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ECOLOGICAL MONITORING AND COMPLIANCE PROGRAM

2025 REPORT



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2025 REPORT

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and **Fernando K. Diaz**

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EXECUTIVE SUMMARY

The Ecological Monitoring and Compliance Program, funded through the United States Department of Energy, National Nuclear Security Administration Nevada Field Office, monitors the ecosystems 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 2025. 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 implementation and monitoring. During 2025, all applicable laws, regulations, and permit requirements were met except for one case of unauthorized off-road driving.

Sensitive and protected/regulated species of the NNSS include 43 plants, 1 mollusk, 2 insects, 2 reptiles, 242 birds, and 31 mammals. These species are protected, regulated, or considered sensitive according to state or federal regulations and natural resource agencies and organizations. The Nevada Department of Natural Heritage (NDNH) combined their Watch and At-risk Plant and Animal Track Lists which greatly increased the number of potential sensitive species occurring on the NNSS. This new list will be evaluated during 2026 to revise the NNSS sensitive plant and animal list. 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 22 projects. A total of 171.7 hectares (ha) were surveyed for these projects. Some of the sensitive and protected/regulated species and important biological resources found during the surveys included: one large tortoise relocated off an access road to a project area; one manmade pitfall that was backfilled to avoid animal entrapment; one tortoise burrow (collapsed); two hibernating Townsend's big-eared bats (*Corynorhinus townsendii*) (avoided); one burrowing owl (*Athene cunicularia*) (avoided); one inactive greater roadrunner (*Geococcyx californianus*) nest (avoided); several inactive bird nests (avoided or removed); 17 dead birds in an open, lined sump containing drilling discharge water; several Say's Phoebe (*Sayornis saya*) carcasses inside an abandoned building scheduled for demolition; invasive plant Sahara mustard (*Brassica tournefortii*) at one project area; ungulate sign (pronghorn antelope [*Antilocapra americana*], feral burro [*Equus asinus*], and mule deer [*Odocoileus hemionus*]); yucca plants (Joshua tree [*Yucca brevifolia*] and Mojave yucca [*Yucca schidigera*]); and multiple cactus species. NNSS biologists communicated with ground crews and provided written summary reports to project managers of survey findings and mitigation recommendations when applicable.

Ten tortoise clearance surveys were conducted by NNSS biologists. One large tortoise was relocated off an access road to a project area. No tortoises were reported injured or killed during projects. Projects did not disturb any tortoise habitat during 2025. One project had a noncompliance incident with off-road driving. All other projects that were monitored within tortoise habitat remained within the surveyed area. There were 77 tortoise roadside observations with three being roadkill. Juvenile tortoises continue to be monitored as part of a collaborative effort to study survival of translocated animals. After 160 months post-release, 10 of the 60 tortoises (16.7%) (4 female, 6 male) were known to be alive and doing well.

From 1978 to 2025, an average of 9.8 wildland fires per year and about 130 ha per fire have burned on the NNSS. Many 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 species [*Pinus monophylla/Juniperus osteosperma/Artemisia* spp.] plant communities). These vegetation 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). Ten wildland fires were documented on the NNSS in 2025. Eight were project related and two were caused by lightning. The

lightning-caused Cat Canyon Fire was the largest and burned approximately 6,571 ha (3,628 ha on NNSS, 2,943 ha on Nevada Test and Training Range [NTTR]) in primarily sagebrush and pinyon-juniper habitat in Area 30 and onto the NTTR. One was a single tree fire, also caused by lightning and started on the same day as the Cat Canyon Fire, that burned about 0.1 ha in Area 20. The eight small fires were project related and contained in a small area (0.4 ha).

The Sahara mustard (*Brassica tournefortii*) eradication program that began in 2024 continued into 2025. The NNSS Roads and Grounds department treated thirty acres of invaded habitat with Rejuvra (indaziflam) herbicide along roads, pads cleared of native vegetation, and near abandoned buildings.

A small study to investigate potential impacts of the Ribbon Cliff Wildland Fire on reptiles was conducted and some opportunistic reptile observations were documented during 2025. Wildlife use at 10 natural water sources (6 springs, 4 rock tanks) and 4 constructed water sources (1 well pond, 2 water troughs, and 1 radiologically contaminated sump) was documented using motion-activated cameras.

There are currently 19 vascular plants and 1 non-vascular plant included in the NNSS sensitive plant monitoring program. A new location of sand cholla (*Grusonia pulchella*) and Lahontan beardtongue (*Penstemon palmeri* variety [var.] *macranthus*) were observed this year. Long-term monitoring was not conducted. One Beatley milkvetch (*Astragalus beatleyae*) population was visited, and a post-fire survey was conducted for Clokey eggvetch (*Astragalus oophorus* var. *clokeyanus*) in association with the 2025 Cat Canyon Fire.

Surveys of sensitive and protected/regulated animals during 2025 focused on (a) Mercury weevil (*Miloderes mercuryensis*), (b) birds, (c) bats, (d) feral horses (*Equus caballus*), (e) mule deer, (f) pronghorn antelope, (g) desert bighorn sheep (*Ovis canadensis nelsoni*), and (h) mountain lions (*Puma concolor*). Information about the monarch butterfly (*Danaus plexippus*), other noteworthy wildlife observations, bird mortalities, and a summary of nuisance animals and their control on the NNSS is also presented.

A total of 31 dead birds were documented on the NNSS in 2025. Five birds were electrocuted, one was killed by a vehicle collision, one died of entrapment on a glue trap, one chick mortality, six were found dead due to unknown causes, and seventeen apparently died from exposure to drilling fluids at the new ER 20-13 plastic-lined sump.

Observations of red-tailed hawks (*Buteo jamaicensis*) were detected during both winter raptor surveys on the southern route. Observations of three raptor species including 15 red-tailed hawk, 4 prairie falcon (*Falco mexicanus*), and 3 American kestrel (*Falco sparverius*) observations were detected on the northern route. Three bird survey routes patterned after United States Geological Survey (USGS) Breeding Bird Surveys (BBS) were monitored for a second year in a row. A total of 32 different species and 377 total birds were detected. Species richness was nearly the same as 2024 (33 species), but considerably fewer total birds were detected than in 2024 (566 birds). Fewer birds were expected given the lower moisture received in 2025 across the NNSS. Black-throated sparrows (*Amphispiza bilineata*) were again the most common species (~29% of birds counted versus ~33% in 2024). Noteworthy observations of sensitive species include 4 sagebrush sparrows (*Artemisiospiza nevadensis*), 11 pinyon jays on the North Route, and a LeConte's thrasher (*Toxostoma lecontei*) on the Yucca Flat Route.

Acoustic bat monitoring continued for the fifth consecutive year as part of the North American Bat Monitoring Program. 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, and 30 individual horses were identified. A total of 40 deer observations were made on two survey routes, which equates to an average of 6.7 deer per night. This is nearly half the number observed in 2024 when 11.7 deer per night were observed.

Based on camera trap data, desert bighorn sheep were detected at seven water sources including one image of a ram at Cane Spring on December 20, 2025. This is the first documented use of Cane Spring by a desert bighorn sheep which is a significant finding. Other locations where sheep were documented were Delirium Canyon Tanks (492 images), South Pah Canyon Tanks (65 images), Twin Spring (51 images), Cottonwood Spring (44 images), Fortymile Canyon Tanks (42 images), and Rock Valley Tank (2 images). Combining these observations, at least 18 sheep (3 marked ewes, 7 unmarked ewes, 2 older lambs, 3 lambs, 2 mature rams, 1 young ram) were documented on the NNSS during 2025.

