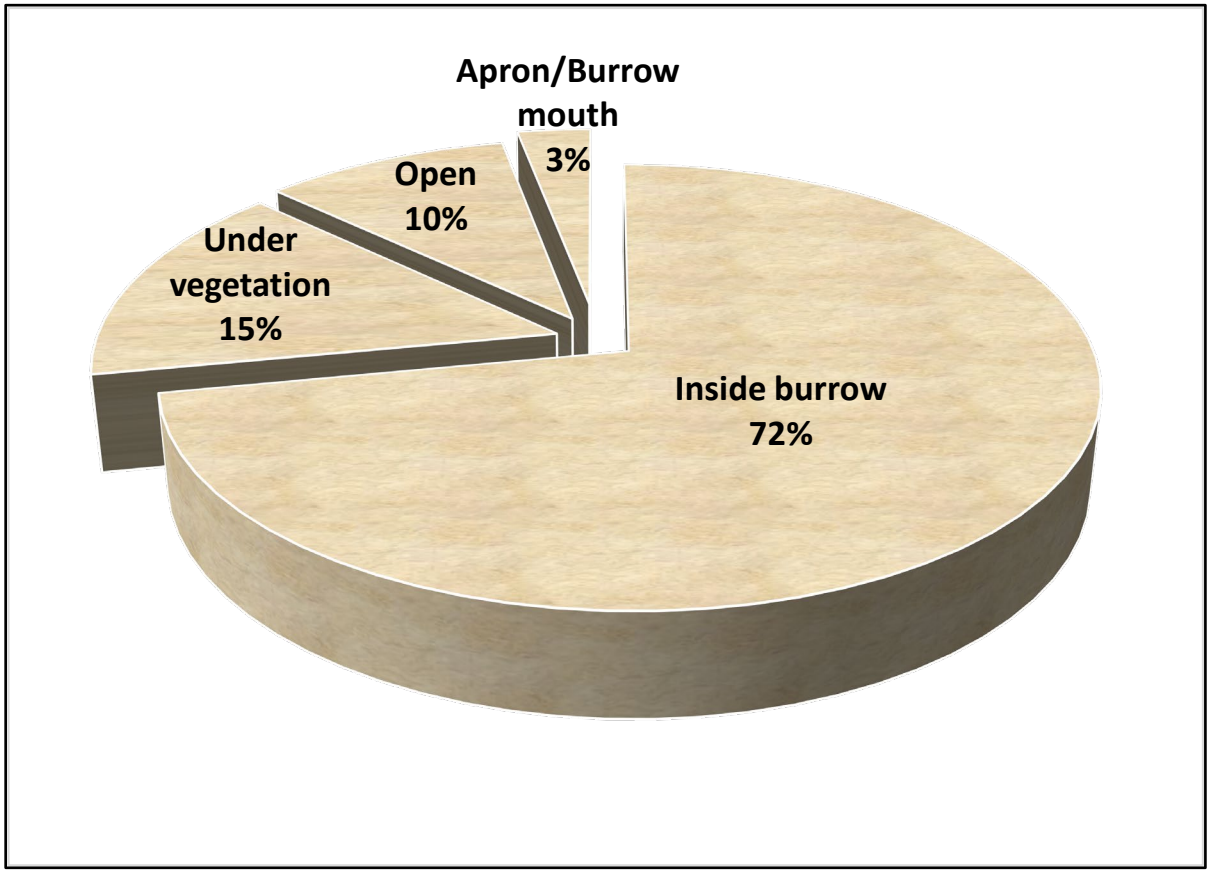

Figure 3-10. Percentage of observations (n = 669) of 24 juvenile tortoises by location, January 2020–January 2021.

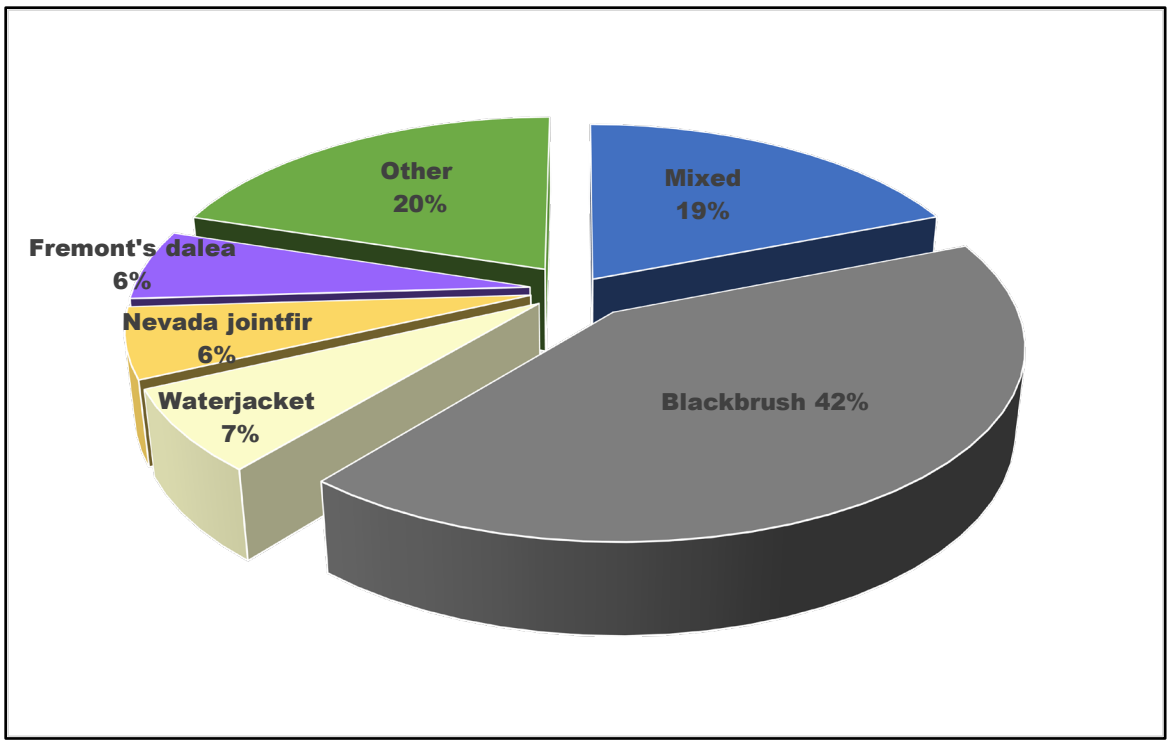

Figure 3-11. Percentage of observations (n = 97) of 24 juvenile tortoises found under vegetation by species, January 2020–January 2021.

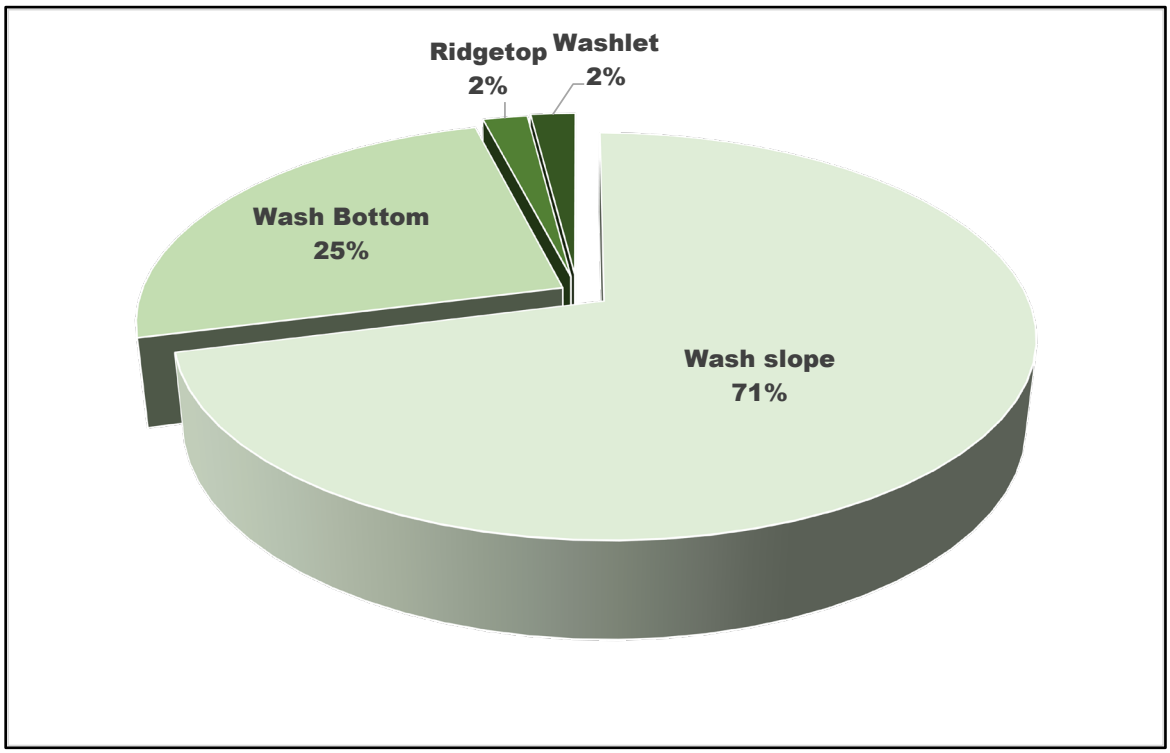

Figure 3-12. Percentage of new juvenile tortoise burrows by topographic position, January 2020–January 2021 (n = 48).

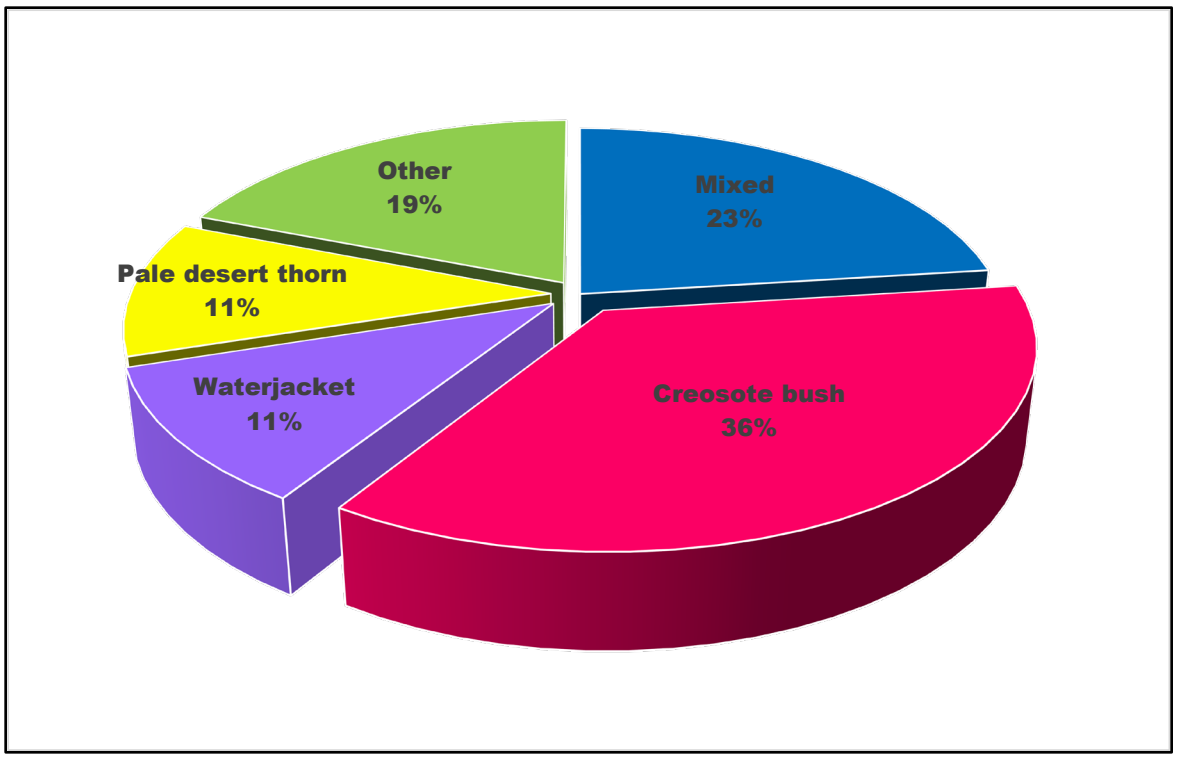

Figure 3-13. Percentage of new juvenile tortoise burrows by vegetation cover at the burrow, January 2020–January 2021 (n = 47).

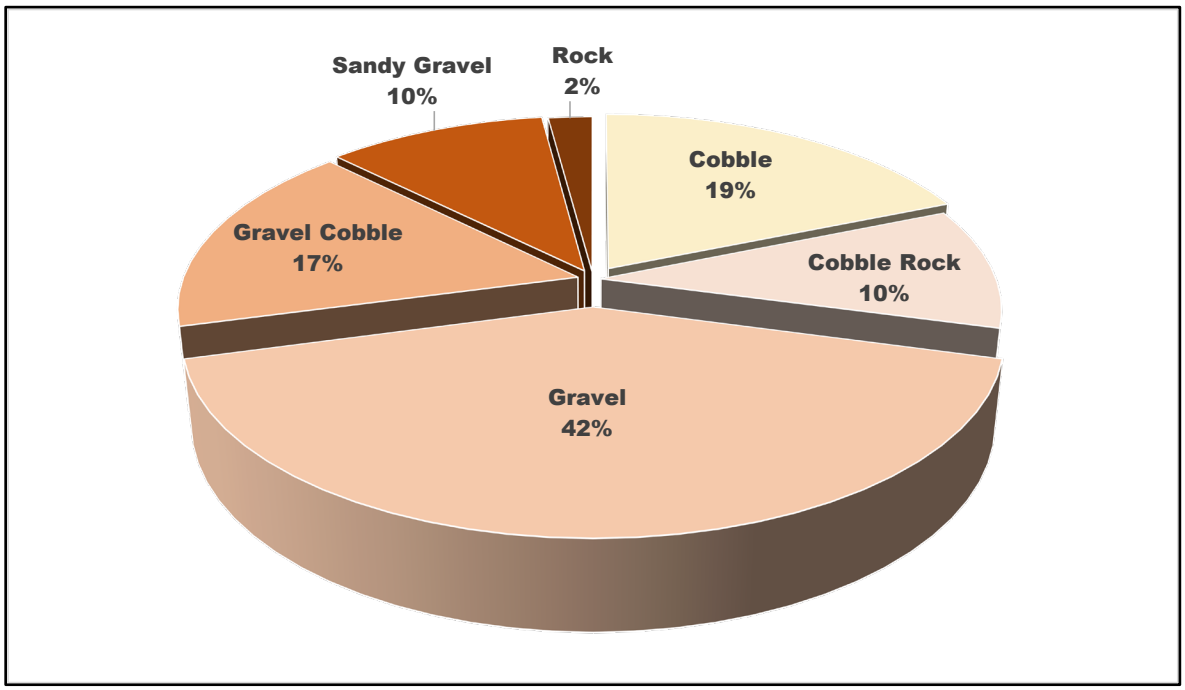

Figure 3-14. Percentage of juvenile tortoise burrows by substrate, January 2020–January 2021 (n = 48).

Evidence of foraging was documented on 21 tortoises, 77 times between March 9 and October 12, 2020, with foraging peaks in April (30 times) and May (27 times) (Figure 3-15). The most commonly observed species eaten were desert globemallow (*Sphaeralcea ambigua*) (3.9%), red brome (*Bromus rubens*) (3.9%), bluedicks (*Dichelostemma capitatum*) (2.6%), Esteve's pincushion (*Chaenactis stevioides*) (2.6%) (Figure 3-16), and brightwhite (*Prenanthella exigua*) (2.6%). Seven other species were observed being eaten by tortoises one time each: redstem stork's bill (*Erodium cicutarium*), Pacific blazingstar (*Mentzelia obscura*), bristly fiddleneck (*Amsinckia tessellata*), broadleaved pepperweed (*Lepidium latifolium*), Nevada cryptantha (*Cryptantha nevadensis*), Booth's evening primrose (*Camissonia boothii*), and Mojave woodyaster (*Xylorhiza tortifolia*). Most (75%) of the time, it was not possible to identify what the tortoises had eaten. Winter and spring precipitation was about 1.5 times above normal. Vegetation production was good during the spring green-up and there was an abundant, diverse community of native forbs available for tortoises to forage on, especially during April and May. Summer/fall precipitation was well below normal which resulted in virtually no plant production and reduced foraging opportunities during this time period.

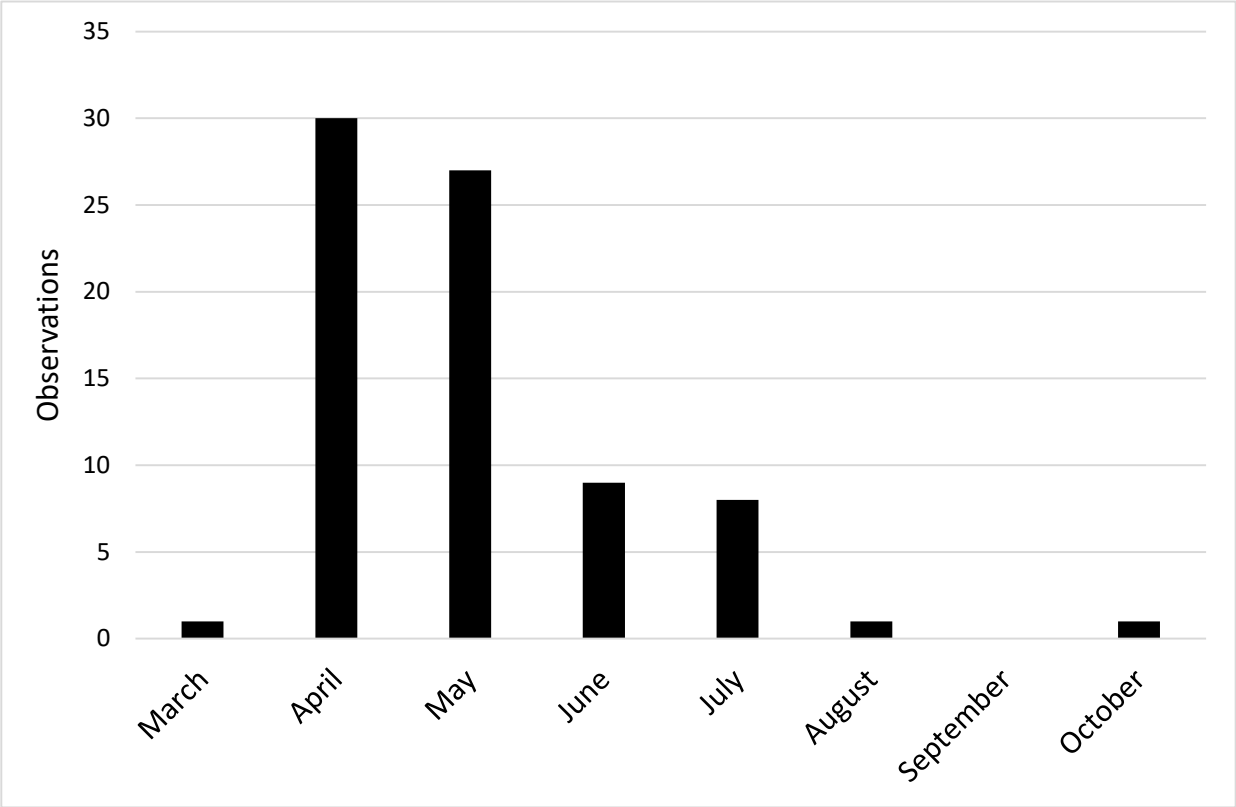

Figure 3-15. Number of times evidence of foraging was detected by month for 24 juvenile tortoises, January 2020–January 2021 (n = 77) (no evidence of foraging was detected in September, November, December, January, or February).

Figure 3-16. Male tortoise (#4033) eating Esteve's pincushion, April 2020.

(Photo by D.B. Hall April 27, 2020).

All transmitters were changed in the fall and health assessments were conducted at the time of transmitter changes except for one tortoise (4039) which was not found outside of its burrow. Tortoises were also measured and weighed and given a Body Condition Score (BCS) (1-3 = under condition, 4-6 = good condition, 7-9 = over condition) in both spring and fall. Table 3-6 contains information on midline carapace length (MCL) (mm) and BCS for fall 2012 (pre-release), spring 2020 and fall 2020 and weight without transmitter (grams) (g) for fall 2012 (pre-release) and fall 2020. Results from health assessments indicated that all tortoises were in good condition (BCS 4-5). Some observations from the health assessments include: four tortoises had occluded nares (4007, 4014, 4025, and 4033) and one of these (4014) had mild serous discharge from both nares and sunken eyes; five had trauma to the carapace (3 from suspected predator attack [4046, 4048, 4053], 1 from transmitter [4005], and 1 unknown [4034]); two had whitish flaking on the carapace (1 from transmitter [4033], 1 unknown [4014]), and one had extra scutes (4044). No tortoises voided during handling. Male 4033 and male 4019 were found dead after their transmitters had been changed.

The main factor for survival appears to be sex with higher survival of males than females. This has been observed by other researchers as well (Esque et al. 2010; Melia Nafus, ICR, personal communication, December 4, 2014). Size, weight, overall health, and presence of *Mycoplasma* species (bacteria that causes upper 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 and kit fox tracks have been observed on multiple occasions while conducting tortoise monitoring and at several of the mortality sites which suggests these canids are the main predators of our 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

Table 3-6. Midline carapace length (MCL) (mm) and body condition score in fall 2012, spring 2020, and fall 2020; weight without transmitters (gram [g]) in fall 2012 and fall 2020; MCL growth and weight gain from fall 2012 to fall 2020; and MCL growth spring 2020 to fall 2020 for 24 tortoises monitored in 2020.

Tortoise Number	Sex	Pre-release MCL (mm) 2012	MCL (mm) (Spring 2020)	MCL (mm) (Fall 2020)	MCL Growth (mm) (2012-2020)	MCL Growth (mm) Spring 2020 to Fall 2020	Pre-release Weight (g) (2012)	Weight (g) (Fall 2020)	Weight gain (g) (2012-2020)	Pre-release Body Condition (2012)	Body Condition (Spring 2020)	Body Condition (Fall 2020)
4010	Female	142	*	*	*	*	590	*	*	4	*	*
4014	Female	136	170	170	34	0	485	840	355	5	4	4
4030	Female	148	186	190	42	4	562	1350	788	4	4	4
4039	Female	117	164	*	*	*	315	*	*	5	4	*
4044	Female	146	190	198	52	8	484	1200	716	4	4.5	4.5
4045	Female	129	166	167	38	1	400	855	455	4	4	4.5
4046	Female	126	185	190	64	5	476	1300	824	4	4	4
4049	Female	106	149	*	*	*	238	*	*	4	4	*
4004	Male	117	165	170	53	5	303	830	527	4	4	4
4005	Male	140	184	189	49	5	564	1050	486	5	5	5
4007	Male	121	140	140	19	0	363	513	150	5	4	4.5
4011	Male	144	216	215	71	-1	634	1400	766	4	4.5	4.5
4019	Male	150	215	216	66	1	654	1700	1046	4	4.5	4.5
4024	Male	146	*	*	*	*	565	*	*	5	*	*
4025	Male	127	181	193	66	12	357	1100	743	5	4.5	4.5
4033	Male	126	152	*	*	*	430	*	*	4	4	*
4034	Male	128	182	184	56	2	407	1150	743	4	4	4
4036	Male	132	188	188	56	0	455	1025	570	4	4	4
4038	Male	132	213	213	81	0	457	1550	1093	4	4	4.5
4040	Male	140	180	*	*	*	493	*	*	4	4	*
4041	Male	119	154	*	*	*	322	*	*	4	4	*
4048	Male	135	225	225	90	0	480	1900	1420	5	4	5
4053	Male	150	173	173	23	0	681	900	219	4	4	4
4055	Male	151	212	*	*	*	602	*	*	4	4	*

* = data not taken due to mortality or unable to get out of burrow

to August, 2017; 318 days between January and December, 2018; 239 days between May and December, 2019; and 315 days between January and December, 2020 for a total of 1,012 days. Results showed 11 coyote images which is about one every 92 days, 10 kit fox images which is about one every 101 days, 12 badger (*Taxidea taxus*) images which is about one every 84 days, and 4 bobcat (*Lynx rufus*) images which is about one every 253 days.

Why canid predation is higher on females than males is a question yet to be answered. It does not appear to be due to females being aboveground more than males (Hall and Perry 2020). Coyotes and kit foxes use olfaction as one of their dominant senses, therefore it is possible that differences in chemical signatures between females and males either attract or repel canid predators. Differences between juvenile female and male chemical signatures have been identified but results from field trials did not find a difference in predator response, either positive or negative, to the synthesized female and male tortoise scent (Hall and Perry 2020). Further research is needed to determine if differential canid predation between females and males is occurring in natural or other translocated populations and to investigate the predation ecology of canids on tortoises and possible deterrents.

Overall, the remaining 18 translocated tortoises seem to be doing well. MSTS will continue monitoring the remaining juvenile study animals well into adulthood with adjustments to the monitoring schedule based on the animals' movement activities.

3.2.3 Coordination with Other Biologists and Wildlife Agencies

- MSTS biologists joined the Desert Tortoise Transportation Ecology workshop webinars developed and organized in collaboration with the Center for Large Landscape Conservation, Western Transportation Institute, Federal Highway Administration, NDOT, Bureau of Land Management, Clark County Desert Conservation Program, and Tortoise Group. The collaboration has developed an Interagency Task Force to address issues regarding effects of transportation infrastructure on tortoise recovery and develop measures to minimize road mortality and increase connectivity for tortoise populations. Workshop webinars began monthly in October 2020. An MSTS biologist presented preliminary findings of the NNSS's desert tortoise road study during the first workshop.
- MSTS biologists are working on two separate manuscripts for publication about the juvenile translocation study. The first is titled, "Factors Influencing Survival of Translocated Juvenile Desert Tortoises of Known Sex in Southern Nevada" and contains results from the first five years of the study. The second manuscript is titled, "Are Females Smellier than Males: Differential Canid Predation of Translocated Juvenile Desert Tortoises." It is anticipated that these two manuscripts will be submitted to appropriate peer-reviewed journals for publication during 2021.
- MSTS biologists are collaborating with LANL on a study to determine radiation impacts on tortoises through scute sampling.

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 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 MSTS 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 2020 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 2020

From 1978 to 2020, an average of 10.2 wildland fires per year and about 103.6 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 were reported on the NNSS in 2020. The largest of these, named the Area 16 Fire, started in late July, from a lightning strike. It burned about 1,274 ha in Area 16 and Area 1, primarily in the Blackbrush-Nevada jointfir shrubland association. It took NNSS Fire and Rescue and some additional assets, including fire retardant drops from aircraft, several days to put the fire out. A post-fire ecological evaluation was performed shortly after the fire was extinguished and a report written and submitted to NNSS Fire and Rescue. The other four fires were caused by lightning (one), electrocuted raptor (one), and manmade activities (two) but were all small, <0.1 ha in size. These fires 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 DOE O 231.1B, surveys were initiated on the NNSS to identify wildland fire hazards. Vegetation surveys were conducted between April 24 and May 27, 2020, at sites located along and adjacent to major NNSS corridors to estimate the abundance of

fuels produced by native and invasive plants. Information about climate was also identified and summarized as part of the wildland fire hazards assessment.

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 a report by 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 these survey sites were then plotted on a geographic information system (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. 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 2020 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 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 five months is correlated ($r = 0.770$) with our estimations of the combined fuel loads. During 2020, the average precipitation from the remaining 14 rain gauge stations on the NNSS during December–April was 147.7 mm, which is well above the average amount of 104.6 mm received on the NNSS.

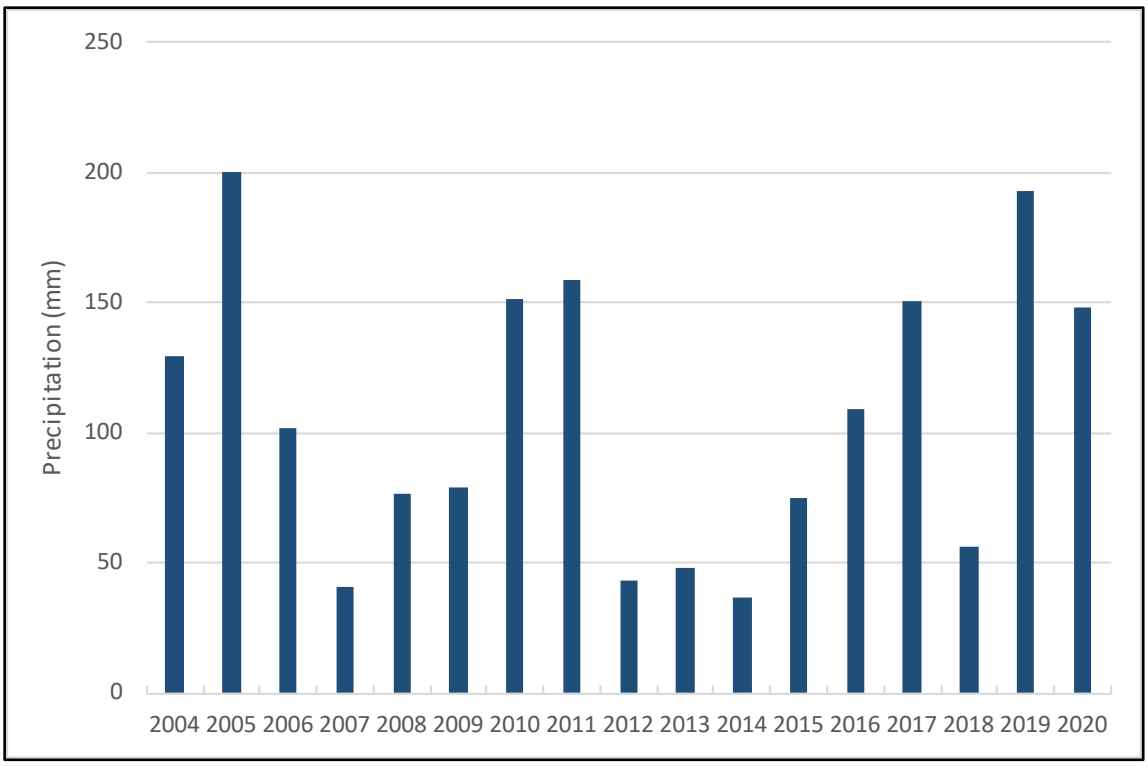

Figure 4-1. Average precipitation from December (previous year) through April for the years 2004 through 2020 (long-term average 104.6 mm).

4.1.3.2 Fuels

Due to the above-average precipitation received during winter/spring 2019-20, production of annual grasses was high and annual forb production was moderate. Production of perennial herbaceous grasses and forbs was also moderate.

The fine fuels index increased from 2.41 in 2019 to 2.53 in 2020, and was the fourth highest recorded since 2004 (Table 4-1). Most of the fine fuels were from invasive annual grasses such as red brome (*Bromus rubens*) and cheatgrass (*Bromus tectorum*) rather than annual forbs like last year.

The woody fuels index value was slightly higher in 2020 (2.60) than in 2019 (2.59) (Table 4-1). This was an average value in comparison to the other index values since 2004.

The combined index values (fine fuels plus woody fuels) for 2020 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 increased from 5.00 in 2019 to 5.13 in 2020, which was the fourth highest value recorded since 2004 (Table 4-1), suggesting above-normal fuels for the NNSS.

The locations and results of the fine fuels, woody fuels and combined fuels surveys at 104 stations on the NNSS inspected during 2020 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, Mid Valley, and southern Yucca Flat. High amounts of fine fuels were found in Fortymile Canyon, Yucca Flat, and Mid Valley. High amounts of woody fuels

were primarily found in the forested portions of Pahute Mesa, but also occurred along Stockade Wash Road and Cane Spring Road and upper Fortymile Canyon.

Table 4-1. Woody fuels, fine fuels and combined fuels index values for 2004–2020

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
2019	2.59	2.41	5.00
2020	2.60	2.53	5.13

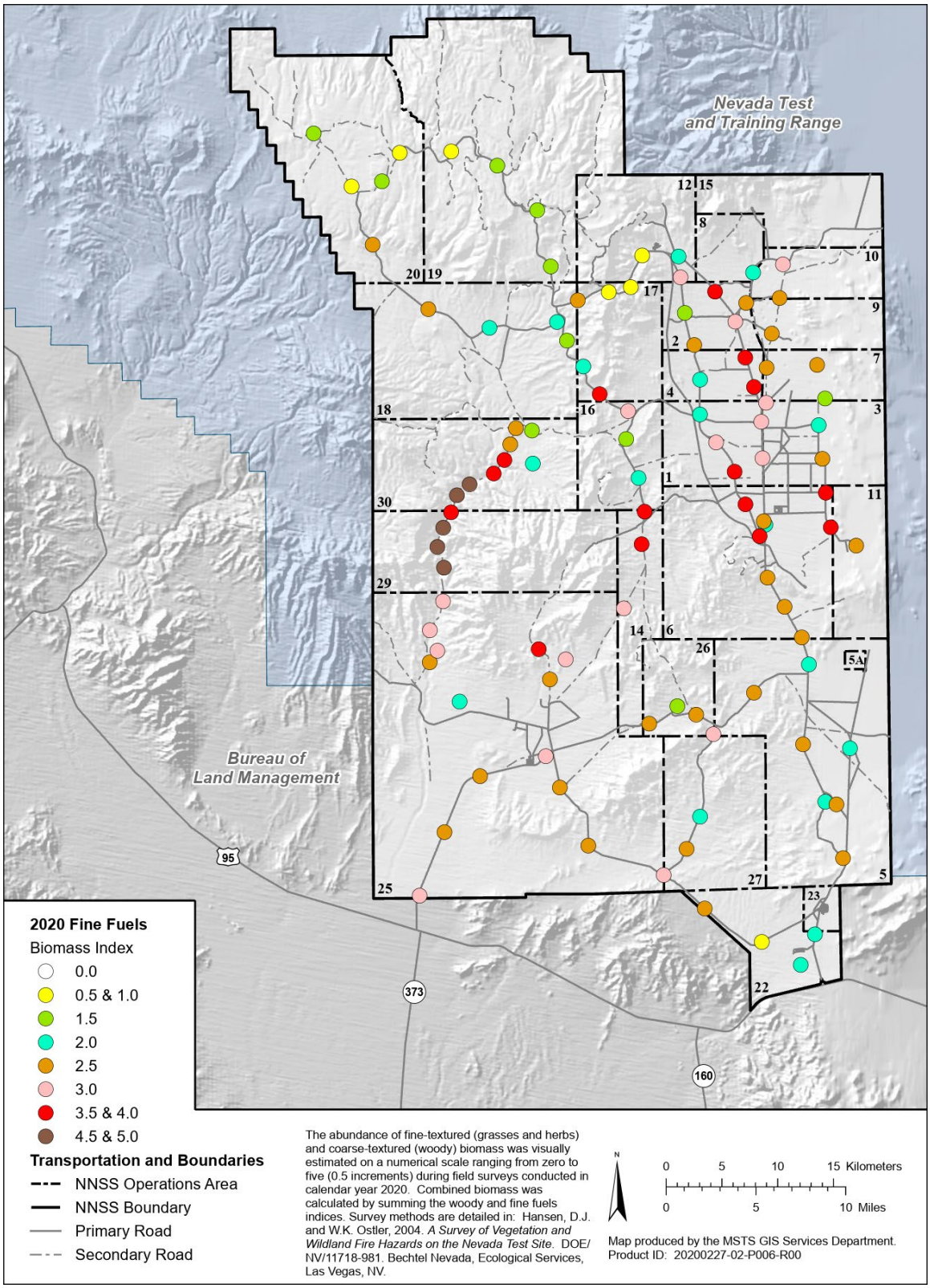

Figure 4-2. Index of fine fuels for 104 survey stations on the NNSS during 2020.

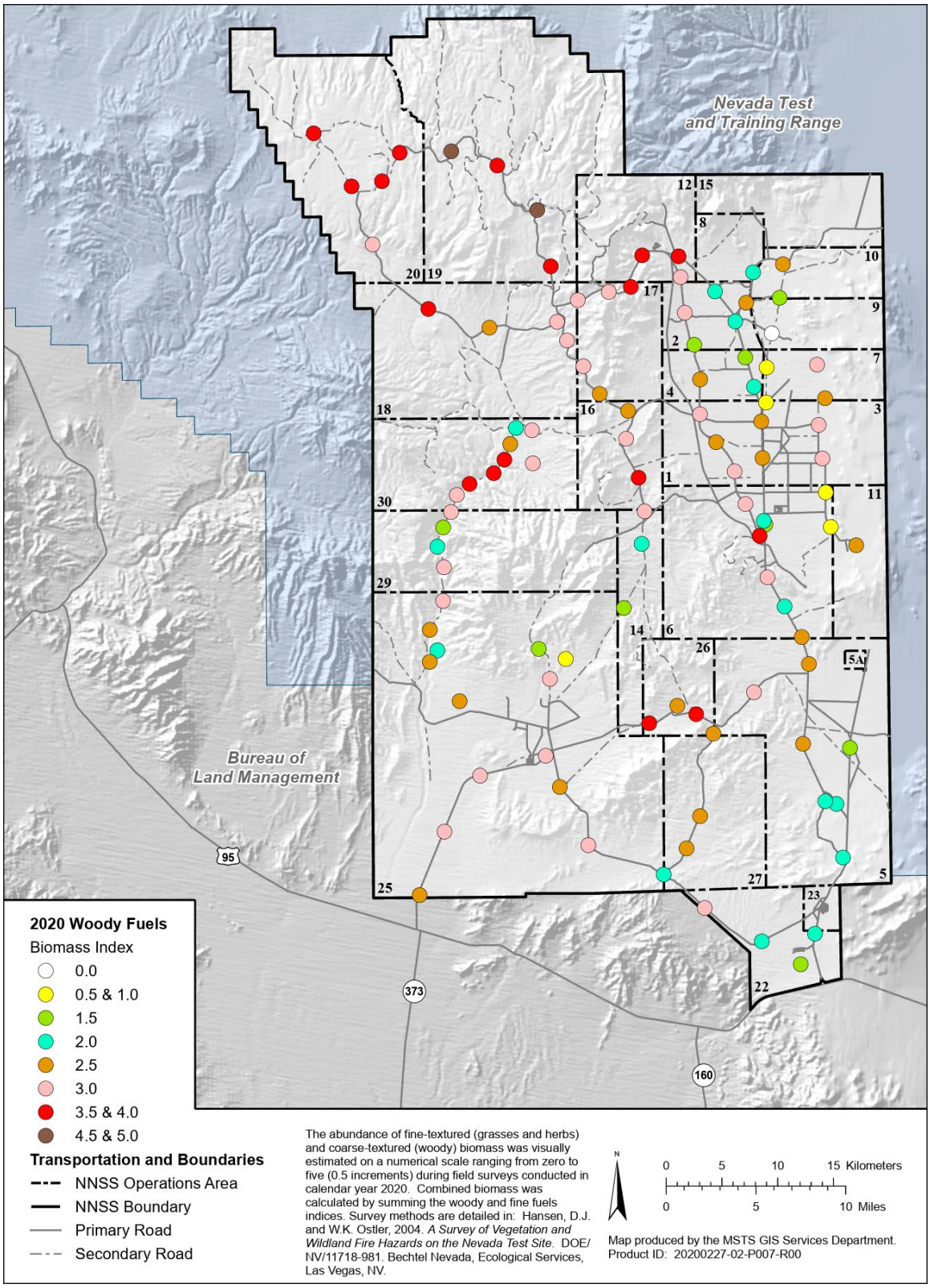

Figure 4-3. Index of woody fuels for 104 survey stations on the NNSS during 2020.

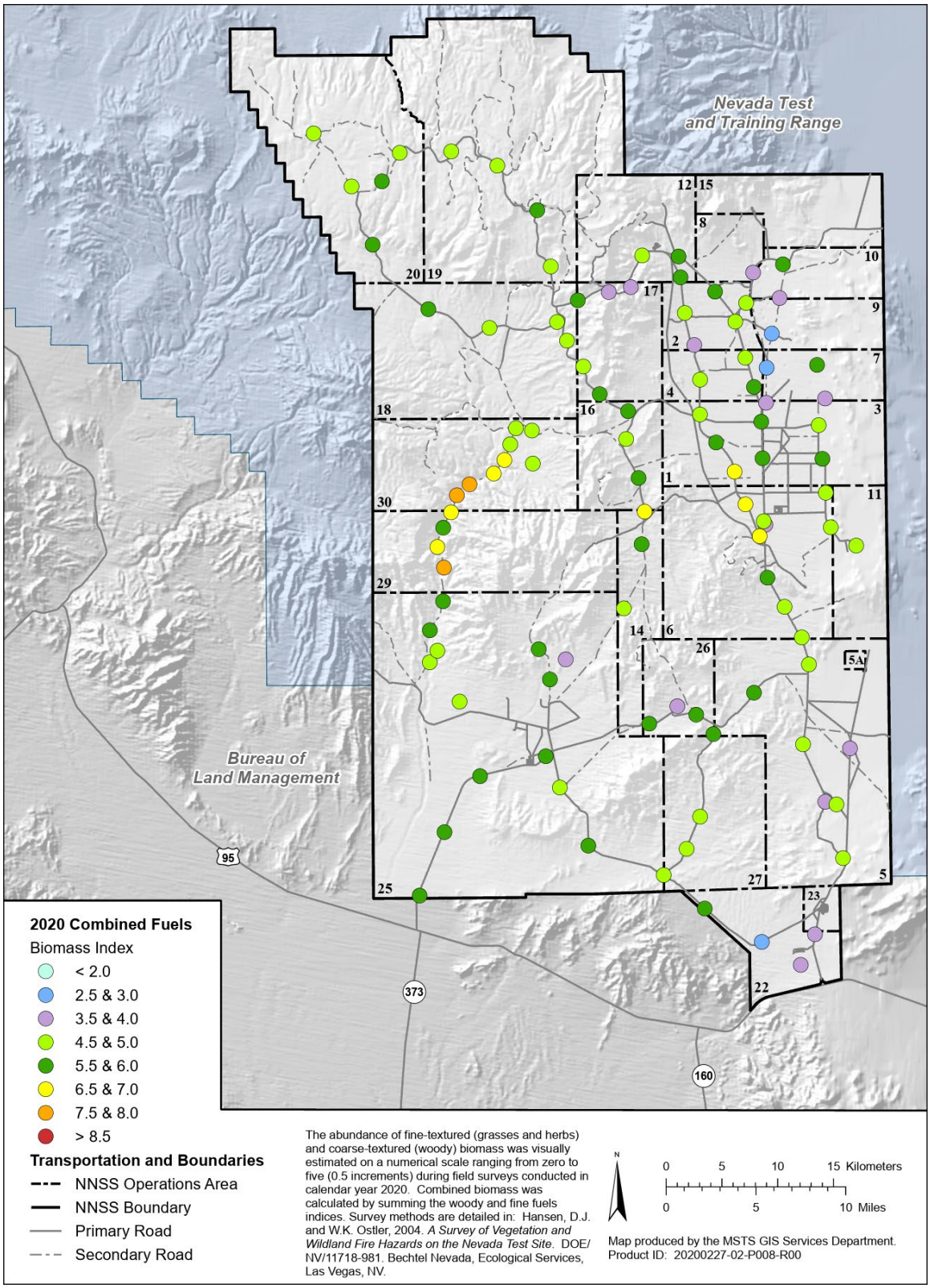

Figure 4-4. Index of combined fine fuels and woody fuels for 104 survey stations on the NNSS during 2020.

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 2017, 2018, 2019, and 2020. 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.

4.1.4 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 80% of the study sites. While it was predominantly found at middle to higher elevations it was found at lower elevation sites as well. Red brome (68%) and bristly fiddleneck (60%) were found on over half of the sites sampled. Precipitation history (Figure 4-1, shown previously) is 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. Red brome and cheatgrass for example were found at virtually the same percent presence in 2019 and 2020 but the biomass in 2020 was much higher than in 2019 even though precipitation was substantially higher in 2019 than in 2020. Conditions in 2019 were more conducive to native annual forb germination and biomass production rather than brome production. Cool, wet springs appear to favor native annual forbs over red brome and cheatgrass, especially in unburned areas.

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 that can be costly. Blackbrush, sagebrush, juniper and pinyon pine do not resprout following fires. Untreated areas become much more vulnerable to future fires once invasive grass species, rather than native species, colonize a burned area.

Overall, the hazards of residual fuels contributing to wildland fires were above average for 2020 and presented a substantial 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, Mid Valley, and the eastern slopes of Timber Mountain 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 4-5. Site 99 on the west side of Yucca Flat in 2017 (top left), 2018 (top right), 2019 (bottom left), and 2020 (bottom right).

(Photos by J.A. Perry, April 26, 2017 [top left], April 24, 2018 [top right], May 14, 2019 [bottom left], and May 6, 2020 [bottom right]).

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	2019	2020
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	192.6	147.7
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	67.3	68.3
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	78.8	79.8
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	50	45.2
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	18.3	9.6
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	65.4	59.6
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	23.1	7.7
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	28.8	10.6

4.2 REPTILE STUDIES

No formal trapping or roadkill studies took place in 2020. 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.

One juvenile western patch-nosed snake (*Salvadora hexalepis*) was found alive on a glue trap in Mercury, extracted and released. A sidewinder rattlesnake (*Crotalus cerastes*) was found in a utility vault in Mercury, extracted and released. Three ground snakes (*Sonora semiannulata*) were found on glue traps in Mercury, extracted and released. One dead ground snake and one dead juvenile red racer (*Masticophis flagellum*) were found in Mercury and disposed of.

4.3 NATURAL WATER SOURCE MONITORING

Nine natural water sources (six springs, three rock tanks) were monitored with motion-activated cameras in 2020, primarily to document the presence of mountain lions (*Puma concolor*) and other wildlife (Figure 4-6). Results are found in Table 6-3 (see Section 6.7.1, 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. During 2020, Topopah Spring was nearly dry with just a small wet spot in the cave pool. Vegetation was heavily trampled primarily by burros and mule deer at Twin Spring with numerous new burro trails on the slope leading to the spring. There was also a small perennial pool of standing water. Vegetation at Captain Jack Spring was pretty dense in the absence of feral horses using the perennial spring, and cattails (*Typha domingensis*) were very dense around Cane Spring. Burros discovered Cottonwood Spring and the area around it was heavily trampled with little to no vegetation left. Gold Meadows Spring dried up in early August and then a rain/hail event on August 23 filled it up to the size of a large pond. A nearby weather station recorded 46 mm of precipitation on that date.

Gold Meadows Spring (#18) had the most images (12,153; 8 mammals, 24 birds) with most of them comprised of horses (*Equus caballus*) (3,644 images), mule deer (3,386 images), and common ravens (*Corvus corax*) (2,301 images) (Table 6-3). One photo of a bald eagle (*Haliaeetus leucocephalus*) was taken on October 20, 2020 (Figure 4-7). This is only the sixth record of this species on the NNSS. In addition, 10 images of peregrine falcons (*Falco peregrinus*) were captured between July 20 and August 2, 2020 (Figure 4-8). This is only the fifth record of this species on the NNSS. Several species of shorebird and waterfowls were also photographed after the spring filled up in late August, some finding the new water within a few days of it filling up.

Captain Jack Spring (#12) had 16 species recorded (8 mammals and 8 birds) and 2,677 images (Table 6-3). Most of these (1,759) contained images of pinyon jays (*Gymnorhinus cyanocephalus*) sometimes in groups of 50 or more. Mule deer were also commonly photographed (567 images).

Twin Spring (#21) had 14 species (7 mammals, 7 birds) documented in 2,184 images (Table 6-3). Burros dominated with 1,406 images followed by chukar (*Alectoris chukar*) (469 images), mule deer (139 images), and mourning doves (*Zenaida macroura*) (95 images).

Cottonwood Spring (#4) had 13 species documented (7 mammals, 4 birds, and 2 reptiles) in 816 images (Table 6-3). Mourning doves (430 images) and desert bighorn sheep (*Ovis canadensis nelson*) (132 images) were the most prevalent species photographed.

Only 6 species (3 mammals, 3 birds) were detected in 442 images at Cane Spring (#7) with 216 images of mourning doves and 189 images of mule deer (Table 6-3). Six species (3 mammals, 3 birds) were also

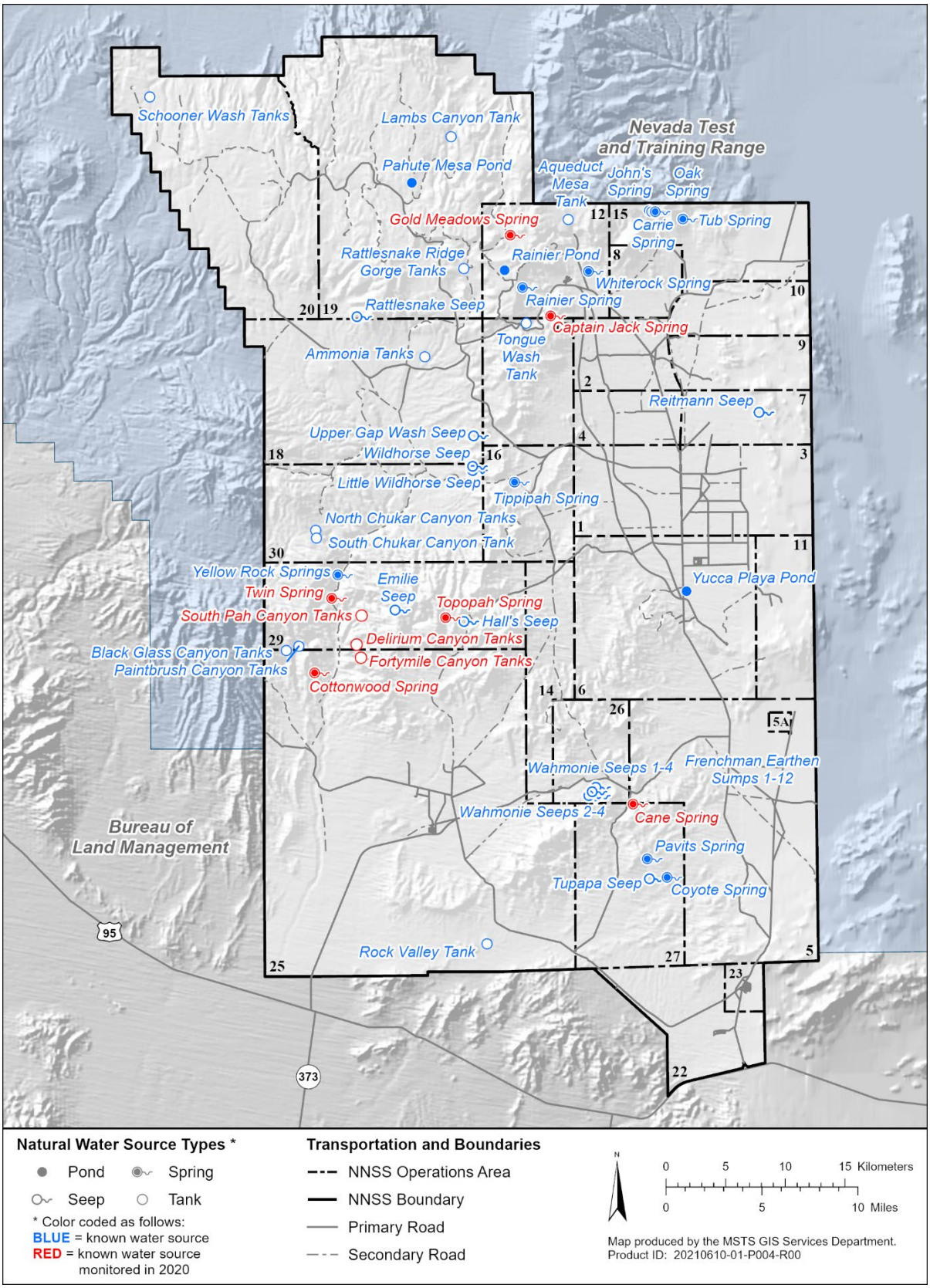

Figure 4-6. Natural water sources on the NNSS, including those monitored in 2020.