In November 2022, NNSS biologists collaborated with Nevada Department of Wildlife to capture several sheep on and around the NNSS (e.g., Bare Mountain, NTTR, Specter Range) as part of a test and remove project to reduce the devastating impact of a disease that causes pneumonia in bighorn sheep. Three ewes (NT30, NT31, and NT32) were captured on or near the NNSS on November 11, 2022. Oral, nasal, and blood samples were taken for disease testing, radio collars were attached, and the animals were then released. None of the animals tested positive for the disease. Animals continued to be tracked during 2025. NT31 (10-year-old female) was killed by a mountain lion around January 13 just north of Cottonwood Spring and NT32 (6-year-old female) was killed by a mountain lion around January 29 west of the Yucca Mountain crest. A total of 1,458 locations were recorded during 2025 for ewe NT30 who is still alive. She focused her activity on the ridge extending south from Yucca Mountain and in the rugged canyons and ridges on the east and west sides of Fortymile Canyon.

A total of 233 mountain lion images (i.e., photographs or video clips) were taken during 130,512 camera hours across all sites. This equates to about 1.8 mountain lion images per 1,000 camera hours. This is a substantial drop from 3.2 images per 1,000 camera hours recorded in 2024, and it is unknown if this represents an actual decline in mountain lion numbers or just a detectability issue based on animal movements and behavior. Mountain lions were detected at 12 of the 17 sites, including 10 water sources and 2 canyon sites. At least five individuals (adult male, adult female, three cubs) were documented in 2025. A total of 24,622 images of at least 73 species other than mountain lions were also taken during 130,512 camera hours across all sites which is about 189 images per 1,000 camera hours. Feral burros and chukar (*Alectoris chukar*) were the most photographed species.

During 2025, NNSS biologists documented 91 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 (35 calls), bats (3 calls), other mammals (31 calls), reptiles (18 calls, including 3 rattlesnake removals), and invertebrates (4 calls). Mitigation measures taken typically involved relocating the animals away from people, instructing workers to leave the animal in place, or disposing of dead animals. An adult badger (*Taxidea taxus*) that was digging in the Area 23 landfill was captured and relocated to Camp 17 Pond in early October.

The objectives of habitat restoration and revegetation include: 1) establish a perennial vegetation community on waste cover caps to prevent water from infiltrating into buried waste, 2) establish a perennial vegetation community in disturbed areas (e.g., burned areas) to outcompete invasive annual grasses, reduce the risk of wildland fires, restore ecosystem function, and create wildlife habitat, 3) support the intent of U.S. Executive Order 13112, “Invasive Species,” (1999) and U.S. Executive Order 13751, “Safeguarding the Nation from the Impacts of Invasive Species,” (2016) to prevent the introduction and spread of non-native species and restore native species to disturbed sites, and 4) revegetation may qualify as mitigation for the loss of desert tortoise habitat under the current Opinion.

Activities conducted in 2025 included: 1) qualitative vegetation assessment at the U-3ax/bl closure cover (Corrective Action Unit [CAU] 110) (Area 3 Radioactive Waste Management Site) and West Cover at the 92-Acre Site (CAU 111) (Area 5 Radioactive Waste Management Complex [RWMC]), 2) revegetating and monitoring seeding success at North South Cover (CAU 111) and Cells 8 and 16 Cover (Area 5

RWMC), 3) monitoring revegetation success and planting transplants at South Cover (CAU 111, Area 5 RWMC), 4) monitoring revegetation success at Cell 21 (CAU 577) and North North Cover (CAU 111) (Area 5 RWMC), 5) monitoring revegetation success at Cells 19/20 (CAU 577, Area 5 RWMC), 6) assessing revegetation success at East and West Cover Caps (CAU 577, Area 5 RWMC), 7) assessing revegetation success on Cell 18 (Area 5 RWMC), 8) monitoring results from a research study to evaluate the effectiveness of different herbicide treatments to control cheatgrass after the Cherrywood Fire, 9) aerially applying herbicide over large, previously burned areas to create firebreaks in cheatgrass dominated areas and monitoring results, and 10) monitoring seeding success in a revegetated area in the Area 16 Burn.

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ACRONYMS AND ABBREVIATIONS

ac	acre(s)
APP	Avian Protection Plan
BBS	Breeding Bird Survey
BCS	Body Condition Score
BYU	Brigham Young University
CAU	Corrective Action Unit
cm	centimeter(s)
DOE	U.S. Department of Energy
DOE EM/NV	U.S. Department of Energy, Environmental Management Nevada Program
DOE/NV	U.S. Department of Energy, Nevada Operations Office
DTM	Desert Tortoise Monitor
EGIS	Ecological Geographic Information System
ELU	Ecological Landform Unit
EMAC	Ecological Monitoring and Compliance Program
ER	Environmental Restoration
ESA	Endangered Species Act
FWS	U.S. Fish and Wildlife Service
g	gram(s)
gal	gallon(s)
GIS	Geographic Information System
GPS	Global Positioning System(s)
ha	hectare(s)
kg	kilogram(s)
km	kilometer(s)
lb(s)	pound(s)
m	meter(s)
m^2	square meter(s)
mE	meters Easting
mN	meters Northing
MBTA	Migratory Bird Treaty Act
MCL	midline carapace length
MDC	Minimum detectable concentration
mm	millimeter(s)

MOU	Memorandum of Understanding
MSTS	Mission Support and Test Services, LLC
n	sample size
NABat	North American Bat Monitoring Program
NAC	Nevada Administrative Code
NAD	North American Datum
NDNH	Nevada Division of Natural Heritage
NDOW	Nevada Department of Wildlife
NVNPS	Nevada Native Plant Society
NNSA/NFO	U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office
NNSS	Nevada National Security Site
NOAA	National Oceanic and Atmospheric Administration
NTTR	Nevada Test and Training Range
oz	ounce(s)
PLS	pure live seed
PTT	platform transmitter terminal
R, R^2	correlation coefficient
RWMC	Radioactive Waste Management Complex
sd	standard deviation
SPP	Strategic Partnership Project
spp.	species
ssp.	subspecies
TCS	tortoise clearance survey
UGTA	Underground Test Area
U.S.	United States
USGS	United States Geological Survey
UTM	Universal Transverse Mercator
UTV	utility task vehicle
var.	variety

1.0 INTRODUCTION

United States (U.S.) Department of Energy (DOE) 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 2025, all applicable laws and regulations were followed, and the permit requirements were met except for one case of unauthorized off-road driving.

This report summarizes the EMAC activities conducted by MSTS during calendar year 2025. Monitoring tasks 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 implementation and 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 a 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 within 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, as opposed to protected/regulated 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 but are not protected by law. They could include species on the Nevada Division of Natural Heritage (NDNH) At-risk Plant and Animal Track List (NDNH 2026), species with a special status identified by the Nevada Native Plant Society (NVNPS), or species known to be restricted in range. 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 habitat, cover sites, nest or burrow sites, roost sites, or water sources important to sensitive species. Survey reports document species, track resources found, and provide mitigation requirements and recommendations.