Figure 4-7. Bald eagle at Gold Meadows Spring.

(Photo by motion-activated camera, October 20, 2020)

Figure 4-8. Peregrine falcon at Gold Meadows Spring.

(Photo by motion-activated camera, August 3, 2020)

detected at Topopah Spring (#9) in 68 images (Table 6-3) with 26 images of chukar and 18 images of western scrub jay (*Aphelocoma californica*).

The highest species richness (34 species) was documented at South Pah Canyon Tanks (#15) and included 10 mammal species, 21 bird species, 1 reptile species, and 2 invertebrate species in 2,643 images (Table 6-3). Mourning doves dominated (1,010 images) followed by pinyon jays (593 images), bats (256 images), white-crowned sparrows (*Zonotrichia leucophys*), and desert bighorn sheep (165 images). One photo of a ring-tailed cat (*Bassariscus astutus*), 2 photos of a spotted skunk (*Spilogale gracilis*), and 6 images of lazuli bunting (*Passerina amoena*) were also recorded.

Delirium Canyon Tanks (#5) had 14 species (9 mammals, 4 birds, and 1 reptile) in 441 images. The mourning dove (241 images) was the most photographed species. Three images of ring-tailed cats were also photographed. At Fortymile Canyon Tanks (#11) 2 mammal and 2 bird species were detected in 34 images with 30 images of desert bighorn sheep.

4.4 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 2020. 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).

A total of 31 species (7 mammals, 24 birds) were detected at Camp 17 Pond (#6) in 5,806 images (Table 6-3). Horses (1,716 images), mule deer (1,013 images), mourning doves (854 images), turkey vultures (711 images), red-tailed hawks (*Buteo jamaicensis*) (461 images), coyotes (320 images), and common ravens (238 images) were the dominant species. A common blackhawk (*Buteogallus anthracinus*) was photographed on June 22, 2020 (Figure 4-10). This is only the second record of this species on the NNSS. Several species of shorebirds and a belted kingfisher (*Megaceryle alcyon*) (1 image) were also documented.

4.4.1 Mitigating Water Loss for Wildlife

Water conservation measures were implemented on the NNSS in 2012 at four sites: Area 6 Construction Yard (Area 6 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 (Area 6 Construction 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 2020 are included in Table 6-3 (see Section 6.7.1, Motion-Activated Cameras).

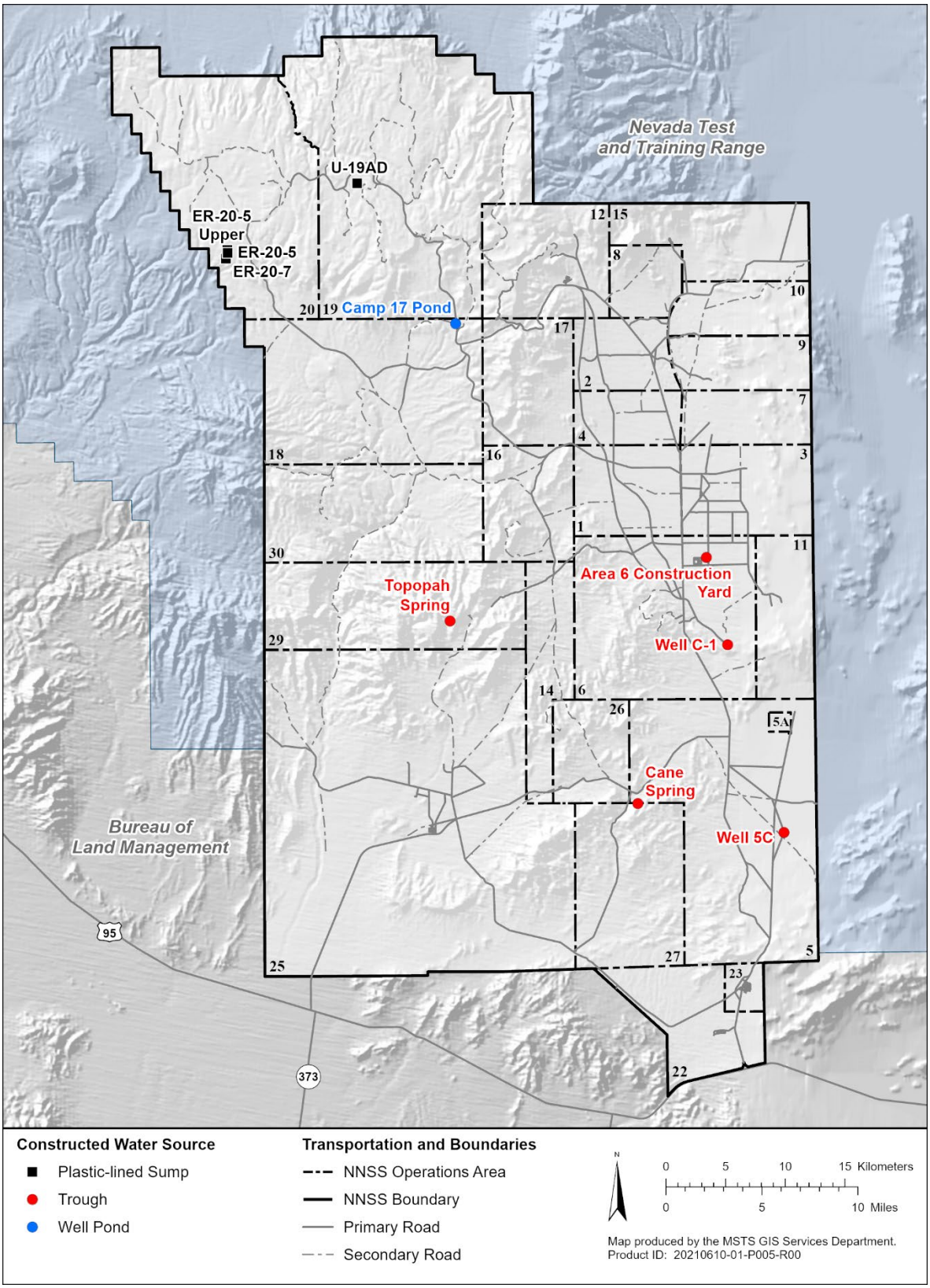

Figure 4-9. Constructed water sources monitored with motion-activated cameras for wildlife use during 2020.

Figure 4-10. Common Blackhawk at Camp 17 Pond.

(Photo by motion-activated camera, June 22, 2020)

Wildlife use at Well 5C trough (#24) was very heavy with 2,565 images of 22 species (8 mammals, 13 birds, and 1 invertebrate) (Table 6-3). Horned larks (*Eremophila alpestris*) and mourning doves dominated with 404 and 401 images, respectively, followed by house finches (*Carpodacus mexicanus*) (364 images), black-tailed jackrabbits (*Lepus californicus*) (338 images), coyotes (318 images), burros (248 images), pronghorn antelope (242 images), and common ravens (152 images).

Wildlife use at Well C1 Trough was moderate with 134 images of 11 species (5 mammals, 6 birds). Mule deer was the most commonly photographed species (39 images). Wildlife use at Area 6 LANL Pond Trough was light with 18 images of 3 mammal species and 1 bird species. Pronghorn antelope and burros were the most common with 9 and 7 images, respectively. Wildlife use of the trough has decreased drastically over the last couple of years due to the abundance of overflow water from the adjacent fillstand. Surface water extends at least 100 m past the fillstand where wildlife can drink from.

Wildlife use at Cane Spring Trough and Topopah Spring Trough was extremely light with only a single mule deer photographed at each site. Water availability was limited to mainly the winter and spring months. 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.

4.4.2 Monitoring Wildlife Use at Potentially Contaminated Water Sources

During 2020, 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 Environmental Restoration (ER) 20-7 (#13), ER 20-5 Upper (#2), ER 20-5 (#26), and U19ad (#25) (Figure 4-9). The cameras were also added to the network of cameras used for mountain lion monitoring (see Section 6.7.1, Motion-Activated Cameras) (Table 6-3). 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.

Overall, wildlife use at the contaminated sumps was light with ER 20-5 (#26) and ER 20-5 Upper (#2) having the most use with 28 and 25 images, respectively (Table 6-3). Common ravens were the most common (24 and 21 images, respectively). Say's phoebes (*Sayornis saya*) (3 images) were detected at ER 20-5 (#26) and pinyon jays (2 images) and bats (2 images) were detected at ER 20-5 Upper (#2). ER 20-7 (#13) had 12 images with coyotes (2 images), turkey vulture (*Cathartes aura*) (1 image), and common ravens (8 images) photographed. No images of wildlife were recorded at U19ad (#25).

A motion-activated camera was also set at E Tunnel Ponds, a perennial source of contaminated water flowing from E Tunnel, as part of another project (Ron Warren, personal communication). Mule deer (180 images), mountain lions (2 images), golden eagles (*Aquila chrysaetos)* (25 images), bobcat (1 image), coyote (6 images), great blue heron (*Ardea herodias*) (4 images) and numerous photos of desert cottontail rabbits (*Sylvilagus audubonii*) and other bird species, including mourning doves, chukar, and red-tailed hawks were also documented.

Important species are using these sites and are potentially up-taking radiological contaminants. Hunt-able species such as chukar and mourning doves are a potential pathway of exposure to the general public. Protected birds such as golden eagles, turkey vultures, common ravens, pinyon jays, and Say's phoebes and most passerines may also be impacted. Contaminated water sources 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 2020) available at https://www.nnss.gov/pages/resources/library/NNSSER.html

4.5 COORDINATION WITH SCIENTISTS AND ECOSYSTEM MANAGEMENT AGENCIES

MSTS biologists interfaced with other scientists and ecosystem management agencies in 2020 for the following activities:

- Participated in multiple conference calls for the Mojave Seeds of Success Program.
- Gave a presentation entitled, "Revegetation Efforts on the Nevada National Security Site and Surrounding Areas" at the Mojave Desert Native Plant Program meeting in Las Vegas, Nevada, February 2020.
- Participated in multiple conference calls for the DOE Invasive and Endangered Species Working Group.

- Collaborated with Sasha Reed (USGS) and Sam Jordan (Arizona State University) to establish and collect data from a study site on the NNSS for a Strategic Environmental Research and Development Program funded project entitled "Forecasting Dryland Ecosystem Vulnerability to Climate Change: A Cross-Systems Assessment of Vegetation and Process Responses to Disturbance and Climate Variability on DoD/DOE Lands."
- Participated in meetings with the Southern Nevada Interagency Partnership and gave a presentation entitled, "Ecological Studies and Compliance on the Nevada National Security Site" at the October virtual meeting.
- Submitted a manuscript entitled, "Mosquito Distribution and West Nile Surveillance Results on the Nevada National Security Site in South Central Nevada" to the Western North American Naturalist for publication.
- Provided pre-activity survey and revegetation data from several cleanup sites on the Tonopah Test Range and Nevada Test and Training Range to DOE Legacy Management for transition of these sites to long-term monitoring.

5.0 SENSITIVE AND PROTECTED/REGULATED PLANT MONITORING

The list of sensitive and protected/regulated 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. The working list of over 850 plant species identified on the NNSS was reviewed alongside the 2021 NDNH At-Risk Plant and Animal Tracking List (NDNH List) to determine if any updates were needed to the NNSS sensitive plant monitoring program. Although there were no updates associated with the NDNH List, there were several updates to the NNSS sensitive plant monitoring program. Two cactus species were removed; sand cholla (*Grusonia pulchella*) and Redspined fishhook cactus (*Sclerocactus polyancistrus*). Both cactus species continue to be monitored and avoided during construction projects, as well as being protected by the state from collection, but will not be included in the NNSS's long-term monitoring program. Nye milkvetch (*Astragalus nyensis*) was removed pending additional surveys to confirm its occurrence on the NNSS. Two species were added after being confirmed to occur on the NNSS: Clokey's cryptantha (*Cryptantha clokeyi*) and Lahontan beardtongue (*Penstemon palmeri* var. *macranthus*). Currently there are 19 vascular plants and one non-vascular plant considered sensitive and warrant inclusion in the NNSS sensitive plant monitoring program (Table 2-1).

A review of past monitoring surveys, known and historical populations, and the database of the sensitive plant species on the NNSS began in 2019 and was completed in 2020. The NNSS's Adaptive Management Plan for Sensitive Species on the Nevada Test Site (Bechtel Nevada 2001) and MSTS's Organization Procedure titled *Monitoring Sensitive Plant Species* lay out monitoring, management, and goals for sensitive plant protection. A systematic monitoring schedule was created, along with short- and long-term monitoring goals for each sensitive plant. Updated data, maps, and facts on each sensitive plant was compiled and digitized. This updated information will be converted into fact sheets to include the following: known population locations and size on the NNSS, range wide distribution, herbarium collections, monitoring surveys, known habitat, known threats and photos. Fact sheets for each species shall be maintained per the NNSS's Adaptive Management Plan for Sensitive Species on the Nevada Test Site (Bechtel Nevada 2001) for use by MSTS biologists, employees, and shared with NDNH.

The NNSS sensitive plant rankings, which were last evaluated in 2012, were revisited. The ranking rubric from 2012 included the following rankings based on the plant's overall distribution, abundance, and rarity: high, moderate, watch, and marginal (Hall et al. 2013). Ranking criteria were updated to reflect more detailed descriptions, making it more user friendly (Table 5-1). A numerical rating was assigned for each criterion (Table 5-1). These were then totaled to determine the plant's ranking: high, moderate, watch, or evaluate (Table 5-2). If updated information for the plant was not known, the original numerical rating from 2012 was maintained. The lower the numerical rating, the lower the ranking. Definitions for each ranking are described in Table 5-3.

Four plants shifted rank: Sanicle biscuitroot (*Cymopterus ripleyi* var. *saniculoides*), Death Valley beardtongue (*Penstemon fruticiformis* ssp. *amargosae*), Clarke phacelia (*Phacelia filiae*), and Weasel phacelia (*Phacelia mustelina*). Sanicle biscuitroot is more widespread than originally known, which accounted for its reduction from moderate ranking to watch. Death Valley beardtongue currently has one known remote location on the NNSS in the Striped Hills at the southern border of Area 25, with the majority of its distribution off site and in California. With no threats on the NNSS, its ranking was reduced from high to moderate. Clarke phacelia is widespread throughout the southern portion of the NNSS with 62 monitoring locations within five populations. The plant is rarely encountered during NNSS activities, which justifies its reduction from moderate ranking to watch. Lastly, Weasel phacelia's ranking was shifted from marginal to watch, simply due to the elimination of the marginal ranking.

Table 5-1. Criteria used in ranking sensitive plants known to occur on the NNSS.

Criteria	Description	Numerical Rating
Global Ranking	G1 = Less than 6 viable EOs [a] OR less than 1000 individuals OR less than 1000 acres (critically imperiled)	4
	G2 = 6-20 EOs OR 1000-3000 individuals OR 2000-10000 acres (imperiled)	3
	G3 = 21-80 EOs OR 3000-10000 individuals OR 10000-50000 acres (vulnerable)	2
	G4 = apparently secure	1
	G5 = Secure	0
State Ranking	S1 = Less than 6 EOs OR less than 1000 individuals OR less than 2000 acres	2
	S2 = 6-20 EOs or 1000-3000 individuals OR 2000-10000 acres	1
	S3 = 21-80 EOs or 3000-10000 individuals or 10-50000 acres	0
Populations in Nevada	<10	2
	10-25	1
	>25	0
Known Populations on NNSS	2/3 of populations on NNSS	2
	1/3 to 2/3 of populations on NNSS	1
	<1/3 of populations on NNSS	0
Known Locations on NNSS	0-9	2
	10-50	1
	>50	0
Habitat Specificity	Few specialized geologic substrates, soil types, or vegetation types	2
	Some, not many, geologic substrates, soil types, vegetation types	1
	Numerous substrates	0
Natural or Intrinsic Rarity	High (low growth rates, long generation time, few reproductive episodes in a lifetime, large area requirements, high specialization, poor dispersal, rare suitable habitat)	2
	Moderate	1
	Low	0
Threats in Nevada	High – significant, far reaching	2
	Moderate	1
	Low – minor, small percentage	0
Threats on NNSS	High – significant, far reaching	2
	Moderate	1
	Low – minor, small percentage	0
Population Trend	Declining	2
	Stable	1
	Increasing	0

[a] Element occurrences

Table 5-2. Ranking of sensitive plants known to occur on the NNSS.

Species	Global Ranking	State Ranking	Pop.s in NV	Known Pop.s on NNSS	Known Locations on NNSS	Habitat Specificity	Intrinsic Rarity	Threats in NV	Threats on NNSS	Pop. Trend	Total	Ranking
Arctomecon merriamii	2	0	0	0	1	1	1	1	0	2	**8**	**Moderate**
Astragalus beatleyae	2	0	1	2	1	2	2	1	0	1	**12**	**High**
Astragalus funereus	3	1	1	0	1	2	2	0	0	1	**11**	**High**
Astragalus oophorus var. *clokeyanus*	1	1	1	0	1	1	1	0	0	1	**7**	**Watch**
Chylismia megalantha	2	0	1	2	1	1	1	0	0	1	**9**	**Moderate**
Cryptantha clokeyi	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**	**Evaluate**
Cymopterus ripleyi var. *saniculoides*	2	0	1	1	0	1	1	0	0	1	**7**	**Watch**
Entosthodon planoconvexus	4	2	2	2	2	1	2	0	0	1	**16**	**High**
Eriogonum concinnum	2	0	1	1	1	1	1	0	0	1	**8**	**Moderate**
Eriogonum heermannii var. *clokeyi*	0	1	2	0	1	0	0	0	0	1	**5**	**Watch**
Frasera pahutensis	2	0	1	0	2	1	1	0	0	1	**8**	**Moderate**
Galium hilendiae ssp. *kingstonense*	1	2	2	1	2	1	2	0	0	1	**12**	**High**
Hulsea vestita ssp. *inyoensis*	0	1	1	1	1	1	1	0	0	1	**7**	**Watch**
Ivesia arizonica var. *saxosa*	2	1	2	1	1	2	2	0	0	1	**12**	**High**
Penstemon fruticiformis ssp. *amargosae*	1	1	1	0	2	1	2	0	0	1	**9**	**Moderate**
Penstemon pahutensis	2	0	0	1	0	0	0	0	1	1	**5**	**Watch**
Penstemon palmeri var. *macranthus*	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	**NA**	**Evaluate**
Phacelia beatleyae	2	1	1	2	1	1	1	0	0	1	**10**	**Moderate**
Phacelia filiae	3	0	1	0	0	1	1	0	0	1	**7**	**Watch**
Phacelia mustelina	2	0	1	0	1	0	0	0	0	1	**5**	**Watch**

Table 5-3. Ranking definitions and numerical ratings.

Ranking	Numerical Rating
High (High potential for NNSS populations to become at risk in the future and/or the plant is limited in range)	≥ 11
Moderate (Average potential for NNSS populations to become at risk in the future)	8-10
Watch (Low potential for NNSS populations to become at risk in the future)	0-7
Evaluate (status unknown)	NA

5.1 SPECIES EVALUATIONS

5.1.1 Clokey's cryptantha (*Cryptantha clokeyi*)

Clokey's cryptantha was added to the NDNH List in January 2019. Previously known to be endemic to California, this species was found in Nevada in 2016 in Perlite Canyon (Figure 5-1), just east of Beatty by Dr. James M. André, currently with Granite Mountains Desert Research Center. MSTS biologists visited the Perlite Canyon locality on May 7, 2020 to become familiar with identification and habitat of the species. Only two plants were observed (Figure 5-2), which were identified as Clokey's cryptantha in the field and later confirmed by Dr. André via email correspondence with photos of the nutlets under a microscope (personal correspondence, June 2, 2020). One of the two plants was collected, pressed, and accessioned into the NNSS's herbarium (accession number 18420), which was the first collection of Clokey's cryptantha added to the NNSS's herbarium.

The plants in Perlite Canyon were found in *Artemisia tridentata-Ephedra viridis* habitat at 1,264 m elevation in full shade very close to previous collections from 2016. Dr. André did note the "taxon does very well in full sun on dry gravelly/rocky low-nutrient rhyolite or breccia" areas (personal correspondence, June 2, 2020). Clokey's cryptantha may have bloomed earlier in 2020, not responding to the late winter precipitation (March through April) which the area received, explaining the small number of plants found.

It was noted during correspondence with Dr. André that: "It is more challenging to identify *C. clokeyi* when plants/materials are fresh. Calyx lobes in drying plants will elongate substantially (looking a bit like *C. nevadensis*), and as plants dry the sparse stiff hairs in the inflorescence will turn a diagnostic rusty brown. Also, nutlet tubercles become more clearly translucent with age" (personal correspondence, June 2, 2020). This species grows alongside several other *Cryptantha* species, as well as being very similar morphologically with *C. nevadensis*, making it difficult to identify in the field. Clokey's cryptantha differs from *C. nevadensis* in that *C. nevadensis* is more sprawling in structure and differs from other Cryptantha species based on its triangular nutlets with translucent tubercles. Positive identification can be accomplished by collecting nutlets, allowing them to dry if they are fresh, and observing them under a microscope. The key in *The Jepson Manual: Higher Plants of California* (Baldwin 2012), alongside Simpson and Hasenstab's 2009 publication "*Cryptantha* of Southern California" can be used for positive identification, with one adjustment: Dr. André found nutlets collected from plants in Perlite Canyon were typically 2-2.5 mm, as opposed to 3 mm listed in published keys.

Habitat similar to Perlite Canyon, which was a light-colored rocky outcrop with rhyolitic tuff at 1,264 m elevation, was identified in Fortymile Canyon on the NNSS at Yellow Rock Springs and surveyed May 12th, 2020 (UTM NAD83 555886mE, 4091875mN) (Figure 5-1). Three plants that were found were identified in the field as Clokey's cryptantha and later confirmed by Dr. André (Figure 5-3). The plants

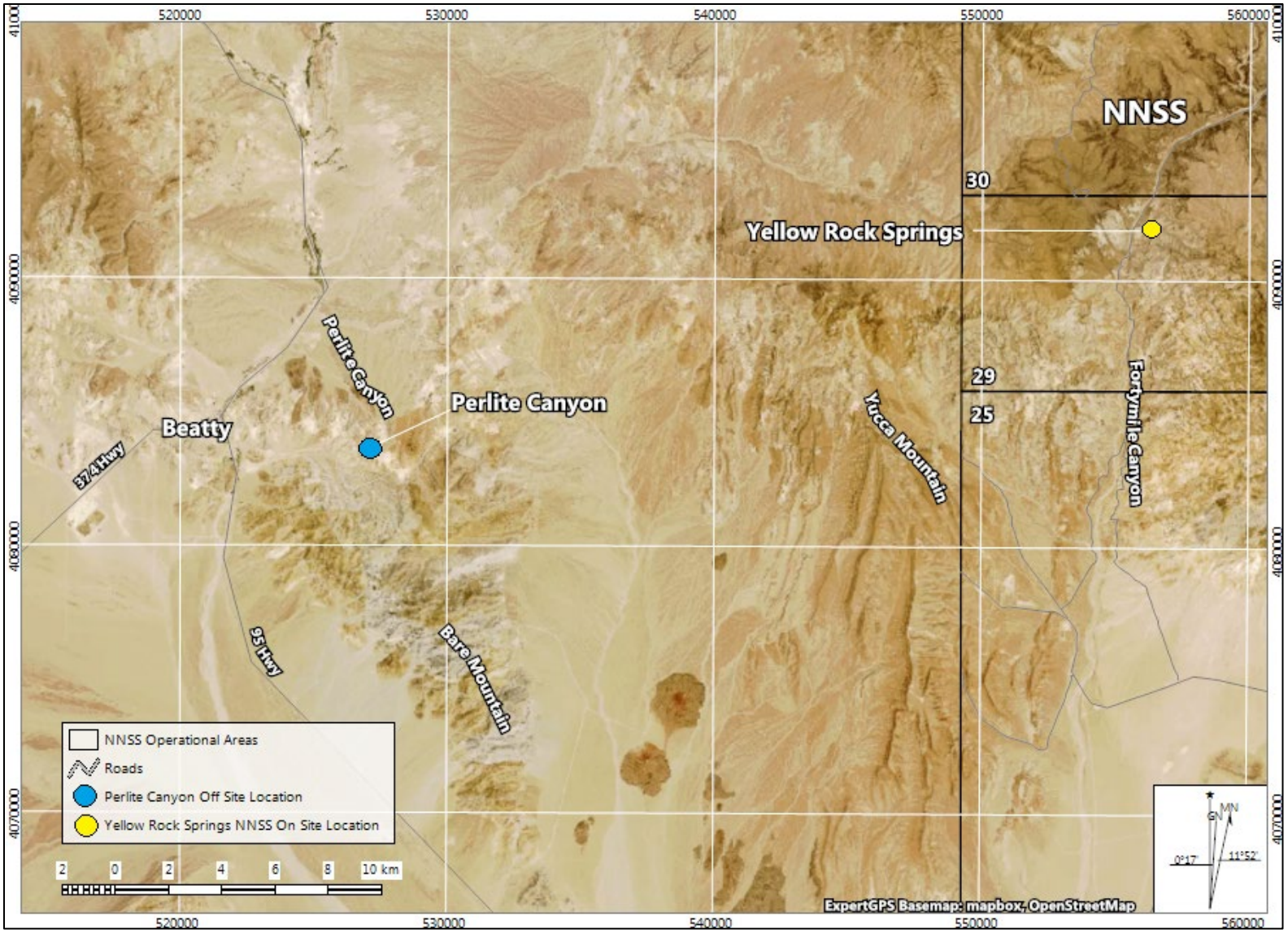

Figure 5-1. Known locations of Clokey's cryptantha in Nevada (UTM [Zone 11, meters], NAD83). Plants were found in Perlite Canyon and Yellow Rock Springs during surveys in 2020.

Figure 5-2. Habitat (top left) at the offsite locality in Perlite Canyon, with Clokey's cryptantha plant (bottom right and left), nutlets (bottom center), and nutlet under a dissection microscope with millimeter ruler scale (top right).

(Photos by D.B. Hall [top left] and J.A. Perry, May 12, 2020)

Figure 5-3. Habitat (top left) at the onsite locality at Yellow Rock Springs in Fortymile Canyon, with Clokey's cryptantha plant (top right), nutlets under a dissecting microscope with millimeter ruler scale (bottom left), and translucent tubercles on nutlet under a microscope (bottom right).

(Photos by J.A. Perry, May 12, 2020)

were found in *Ephedra viridis* habitat with *Rhus trilobata var. anisophylla*, *Symphoricarpos longiflorus*, *Purshia stansburiana*, and several *Cryptantha* species (*C. pterocarya*, *C. nevadensis*, and *C. circumscissa*). NNSS geologist Lance Prothro identified Fortymile Canyon geology as follows: "Rhyolite lava and associated pyroclastic deposits are exposed along the sides of Fortymile Canyon near Yellow Rock Springs (Christiansen and Lipman 1965, Orkild and O'Connor 1970). Yellow Rock Springs discharges from pyroclastic deposits consisting of ash-flow and ash-fall deposits that have been altered locally to zeolite."

With confirmation that Clokey's cryptantha occurs on the NNSS, it has been added to the NNSS sensitive plant monitoring program with a ranking of evaluate. With few plants located over a large area (~8 ha surveyed) at Yellow Rock Springs, a potentially missed early bloom, and more work to be done identifying Clokey's cryptantha habitat on the NNSS, more surveys are recommended to determine distribution. With few surveys conducted in Nevada for this species and its challenging field identification, it is possible it is more widely distributed than currently known in southern Nevada.

5.1.2 Lahontan beardtongue (Penstemon palmeri var. macranthus)

There are three varieties (var.) of *Penstemon palmeri* found in the western United States: scented beardtongue (*P. palmeri* var. *eglandulosus*), Palmer's penstemon (*P. palmeri* var. *palmeri*) and Lahontan beardtongue (*P. palmeri* var. *macranthus*). Scented beardtongue is not found in Nevada, while the other two varieties are. The two varieties found in Nevada are very similar and overlap in distribution. A key to the three varieties can be found in Cronquist et al. (1984).

Lahontan beardtongue is a Nevada endemic perennial subshrub with large, pale lavender tubular flowers. It is listed on the NDNH List and has been found in Churchill, Nye, Pershing, and White Pine counties in Nevada. It has been observed between 1,045 to 2,300 m elevation. Palmer's penstemon, on the other hand, is wide spread throughout the western United States from lower to upper elevations (300-2,600 m) and is not considered an at-risk, rare, or sensitive plant. Lahontan beardtongue is distinguished from Palmer's penstemon by its longer corolla tube (cylindrical, hollow base of the flower measuring 7-8 mm for Lahontan beardtongue and 4-6 mm for Palmer's penstemon) and its often sessile (not fused surrounding the stem) upper leaves.

Not able to confirm which variety grows on the NNSS from herbarium specimens collected from 1959 through 1978, field surveys were scheduled. One lower elevation location identified by Janice Beatley in 1978 was revisited, as well as an opportunistic sighting at a mid-elevation location, and another at higher elevation.

Palmer's penstemon was found at a lower elevation (1,089 m) location on April 27, 2020, confirmed by its corolla tubes measuring 4-6 mm and all leaves being connate-perfoliate (fused surrounding the stem) (Figure 5-4). Ten plants were found at this location, which was along the road shoulder of Jackass Flats Road just west of Mercury (UTM NAD83 588343mE, 4056843mN).

An opportunistic observation at mid-elevation (1,228 m) location at the southern base of Skull Mountain of seven plants in senescence occurred on July 20, 2020 (UTM NAD83 576361mE, 4066162mN). Some upper leaves were sessile, as well as the flowers appearing to be more tubular (longer corolla tube) than bulbous. Unfortunately, flowers were too far into senescence to be measured. Possibly Lahontan beardtongue, it is recommended this location be revisited during bloom season for positive identification.

Many plants were found opportunistically just northwest of Gold Meadows in southern Kawich Canyon at a higher elevation (~2,050 m) on July 21, 2020 (UTM NAD83 568945mE, 4121647mN) (Figure 5-5). Plants were in full bloom, some with seeds. Leaf characteristics varied with few upper leaves, but plants

Figure 5-4. Palmer's penstemon observed along Jackass Flats Road shoulder.

(Photos by J.A. Perry, April 27, 2020)

Figure 5-5. Lahontan beardtongue observed in Kawich Canyon.

(Photos by P. Hardesty [left, center and top right] and J. Perry [bottom right], July 21, 2020)

that had upper leaves had some sessile leaves, while others were connate-perfoliate. Specimens were collected, keyed, and confirmed Lahontan beardtongue (Figure 5-5). The corolla tubes measured greater than 6 mm for most flowers, with some just at 6 mm (Figure 5-5). Viewing the Jackass Flats Road shoulder flowers next to the Kawich Canyon flowers, a slight difference in the flower shape was observed (Figure 5-6). The Kawich Canyon flowers had a more narrow, longer corolla tube (Figure 5-6). It is recommended this location be revisited to collect habitat, substrate, and elevation data, as well as a pressed specimen to accession into the NNSS herbarium.

With Lahontan beardtongue confirmed to occur on the NNSS, it has been added to the NNSS sensitive plant monitoring list with the ranking evaluate. More surveys are needed to determine its distribution on the NNSS, as well as any threats. It is recommended that known locations identified from ELU mapping surveys (Ostler et al. 2000) are visited.

Figure 5-6. Lahontan beardtongue (left) and Palmer's penstemon (right). Figure shows the slight difference in the shape of the flowers between the two varieties.

(Photos by P. Hardesty [left], July 21, 2020 and J.A. Perry [right], April 27, 2020)

5.1.3 Nye milkvetch (Astragalus nyensis)

Nye milkvetch is a small, herbaceous annual thought to be extirpated from southern Frenchman Flat in Area 5 by construction of several borrow/gravel pits (Beatley 1977) (Figure 5-7). The plant is listed on the NDNH List and is found in Clark, Lincoln, and Nye counties in Nevada. The species has also been documented in eastern California, southwestern Utah and northwestern Arizona. The plant was first identified and collected in 1941 in southern Frenchman Flat on the NNSS, its type locality (Figure 5-7). Surveys conducted in April and May in 1978 by EG&G Energy Measurements Group found Nye

milkvetch in two areas of southern Frenchman Flat, one of which was at the existing borrow/gravel pits (Figure 5-8). These findings were reported in January 1979 in an addendum to a report published in 1977 (Rhoads and Williams 1977, Rhoads et al. 1979). A survey data sheet from May 1995 stated, "some Nye milkvetch plants" were found during a survey for a different sensitive plant species at the Area 5 borrow/gravel pits. This was the last documented survey for Nye milkvetch that could be found on the NNSS.

It was determined there are possibly two locations of Nye milkvetch on the NNSS in Area 5: at the borrow/gravel pits (UTM NAD83 591982mE, 4068456mN) and approximately two km east at the type locality (UTM NAD83 593803mE, 4069151mN) (Figure 5-8). Both locations were surveyed April 4, 2020 (Figure 5-8). Although one other *Astragalus* species, *A. tidestromii*, was found common throughout the area, Nye milkvetch was not found.

Nye milkvetch has been removed from the NNSS's sensitive plant monitoring program until it can be confirmed to occur on the NNSS. Locations in Area 5 will continue to be surveyed, especially during good precipitation years.

Figure 5-7. Nye milkvetch type locality habitat in southern Frenchman Flat with Nye milkvetch plant inlay.

(Photos by J. A. Perry [habitat], April 4, 2020 and S. Cochrane [inlay], April 24, 1978)

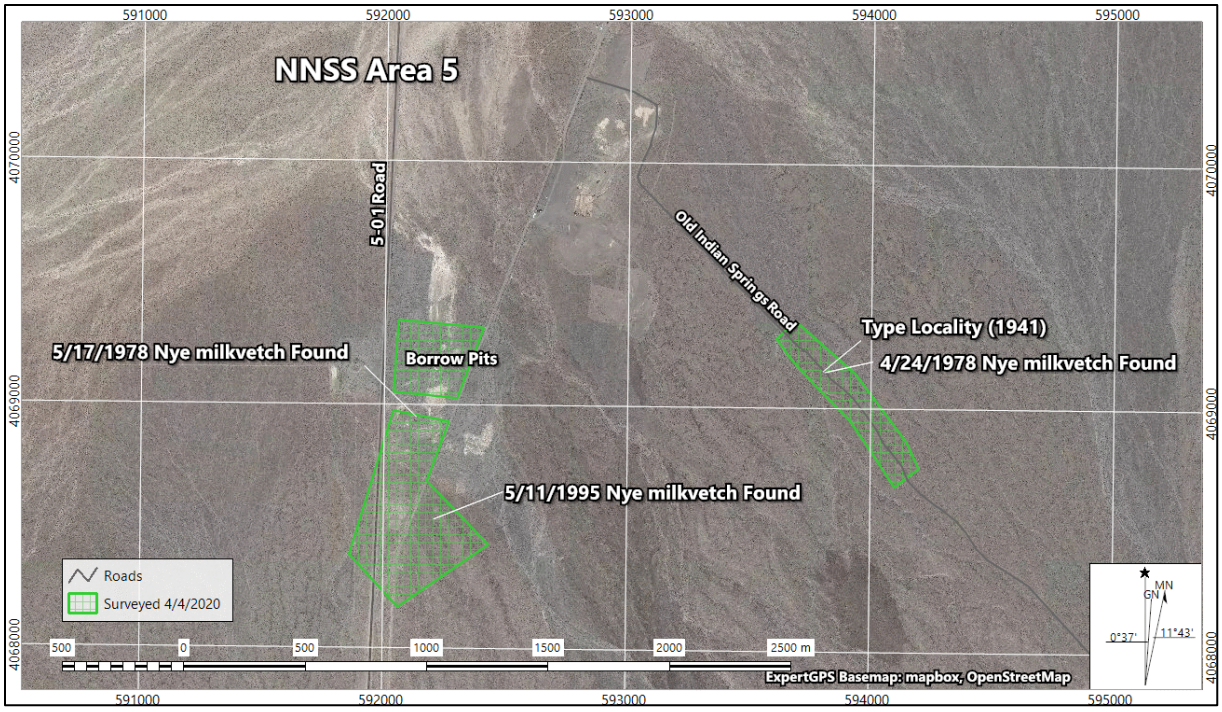

Figure 5-8. Areas surveyed for Nye milkvetch in 2020 (green areas), but no plants were found (UTM [Zone 11, meters], NAD83).

5.1.4 Redspined fishhook cactus (*Sclerocactus polyancistrus*)

Redspined fishhook cactus, also known as pineapple cactus, is native to California and Nevada. Rhoads et al. (1978) stated "*Sclerocactus polyancistrus* grows on gravelly slopes near flatrock areas of igneous in *Artemisia*-Pinyon-Juniper and *Atriplex-Ceratoides* vegetation on the [NNSS]. Further south in California it occurs in Creosote Bush Scrub on limestone hills." The cactus is known for its hooked spines, slightly pubescent, not wooly, fruits and tuberculate seeds (Rhoads et al. 1978). Its "barrel shape and hooked red-brown spines," as well as its flat, white distal spines are its featured characteristics, but "flowers and fruits are helpful for positive identification" (Rhoads et al. 1978).

Redspined fishhook cactus was added to the NNSS sensitive plant monitoring program in the early 2000's based on its addition to the NDNH List. In 2006, the plant was removed from the monitoring program because "it was the general consensus during the 2006 Rare Plant workshop that this species is widespread throughout several western states" (National Security Technologies, LLC, Ecological Services 2007). The plant was re-added to the monitoring program in 2016 with the intent of increasing awareness of the species during pre-activity surveys. Because of its dispersed occurrence (e.g., after locating one plant, another plant will not be found for miles), it is difficult to conduct systematic surveys.

The plant was identified during ELU surveys from 1997 through 1998 as occurring in 26 different ELUs (Ostler et al. 2000). The plant has been described by Beatley (1976) in Area 19 on "Nw. Pahute Mesa and below N face (S. Gold flat)", in Area 18 from herbarium collections by Susan Cochrane and K.S. Moor in 1977 on Buckboard Mesa, in Area 6 from herbarium collections by M.P. Williams in 1978 within one mile south of CP Hill, and Area 25 by Paul Peterson (unknown source) on Yucca Mountain.

Based on its dispersed distribution and information from the 2006 Rare Plant workshop, Redspined fishhook cactus has been removed from the NNSS sensitive plant monitoring program. It will continue to be protected from collection by state law, as well as at monitored and avoided at construction sites.

5.1.5 Sand cholla (Grusonia pulchella)

Sand cholla (*Grusonia pulchella*, formerly *Opuntia pulchella*) is a cactus species on the NDNH List and is known to occur on the NNSS. Evaluation and surveys for this species began in 2019 to determine if it warrants adding to the NNSS sensitive plant monitoring program. Sand cholla is a small cactus, growing typically less than ten inches tall, and is known to grow under the canopy of other shrubs, making it difficult to find during surveys (Poulson 2017). Poulson (2017) reported there could be "many plants near where one is found, but its rarity is in the widely spaced specimens."

The plant's common name, sand cholla or club-cholla, can be misleading as the plant is not in the cholla genus (*Cylindropuntia*) and can "occur[s] sporadically on gravelly, silty, sometimes rocky, alluvial fans, and less often along dry lake beds or in sandy areas" (ManTech 2018). According to the plant's NDNH 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).

This small, tuber-based cactus has adapted several unique survival techniques. Its "heavily spined tuberous root" allows it to "shed its branches and regrow them quickly each year" if needed during harsh conditions (Poulson 2017). Poulson (2017) also reported the "tuberous root maintains reserves to not only support regrowth of the crown, but to also sustain flowering in even moisture stressed conditions."

Sand cholla can easily be overlooked as a young cholla plant. Identifying and locating it outside its bloom season, May through June, can be difficult. Key characteristics can be found in the Jepson Flora Project (2019) which includes the following characteristics: the longest spine is flat and can be dark brown or white, sheaths covering the spines separate near the tip, and spines emerge from the stem from barbed bunches of fuzzy bristles at the areole termed glochids.

Three locations found just off the NNSS, west of Area 22 on Bureau of Land Management land in 2019 were revisited May 4, 2020 (Figure 5-9). No plants were found at the western-most locations, while one plant was found at the eastern location in poor condition (two stems: one dead, one alive).

One possible sand cholla was found during project 18-34, a substation upgrade, on May 11, 2020 (Figure 5-9; UTM NAD83 585202mE, 4084645mN). The plant was not in flower, had a wrinkled look, fuzzy glochids, longest spines were flat, and spine sheaths were easily removed from the tips of the spines. The plant was flagged and avoided during construction activities.

Another occurrence was opportunistically recorded at 1,572 m elevation on June 23, 2020 at Tippipah Spring during vegetation sampling (Figure 5-9; UTM NAD83 570794mE, 4100011mN). The plant was found in good condition with no apparent threats to the location.

One plant was destroyed during project 19-16, the construction of a new batch plant, in late 2019 (Figure 5-9; UTM NAD83 584178mE, 4090062mN). The plant was within a corridor which was bladed for utility access to the new batch plant.

Sand cholla has been removed from the NNSS sensitive plant monitoring program based on the findings from 2019 through 2020, as well as the plant being found widespread throughout the NNSS during ELU mapping surveys in the late 1990s (Ostler et al. 2000). The cactus will continue to be protected by state law from collection, as well as monitored and avoided during construction projects.

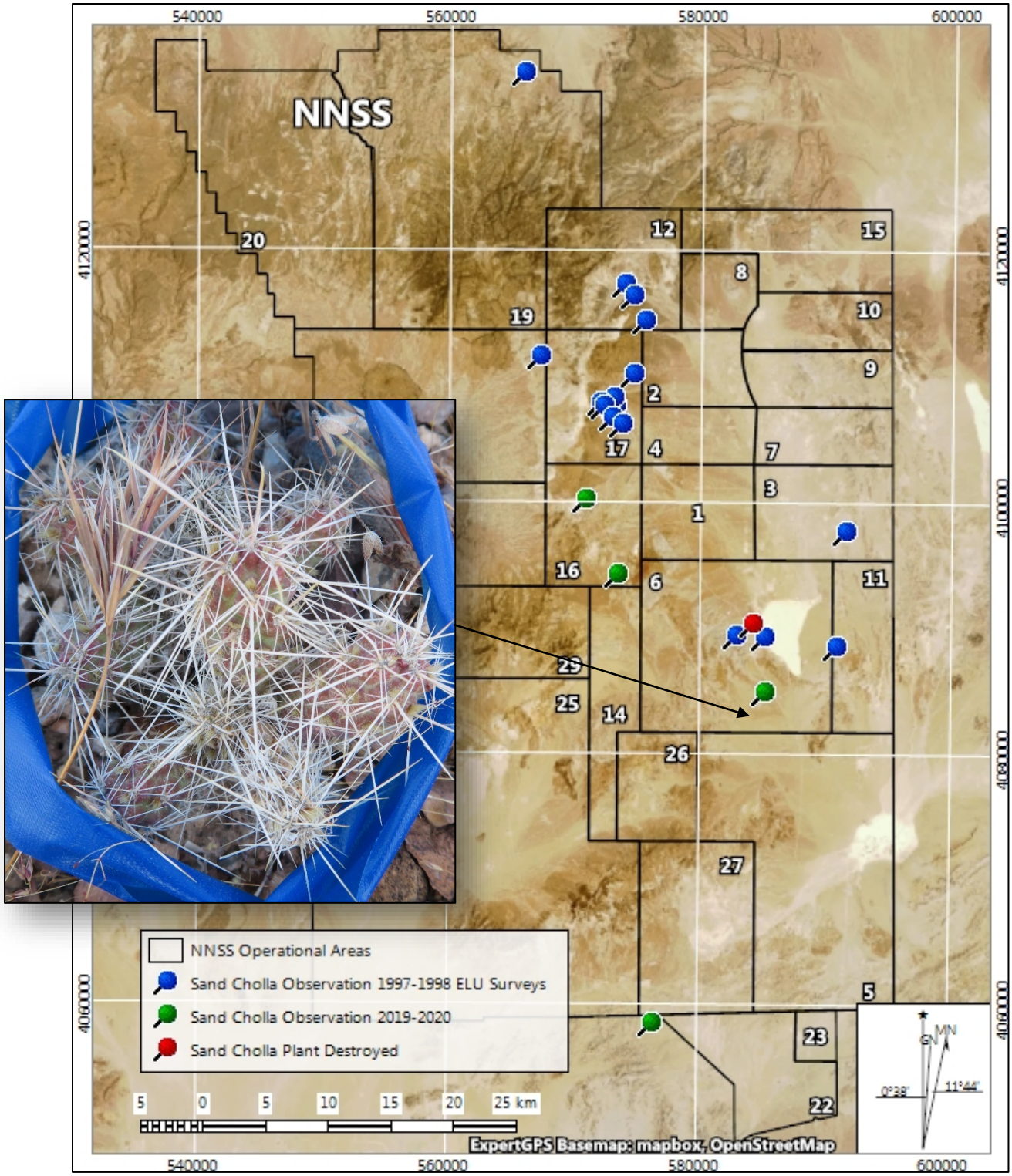

Figure 5-9. Known occurrences of sand cholla on the NNSS, with one occurrence just off the NNSS (UTM [Zone 11, meters], NAD83).

(Photo (inlay) by J.A. Perry, May 11, 2020)

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. Field surveys are conducted to verify previously reported locations, better define population boundaries, and to identify existing or potential threats to populations. The primary focus in 2020 was to evaluate the status of Clokey's cryptantha, Lahontan beardtongue, Nye milkvetch, and sand cholla (see section 5.1 Species Evaluations). Along with species evaluations, several other species' populations were opportunistically visited and surveyed during tortoise and pre-activity surveys: white bearpoppy (*Arctomecon merriamii*), Sanicle biscuitroot (*Cymopterus ripleyi* var. *saniculoides*), Pahute Mesa beardtongue (*Penstemon pahutensis*), and Weasel phacelia (*Phacelia mustelina*). There were three additional species that were monitored under the long-term monitoring program: Cane Spring suncup (*Chylismia megalantha*), Clarke phacelia (*Phacelia filiae*), and Kingston Mountains bedstraw (*Galium hilendiae* ssp. *kingstonense*).

5.2.1 Cane Spring Suncup (*Chylismia megalantha*)

The Cane Spring suncup (*Chylismia megalantha*, formerly *Camissonia megalantha*) is a large annual that blooms in the fall with a showy pink flower and large foliage. The plant grows well on steep slopes and disturbances, including manmade disturbances. A similar species, Shockley's evening primrose (*Chylismia heterochroma*), is a smaller version of Cane Spring suncup with differences in plant size and flower at peak maturity. Shockley's evening primrose is widespread and not included on the NDNH List or the NNSS sensitive plant monitoring program. These two species are very similar and overlap in distribution, making the flower at peak maturity essential for positive identification.

During recent surveys for this plant, it became clear the two very similar species grow side-by-side, some plants showing both characteristics of Cane Spring suncup and Shockley's evening primrose. This led to a review of the distribution of both species on the NNSS to better delineate populations for monitoring purposes. Known locations from the NNSS's database were plotted in ArcMap, as well as historical locations which had not been entered into the database (Figure 5-10).

A review of herbarium collections of both species made from 1992 through 1993 that were sent to a specialist, Dr. Warren L. Wagner, who was at the time with the Smithsonian Institution, in 1994 for positive identification revealed variation in species identification across botanists (correspondence from the Missouri Botanical Garden, April 13, 1994) (Table 5-3, Figure 5-10). Collections that were identified in the field as Cane Spring suncup were redetermined by Dr. Wagner as Shockley's evening primrose (Table 5-3, Figure 5-10). After identification by Dr. Wagner, the specimen collections were distributed to several herbariums, including the Wesley E. Niles Herbarium at the University of Nevada, Las Vegas (UNLV). Some of the specimens sent to the UNLV herbarium were not relabeled with the 1994 determinations and remain in the database with original determinations.

An NNSS biologist visited the UNLV herbarium with expectations of viewing some of the 1992-1993 collections, as well as older collections from the NNSS, to confirm characteristics of each species. Fifteen collections were viewed, collected from 1969 through 1994. Flowers were not present on many of the collections, as well as several were in poor condition based on collection dates. Four of the specimens collected as Cane Spring suncup were confirmed as Cane Spring suncup. Three specimens collected as Shockley's evening primrose and eight Cane Spring suncup specimen collections were in poor condition or did not have flower material and could not be used to confirm identification. Utilizing historic herbarium collections in order to delineate the distribution of the two species on the NNSS was proven unsuccessful.

Surveys for Cane Spring suncup in 2020 focused on confirming several known populations and visiting historical populations. A population located in 2019 in Area 11 near French Peak at an explosive disposal facility was revisited during project 20-27 on June 17, 2020 (Figure 5-10). This population could not be confirmed as Cane Spring suncup in 2019 due to the timing of the survey revealing flowers not in peak maturity. This location is very close to the French Peak population included in the NNSS database, as well as overlapping a historical population found on an unpublished map not included in the NNSS database (Figure 5-10). A total of 116 plants were counted along the 6-03 Road and the facility's test pads. Four plants were observed with flowers, all which showed the characteristic stigma protruding past the anthers of Cane Spring suncup.