2.1 Sites Surveyed and Sensitive and Protected/Regulated Species Observed

In 2025, biological surveys were conducted for 22 projects on the NNSS (Figure 2-1, Table 2-2). Several projects had multiple survey locations. Post-activity surveys, which ensure the project adhered to mitigation requirements, were conducted for projects completed prior to 2025, as well as projects completed during 2025 (Figure 2-1, Table 2-2). Biologists surveyed a total of 171.7 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. Projects disturbed a total of 0.6 ha of undisturbed land (Table 2-2). Project 24-05 had a noncompliance incident involving a flatbed truck driving off-road without requesting a tortoise clearance survey (see Section 3.0 Desert Tortoise Compliance). Project 21-51 drilled a new radiological monitoring well in Area 20 (ER 20-13), leaving an open, lined sump full of drilling discharge water that apparently contributed to the death of 17 birds from July to December. Details are discussed in Section 6.4.2 Bird Mortalities. Sensitive and protected/regulated plant and animal species and important biological resources found during the surveys included: one large tortoise (*Gopherus agassizii*) relocated off an access road to a project area; one manmade pitfall that was backfilled to avoid animal entrapment; one tortoise burrow (collapsed); two hibernating Townsend's big-eared bats (*Corynorhinus townsendii*) (avoided); one burrowing owl (*Athene cunicularia*) (avoided); one inactive greater roadrunner (*Geococcyx californianus*) nest (avoided); several inactive bird nests (avoided or removed); several Say's Phoebe (*Sayornis saya*) carcasses inside an abandoned building scheduled for demolition; invasive plant Sahara mustard (*Brassica tournefortii*) at one project area; ungulate sign (pronghorn antelope [*Antilocapra americana*], feral burro [*Equus asinus*], and mule deer [*Odocoileus hemionus*]); yucca plants (Joshua tree [*Yucca brevifolia*] and Mojave yucca [*Yucca schidigera*]); and multiple cactus species (see Table 2-2 for resources listed by project). Scientists communicated with project personnel and provided written summary reports to project managers of survey findings and mitigation recommendations when applicable.

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. i*nyoensis*	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 monophyla	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
Beetle Species		
Miloderes mercuryensis	Mercury weevil	S, A
Butterfly Species		
Danaus plexippus	Monarch butterfly	S, A
Reptile Species		
Plestiodon gilberti rubricaudatus	Western red-tailed skink	S, IA
Gopherus agassizii	Desert tortoise	LT, S, NPT, A
Bird Species[b]		
Astur atricapillus	American goshawk	S, NPS, A
Alectoris chukar	Chukar	G, IA
Aquila chrysaetos	Golden eagle	EA, NPS, A
Artemisiospiza nevadensis	Sagebrush sparrow	S, NPS. A
Asio flammeus	Short-eared owl	S, NPS, A
Asio otus	Long-eared owl	S, NP, A
Callipepla gambelii	Gambel's quail	G, IA
Coccyzus americanus	Western yellow-billed cuckoo	LT, S, NPT, IA
Corvus brachyrhynchos	American crow	G, IA
Falco peregrinus	Peregrine falcon	S, NPS, A
Gymnorhinus cyanocephalus	Pinyon jay	S, NP, IA
Haliaeetus leucocephalus	Bald eagle	EA, S, NPS, A
Ixobrychus exillis	Least bittern	S, NP, IA
Lanius ludovicianus	Loggerhead shrike	NPS, A
Melanerpes lewis	Lewis's woodpecker	S, NP, IA
Oreoscoptes montanus	Sage thrasher	NPS, IA
Riparia riparia	Bank swallow	S, NP, IA
Spinus pinus	Pine siskin	S, NP, IA
Spizella breweri	Brewer's sparrow	NPS, IA
Toxostoma lecontei	LeConte's thrasher	S, NP, IA

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

Animal Species	Common Name	Status[a]
Mammal Species		
Antilocapra americana	Pronghorn antelope	G, A
Antrozous pallidus	Pallid bat	NP, A
Cervus elaphus nelsoni	Rocky Mountain elk	G, IA
Corynorhinus townsendii	Townsend's big-eared bat	S, NP, A
Equus asinus	Burro	H&B, A
Eptesicus fuscus	Big brown bat	NP, A
Equus caballus	Horse	H&B, A
Euderma maculatum	Spotted bat	S, NP, A
Lasionycteris noctivagans	Silver-haired bat	S, NP, A
Lasiurus frantzii	Western red bat	S, NP, A
Lasiurus cinereus	Hoary bat	S, NP, A
Lynx rufus	Bobcat	F, IA
Microdipodops megacephalus	Dark kangaroo mouse	NPS, IA
Microdipodops pallidus	Pale kangaroo mouse	S, NPS, IA
Myotis californicus	California myotis	NP, A
Myotis ciliolabrum	Western small-footed myotis	NP, A
Myotis evotis	Long-eared myotis	NP, A
Myotis lucifugus	Little brown bat	S, NP, A
Myotis thysanodes	Fringed myotis	S, NP, A
Myotis volans	Long-legged myotis	NP, A
Myotis yumanensis	Yuma myotis	NP, A
Ovis canadensis nelsoni	Desert bighorn sheep	G, A
Odocoileus hemionus	Mule deer	G, A
Parastrellus hesperus	Canyon bat	NP, A
Puma concolor	Mountain lion	G, A
Sorex tenellus	Inyo shrew	S, IA
Sylvilagus audubonii	Desert cottontail	G, IA
Sylvilagus nuttallii	Nuttall's cottontail	G, IA
Tadarida brasiliensis	Brazilian free-tailed bat	NP, A

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

Animal Species	Common Name	Status
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 List
- NPT — Nevada Protected-Threatened, species protected under Nevada Administrative Code (NAC) 503
- NPS — Nevada Protected-Sensitive, species protected under NAC 503
- NP — Nevada Protected, species protected under NAC 503
- G — Regulated as game species under NAC 503
- F — Regulated as fur bearer species under NAC 503

State of Nevada – Plants
- S — NDNH – At-Risk Plant and Animal Track List
- CY — Protected as a cactus, yucca, or Christmas tree from unauthorized collection on public lands under NAC 527

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 future)
- 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 (*Alectoris chukar*), Gambel's quail (*Callipepla gambelii*), 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 NAC 503.