A small burn of approximately 0.1 ha off the southern test pad occurred after the June 17 survey and was re-surveyed post-burn. Although the steep, disturbed slope is ideal Cane Spring suncup habitat, no plants were found during the June 17 nor the post-burn survey. It was determined the burn had no impact to the Cane Spring suncup.

Two small *Chylismia* plants were found during a pre-project walkdown at Port Gaston in Area 26 at a launch pad built in 2017 (Figure 5-10). The plants were very small with flowers past their prime. It could not be determined if they were Cane Spring suncup or Shokley's evening primrose. Substrate was brought in to build the launch pad after blading the area in 2017, but the origin of the soil remains unknown. A revisit to this location during the bloom season may determine the population to be Shokley's evening primrose, based on the size of the flowers and leaves.

During a tortoise clearance survey for project 20-46 at well ER 11-2 on October 27, 2020, many Cane Spring suncup plants were found (Figure 5-10). Some plants at this newly identified population measured to the size of Cane Spring suncup, but did not reveal its signature mature flower characteristic of the stigma protruding past the anthers (Figure 5-11). Some plants did show this characteristic, grew very large, and were confirmed to be Cane Spring suncup (Figure 5-11). This population was added to the NNSS database and sensitive plant monitoring program. Finding Cane Spring suncup plants at this location led to a survey of a historical population, termed population 11-3, found on an unpublished map. The area was surveyed October 27, 2020 but no plants were found (Figure 5-10).

During revegetation work on Cell 18 at the Area 5 RWMC (see section 7.0 Habitat Restoration Monitoring), an opportunistic survey of the Cane Spring suncup population growing on the northeastern facility perimeter berm occurred on November 2, 2020 (UTM NAD83 593226mE, 4080598mN). The survey went further west of the known population into a flat, previously disturbed area between the inner and outer facility perimeter berms. Approximately 158 plants were found, including one at the fence line of Cell 18. Many plants were dispersing seeds, which were collected to observe under a microscope (Figure 5-12). With Cell 18 in the process of being revegetated by MSTS biologists and Cane Spring suncup growing well in disturbances, it is possible Cane Spring suncup will be found on Cell 18.

Work will continue to be done to identify which Cane Spring suncup populations require long-term monitoring under the NNSS sensitive plant monitoring program, as well as identifying Shockley's evening primrose distribution on the NNSS. Blomquist et al. (1995) stated "Observations made during surveys on [NNSS] conducted from 1991 to 1994 indicate that there is no clear geographic separation between the two species on [NNSS]." This publication further explains the difficulties of separating these two species as several collections from the NNSS that were previously identified as Cane Spring suncup were annotated in 1994 as Shockley's evening primrose, and vice versa.

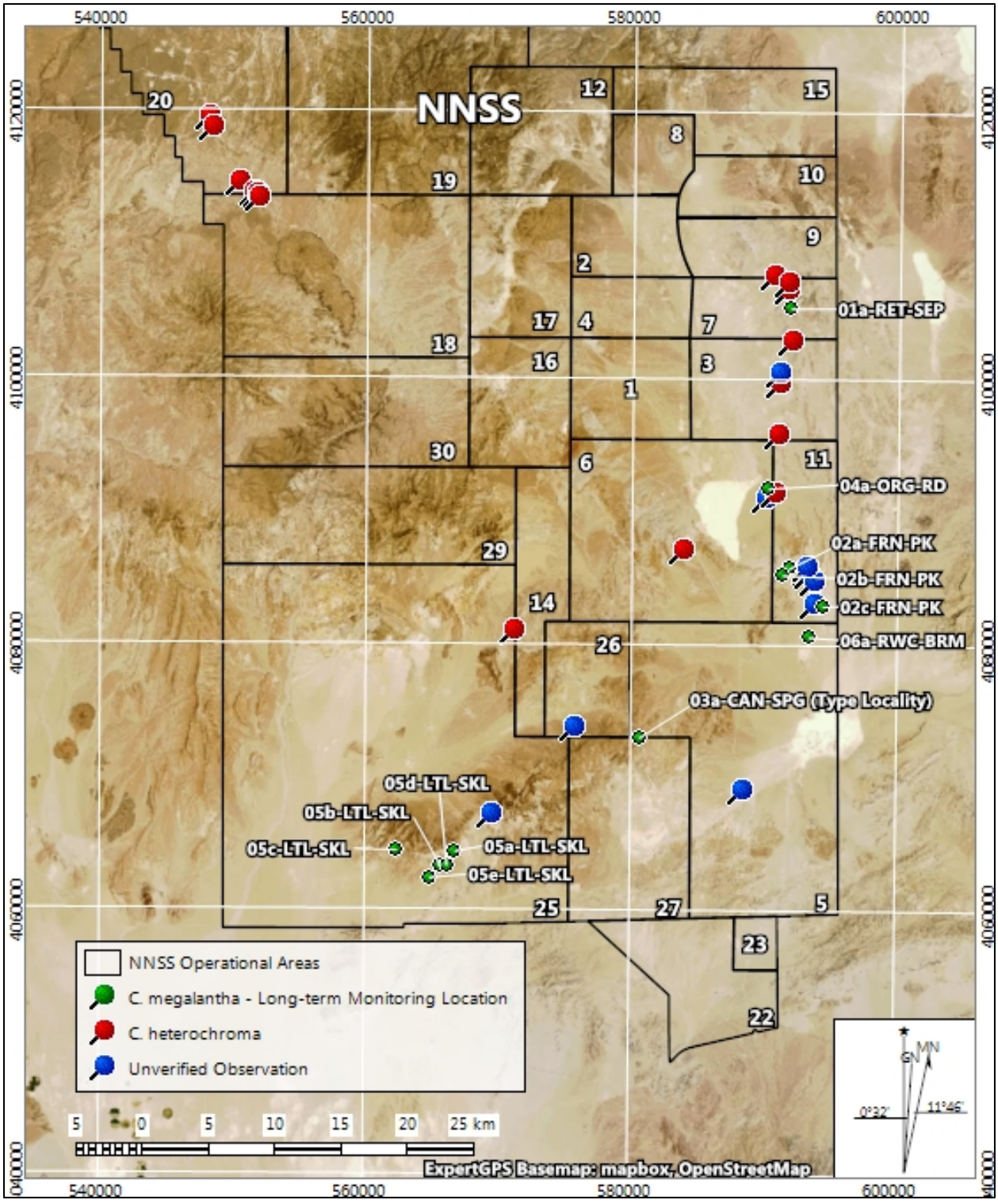

Figure 5-10. Known, historical and unverified locations of Cane Spring suncup (C. megalantha) and Shockley's evening primrose (C. heterochroma) (UTM [Zone 11, meters], NAD83).

Table 5-4. Determinations of herbarium collections in 1994 for Cane Spring suncup (C. megalantha) and Shockley's evening primrose (C. heterochroma) (UTMs are approximate [Zone 11, meters], NAD83).

Collection No.	Collection Date	Collector	Collector's Determination	Dr. Warren L. Wagner's Determination	Easting	Northing	Elevation (m)	Notes
1	8/4/1992	Rod Goodwin	C. megalantha	C. heterochroma	593065	4085743	1,250	Kevin Blomquist determined this collection as *C. megalantha* in 1992
5	8/7/1992	Pam Hall	C. megalantha	C. heterochroma	590999	4099476	1,356	Population previously identified as *C. megalantha* by Beatley in 1976, as well as Collins and O'Farrell in 1984
6	8/7/1992	Pam Hall	Not identified	C. heterochroma	590674	4091179	1,280	Specimen collected approximately <1 km from known *C. megalantha* population (04-ORG-RD)
8	8/11/1993	Pam Hall	Not identified	C. heterochroma	590925	4095673	1,250	Population previously identified as *C. megalantha* by Beatley in 1976, as well as Collins and O'Farrell in 1984
9	8/11/1993	Pam Hall	Not identified	C. heterochroma	591781	4102630	1,370	Population previously identified as *C. megalantha* by Beatley in 1976, as well as Collins and O'Farrell in 1984
10	8/10/1993	Pam Hall	Not identified	C. heterochroma	591573	4107075	1,524	
43	8/25/1993	Tim Lindemann	C. megalantha	C. heterochroma	571047	4080855	1,554	
47	8/19/1993	Tim Lindemann	C. megalantha	C. heterochroma	583833	4086971	1,268	
57	5/14/1992	Kevin Blomquist	Not identified	C. megalantha	565664	4063238	1,128	Known *C. megalantha* population 05b-LTL-SKL
59	5/14/1992	Kevin Blomquist	Not identified	C. megalantha	565664	4063238	1,128	Known *C. megalantha* population 05b-LTL-SKL
60	5/29/1992	Kevin Blomquist	Not identified	C. megalantha	591825	4105379	1,430	Known *C. megalantha* population 01a-RET-SEP
61	5/29/1992	Kevin Blomquist	Not identified	C. megalantha	591825	4105379	1,430	Known *C. megalantha* population 01a-RET-SEP
62	7/15/1992	Kevin Blomquist	C. megalantha	C. megalantha	590287	4091793	1,219	Known *C. megalantha* population 04a-ORG-RD
1 & 2	8/6/1992	Pam Hall	C. megalantha	C. megalantha	580699	4072997	1250	Known *C. megalantha* population 03a-CAN-SPG (type locality)

Figure 5-11. Plants found at well ER 11-2 near historic population 11-3. Some plants remained small in growth habit (left), while others grew very tall (center). Some plants showed Cane Spring suncup's flower characteristic with the stigma protruding past the anthers (bottom right with mm ruler scale). The stigma was in line with the anthers for other plants (top right with mm ruler scale).

(Photos by J.A. Perry, October 27, 2020)

Figure 5-12. Cane Spring suncup plants found at the Area 5 RWMC manmade berm population were dispersing seeds. Open seed pods (left) and seeds under a dissection microscope with mm ruler scale (right).

(Photos by J.A. Perry, November 2, 2020)

5.2.2 Clarke phacelia (*Phacelia filiae*)

Clarke phacelia (*Phacelia filiae*), a small annual herb with purple flowers with a yellow flower tube, was first identified in 1977 on the NNSS as a different, but very similar species, Parish's phacelia (*P. parishii*). Surveys conducted in 1995 on adjacent Air Force lands managed by DoD identified similar plants as a new species. This new species was published by Atwood et al. in 2002 as Clarke phacelia. After surveys were conducted during the favorable growing season on the NNSS in 2010, it was determined the plants on the NNSS better matched the newly described Clarke phacelia, rather than Parish's phacelia. In 2018 at the Nevada Rare Plant Workshop hosted by the Nevada Native Plant Society, the taxonomy of the two plants was revisited. Personal communication with Ann Howald, a retired botanist with the California Native Plant Society, explained the research she conducted on the plants she observed from Pahrump Valley, Nevada, were possibly hybrids with intermediate seed characteristics of Clarke phacelia and Parish's phacelia (personal correspondence, May 28, 2020). Ann Howald explained "[Clarke phacelia] *P. filiae* has "broken" spots at the base of each pit, whereas [Parish's phacelia] *P. parishii* does not" and that "the Pahrump Valley seeds had a mixture of broken and unbroken pits" (personal correspondence, May 31, 2020).

Several seed collections were made on May 26, 2020 on the NNSS at a population just east of the Jackass Flats Road and 27-01 Road intersection off the north side of the 27-01 Road in a small area with pink colored substrate (Figure 5-13; UTM NAD83 576357mE, 4061529mN). The seed capsules held 20 to 23 seeds and the seeds were 1.1 to 1.8 mm in length. The seeds were angular with narrowed or rounded ends with deep pits (Figure 5-13). These characteristics match the description of Clarke phacelia found in Atwood et al. (2002). The bases of the seed pits were not able to be viewed due to limitations with the microscope.

An opportunistic visit to a population in Rock Valley, which had not been visited since 1995, occurred on May 4, 2020 (UTM NAD83 579054mE, 4061288mN). The habitat consisted of ideal light-colored Clarke phacelia substrate, but no plants were observed. Seed analysis of Clarke phacelia will be the focus of future monitoring on the NNSS, as well as visiting the Pahrump Valley Parish's phacelia populations to document and compare seed characteristics.

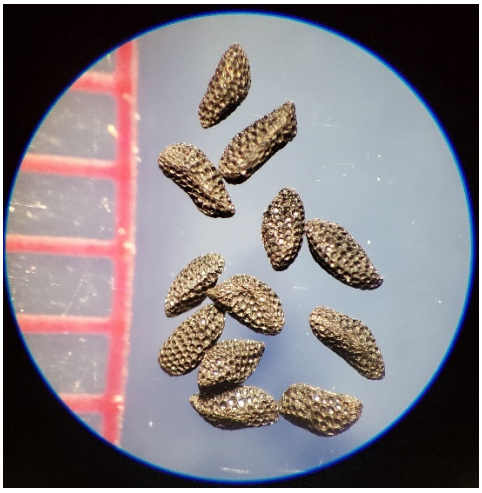

Figure 5-13. Clarke phacelia plants (top) with ruler scale in centimeters and deeply pitted seeds under a dissection microscope with ruler scale in mm (bottom) collected from a population off the north side of the 27-01 Road.

(Photos by J.A. Perry, May 26, 2020)

5.2.3 Kingston Mountains bedstraw (*Galium hilendiae* ssp. *kingstonense*)

Kingston Mountains bedstraw is a small, slender perennial with pink, bell-shaped flowers found on steep slopes typically beneath the canopies of single-leaf Pinyon, Utah juniper, Gambel oak (*Quercus gambelii*), and Sumac (*Rhus*) species. Kingston Mountains bedstraw can be distinguished from others in the genus by its large, bell-shaped, narrow throated, pink flowers in dense terminal clusters.

A newly identified population of *Galium hilendiae* located on Yucca Mountain (UTM NAD83 549348mE, 4087880mN) in 2018 was revisited on June 24, 2020. The population was relocated on Yucca Mountain along the Pinnacles Ridge in Area 29 on the NNSS, as well as a small section on Air Force land managed by the DoD. Approximately 29 plants were found with dried flowers, matured fruit, and/or dispersed seeds from 1,835 to 1,861 m elevation. The clumping or mat-forming growth habit of the plant makes it difficult to determine the exact number of plants during surveys. When the population was located in 2018, it was in senescence and could not be identified to subspecies (ssp.) level. The visit in 2020 revealed some dried flowers with a more narrowed corolla throat, more indicative of ssp. *kingstonense*. Dr. W. Kent Ostler confirmed the flowers and habitat appeared to be more like ssp. *kingstonense*, but a visit to the population during peak flowering is needed to confirm (personal correspondence, July 1, 2020).

A long-term monitoring survey for Kingston Mountains bedstraw was conducted on July 21, 2020 at a Tub Spring population (UTM NAD83 584888mE, 4122226mN), which is a small population just north of the spring in Area 15. The plant was rare in the area, with 16 plants observed in senescence with no apparent threats.

5.2.4 Pahute Mesa beardtongue (*Penstemon pahutensis*)

Pahute Mesa beardtongue, a perennial forb/herb, is known for its large, showy pinkish-lavender to bluish-lavender flowers with a unique beard on the upper inner portion of the corolla. It has been found in Nye and Esmeralda counties in Nevada, with a small population in Inyo county (Grapevine Mountains) in California. It is widely distributed on the NNSS throughout Rainier Mesa, Pahute Mesa, and Shoshone Mountain, with a small population at Oak Spring Butte. Intense surveys in the 1990's revealed the plant was more widely distributed than previously known, growing in a range of habitats on the mesas. Monitoring of this plant has not occurred since 1993.

Two populations were opportunistically visited: a roadcut traversing Gold Meadows into Aqueduct Mesa in Area 12 (UTM NAD83 572166mE, 4120430mN) and a Rainier Mesa population in Area 17 (UTM NAD83 570854mE, 4112932mN and 571018mE, 4112832mN). Approximately 20 plants were found locally abundant along a dirt road cutting through the Aqueduct Mesa population on September 23, 2020. Leaves on the plants had greened up, but plants were post-flower. No apparent threats were observed besides the dirt road. An extension of a Rainier Mesa population was observed during a pre-activity survey for project 20-55, a reroute of a powerline. Plants were observed along the Stockade Wash roadcut approximately 200 m east of the existing population on October 28, 2020, suggesting the population was larger than originally mapped. On December 15, 2020, the expansion of the existing population was confirmed when approximately 125 plants were observed north and east of the existing population outwards to 250 m. A majority of the area was an existing powerline with two dirt access roads. During project 20-55, the powerline was bladed with several new poles installed. This work disturbed several Pahute Mesa beardtongue plants, but had minimal impacts to the entire population.

5.2.5 Sanicle biscuitroot (Cymopterus ripleyi var. saniculoides)

There are two varieties of Sanicle biscuitroot that occur on the NNSS; *Cymopterus ripleyi* var. *saniculoides* listed on the NDNH List and *C. ripleyi* var. *ripleyi*, a more widely distributed species not considered at-risk. *C. ripleyi* var. *saniculoides* has purple flowers and grows along drainages in sandy washes at lower elevations on the NNSS. *C. ripleyi* var. *ripleyi* has white flowers and grows "along sandy slopes, or in shrub interspaces, with no apparent affinity for washes or drainages" at higher elevations on the NNSS (Hansen et al. 2010). The two varieties are not included in *The Jepson Manual: Higher Plants of California* (Baldwin 2012) nor the U.S. Department of Agriculture (USDA) PLANTS database (USDA 2020) but are widely accepted by NDNH and NNSS botanists as separate taxa. After a thorough review and surveys of both plants, Hansen et al. (2010) stated that, "Based on the lack of evidence that both varieties of *C. ripleyi* are occurring at the same location and the unique habitat preference for both varieties, *C. ripleyi* var. *saniculoides* will continue to be considered a valid taxon and will be monitored along with other sensitive plants known to occur on the [NNSS]."

With the recent review of plant rankings, Sanicle biscuitroot was reduced from moderate ranking to watch based on surveys conducted over the past few years revealing the plant is more widespread than originally mapped on the NNSS. Several new locations have been identified over the past few years, as well as several population expansions (Figure 5-14). The plant grows throughout the NNSS and is thought to grow in many of the sandy washes in Rock Valley, most of which have not been surveyed.

A new location was identified on April 27, 2020 in Rock Valley (Figure 5-14) (UTM NAD83 579334mE, 4058096mN). Approximately 13 plants were observed in a sandy wash approximately 500 m south of a known location (Figure 5-14). Many plants were in bloom, revealing purple flowers.

A second new location was identified on May 4, 2020 also in Rock Valley (Figure 5-14) (UTM NAD83 578992mE, 4060054mN). Approximately eight plants, four of which were flowering and had purple flowers, where observed approximately 2.5 km north of a powerline road (Figure 5-14).

On May 11, 2020 a known population along the powerline road in Rock Valley was visited with only two plants observed (UTM NAD83 579990mE, 4062012mN). The population is along the powerline road, with road traffic creating a threat of disturbance, as well as foraging antelope utilizing the road as a movement corridor.

5.2.6 Weasel phacelia (*Phacelia mustelina*)

Weasel phacelia is a widely distributed, small annual plant with a violet flower and a strong, disagreeable odor. "[This plant] does not occur in large numbers but does occur over most of the NNSS as well as at many locations off the NNSS" (Hall et al. 2013). Two new locations of this species were opportunistically found May 26, 2020 at the southern base of Skull Mountain in Area 25 (UTM NAD83 575174mE, 4066830mN and 574714mE, 4066978mN). The first location had 25 seed dispersed-plants and the second location only had one seed-dispersed plant. Flowers were still present on some of the plants, which were light purple to white in color. Plants grew in bedrock locations at the bottom of two large canyons until the substrate turned to loose gravel, where the plants were not growing. The locations were very remote, only accessible by foot, with no current threats. It is recommended the populations be revisited during a better growing year to determine the size of the two locations.

5.2.7 White bearpoppy (Arctomecon merriamii)

White bearpoppy is found throughout Mercury Ridge, Red Mountain, and Mercury Township in Areas 5 and 23 on the NNSS. Its bluish-green foliage covered with long, silvery, pilose hairs and white, showy

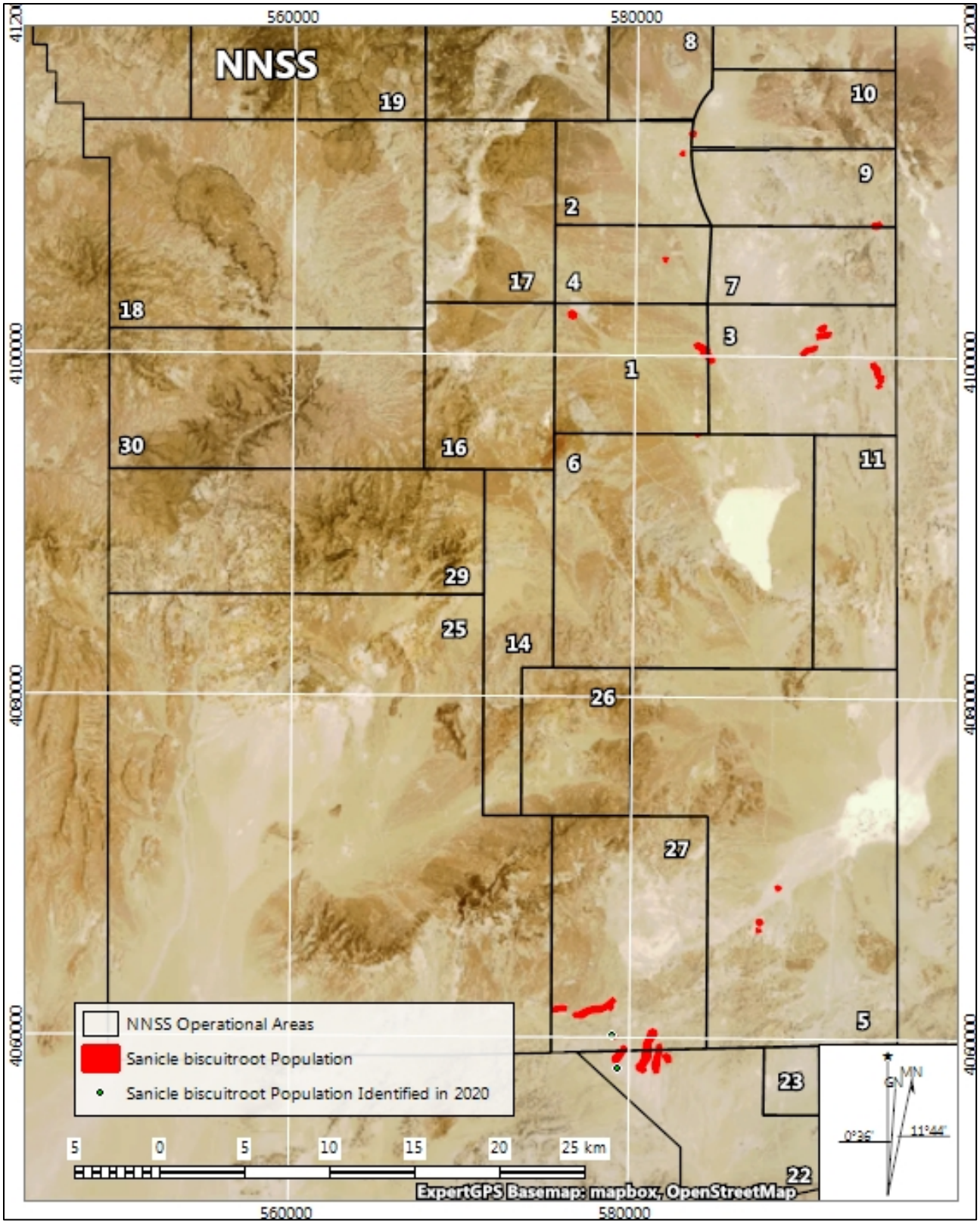

Figure 5-14. Distribution of Sanicle biscuitroot on the NNSS (UTM [Zone 11, meters], NAD83).

flowers inclined to nod in bud on long (20-30 cm), naked stems, can be easily spotted during its bloom period.

An opportunistic visit to the white bearpoppy population just north of Mercury Township (last documented in 1993), occurred on June 2, 2020 (UTM NAD83 589976mE, 4058725mN). Five healthy plants with dispersed seeds were observed. This population is within an old, regrown disturbance but does not have any current threats.

5.3 COORDINATION WITH OTHER SCIENTISTS

- With the uncertain future of the Wesley E. Niles Herbarium at UNLV due to possible defunding and/or relocation, an NNSS biologist visited the herbarium to review several NNSS collections. Cane Spring suncup and Sanicle biscuitroot specimens were reviewed.

- With several plant meetings for the Nevada Native Plant Society and NDNH canceled due to the COVID19 pandemic, MSTS biologists contacted several plant experts virtually in order to maintain sensitive plant networking. Experts were contacted in regards to Clarke phacelia, Parish's phacelia, Clokey's cryptantha, and Kingston Mountains bedstraw.

6.0 SENSITIVE AND PROTECTED/REGULATED ANIMAL MONITORING

The NDNH At-Risk Plant and Animal Tracking List (NDNH 2021); NAC 503, "Hunting, Fishing and Trapping; Miscellaneous Protective Measures" (NAC 2021); FWS Endangered Species home page (FWS 2021); 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 southeast Nevada pyrg (*Pyrgulopsis turbatrix*) was changed to the southwest Nevada pyrg. 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 2020 focused on (a) birds, (b) bats (c) feral horses, (d) mule deer, (e) pronghorn antelope, (f) desert bighorn sheep, and (g) 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 2020 focused on Migratory Bird Treaty Act (MBTA) compliance, documenting bird mortalities, implementing the NNSS Avian Protection Plan, conducting winter raptor surveys, and a western burrowing owl radio-tracking study.

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 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.

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

Actions taken to comply with the MBTA and MOU during 2020 included the following: 1) conducted pre-activity surveys for proposed projects before surface-disturbing work to avoid harming birds or their nests, 2) relocated a red-tailed hawk nest and three chicks to a safe, artificial nest platform, 3) removed white-crowned sparrow from glue trap and released it, 4) installed bird guard, protective covers and other retrofits on power lines to reduce avian mortality, and 5) reported dead/injured birds to FWS.

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 two types: electrocution 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. A total of eight dead birds were documented on the NNSS in 2020 (Figure 6-1). This is the lowest number of recorded mortalities since 2012. Five (4 red-tailed hawks and 1 common raven) were electrocuted, one prairie falcon (*Falco mexicanus*) and one unknown passerine were found dead from unknown causes, and one green-tailed towhee (*Pipilo chlorurus*) was euthanized after being severely injured from being stuck on a glue trap.

Numerous poles were identified by MSTS biologists and the power group to install retrofits or reconfigure to make them avian friendly (Figure 6-2). A total of 87 poles were retrofitted or reconfigured during 2020. A variety of retrofits were made including installing insulator covers, conductor wire covers, and extending the length of the cross arm from 2.4 m to 3.0 m.

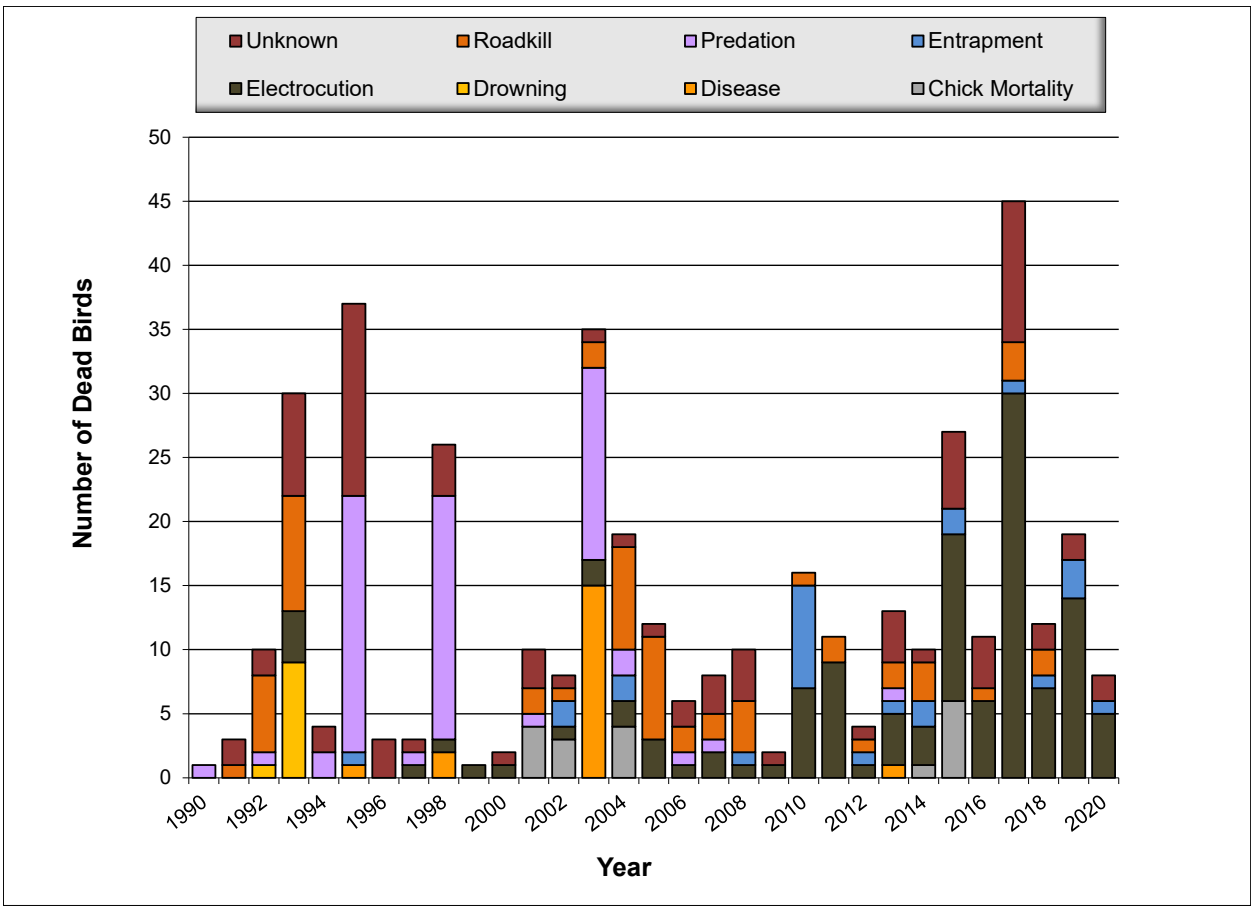

Figure 6-1. Records of reported bird deaths on the NNSS, 1990–2020.

Figure 6-2. 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 is 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 2020 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, there are 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 ESA). All permit conditions were met and an annual report summarizing 2020 activities was submitted to FWS. No mourning doves were taken and no bird specimens were 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 2020 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 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 2020 activities was submitted to NDOW.

- Several mortality reduction measures were taken. These include the aforementioned retrofits on 87 power poles, relocating a red-tailed hawk nest from a hazardous location to a safe, artificial nest platform (Figure 6-3), removing one inactive nest, surveying 147 ha at 48 project sites for active bird nests before disturbance, and removing several dead rabbits and snakes from roads to reduce the potential for vehicle mortalities. These measures were effective at reducing avian mortalities.

Figure 6-3. Three red-tailed hawk chicks in their relocated nest

(Photo by D.B. Hall, May 8, 2020)

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' nationwide mid-winter bald eagle survey and NDOW's statewide monitoring effort. Surveys continued in 2020, 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 14 (Southern NNSS) and January 15 (Yucca Flat) to coincide with the national bald and golden eagle survey and on February 18 (Southern NNSS) and February 19 (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 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).

Only three raptor species were detected during the surveys in 2020 (Table 6-1). No golden eagle sightings were documented during any of the surveys which is uncharacteristic. Typically, at least a few sightings are documented especially on the Yucca Flat Route. As in previous years, the red-tailed hawk was the most common species detected on both routes, comprising over 70% of all raptor sightings (Table 6-1).

Table 6-1. Results of winter 2020 raptor surveys on the NNSS.

Species	Southern NNSS (1/14/20)	Southern NNSS (2/18/20)	Yucca Flat (1/15/20)	Yucca Flat (2/19/20)
Red-tailed Hawk (*Buteo jamaicensis*)	2	3	4	8
American Kestrel (*Falco sparverius*)	1	0	3	1
Western Burrowing Owl (*Athene cunicularia hypugaea*)	0	0	1	1
Total Raptors	**3**	**3**	**8**	**10**
Common Raven (*Corvus corax*)	1	12	5	4
Loggerhead Shrike (*Lanius ludovicianus*)	0	0	1	3

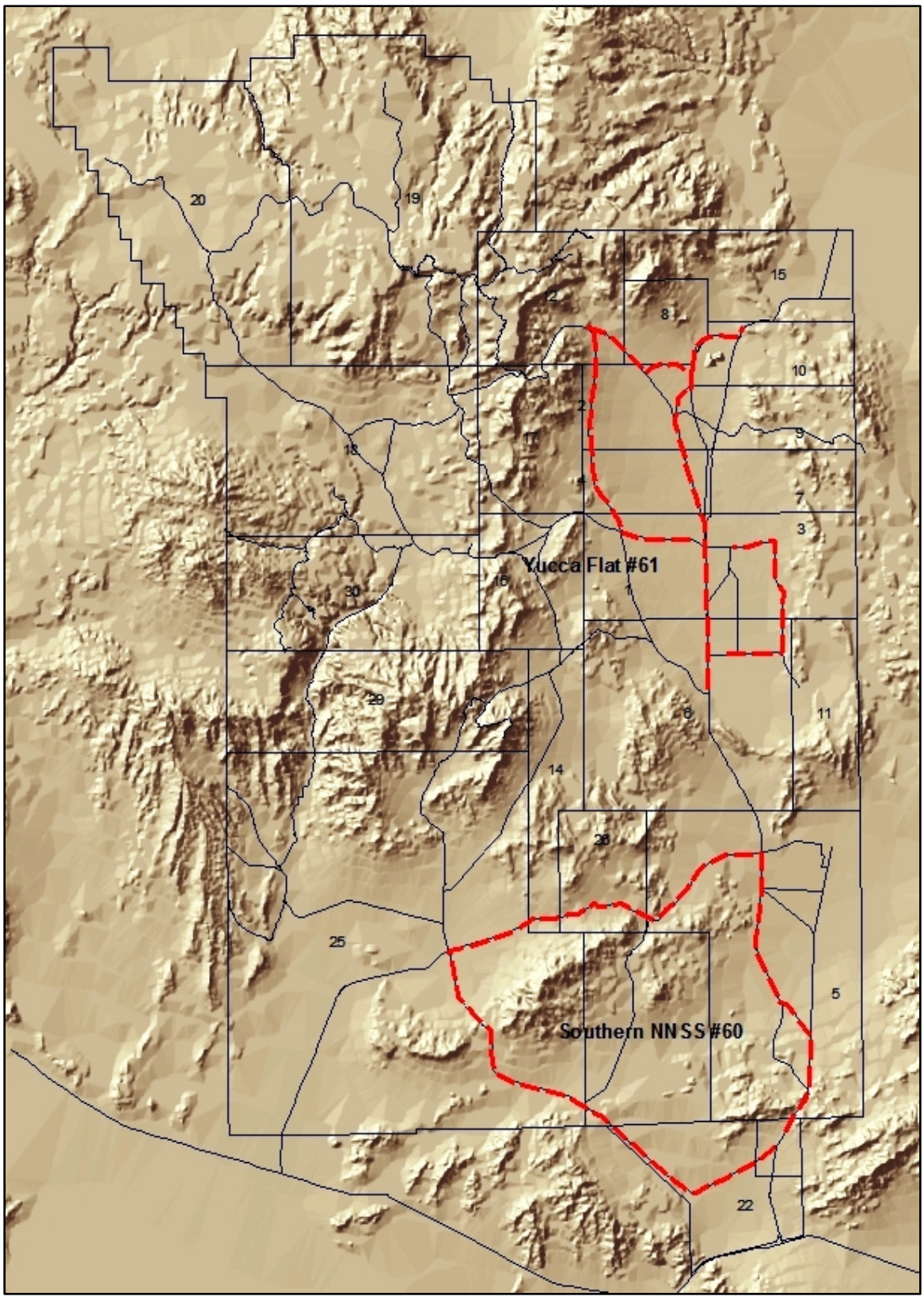

Figure 6-4. Winter raptor survey routes (red lines) on the NNSS.

A western burrowing owl was observed at a known burrow site during each survey in Yucca Flat. Common ravens were more prevalent on the southern route this year than in Yucca Flat with most of them observed near the Mercury Sewage Lagoons. Data were entered into the Ecological Geographic Information System (EGIS) faunal database, and given to NDOW for inclusion in their analyses.

6.1.5 Western Burrowing Owl Radio-tracking Study

The western burrowing owl is a National Species of Conservation Concern that has been declining in certain parts of its range for many years. Western burrowing owls have been studied on the NNSS since 1996 (Steen et al. 1997, Hall et al. 2003, Greger and Hall 2009, Hall et al. 2009, Conway et al. 2010, Hall and Greger 2014) and much has been learned about their natural history and ecology on their summer range. Little is known about their migration ecology including where they spend the winter, migration routes, and stopover sites. This type of information is important to understand threats to this species during migration and on their wintering range.

New technology has recently become available to use satellites and Global Positioning Systems (GPS) to track western burrowing owls over vast areas to identify specific migration routes, important stopover sites and wintering areas. Lightweight (5 g), solar-powered, Platform Transmitter Terminals (PTT) (Microwave Telemetry, Incorporated) are transmitters that are light enough to attach to western burrowing owls without exceeding the general rule of adding no more than 5% of an animal's body weight when attaching transmitters or other devices.

In June 2019, a collaborative study between MSTS, Dr. Courtney Conway (USGS, University of Idaho), and Carl Lundblad resulted in the capture of seven western burrowing owls. PTT transmitters were attached to each owl (Figure 6-5) as well as an FWS-approved leg band for future identification. Results from the fall migration revealed that three owls wintered in southern California, three in Baja, Mexico, and one presumably on the NNSS (Figure 6-6). Two owls with functional transmitters continued to be monitored in 2020. During spring migration, Male #180443 left southern California in late March and returned to the NNSS. He mated with a different female than in 2019 within 1.5 km of its 2019 capture location. He left the NNSS around mid-October and within a couple of weeks was back at the same location near the Salton Sea in southern California where he wintered last year. This is amazing data that could not be obtained without this new satellite technology and small, light-weight transmitters. Male #180446 left its winter territory in Mexico in early April and spent the summer of 2020 about 30 km northeast of Tonopah. His transmitter stopped working and it is unknown if the owl died or the transmitter failed. Both fall and spring migrations occurred over a two to three-week period revealing these owls migrate long distances quickly. Dr. Conway and his team have been deploying these satellite transmitters at study sites throughout the U.S. and Canada and are seeing a similar strong north to south migration pattern. They recently documented one of the longest documented burrowing owl migrations from southeastern Wyoming to just north of Acapulco, Mexico. We hope to continue our study and attach additional transmitters on several owls in 2021.

Figure 6-5. Western burrowing owl with transmitter attached.

(Photo by D.B. Hall, June 17, 2019)

6.2 BAT SURVEYS

Bat monitoring in 2020 consisted of documenting roost sites of bats found around buildings. Two dead canyon bats (*Parastrellus hesperus*) were found on glue traps, one in 23-600 (Mercury) and one in CP-100 (Area 6). Another adult male canyon bat was found on a glue trap in Building 23-1010 and was extracted and released. An adult female California myotis (*Myotis californicus*) was found in a bathroom in 23-751 and was released west of Mercury. There were numerous moths on the bathroom walls which may have attracted the bat into the room. Unknown myotis species, most likely California myotis, were found day roosting outside 23-460 (one bat) and 23-652 (one to three bats). An unknown myotis species was also moved out of Building 23-726. Roost site locations at these buildings were entered in the EGIS faunal database. Additionally, 306 images of bats were photographed at 8 of 26 sites monitored for mountain lions, all of which were water sources (Table 6-3).

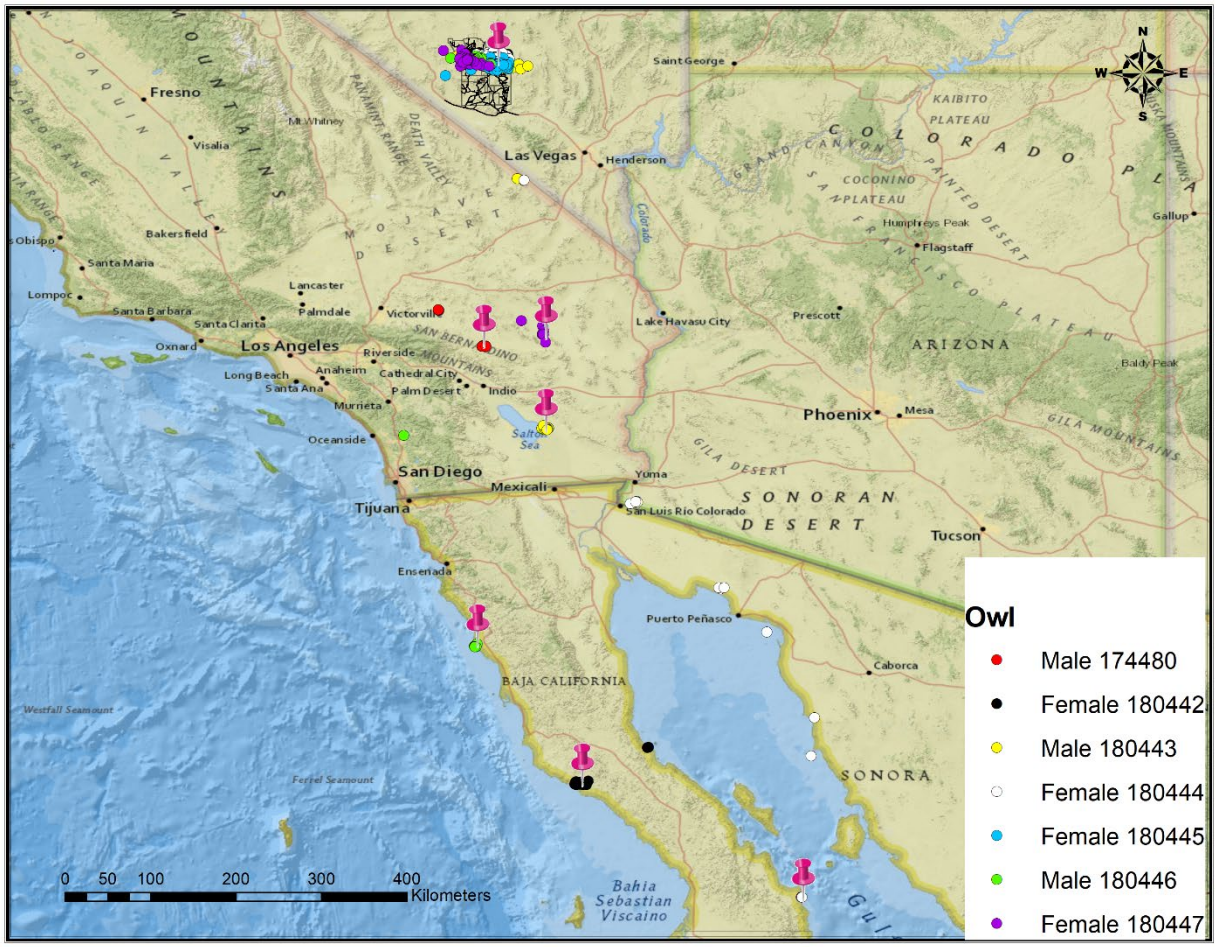

Figure 6-6. Map of wintering sites (pink pins) and coarse migration routes (various colored dots) for seven western burrowing owls captured on the NNSS.

6.3 FERAL HORSE SURVEYS

Horse monitoring in 2020 was limited to opportunistic observations and data from camera traps (see Table 6-3 in Section 6.7.1 Motion-Activated Cameras). At least 21 individual horses were observed including three juveniles and five foals. Gold Meadows Spring and Camp 17 Pond continued to be valuable resources for these animals, especially during the hot, dry summer. A total of 3,644 and 1,716 photos of horses were recorded using a motion-activated camera at Gold Meadows Spring and Camp 17 Pond (Figure 6-7), respectively (Table 6-3). 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 eighth consecutive year.

Figure 6-7. Group of horses "cooling off" and foraging in Camp 17 Pond.

(Photo by motion-activated camera, September 3, 2020)

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 2006-2020. 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 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 (Figure 6-8). 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 handheld 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 21-23 and October 5-7, 2020, a total of 222 deer were observed on both routes combined, which equates to an average of 37.0 deer per night. This is nearly double what was observed in 2019 with 119 deer observed and an average of 19.8 deer per night. On average, this is about 7 deer per night higher than the long-term average since 1989. There has been a decreasing trend ($y = -1.6784x + 45.092$, $r^2 = 0.38$) the last 15 years with counts fluctuating widely (Figure 6-9). The trend for the entire study period (1989-2020, excluding 1995-1998 and 2001-2005) is nearly flat ($y = -0.0583x + 30.791$, $r^2 = 0.0024$). Specific causes for the fluctuation in deer numbers is unknown and requires further investigation.

Unlike last year, the number of deer per 10 km was higher on Rainier Mesa than Pahute Mesa in 2020 (Figure 6-10). This may be due to the presence of an abundance of water at Gold Meadows Spring. A total of 98 deer groups were detected, and group size varied from 1 to 10 animals. The average group size was nearly equal between the Pahute Mesa and Rainier Mesa routes (2.2 and 2.3, respectively).

6.4.2 Sex and Fawn/Doe Ratios

The deer sex ratio (number of bucks per 100 does) decreased from 87 in 2019 to 63 in 2020, which is the second lowest recorded since 2006. (Table 6-2). 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 2020 was 17 in 2019 which is quite a bit lower than the average of 24 since 2006. (Table 6-2). The percentage of individuals unclassified to sex in 2020 was 18.9% which is about the same as the average percentage of unclassified sex since 2006 (18.0%). 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.

6.5 MULE DEER AND PRONGHORN ANTELOPE DISTRIBUTION STUDY

Mule deer and pronghorn antelope are mobile game animals that inhabit the NNSS. Both are generally considered to be migratory with distinct winter and summer ranges. Mule deer typically prefer the forested, mountainous habitats in the northern and western portions of the NNSS while pronghorn typically prefer the open valleys in the southern and eastern portions of the NNSS. Gold Meadows on the northern NNSS boundary is one of the few places where mule deer and pronghorn regularly occur together during the summer. Mule deer are much more abundant than pronghorn on the NNSS. Mule deer movements on the NNSS were studied more than 30 years ago (Giles and Cooper 1985) using radio-collars that required triangulating locations that lacked the accuracy of current GPS radio-collars. They identified summer and winter ranges and a couple of long-distance movements of mule deer into areas where hunting is allowed on public land. Mule deer in their study were not necessarily those known to be using radioactively contaminated locations. Pronghorn are relatively new residents to the NNSS (first observed in 1991) and their use of the NNSS has never been studied but they are known to be widespread.

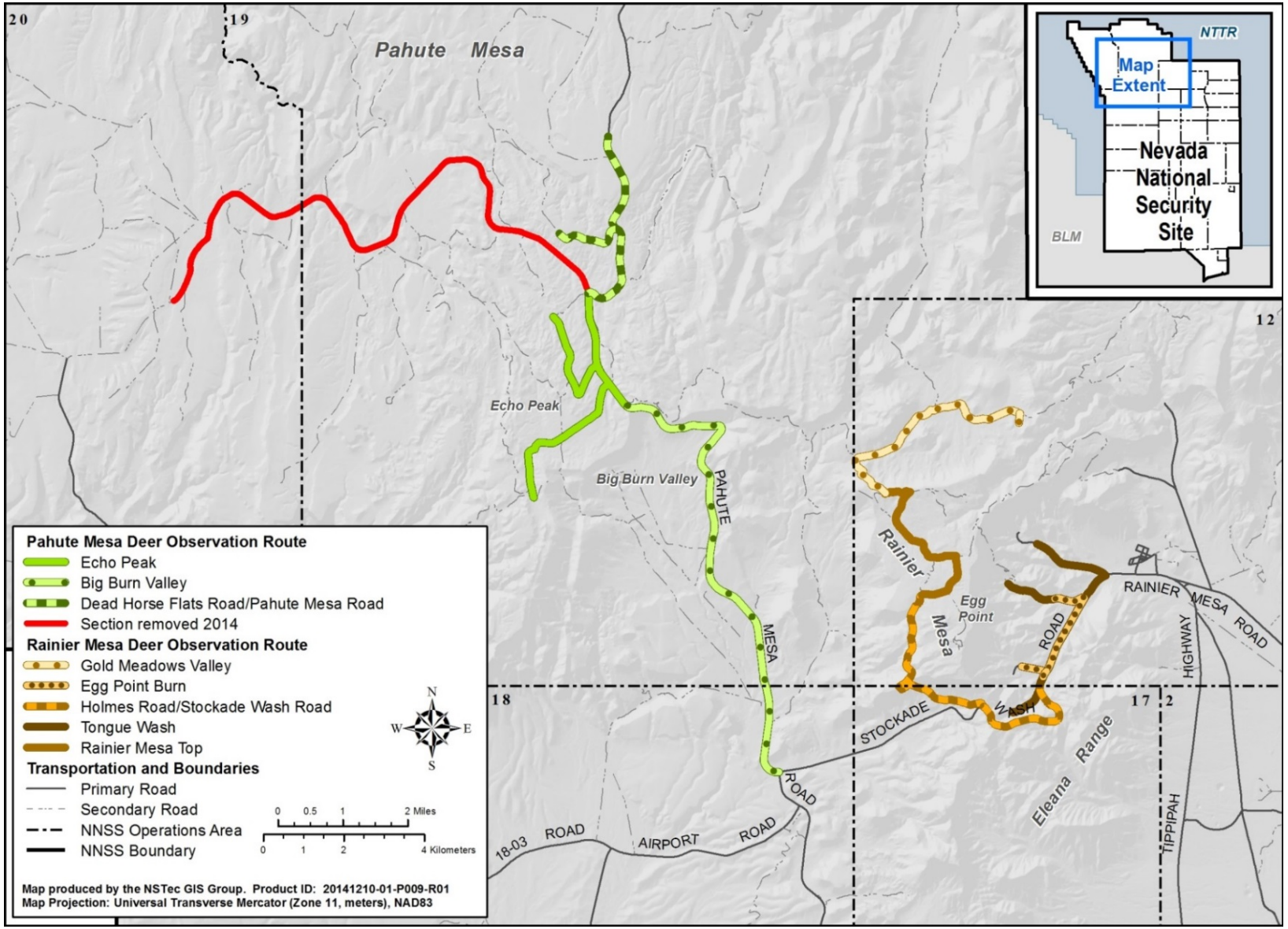

Figure 6-8. Road routes and sub-routes of two NNSS regions driven in 2020 to count deer and section removed due to road closure.