Sources used: NDNH 2026; NAC 2026a,b; FWS 2026

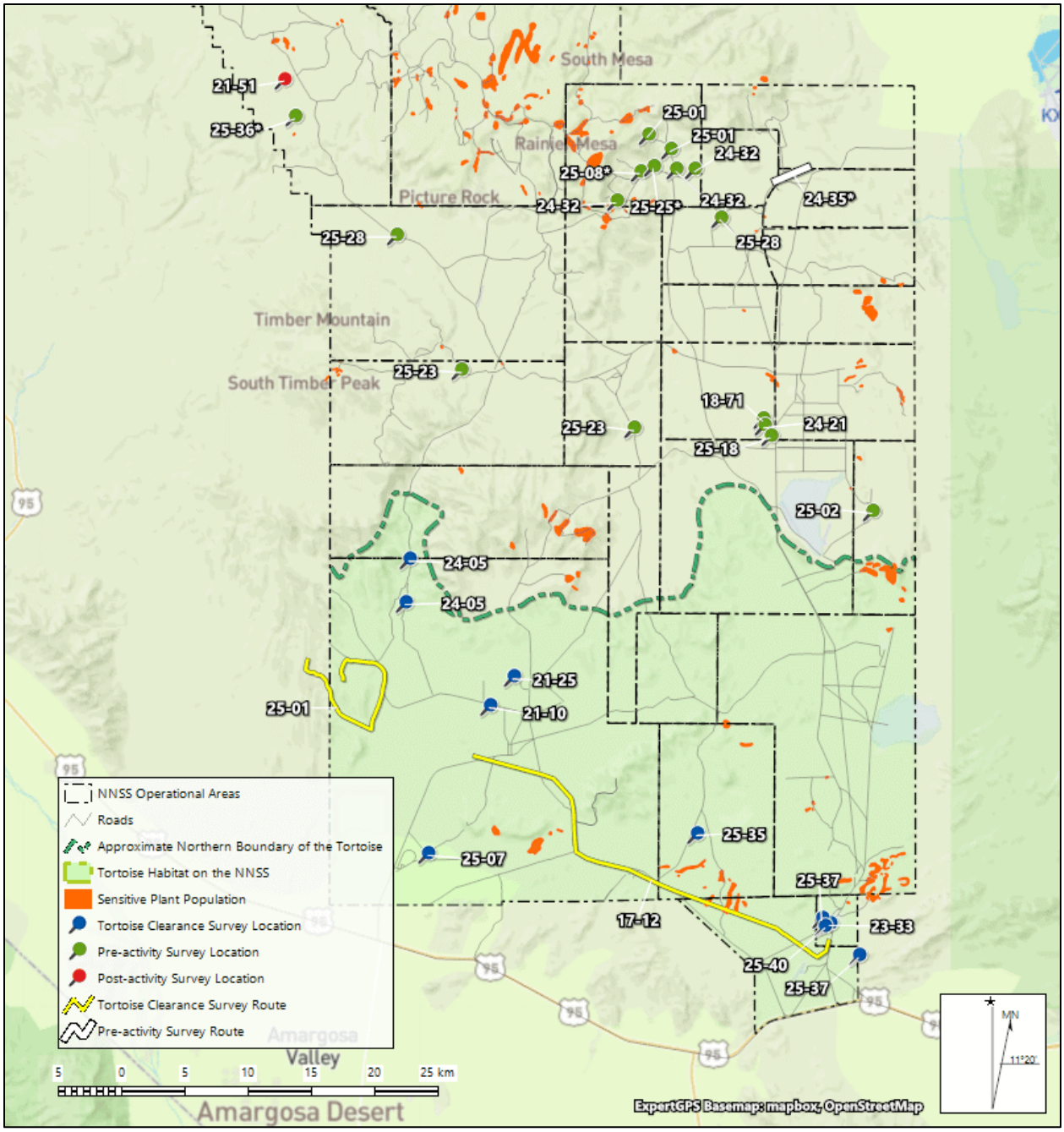

Figure 2-1. Biological surveys conducted in 2025. Projects with an asterisk (*) also had a post-activity survey completed in 2025.

Table 2-2. Summary of biological surveys conducted on the NNSS during 2025; TCS = tortoise clearance survey; DTM = desert tortoise monitor.

Project No.	Project Name	Important Species/Resources Found	Area Surveyed (ha)	Project area in Undisturbed Habitat (ha)	Mitigation in 2025
17-12	Power Pole Vegetation Abatement	3 predator burrows (collapsed), 1 predator burrow (avoided)	7.0	0	TCS, DTM
18-71	U1a (PULSE) Modernization	Yucca, cacti, ungulate sign, 17 predator burrows (avoided)	68.8	In progress	Pre-activity Survey
21-10	Corrective Action Unit 114	Inactive bird nest	0.1	0	TCS, DTM
21-25	Corrective Action Unit 572	Yucca, cacti, ungulate sign, 3 predator burrows (avoided), small pit fall (backfilled)	3.6	0	TCS, DTM
21-51	UGTA New Well	17 dead migratory birds in lined sump	NA	0	Post-activity Survey (Sump Monitoring)
23-33	Solar Photovoltaic and Storage Projects	Yucca, cacti, tortoise burrow (collapsed)	4.4	In progress	TCS, DTM
24-05	Canyon to Stockade Power Pole Repairs	Ungulate sign, 1 adult tortoise relocated off dirt access road to project area	3.2	0	TCS, DTM, noncompliance (off-road driving)
24-21	U1a (PULSE) New Access Project	3 predator burrows (collapsed)	6.0	In progress	Pre-activity Survey
24-32	Fiscal Year 2025 Demolition	2 hibernating Townsend's big-eared bats (avoided), inactive raptor nest, 2 inactive bird nests, owl sign	3.3	0	Pre-activity Survey for Buildings
24-35	Gate 700 Substation Upgrades	Yucca, cacti, ungulate sign	8.1	0	Pre-activity Survey, Post-activity Survey
25-01	Roads and Grounds Maintenance Activities	1 tortoise burrow (avoided), invasive plant (Sahara mustard)	27.5	0	TCS, DTM, Pre-activity Survey
25-02	Area 11 New Transformer	Yucca, cacti	2.3	In progress	Pre-activity Survey
25-07	Unmanned Aircraft System Operations	Ungulate sign, burrowing owl (avoided)	16.8	0	TCS, DTM
25-08	U12u Glass House Replacement	Pinyon pine/Juniper trees, deer sign	0.7	0.2	Pre-activity Survey, Post-activity Survey
25-18	U1a (PULSE) Muck Pile Removal	Yucca, ungulate sign	8.5	In progress	Pre-activity Survey
25-23	Vehicle Relocations	None	0	0	Pre-activity Survey for Buildings
25-25	Building 12-31 Modifications	Ungulate sign	0.5	0.1	Pre-activity Survey, Post-activity Survey
25-28	Safe Site Teardown	Inactive raven nest with 1 dead juvenile raven on ground	0	0	Pre-activity Survey for Buildings
25-35	Ground Fiber	Cacti, ungulate sign, 3 predator burrows (avoided), 2 caliche burrows (avoided)	3.7	In progress	TCS, DTM

Table 2-2. Summary of biological surveys conducted on the NNSS during 2025; TCS = tortoise clearance survey; DTM = desert tortoise monitor (continued).

Project No.	Project Name	Important Species/Resources Found	Area Surveyed (ha)	Project area in Undisturbed Habitat (ha)	Mitigation in 2025
25-36	ER-20-1 Access Road Turnouts	Pinyon pine/Juniper trees	4.7	0.3	Pre-activity Survey, Post-activity Survey
25-37	Demolition 22-2210 and 23-810A	Yucca, cacti, bird carcasses in 22-2210	0	In progress	TCS, Pre-activity Survey for Buildings
25-40	Mercury Fire Training Site Improvements	Ungulate sign, inactive roadrunner nest (avoided), inactive bird nest in trailer	2.5	0	TCS, DTM, Pre-activity Survey for Buildings
		Total	**171.7**	**0.6**	

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 project areas and may be concealed under vegetation during activities where heavy equipment is used. 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 (TCS) is required within 24 hours of 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 of 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 or structures, reactivation of decommissioned buildings, or relocation of trailers. The pre-activity survey for buildings also includes a survey of the outside of the building and the entire construction area. A pre-activity exit survey for tunnels or structures that may be used by bats is required prior to reactivation of deactivated tunnels or structures. 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 2-2 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 *Diverse Habitat* (having high plant species diversity).

Projects in 2025 disturbed a total of 0.6 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. Project 25-08 disturbed 0.2 ha of *Sensitive Habitat*. Projects 25-25 and 25-36 disturbed 0.4 ha of habitat not designated as important habitat. The total area disturbed (ha) of important habitat types tracked since 1999 comprises 11.01 (*Pristine*), 25.92 (*Unique*), 431.49 (*Sensitive*), and 87.55 (*Diverse*).

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 U.S. Fish and Wildlife Service (FWS) concerning the effects of NNSA/NFO activities, as described in the *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada* (DOE/NV 1996), on the 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 Programmatic Biological Opinion (herein referred to as Opinion) on August 27, 2019 (FWS 2019).

The Desert Tortoise Compliance task of EMAC implements the protective measures of the 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 biologists in 2025, including (a) conducting one-hundred percent coverage TCSs at project sites within 24 hours from the start of project construction, (b) ensuring projects have a trained desert tortoise monitor (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

Twenty-one projects occurring within the range of the tortoise were reviewed by biologists in 2025 and ten 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).

TCSs were completed for ten projects in 2025, with some projects having multiple survey locations (Figure 2-1, Table 3-1). One large tortoise was relocated off an access road to a project area for project 24-05. No tortoises were reported injured or killed during projects. Projects did not disturb any tortoise habitat during 2025. One project, 24-05, allowed a flatbed truck to drive off road to stage power poles without requesting a TCS. The area was surveyed after off-roading occurred and no impacts to the tortoises (e.g., no carcasses or collapsed burrows; no permanent habitat disturbance) was observed. Noncompliance was addressed with all parties involved and reported in the annual report to FWS.

In January 2026, the annual report summarizing tortoise compliance activities conducted on the NNSS from January 1 through December 31, 2025, 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 2025; TCS = tortoise clearance survey, DTM = desert tortoise monitor.