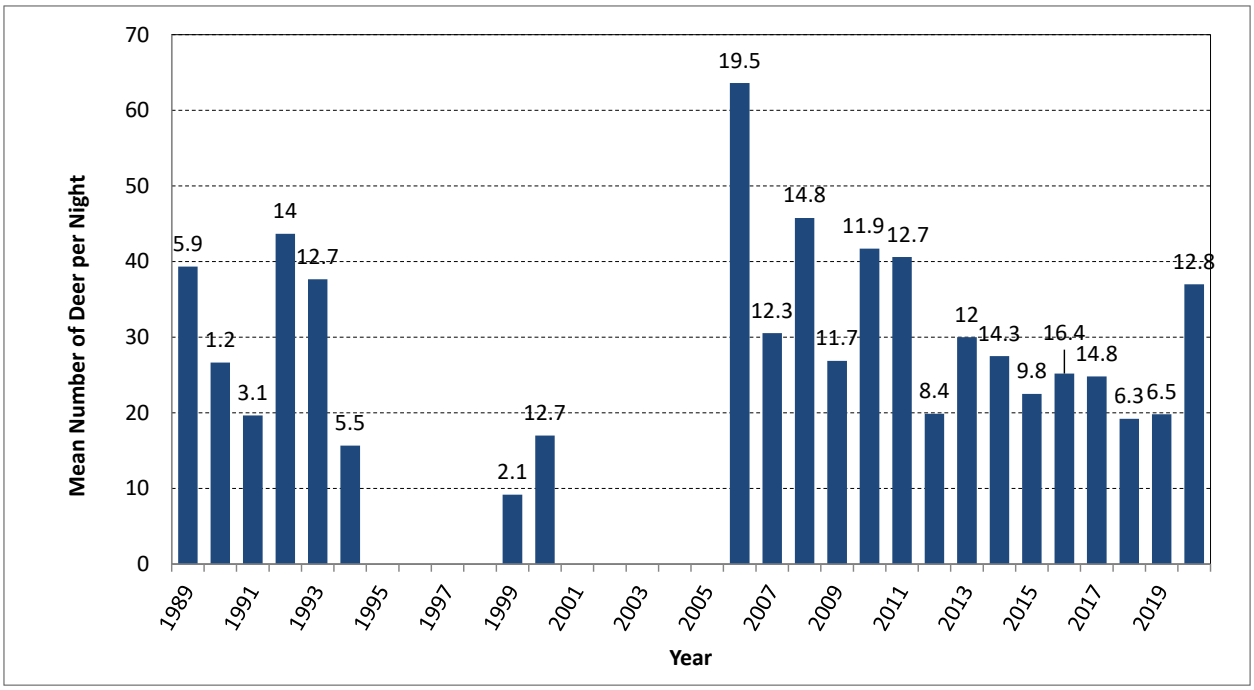

Figure 6-9. Trends in total deer count per night from 1989 to 2020 on the NNSS (surveys were not conducted during 1995–1998 or 2001–2005). Standard deviation values above bars.

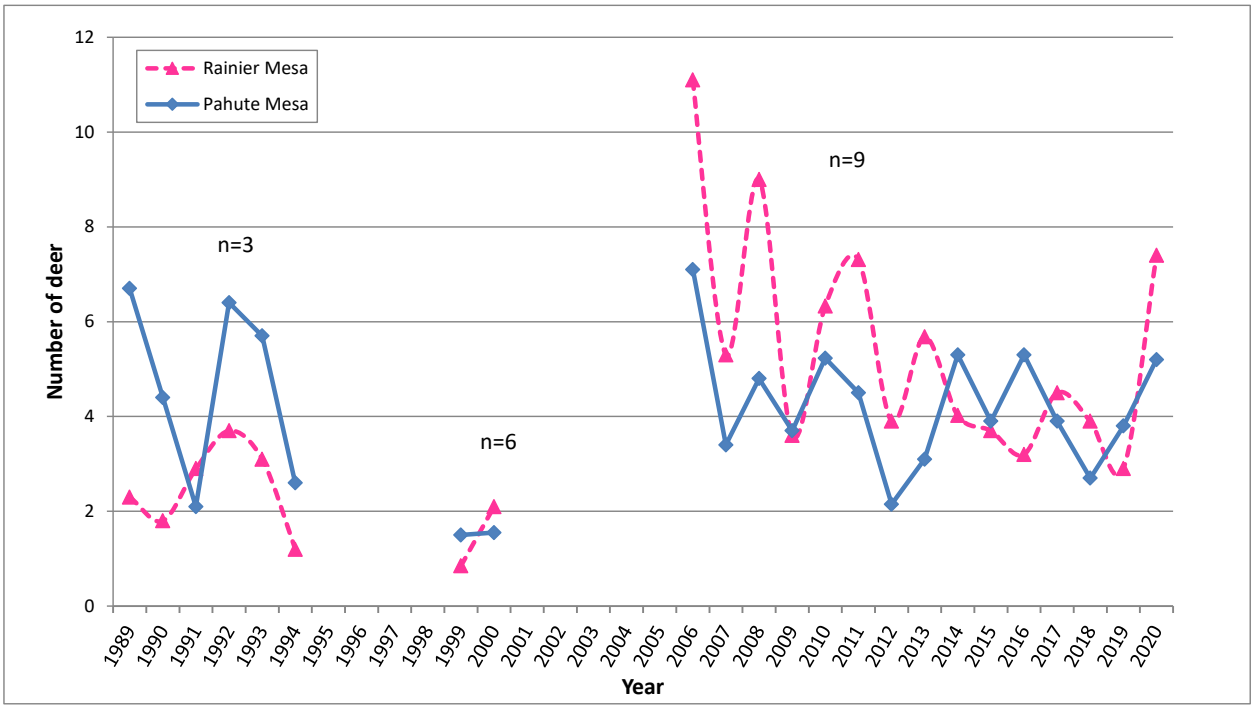

Figure 6-10. Mean number of mule deer per 10 km per night, counted on two routes (n = number of survey nights; exceptions n = 12 for 2012, n = 8 for 2013, n = 6 for 2015–2020).

Table 6-2. Mule deer classified by sex and age, with sex ratios, and fawn to doe ratios from 2006 to 2020 on the NNSS (12 survey nights for 2012, 8 for 2013, 6 for 2015–2020, 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
2019	119	41	47	21	87	10	21
2020	222	63	100	42	63	17	17

Tsukamoto et al. (2003) report the distribution of pronghorn in Nevada as of 2002 with the nearest population to the NNSS being just north in Emigrant Valley. The NNSS represents an expansion of pronghorn range in Nevada.

A research study involving the capture and radio-collaring of mule deer and pronghorn antelope on the NNSS was initiated in November 2019 to better understand the potential radiological dose to the off-site public via the hunter pathway. This was a true collaborative effort involving Kathy Longshore (Co-Principal Investigator, USGS), NDOW (Dr. Peregrine Wolff and Chris Morris [veterinarian support]; Joe Bennett, Pat Cummings, and Cody Schroeder [game biologists]) and MSTS biologists. Native Range Capture Services (David Rivers, pilot, and his crew) was contracted to capture the animals using net guns from a helicopter. NNSA/NFO and DOE Environmental Management Nevada Program graciously provided funding for the study. Study objectives included: 1) determine the distribution, abundance, and range of movements of mule deer and pronghorn, 2) estimate the potential for hunters to harvest mule deer and pronghorn which use the NNSS, 3) evaluate mule deer and pronghorn use of contaminated areas, 4) obtain information on the potential radiological dose to someone consuming deer and pronghorn from the NNSS, 5) determine the potential radiological dose to mule deer and pronghorn on the NNSS, 6) document survival and causes of mortality for both mule deer and pronghorn, 7) refine habitat use patterns for both mule deer and pronghorn using resource selection functions and correlate that with phenological changes in the vegetation, and 8) assess the overall health, disease status, and genetics of NNSS mule deer and pronghorn.

In November 2019, a total of 23 mule deer (16 does, 7 bucks) and 20 pronghorn (14 does, 6 bucks) were captured. All 23 mule deer were radio-collared and ear-tagged, and 18 pronghorn (12 does, 6 bucks) were radio-collared and ear-tagged. Two pronghorn does died within a few days of capture and were killed or scavenged by coyotes. The remaining collared animals were monitored during 2020. Pronghorn spent a majority of time in Frenchman Flat and Yucca Flat with no large seasonal migrations (Figure 6-11), although they remained close to water sources and shade during the hot, dry summer. One doe made a

foray into Emigrant Valley for a few days during late August. Mule deer made seasonal migrations, migrating primarily off the high elevation portions of Rainier and Pahute mesas to lower elevation areas in the CP Hills, Eleana Range, Pahute Mesa, and eastern slopes of Rainier Mesa (Figure 6-11). A buck and a doe migrated from their wintering areas in the Eleana Range and Pahute Mesa to spend the summer in the Kawich Peak area, a distance of nearly 90 km. A few deer also spent time on Shoshone Mountain and Timber Mountain. Six pronghorn (3 bucks, 3 does) and 5 mule deer (2 buck, 3 does) were found dead. One pronghorn buck had been attacked by a mountain lion and the other 5 had either been killed by coyotes or scavenged by coyotes after dying from other causes. Two mule deer were killed by mountain lions, 1 buck was legally harvested by a hunter near Kawich Peak (90 km north of its capture location), and 2 were scavenged or killed by unknown predators. This study will continue through 2022.

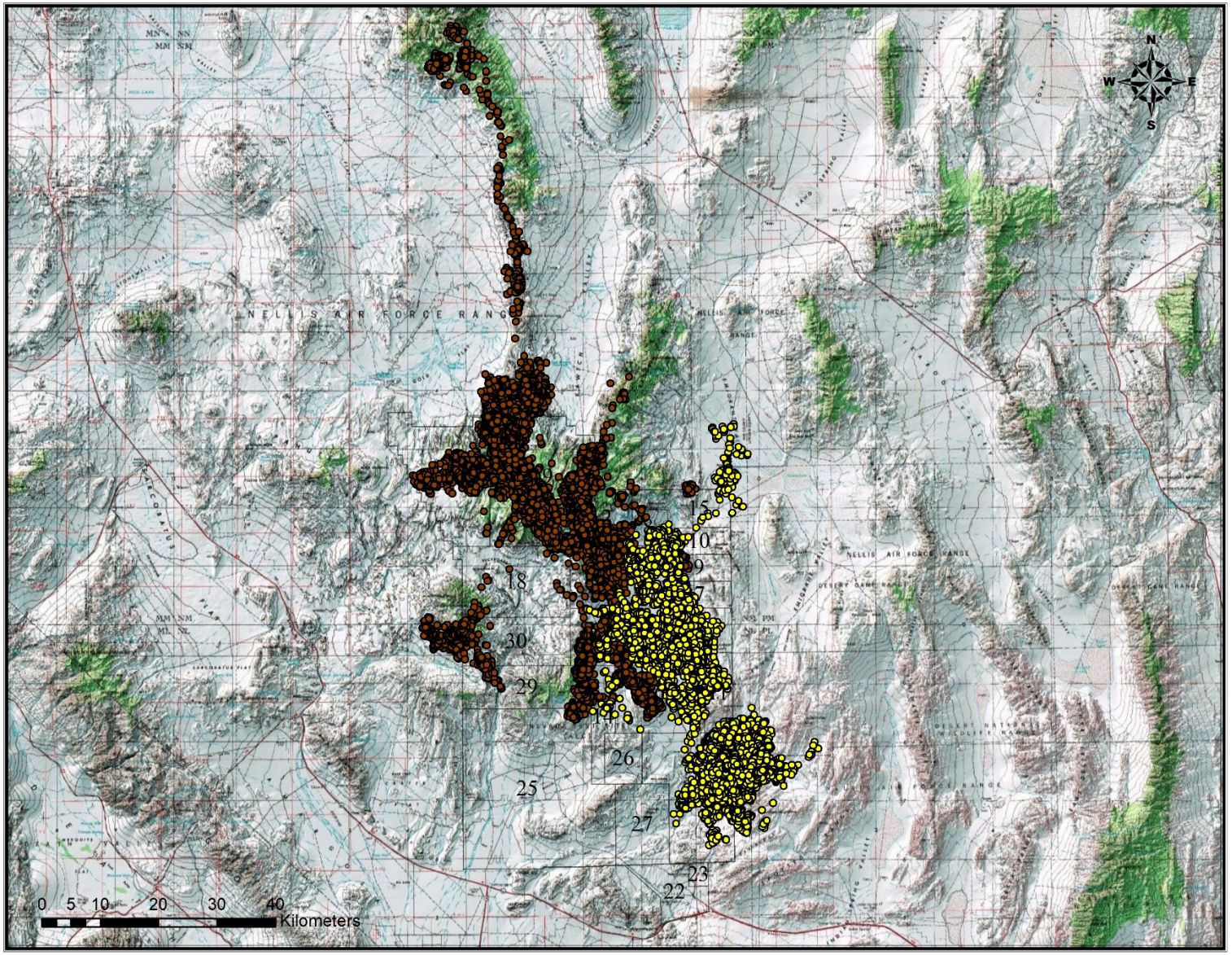

Figure 6-11. Locations of collared mule deer (brown dots) and pronghorn antelope (yellow dots) during 2020.

6.6 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 a recent mountain lion study, including the discovery of ewes and lambs in the Yucca Mountain/Fortymile Canyon area in 2011. These new data expanded the known distribution of sheep on and near the NNSS and prompted the radio-tracking study from 2015-2018. Results of this study were summarized in the 2018 EMAC Report (Hall and Perry 2019) and a comprehensive USGS Open File Report on the study is being finalized for publication. Conclusions from the radio-tracking study recommend continued monitoring of the NNSS sheep population. In 2020, this was done by documenting sheep use at several water sources using camera traps. In addition, a ram was observed in Mercury in late December and it was observed ramming an air conditioning unit on the side of a building. It was also responsible for ramming and breaking windows at buildings 23-143 and 23-650.

6.6.1 Camera Trap Results

During 2020, motion-activated cameras detected sheep at South Pah Canyon Tanks (#15) (165 images) (Figure 6-12), Cottonwood Spring (#4) (132 images), Fortymile Canyon Tanks (#11) (30 images), Delirium Canyon Tanks (#5) (22 images), and Twin Spring (#21) (11 images) (Table 6-3). Eight marked sheep (6 ewes, 2 rams) were identified including Ewe 686314, Ewe 686315, Ewe 686317, Ewe 686320, Ewe 686318, Ewe 686319, Ram 686329, and Ram 123. Six marked sheep (all but Ewe 686315 and Ram 123) were detected at Cottonwood Spring (#4), and four marked sheep (Ewe 686315, Ewe 686317, Ewe 686320, and Ram 123) were detected at South Pah Canyon Tanks (#15). At least an additional 5 unmarked sheep were detected making a total of at least 13 sheep documented on the NNSS during 2020. As in previous years, only rams were detected at Twin Spring. Overall, sheep use at these water sources in 2020 was much lower than in 2019 (360 versus 1,348) although use at South Pah Canyon Tanks (#15) increased from 11 images in 2019 to 165 images in 2020. Perhaps this is due to water availability at these ephemeral water sources due to lack of summer rains in 2020.

Figure 6-12. Ewe 686320 and unmarked ewe at South Pah Canyon Tanks.

(Photo taken by motion-activated camera, June 21, 2020)

6.7 MOUNTAIN LION MONITORING

6.7.1 Motion-Activated Cameras

Few data exist for mountain lion numbers and their distribution in southern Nevada, including the NNSS. Since 2006, MSTS 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 2020 at 26 sites (Figure 6-13 and Table 6-3). 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 2019 due to the accessibility and scheduling of camera trap visits.

A total of 148 mountain lion images (i.e., photographs or video clips) were taken during 179,030 camera hours across all sites (Figure 6-13 and Table 6-3). This equates to about 0.8 mountain lion images per 1,000 camera hours. Mountain lions were detected at 9 of the 26 sites, including 6 water sources, 2 roads, and 1 canyon (Figure 6-13). Table 6-4 contains the camera trap results by month and location. Figure 6-14 depicts three mountain lions (adult and 2 subadults) at Gold Meadows Spring (#18). Figure 6-15 shows a mountain lion at South Pah Canyon Tanks (#15).

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 four individuals (adult male, adult female with 2 subadults) were documented in 2020 from the 26 camera traps. This compares to a minimum of three individuals in 2019 and 2018, four individuals in 2017, five individuals in 2016, three individuals in 2015 and four individuals in both 2014 and 2013. A mountain lion was also observed at E Tunnel Ponds on October 6 and near Gold Meadows Spring on October 7 during mule deer spotlight surveys.

In order to investigate temporal activity of mountain lions, camera detection data from all 15 years (2006-2020) were combined. Mountain lions were detected every month with peak occurrences during November (n = 152), August (n = 148), and June (n = 140) (Figure 6-16). The number of images taken during summer and fall (June–November) (n = 718) accounted for nearly 70% of all images compared with the number of images taken during winter and spring (December–May) (n = 318) (Figure 6-16). Nearly three-fourths of mountain lion images were taken between 1700 to 0500 hours (Figure 6-17). From 2011 to 2020, nearly 1.7 times as many images were taken when it was dark (n = 528) compared with when it was light (n = 317).

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 30,216 images of at least 81 species other than mountain lions were taken during 179,030 camera hours across all sites (Table 6-3) which is about 169 images per 1,000 camera hours. This is the greatest species richness documented using camera traps in a given year.

The most prevalent species photographed (18% of all images) was mule deer (5,402 images at 13 of 26 sites). Gold Meadows Spring (3,386 images), Camp 17 Pond (1,013 images) and Captain Jack Spring (567 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 6.6.1), Rocky Mountain elk (*Cervux elaphus*) (see Section 6.10), bobcat (found at 14 of 26 sites), gray fox (*Urocyon*

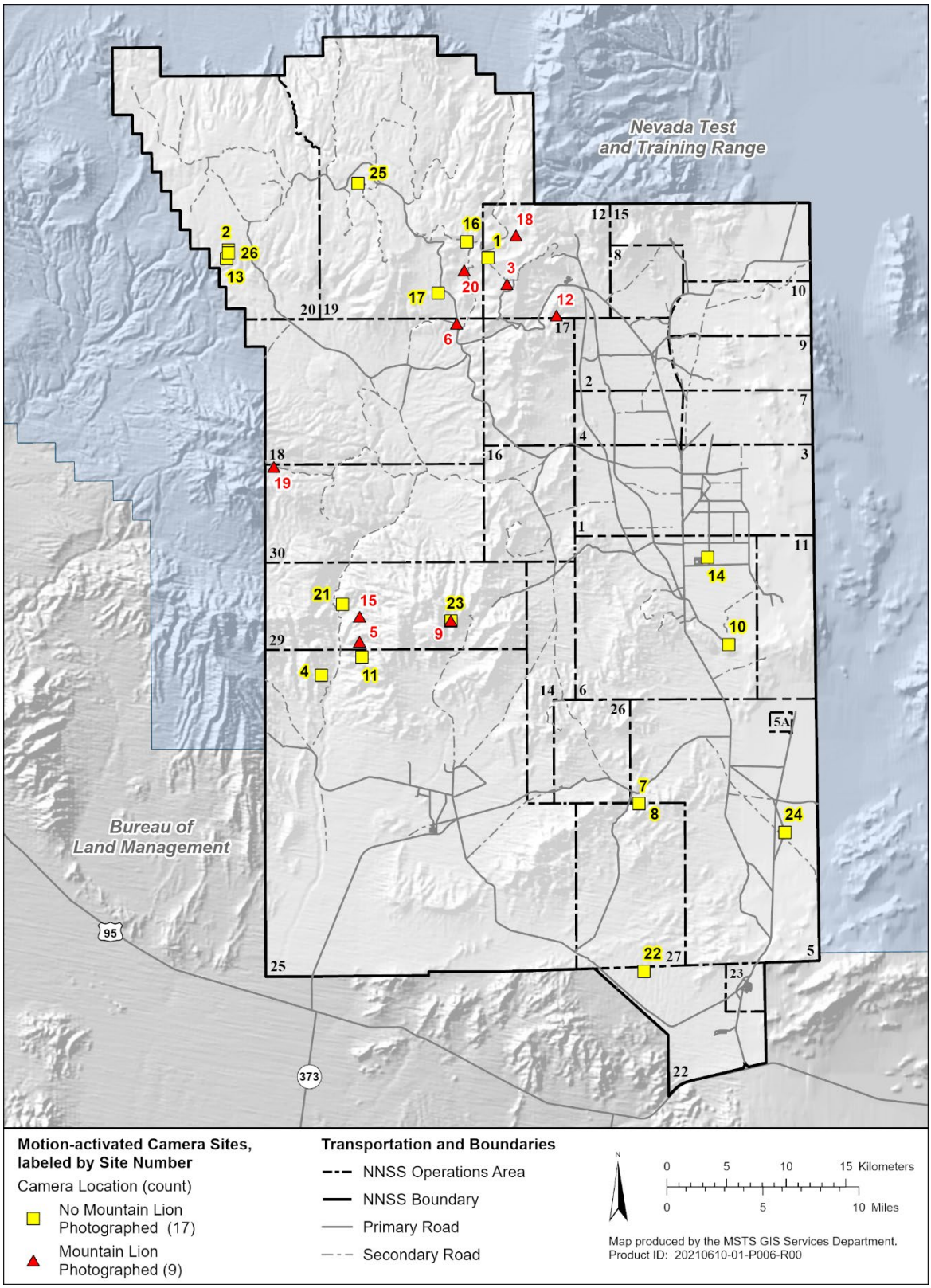

Figure 6-13. Locations of mountain lion photographic detections and camera traps on the NNSS during 2020.

Table 6-3. Results of mountain lion camera surveys during 2020 (a = non-continuous operation due to camera problems, dead batteries, full memory cards, etc.; b = camera hours not known for some time periods)

Location (Site Number)	Dates Sampled	Camera Hours	Mountain Lion Images (Number of Images per 1,000 Camera Hours)	Other Observations (Number of Images)
Gold Meadows Spring (#18)	1/1-12/31/20[a]	5,088	78 (15.3)	Bobcat (1), coyote (719), Rocky Mountain elk (291), pronghorn antelope (727), mule deer (3,386), horse (3,644), bats (9), bald eagle (1), golden eagle (177), peregrine falcon (10), prairie falcon (1), Cooper's Hawk (4), red-tailed hawk (21), great-horned owl (5), turkey vulture (546), chukar (1), mourning dove (7), great egret (7), Bonaparte's gull (26), northern pintail (9), common flicker (1), blue-winged teal (1), green-winged teal (1), ducks (76), common raven (2,301), pinyon jay (1), western tanager (1), northern mockingbird (1), Cassin's kingbird (7), sage sparrow (2), white-crowned sparrow (18), brown-headed cowbird (73)
Topopah Spring (#9)	12/17/19-12/31/20[a]	6,165	18 (2.9)	Bobcat (1), coyote (1), chukar (26), scrub jay (18), lesser goldfinch (4)
Delirium Canyon (#5)	1/16/20-12/31/20	8,414	18 (2.1)	Bobcat (15), gray fox (36), ring-tailed cat (3), coyote (17), desert bighorn sheep (22), rock squirrel (18), cliff chipmunk (4), bats (21), golden eagle (5), red-tailed hawk (12), chukar (26) mourning dove (241), *Sceloporus* spp. (3)
Camp 17 Pond (#6)	12/16/19-12/31/20[a]	6,076	11 (1.8)	Bobcat (16), coyote (320), mule deer (1,013), horse (1,716), black-tailed jackrabbit (22), bats (10), golden eagle (24), common blackhawk (5), Cooper's hawk (117), red-tailed hawk (461), great-horned owl (5), turkey vulture (711), chukar (123), mourning dove (854), common raven (238), great blue heron (13), lesser yellowlegs (16), American avocet (8), willet (28), killdeer (11), American coot (1), ducks (2), belted kingfisher (1), scrub jay (13), western kingbird (5), northern mockingbird (5), great-tailed grackle (6), brown-headed cowbird (4), house finch (15), rock dove (46)

Table 6-3. Results of mountain lion camera surveys during 2020 (a = non-continuous operation due to camera problems, dead batteries, full memory cards, etc.; b = camera hours not known for some time periods)

Location (Site Number)	Dates Sampled	Camera Hours	Mountain Lion Images (Number of Images per 1,000 Camera Hours)	Other Observations (Number of Images)
Rattlesnake Ridge Gorge (#20)	1/1/20-12/31/20[a]	8,793	10 (1.1)	Rock squirrel (1), mourning dove (1)
East Cat Canyon (#19)	12/16/19-12/31/20[a]	6,655	7 (1.1)	Bobcat (2), coyote (4), mule deer (21)
South Pah Canyon (#15)	1/16/20-12/31/20	8,415	4 (0.5)	Bobcat (6), gray fox (38), coyote (1), ring-tailed cat (1), spotted skunk (2), desert bighorn sheep (165), cliff chipmunk (12), bats (256), white-tailed antelope ground squirrel (2), golden eagle (6), red-tailed hawk (34), Cooper's hawk (51), great-horned owl (9), chukar (83), mourning dove (1,010), common raven (3), pinyon jay (593), scrub jay (45), western tanager (3), Scott's oriole (1), lazuli bunting (6), red-shafted common flicker (1), northern mockingbird (10), hummingbird (1), rufous-sided towhee (5), dark-eyed junco (50), white-crowned sparrow (194), Say's phoebe (10), rock wren (33), house finch (4), *Sceloporus* spp. (6), tarantula (1), dragonfly (1)
Captain Jack Spring (#12)	12/16/19-12/31/20[a]	4,292	1 (0.2)	Bobcat (11), gray fox (7), coyote (15), mule deer (567), rock squirrel (4), cliff chipmunk (3), bats (4), Cooper's hawk (4), chukar (164), mourning dove (47), pinyon jay (1,759), common raven (76), red-shafted common flicker (1), rufous sided towhee (8), house finch (6)
Dick Adams Cutoff Road, Rainier Mesa (#3)	12/17/19-12/31/20	9,136	1 (0.1)	Mule deer (66)
East 19-01 Road (#16)	1/1/20-12/31/20[a]	4,649	0 (0.0)	Bobcat (3), gray fox (3), coyote (13), mule deer (7) black-tailed jackrabbit (21)
12T-26, Rainier Mesa (#1)	1/1/20-12/31/20	8,772	0 (0.0)	Mule deer (1)

Table 6-3. Results of mountain lion camera surveys during 2020 (continued).