Project No.	Project Name	Description of Compliance Activity Required	TCS Completed in 2025	Tortoise Habitat Disturbed in 2025 (ha)
17-12 [a]	Power Pole Weed Abatement	Formal Consultation, TCS, DTM	✓	0
18-05 [a]	RWMC Expansion	Formal Consultation, TCS, DTM		0
18-09 [a]	Test Bed South	Formal Consultation, TCS, DTM		0
19-16 [a]	Area 6 Tippipah Batch Plant	Formal Consultation, TCS, DTM		0
20-01 [a]	RWMC Westward Expansion	Formal Consultation, TCS, DTM		0
21-10 [a]	Corrective Action Unit 114	TCS, DTM	✓	0
21-25 [a]	Correction Action Unit 572	TCS, DTM	✓	0
21-44 [a]	Rock Valley Direct Comparison	Formal Consultation, TCS, DTM		0
21-46 [a]	Device Assembly Facility Surface Modernization	Formal Consultation, TCS, DTM		0
23-33	Solar Photovoltaic and Storage Projects	TCS, DTM	✓	0
24-05	Canyon to Stockade Power Pole Repairs	TCS, DTM	✓	0
24-36	23-109 Electric Vehicle Charging Stations	No Effect		0
24-37	23-535 Electric Vehicle Charging Stations	No Effect		0
25-01	Roads and Grounds Maintenance Activities	TCS, DTM	✓	0
25-03	Nevada Capabilities Exercise	No Effect		0
25-04	Cell Tower Foundation Check	No Effect		0
25-07	Area 25 Unmanned Aircraft System Operations	TCS, DTM	✓	0
25-10	Set Infrasound Array	No Effect		0
25-11	Area 5 Storage Pad Expansion	No Effect		0
25-12	Area 6 Garage Apron and Walkway	No Effect		0
25-17	Relocated Underground Cable	No Effect		0
25-21	5B Pumphouse Vault Replacement	No Effect		0
25-29	Area 26 Flagpole Installation	No Effect		0
25-30	Mercury Staging Lot	No Effect		0

[a] Project carried over from previous year.

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 2025; TCS = tortoise clearance survey, DTM = desert tortoise monitor (continued).

Project No.	Project Name	Description of Compliance Activity Required	TCS Completed in 2025	Tortoise Habitat Disturbed in 2025 (ha)
25-31	Southern Border Detections System	No Effect		0
25-35	Rock Valley Ground Fiber	TCS, DTM	✓	0
25-37	Demolition 22-2210 and 23-810A	TCS	✓	0
25-38	Mercury 5 New Buildings	No Effect		0
25-39	Rock Valley Seismic Additions	No Effect		0
25-40	Mercury Fire Training Site Improvements	TCS, DTM	✓	0
25-47	Security Infrastructure Revitalization Project	No Effect		0

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, parameters set by FWS in 2019 require only large tortoises (>180 millimeters [mm] midline carapace length [MCL]) 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 presented in Table 3-2. Cumulative totals of all age classes tracked since 1992 are presented in Table 3-3.

There were 77 reported tortoise roadside observations in 2025 (Figure 3-1). Of these, three were roadkill and one was a bird predation. Two large tortoises were hit and killed by vehicles on Jackass Flats Road on 6/3/2025 and 8/14/2025. A small tortoise was hit and killed by a vehicle on the 27-01 Road on 9/11/2025. A small tortoise carcass was found on a power line dirt access road on 6/9/2025 that was predated upon by a bird. The two large tortoise mortalities were counted as take under the Continued Use of Roads program.

The large tortoise hit and killed on 8/14/2025 was NNSS21, a tortoise that was included in the NNSS's Road Study from 2014-2017. The tortoise crossed the road dozens of times in a year and lived in a culvert under the road. A tortoise awareness sign was installed along the road near the culvert in 2017. The tortoise had been moved off the road seven times this year before it was hit and killed.

One of the roadside observations was a large tortoise moved off a road during project 24-05. Biologists were driving on a power line dirt access road to reach the project area to conduct a TCS where several power poles were to be replaced. They came upon a flatbed truck that was carrying the replacement poles that had stopped because there was a large tortoise on the dirt road. The driver informed the biologists, who safely moved the tortoise off the road. The biologists then drove ahead of the flatbed truck to watch

Table 3-2. Summary of tortoise habitat disturbance, tortoise habitat disturbance limits, incidental take of large tortoises (>180 mm MCL), and incidental take limits of large tortoises under the current Opinion August 27, 2019 – December 31, 2025.

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 [b]
1) Continued Use of Existing Roads	NA	272 (350) [c]	6 (15) [d]
2) Defense	0.3 (202)	0 (10)	0 (2)
3) Waste Management	21.3 (101)	0 (10)	0 (2)
4) Environmental Restoration	0 (101)	0 (10)	0 (2)
5) Nondefense Research and Development	14.8 (405)	0 (20)	0 (4)
6) Work-for-Others	0 (202)	0 (20)	0 (2)
7) Infrastructure	51.1 (202)	3 (20)	0 (4) [e]
Totals	**87.5 (1,213)**	**275 (440)**	**6 (31)**

[a] All tortoises observed in harm's way may be moved to a safe location as outlined in the Opinion. These are estimates of the number FWS expects will need to be moved.
[b] The numbers in parentheses in the Injury/Mortality column represent triggers that if exceeded require re-initiation of the Opinion.
[c] The FWS estimates 35 non-injury/non-mortality tortoises each year. This is an estimate of the number FWS expects will need to be moved. All tortoises observed in harm's way may be moved to a safe location as outlined in the Opinion.
[d] No more than 4 tortoises killed each year and no more than 15 killed during the term of the Opinion.
[e] No more than 2 tortoises killed each year and no more than 4 killed during the term of the Opinion.

the road for more tortoises. The large tortoise was considered take under the project under the Infrastructure program.

There were nine small and 63 large tortoises observed on roads (Figure 3-1). Of the 63 large tortoises, seven did not need to be handled and six were moved off the road twice in one day. When a tortoise is confirmed to be moved off a road multiple times in one day, incidental take of that animal is counted once. The 50 large tortoises that were moved off the roads were determined to be incidental take under the Continued Use of Roads program. Previously tagged tortoises with unique numbers were observed multiple times: NNSS20 seven times, NNSS21 seven times then was hit and killed, NNSS66 four times, NNSS69 two times, NNSS65 one time, NNSS71 one time, and CC0453 (a tortoise marked from a Clark County highway culvert study in 2021) one time.

3.1.1 Mitigation for Loss of Tortoise Habitat

Prior to land-disturbing activities associated with any projects of the Strategic Partnership Projects (SPP) program (formerly Work-for-Others), 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

Table 3-3. Summary of disturbance of tortoise habitat, tortoises observed along roads, tortoises moved off roads, and tortoises killed or injured by vehicles on roads for all size classes (small and large) from 1992–2025.

Calendar Year	Hectares Disturbed	Total Roadside Observations	Tortoises Moved off Roads	Killed or Injured by Vehicles
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	35	19	1
2017	0.5	45	41	2
2018	6.0	34	31	0
2019	0.0	66	56	2
2020	9.9	38	32	2
2021	22.1	38	30	2
2022	11.4	110	93	5
2023	21.8	92	73	3
2024	22.3	40	33	0
2025	0	73	59	3
Total	**238.6**	**884**	**681**	**39**

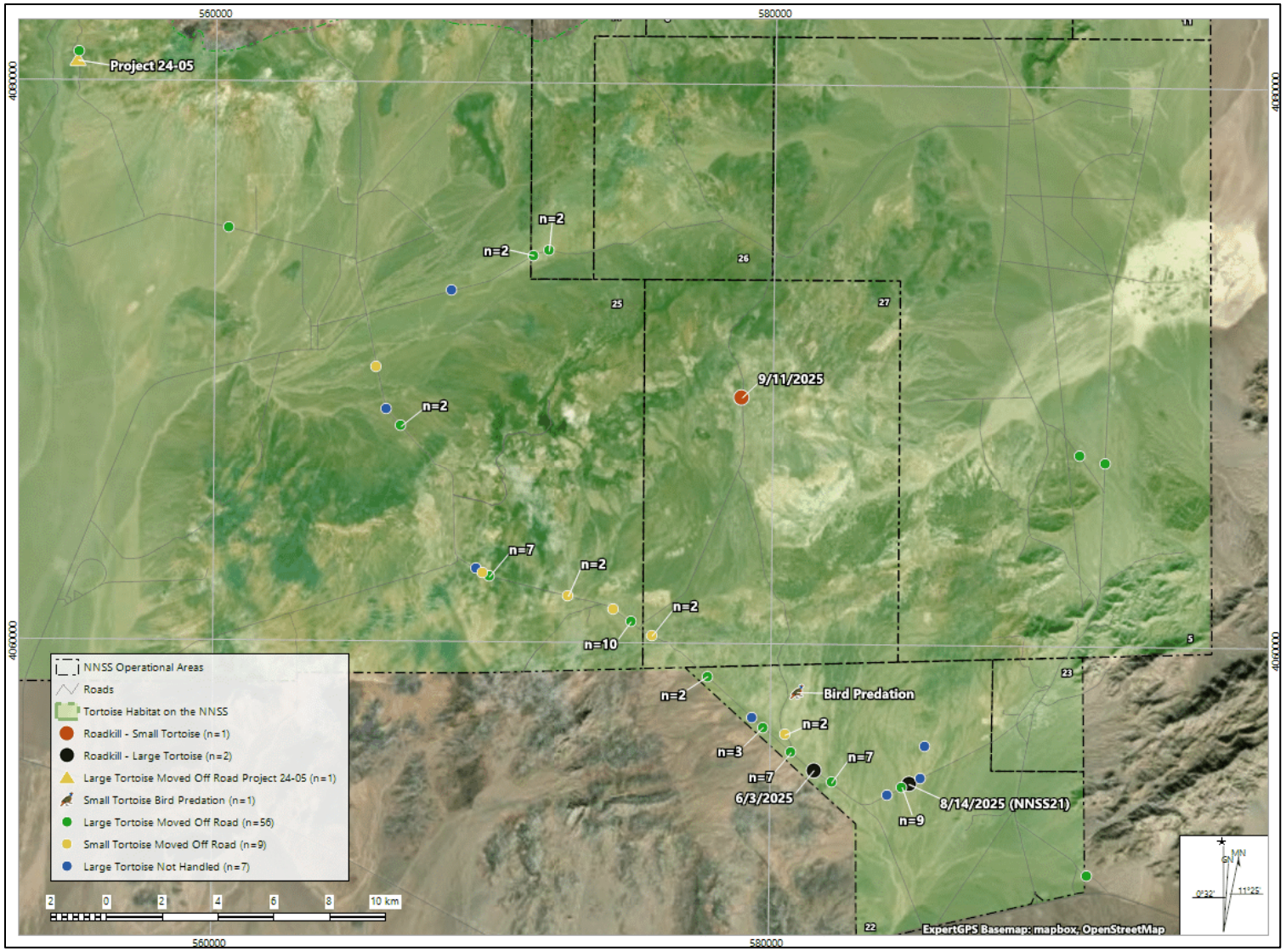

Figure 3-1. Locations of tortoise roadside observations on the NNSS (n=77) with associated size classes (large tortoises are >180 mm MCL and small are ≤180 mm MCL) from January 1 through December 31, 2025. Coordinates in UTM NAD83 (Zone 11, meters).

for all SPP activities at the rate of $1,135 per acre (ac) of disturbance. All other programs can 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 $1,135 per ac of disturbance. No projects disturbed tortoise habitat this year; therefore, no remuneration fees were required.

3.2 Conservation Recommendations

Biologists continue to conduct research and increase tortoise conservation awareness through several MSTS-implemented activities and FWS conservation recommendations.

3.2.1 Radiological Exposure Study

As a recommendation from FWS, biologists implemented a study in 2019 of tortoise exposure to radiological sources or fallout from nuclear testing by opportunistically testing tortoise carcasses for radionuclides. Tortoise carcasses found on the NNSS, mainly roadkill, will be sent to a lab to test for radionuclides. The three roadkill tortoises from this year and three carcasses from Joshua Tree National Park in California that are considered control specimens for the study were processed this year for lab testing. Where there was enough sample, the tortoises were separated into soft tissue and bone/keratin (shell). All samples were homogenized. Water was distilled from tissue samples for Tritium analysis. The tissue samples were submitted for Strontium-90, Plutonium-238, Plutonium-239+240, Americium-241, and gamma spectrometry analysis. No manmade radionuclides were detected in the tortoises sampled from the NNSS. For the control specimens from California, Strontium-90 and Plutonium-239+240 were measured above the Minimum Detectable Concentration (MDC) in one tortoise and Americium-241 was measured above the MDC in a second tortoise. Radionuclide concentrations were below levels considered harmful to the health of plants and animals. For more information about radionuclide monitoring refer to the annual Nevada National Security Site Environmental Reports (e.g., MSTS 2025) available at https://nnss.gov/publication-library/environmental-publications/.

3.2.2 Road Study

The direct and indirect effects roads have on tortoises have been implicated in population declines. The effects that linear habitat disturbances have on the tortoise extend beyond the footprint of the actual road. The Road Study, approved by FWS and conducted from 2012-2018, focused on increasing understanding of tortoise activity near unfenced, moderately trafficked roads (<25 to >600 vehicles/day) within the northern range of the tortoise. Thirty tortoises were captured on or near paved roads and each one was tracked for three active seasons using Global Position System (GPS) loggers and radio telemetry. The study examined habitat use, home range, speed, activity, road-crossings, and movement behavior. Biologists collaborated with the Smithsonian Conservation Biology Institute for the study analysis. A technical report was published by Perry et al. (2023) on February 2, 2023, describing results from the study.

Work continued on studying impacts of roads through an opportunistic mark-recapture study that allows tracking of road crossing events for individual tortoises. The study was approved by FWS and allows biologists to attach identification numbers to tortoises when they are found and moved safely off roads. 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). One tortoise was marked with unique numbers this year: NNSS77. Sixteen tortoises have been given unique numbers from 2020-2025, with two known to have been hit and killed by vehicles: NNSS64 (2022) and NNSS21 (2025). Having the ability to identify tortoises on roadways based on their

identification number has been valuable in identifying the number of tortoises living along roadways, incidental take, and identifying locations where multiple tortoises cross roads in order to place additional signs for tortoise awareness and driver caution.

In response to the three roadkills in 2025, biologists conducted wildlife briefings at facilities that employees commute to on a daily basis through tortoise habitat. As in previous years, biologists continued placing temporary warning signs on either side of the road where multiple tortoise observations occur. These are locations where particular tortoises are observed daily, foraging along the road edges, or crossing the road. Signs are left out for several weeks or until observations stop. All nets radio announcements are made to caution drivers to be aware of tortoises on roadways when weather conditions are anticipated to increase tortoise activity. Biologists also post blogs on the company's webpage on tortoise emergence from hibernation and roadkill events.