Location (Site Number)	Dates Sampled	Camera Hours	Mountain Lion Images (Number of Images per 1,000 Camera Hours)	Other Observations (Number of Images)
Water Bottle Canyon (#17)	12/17/19-12/31/20[a,b]	unknown	0 (0.0)	None
Topopah Spring Trough (#23)	12/17/19-12/31/20	9,132	0 (0.0)	Mule deer (1)
Area 22, Juvenile GOAG [c] Site 2 (#22)	1/7/20-12/31/20[a]	7,397	0 (0.0)	Coyote (3), kit fox (1), badger (4), black-tailed jackrabbit (59), white-tailed antelope ground squirrel (56), kangaroo rat (22), LeConte's thrasher (7), zebra-tailed lizard (3)
Twin Spring (#21)	1/16/20-12/31/20[a]	3,209	0 (0.0)	Bobcat (4), coyote (8), desert bighorn sheep (11), mule deer (139), burro (1,406), desert woodrat (19), bat (1), golden eagle (16), chukar (469), mourning dove (95), loggerhead shrike (1), greater roadrunner (2), common raven (12), house finch (1)
Fortymile Canyon Tanks (#11)	1/16/20-12/31/20[a]	7,927	0 (0.0)	Bobcat (1), desert bighorn sheep (30), golden eagle (2), mourning dove (1)
Cottonwood Spring (#4)	1/16/20-12/31/20[a]	6,728	0 (0.0)	Bobcat (50), coyote (1), desert bighorn sheep (132), burro (52), desert woodrat (15), white-tailed antelope ground squirrel (4), *Peromyscus* spp. (3), chukar (80), mourning dove (430), house finch (36), common raven (1), desert spiny lizard (11), side-blotched lizard (1)
Cane Spring (#7)	12/17/19-12/31/20[a]	216,555	0 (0.0)	Bobcat (5), mule deer (189), bats (4), mourning dove (216), northern mockingbird (25), common raven (3)
Cane Spring Trough (#8)	12/17/19-12/31/20	9,131	0 (0.0)	Mule deer (1)
Area 6 LANL Pond Trough (#14)	12/16/19-12/31/20	9,157	0 (0.0)	Pronghorn antelope (9), mule deer (1), burro (7), common raven (1)

Table 6-3. Results of mountain lion camera surveys during 2020 (continued).

Location (Site Number)	Dates Sampled	Camera Hours	Mountain Lion Images (Number of Images per 1,000 Camera Hours)	Other Observations (Number of Images)
Well C1 Pond Trough (#10)	12/16/19-12/31/20	9,158	0 (0.0)	Bobcat (5), coyote (17), pronghorn antelope (15), mule deer (39), burro (22), golden eagle (3), great-horned owl (1), turkey vulture (14), chukar (3), mourning dove (3), common raven (12)
Well 5C Trough (#24)	12/16/19-12/31/20	9,159	0 (0.0)	Bobcat (63), coyote (318), badger (7), pronghorn antelope (242), burro (248), black-tailed jackrabbit (338), white-tailed antelope ground squirrel (1), bats (3), golden eagle (4), red-tailed hawk (3), prairie falcon (3), turkey vulture (3), mourning dove (401), greater roadrunner (7), common raven (152), western meadowlark (4), horned lark (404), great-tailed grackle (1), Brewer's blackbird (6), house finch (364), European starling (12), swallowtail butterfly (1)
ER 20-5 Upper Plastic-lined Sump (#2)	12/16/19-12/31/20	9,146	0 (0.0)	Bats (2), pinyon jay (2), common raven (21)
U19ad Plastic-lined Sump (#25)	12/16/19-8/13/20[a]	5,376	0 (0.0)	None
ER 20-7 Plastic-lined Sump (#13)	12/16/19-12/31/20[a]	7,355	0 (0.0)	Coyote (2), turkey vulture (1), common raven (8), passerine (1)
ER 20-5 Plastic-lined Sump (#26)	12/16/19-12/31/20	9,145	0 (0.0)	Common raven (24), Say's phoebe (3), passerine (1)

[c] desert tortoise

Table 6-4. Number of mountain lion images taken with camera traps by month and location, December 2019 through December 2020 (orange = number of mountain lion images; yellow = camera operational, no mountain lion images; green = camera not operational).

Camera Location (Site number)	Dec-19	Jan-20	Feb-20	Mar-20	Apr-20	May-20	Jun-20	Jul-20	Aug-20	Sep-20	Oct-20	Nov-20	Dec-20
Delirium Canyon (#5)							4					14	
South Pah Canyon (#15)			1			1				1	1		
Topopah Spring (#9)				3		5	5	1	4				
East Cat Canyon Road (#19)			1			1			2	1	1		1
Captain Jack Spring (#12)					1								
Rattlesnake Ridge Gorge (#20)						2	1		3	1	1	1	1
Camp 17 Pond (#6)	1			1			2	1	1	5			
Dick Adams Cutoff Road (#3)									1				
Gold Meadows Spring (#18)						4	8	24	35	4	3		

Number of mountain lion images

Camera operational, no mountain lions detected

Camera not operational

Figure 6-14. Three mountain lions (adult and two subadults) at Gold Meadows Spring.

(Photo taken October 23, 2020 by motion-activated camera)

Figure 6-15. Mountain lion at South Pah Canyon Tanks.

(Photo taken May 14, 2020 by motion-activated camera)

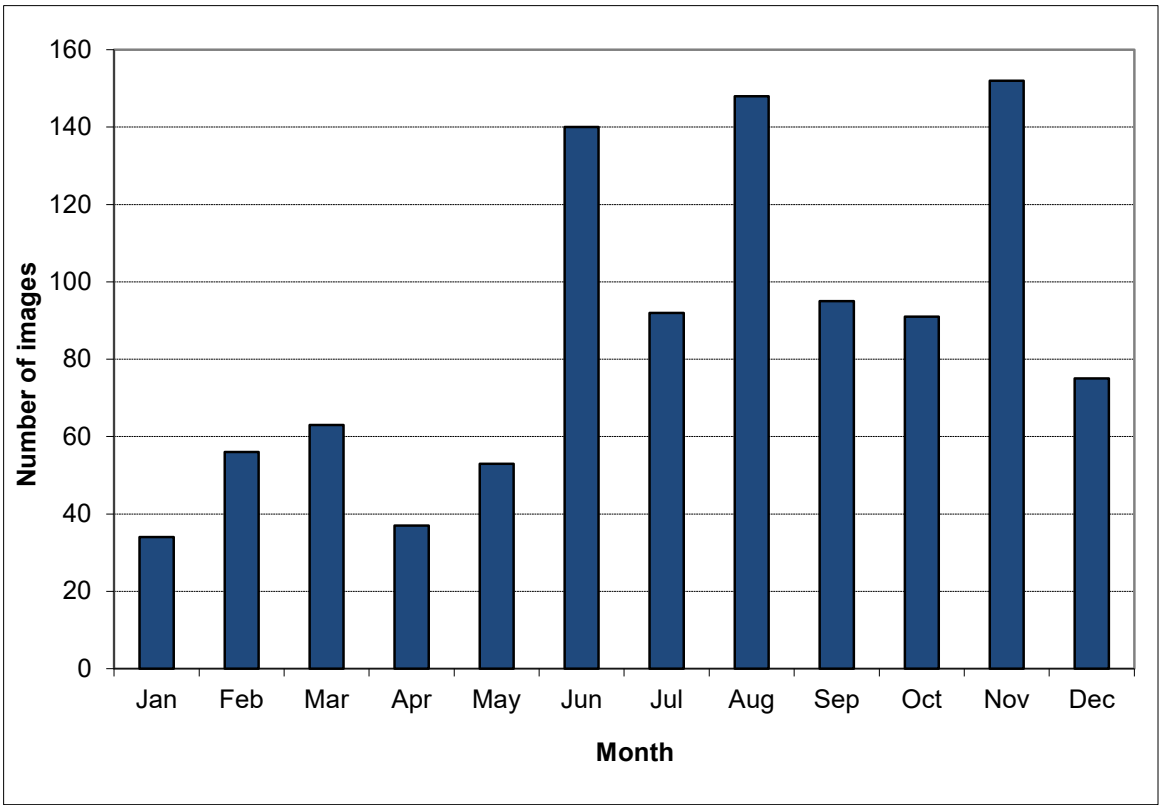

Figure 6-16. Number of mountain lion images by month for camera sites where mountain lions were detected from 2006 through 2020 (n = 1,036).

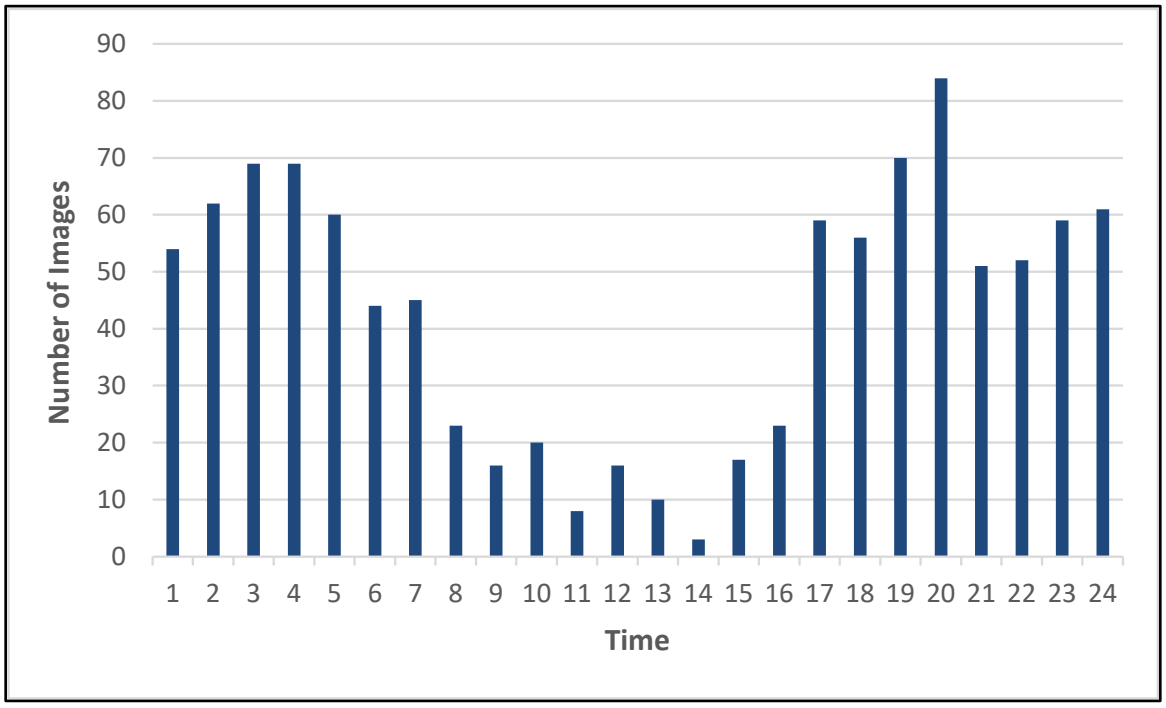

Figure 6-17. Number of mountain lion images by time of day (Pacific Standard Time) for camera sites where mountain lions were detected from 2006 through 2020 (n = 1,031).

cinereoargenteus) (found at 4 of 26 sites), golden eagle (found at 8 of 26 sites), badger (found at 2 of 26 sites), ring-tailed cat (found at 2 of 26 sites), spotted skunk (found at 1 of 26 sites), bald eagle (found at 1 of 26 sites), peregrine falcon (found at 1 of 26 sites), common blackhawk (found at 1 of 26 sites), and pinyon jay (found at 4 of 26 sites) (Table 6-3). Kit fox and LeConte's thrasher (*Toxostoma lecontei*) were documented at the Area 22, Juvenile GOAG Site 2 (#22) location. Noteworthy observations of some of the more common species included 3,306 images of mourning doves at 12 of 26 sites, 2,852 images of common ravens at 13 of 26 sites, and 1,439 images of coyotes at 14 of 26 sites. Greatest use and highest species richness was documented at water sources (both natural and constructed) which emphasizes the importance of various water sources for several wildlife species, particularly during the drier months.

6.8 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 may 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 2020, eight tissue samples were collected opportunistically and analyzed from five mule deer (three does, two bucks) and three pronghorn (three bucks). One pronghorn was killed by a vehicle in Area 3 and the remaining animals were all collared as part of the mule deer and pronghorn distribution study and died of various causes, mostly due to predation. Water was distilled from the tissue samples and submitted to a laboratory for tritium analysis. The remaining tissue samples were submitted for Strontium-90, Plutonium-238, Plutonium-239+240, Americium-241, and gamma spectroscopy analysis.

Results revealed low radionuclide concentrations as follows: tritium in the road killed pronghorn in Area 3, Plutonium-239+240 in one of the mule deer and two of the pronghorn, and Americium-241 in one of the pronghorn. All of these concentrations are very 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 (2020).

6.9 NUISANCE AND POTENTIALLY DANGEROUS WILDLIFE

During 2020, MSTS biologists documented 53 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 (17 calls), bats (8 calls), other mammals (19 calls), reptiles (8 calls, including 2 rattlesnakes), and invertebrates (bees, 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.

Safety presentations were also given and sent out via employee communications to educate NNSS workers about some of the potential hazards NNSS wildlife pose and how to safely work to protect themselves and the animals that call the NNSS their home.

6.10 ELK AND FERAL BURROS

Historic studies on the NNSS do not mention the presence of Rocky Mountain elk (*Cervus elaphus*) (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 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 2020, elk were photographed at Gold Meadows Spring 291 times between May 7 and August 18. At least two bulls were documented (Figure 6-18). Elk were observed with several other species including mountain lion (Figure 6-19), coyote, pronghorn, mule deer, and horse.

Figure 6-18. Two bull elk at Gold Meadows Spring.

(Photo taken by motion-activated camera, July 5, 2020)

Figure 6-19. Mountain lion (foreground) keeping an eye on bull elk (upper right) at Gold Meadows Spring.

(Photo taken by motion-activated camera, August 4, 2020)

Feral burros appear to be increasing in number and expanding their range on the NNSS. During 2020, burros were documented with camera traps at Twin Spring (#21) (1,406 images), Well 5C trough (#24), (248 images), Well C1 Pond Trough (#10) (22 images), Area 6 LANL Pond Trough (#14) (7 images) and at a new location Cottonwood Spring (#4) (52 images) (Table 6-3). The area around Twin Spring and Cottonwood Spring was heavily disturbed from burro use with numerous trails on the hillslopes around the springs. Numerous photos at Twin Spring showed burros with mule deer and desert bighorn sheep and it appeared that burros were dominating use of the water (Figure 6-20).

6.11 COORDINATION WITH BIOLOGISTS AND WILDLIFE AGENCIES

MSTS biologists interfaced with other biologists and wildlife agencies in 2020 for the following activities:

- Wrote an article entitled “Western Burrowing Owl Radio-tracking Study” for the Nevada Chapter of The Wildlife Society Newsletter.
- Finalized a manuscript entitled “Repatriated Desert Bighorn Sheep Population on the Nevada National Security Site” for publication in the 2019 Desert Bighorn Council Transactions: Volume 55.
- Contributed to the draft version of the Nevada Bat Conservation Plan.
- Participated on the Springsnail Conservation Team.

- Submitted a project nomination entitled, "Burrowing Owl and Winter Raptor Monitoring on the Nevada National Security Site" to the Council for the Conservation of Migratory Birds for consideration for the Presidential Migratory Bird Federal Stewardship Award. It was selected as one of three finalists for the award.

Figure 6-20. Burros "protecting" water source from mule deer at Twin Spring.

(Photo taken by motion-activated camera, August 20, 2020)

7.0 HABITAT RESTORATION MONITORING

MSTS biologists have conducted revegetation activities at disturbances on and off the NNSS in support of NNSA/NFO and DOE Environmental Management Nevada Program activities and continue to evaluate those efforts. Revegetation supports the intent of U.S. Executive Order 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 2020 included visually assessing the vegetation at the U-3ax/bl closure cover (Corrective Action Unit [CAU] 110) (Area 3 RWMS) and the "92-Acre Site" (CAU 111) (Area 5 RWMC), preparing for the revegetation of CAU 577 East and West Cover Caps (Area 5 RWMC), and revegetating Cell 18 (Area 5 RWMC).

7.1 CAU 110, U-3AX/BL, CLOSURE COVER

The installation of an evapotranspiration cover on CAU 110, U-3ax/bl closure site, located in Area 3 of the NNSS, was completed in the fall of 2000. Once the evapotranspiration cover was in place, action was taken to establish a cover of native vegetation. Revegetation activities were completed in December 2000. The plant community on the closure cover has been monitored annually since the spring of 2001 to document the vigor of the plant community that has established on the cover and to identify any remedial actions that may be necessary to ensure that it persists.

A qualitative assessment of the vegetation on CAU 110, U3-ax/bl closure cover was made on July 30, 2020. A meandering transect covering the entire cap was walked. The vigor of perennial plant species was assessed based on current year's growth, whether plants were flowering, and if any showed signs of stress, i.e. dead stems or leaves. Shadscale (*Atriplex confertifolia*) continues to be the most abundant shrub species on the closure cover (Figure 7-1). None of the plants observed showed signs of stress, however some dead shadscale plants were noted. Flowering plants were uncommon because of the time of sampling. However, many of the shadscale plants were fruiting and had good seed production. Nevada jointfir, the second most common perennial species, was doing well, although no evidence of seed production was observed. A few winterfat (*Krascheninnikovia lanata*) plants were also noted. No perennial plant seedlings were seen.

No perennial grasses have been found on the closure cover for several years and none were found again this year. Annual plant cover was moderate with abundant cheatgrass growing amongst the shadscale and Nevada jointfir plants. This will be tracked in future years to help ensure it doesn't negatively impact shrub survival. Some native annual forbs, cushion cryptantha (*Cryptantha circumscissa*) and flatcrown buckwheat (*Eriogonum deflexum*), were growing in the shrub interspaces. Saltlover (*Halogeton glomeratus*) and prickly Russian thistle (*Salsola tragus*) were found in small numbers on the cover cap but were the dominant species, along with flatcrown buckwheat, on the unseeded portion on the periphery of the cover cap, highlighting the importance of seeding to establish a perennial vegetation community.

During the vegetation surveys, small mammal activity on the CAU 110, U-3ax/bl closure cover was evaluated. Several burrow complexes were noted but not counted. Many of the burrows were inactive. A small mammal trapping effort for another project revealed a pattern of low numbers of small mammals on the cover cap. The number of burrows on the cover cap is far less than in the native undisturbed areas in Yucca Flat. Trapping for small mammal removal is not recommended at this time. No rabbits were observed or evidence of herbivory on the vegetation. One passerine bird was observed on the cover cap.

Figure 7-1. Overview of plant community that has established on the CAU 110 over the last 20 years. Shadscale and Nevada jointfir are the two most dominant plants found on the closure cover. Note the dense cheatgrass growing amongst the shrubs.

(Photo by D.B. Hall, July 30, 2020)

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

A qualitative assessment of vegetation at the 92-acre site on July 30, 2020 found very few perennial plants on any of the cover caps. There were about 20 large fourwing saltbush 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 pretty high due to the abundant precipitation earlier in the spring and early summer with saltlover, Arabian schismus, and prickly Russian thistle being the most common species (Figure 7-2). No rabbits or fresh rabbit sign were observed. Light rodent burrowing activity was detected.

Figure 7-2. North North Cover on the "92-acre Site" with an abundance of weeds, primarily saltlover, Arabian schismus, and prickly Russian thistle.

(Photo taken July 30, 2020 by D.B. Hall)

7.3 CAU 577 EAST AND WEST COVER CAP REVEGETATION PREPARATION

During 2020, several actions were taken to prepare for the revegetation of CAU 577 East (5.2 ha) and West (7.0 ha) Cover Caps. These included procuring commercial seed; collecting white bursage, creosote bush, desert pepperweed (*Lepidium fremontii*), and desert globemallow seed at the NNSS to include in the seedmix and for growing the transplants; contributing to the design of the wheel line irrigation system; overseeing the writing of the revegetation plan; and providing input to procurement in setting up the revegetation subcontracts.

7.4 AREA 5 RWMC, CELL 18 REVEGETATION

Revegetation of the Cell 18 Cover Cap was initiated in late October. First, the site was ripped to a depth of 30-45 cm using a low, load-bearing bulldozer with a ripper bar. Then a wildland seedmix of native species was broadcast seeded over the site with a drill seeder at a rate of 30 pounds of pure live seed per acre (Table 7-1). Seed was lightly covered using a custom chain harrow dragged behind the seeder (Figure 7-3). Prior to seeding, all white bursage and creosote bush seeds were rinsed with water for about 20 hours in order to prime the seed and remove a chemical germination inhibitor to enhance germination

Table 7-1. Seedmix used at Cell 18 Cover Cap including lifeform, species information, number of pounds of pure live seed (PLS) per acre, number of pure live seeds per square meter, and type of seedbin seed was put in.

Lifeform	Common Name	Species	PLS lbs/acre	PLS seeds/m2	Seedbin
Shrub	White bursage	*Ambrosia dumosa NNSS*	2.8	58	Fluffy
Shrub	White bursage	*Ambrosia dumosa Commercial*	3.7	78	Fluffy
Shrub	Fourwing saltbush	*Atriplex canescens*	1.5	21	Hard
Shrub	Shadscale	*Atriplex confertifolia*	2.0	32	Hard
Shrub	Cattle saltbush	*Atriplex polycarpa*	0.5	99	Hard
Shrub	Nevada joinfir	*Ephedra nevadensis*	6.3	31	Hard
Shrub	Winterfat	*Krascheninnikovia lanata*	1.5	42	Fluffy
Shrub	Creosote bush	*Larrea tridentata NNSS*	1.4	28	Fluffy
Shrub	Creosote bush	*Larrea tridentata Commercial*	4.6	90	Fluffy
Grass	Indian ricegrass	*ACHY var. Paloma*	2.0	80	Hard
Grass	Squirreltail	*Elymus elymoides var. Toe Jam*	1.2	57	Hard
Forb	Desert marigold	*Baileya multiradiata*	0.5	131	Fluffy
Forb	Palmer penstemon	*Penstemon palmeri var. Cedar*	1.0	151	Hard
Forb	Desert globemallow	*Sphaeralcea ambigua*	1.0	124	Hard
		TOTAL	30.0	1022	

Figure 7-3. Broadcast seeding Cell 18 Cover Cap using drill seeder with attached chain harrow to cover the seed.

(Photo taken October 22, 2020 by D.B. Hall)

(Ostler et al. 2002). Two, 0.4 ha plots were seeded with slightly different seed mixes to compare germination and establishment of locally-collected white bursage and cresosote bush seed with commercially purchased seed. Due to the low purity of some of the seed, two passes were required to apply enough bulk seed to achieve the desired rate. The first pass was fluffy only and the second pass was fluffy plus hard seed plus harrowing. Following seeding, a straw mulch plus soil binder product (HydroStraw Guar Plus Formulation) was applied over the site (Figure 7-4) at a rate of 2,240 kg/ha for soil moisture retention, organic matter additive and erosion control. Seeding and hydromulching were done by SoilTech who was a subcontractor to Canyon Electric, the main revegetation subcontractor. Then a wheel line irrigation system (Figure 7-5) as designed by Cascade Earth Sciences (subcontractor to Canyon Electric) was installed at the site by JTS Farmstore, also a subcontractor to Canyon Electric. A total of 5 cm of irrigation was applied over the whole site in November to moisten the soil profile as deep as possible to recharge the water content in the soil profile so the roots of germinated seed had moist soil to grow into. The soil profile was extremely dry due to drought conditions with little to no precipitation at the site since April. Another 2.5 cm was applied in early December to provide a moist chill to break dormancy of certain species like shadscale. Small mesh seedbags containing seed were buried at the site in order to periodically retrieve them and assess the status of germination and verify viable seed was seeded.

The Nevada Division of Forestry nursery is growing about 4,000 plants (~2,000 white bursage, ~2000 creosote bush) to be transplanted at Cell 18 in April, 2021. These plants were seeded with seed collected from Area 5 in 2019. Additional irrigation is planned at the site for germination irrigation in the spring and seedling density counts will be made to assess revegetation progress in late spring.

Figure 7-4. Applying hydromulch at the Cell 18 Cover Cap.

(Photo taken by D.B. Hall, October 26, 2020)

Figure 7-5. Wheel line irrigation system at Cell 18 Cover Cap.

(Photo taken by D.B. Hall, October 29, 2020)

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