3.2.3 Juvenile Translocation Study

In September 2012, 60 captive juvenile tortoises of known sex 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 Global (formerly the Institute for Conservation Research). 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 2024. Regular monitoring was conducted during 2025—once a month in January, February, and December; weekly in March, April, May, September, and October; and twice a month in June, July, August, and November. Additional monitoring was conducted in early January 2026 to determine each tortoise's winter burrow. Once a tortoise was located, information such as date and time, elevation, Universal Transverse Mercator (UTM) coordinates North American Datum 1983 (NAD83), 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 2025, 10 tortoises were known to be alive (Table 3-4; Figure 3-2). By the end of 2025, 10 of the 60 tortoises (16.7%) (4 female, 6 male) were still alive. Our survival rate of 16.7% after 13 years is a little higher than an estimated 13.3% (8 of 60 alive) survival based on an annual survival rate of 85.7% calculated for a natural population (Turner et al. 1987). Excluding the four missing males (4003, 4040, 4041, 4048) and one missing female (4046) there is a higher survival rate, albeit not as high as previous years, for males (22.2% [6 of 27]) compared to females (13.8% [4 of 29]) with most of the mortalities (34 of 45; 76%) caused by suspected coyote (*Canis latrans*) and kit fox (*Vulpes macrotis*) 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, 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 10 tortoises monitored during 2025. On average, the distance between the release location and January 2026 burrow was 2,047 m (range = 205 – 9,584, standard

Table 3-4. Sex, distance in meters (m) between release site and January 2026 burrow, distance between January 2025 burrow and January 2026 burrow, total distance between monitored locations (January 2025 to January 2026), and total number of burrows and new burrows occupied by 10 tortoises monitored during 2025.

Tortoise Number	Sex	Distance (m) release to January 2026 burrow	Distance (m) between January 2025 and January 2026 burrows	Total distance (m) between locations January 2025-2026	Number of burrows used (new burrows)
4030	Female	2315	107	2911	6 (2)
4039	Female	384	47	1675	5 (2)
4044	Female	3790	66	3052	6 (4)
4045	Female	222	172	2071	8 (6)
4004	Male	9584	0	2089	3 (2)
4007	Male	205	99	1522	4 (1)
4011	Male	559	131	8234	4 (2)
4025	Male	1008	34	1711	7 (2)
4034	Male	1277	1386	6411	4 (2)
4036	Male	1128	359	3567	7 (4)
	Average	2047	240	3324	

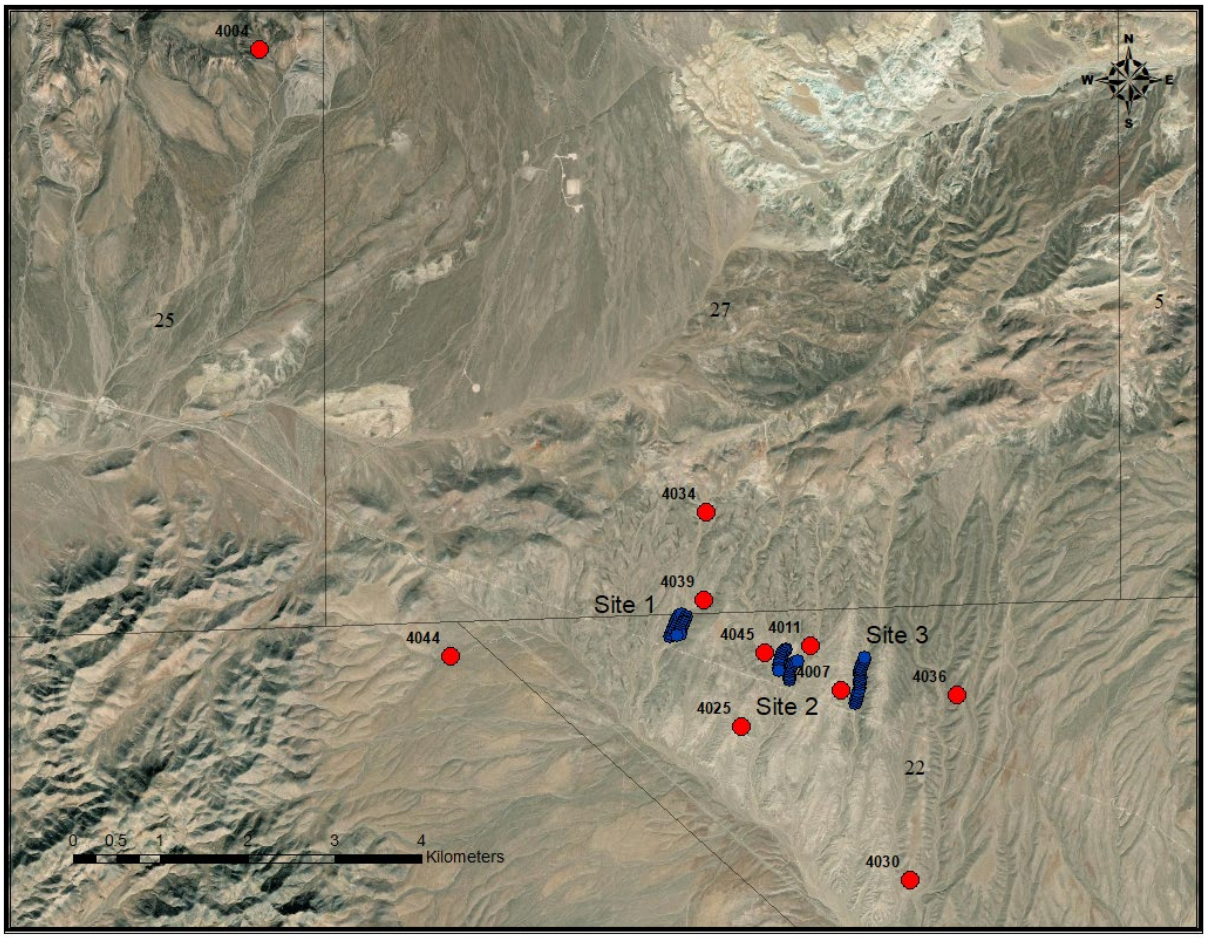

Figure 3-2. Release locations for 60 tortoises, September 2012 (blue dots, 20 at each site) and last known locations for 10 tortoises monitored during 2025 (red dots).

deviation [sd] = 2,870). On average, tortoises used winter burrows in 2026, 240 m away from their 2025 winter burrows. Five tortoises wintered in a burrow within 100 m of their last year's winter burrow, one of which used the same winter burrow as the previous year.

The average distance moved between monitoring checks was 3,324 m (range = 1,522 – 8,234 m; sd = 2,251 m). This is not the total distance a tortoise moved during the year, but the summed straight-line distance between locations recorded during regular monitoring. Movements tortoises made between monitoring checks were not recorded or measured.

During 2025, burrows were marked with unique numbers and data collected included UTM coordinates (NAD83), 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 monitoring events, so it is likely that not all burrows used were documented. A total of 54 unique burrows were used during 2025, including 27 new burrows that were marked and measured. The average height of new burrows was 13.4 mm (range = 9 – 24; sd = 3.5) and average width of burrows was 26.6 mm (range = 16 – 61; sd = 9.2). On average, tortoises used 5.4 unique burrows (range = 3 – 8; sd = 1.6) (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). Temperatures were still warm into November, and rain received in September provided some foraging opportunities into October.

Between early January 2025 and early January 2026, 340 observations were recorded. Tortoises were at burrows 62% of the time and aboveground 38% of the time including under vegetation (23%), in the open (14%), inside the burrow (57%), in the burrow mouth (4%), on the burrow apron (1%), or in a boulder shelter (1%). Of the 77 observations under vegetation, 38% were under blackbrush (*Coleogyne ramosissima*), 9% under water jacket (*Lycium andersonii*), 9% under Fremont's dalea (*Psorothamnus fremontii*), 9% under Nevada jointfir (*Ephedra nevadensis*), 5% under white bursage (*Ambrosia dumosa*), 4% under creosote bush (*Larrea tridentata*), 4% under cheesebush (*Ambrosia salsola*), 16% were under mixed species clumps, and the remaining 6% were under three other shrub species (2.6% pale desert thorn [*Lycium pallidum*], 2.6% Mojave yucca [*Yucca schidigera*], and 1.3% winterfat [*Kraschenninikovia lanata*]).

For the 27 new burrows, tortoises used burrows on wash slopes 78% of the time followed by burrows in wash bottoms (18%), and ridgetops (4%). Vegetation cover at burrows was found at 70% of the burrows, suggesting this may be an important factor in burrow use for these tortoises. Mixed shrub clumps was the dominant cover over burrows (15%) followed by water jacket (*Lycium andersonii*) (11%), pale desert thorn (7%), white bursage (7%), and creosote bush (7%). Nevada jointfir, cheesebush, desert almond (*Prunus fasciculata*), Fremont's dalea, blackbrush, and an unknown species each represented 4%.

Gravel was the dominant substrate at 48% of all new tortoise burrows followed by gravel/cobble (19%), sandy/gravel (19%), caliche/gravel (11%), and gravel/rock (3%). 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 caliche is a hard layer of rock cemented together by calcium carbonate. Combined categories such as gravel/cobble means that both were equal in abundance.

Evidence of foraging was documented on all tortoises except for Female 4044, 31 times between March 24 and October 13, 2025, with foraging peaks in April (9 times) and August (5 times) (Figure 3-3). Documented species eaten include desert globemallow (*Sphaeralcea ambigua*) (10%), red brome (*Bromus rubens*) (7%), Arabian schismus (*Schismus arabicus*) (3%), and desert fluffgrass (*Dasyochloa pulchella*) (3%). Most (77%) of the time, it was not possible to identify what the tortoises had eaten.

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 2014–2025.

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
2021	25	83	October 28
2022	30	90	November 7
2023	10	70	November 21
2024	10	30	November 18
2025	10	80	November 17

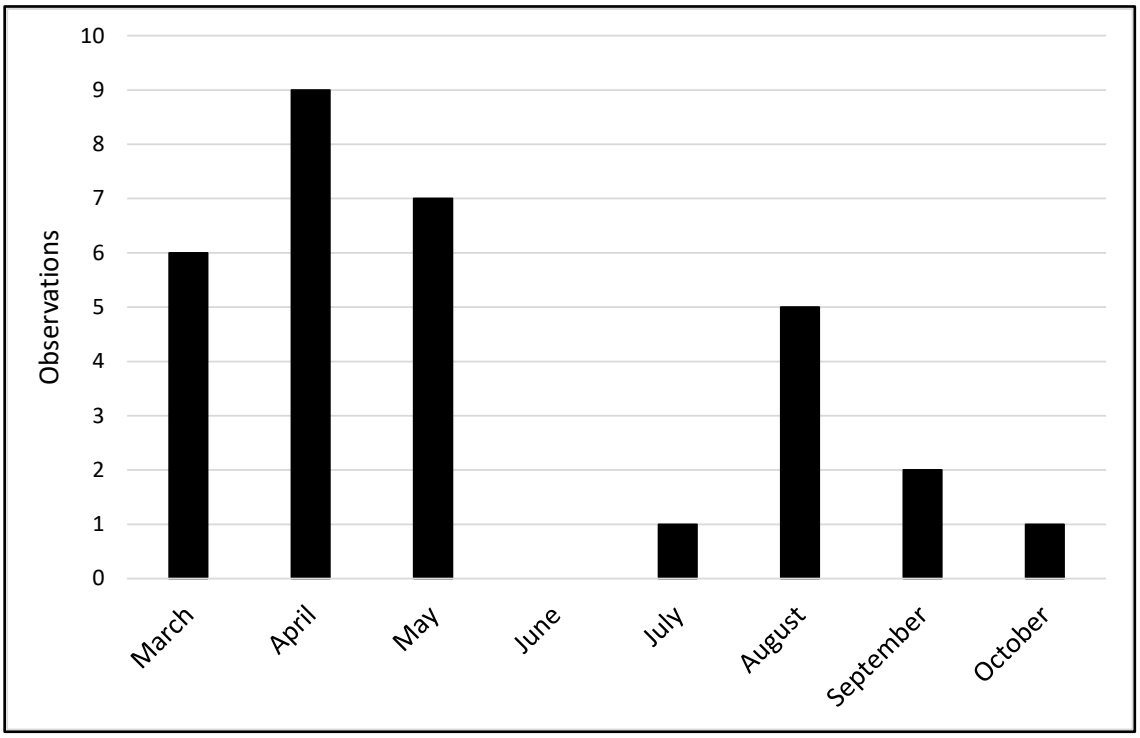

Figure 3-3. Number of times evidence of foraging was detected by month for 10 tortoises, January 2025–January 2026 (n = 31) (no evidence of foraging was detected in January, February, June, November, or December).

Winter and spring precipitation (2024-25) was about half of normal resulting in low plant production and reduced foraging opportunities for tortoises during the spring. A monsoon event in September and warm fall temperatures resulted in limited green up that extended foraging opportunities well into October.

Transmitters were changed out in the fall and health assessments were completed for all 10 tortoises. All 10 tortoises were also measured and weighed and given a Body Condition Score (BCS) in both spring and fall. Table 3-6 contains information on MCL in mm and BCS for fall 2012 (pre-release), spring 2025 and fall 2025 and weight without transmitter in grams (g) for fall 2012 (pre-release) and fall 2025. Also included is the growth (mm) in MCL between spring and fall 2025 which averaged 0.5 mm. Growth during 2025 was substantially less than in 2024 (0.5 mm versus 5.6 mm), most likely due to the much-reduced winter and spring precipitation (about half of normal) received in 2025. Results from health assessments showed that all tortoises were in good condition (BCS 4-5; BCS 1-3, under condition; BCS 4-6, good condition; BCS 7-9, over condition). Some observations from the health assessments include: one tortoise (Female 4044) had increased effort in respiration, two tortoises (Male 4007 and 4036) had minor flaking on the shell, and three tortoises had trauma on the shell. Male 4034 had old trauma on the right side from a suspected predation event, Male 4039 had a lifted scute on LC1 likely caused by the transmitter, and Female 4044 had new trauma from recent predator attack and old trauma from an old attack.

A 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, San Diego Zoo Global, 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 great impact on survival. While it is difficult to determine if a tortoise was scavenged or preyed upon, most 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 a total of 2,470 days from 2017-2025. Results showed 20 coyote images which is about one every 124 days, 17 kit fox images which is about one every 145 days, 14 badger (*Taxidea taxus*) images which is about one every 176 days, and 5 bobcat (*Lynx rufus*) images which is about one every 494 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 or moving farther (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 et al. 2023). 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.

Data for a habitat selection study were collected in 2023 to determine if the translocated tortoises selected specific habitat features such as position (e.g., under vegetation, in the open), plant species composition, landform (e.g., wash bottom, wash slope, ridge), or substrate (e.g., sand, gravel, cobble). Habitat data collected during radio telemetry tracking of tortoises (1,538 aboveground observations [i.e. tortoise was observed outside of its burrow]) was compared to habitat data collected at random points. The following are results from a preliminary analysis with a more thorough analysis planned. Tortoises were found under blackbrush and Nevada jointfir most frequently, but these were also the most frequently occurring

Table 3-6. Midline carapace length (MCL) (mm), weight without transmitters (g), and body condition score (BCS) over time for 10 tortoises monitored in 2025.

Tortoise Number	Sex	Pre-release MCL (mm) 2012	MCL (mm) (Spring 2025)	MCL (mm) (Fall 2025)	MCL Growth (mm) 2012-2025	MCL Growth (mm) Spring to Fall 2025	Pre-release Weight (g) (2012)	Weight (g) (Fall 2025)	Weight gain (g) 2012-2025	Pre-release BCS (2012)	BCS (Spring 2025)	BCS (Fall 2025)
4030	Female	148	211	212	64	1	562	1700	1138	4	4	4
4039	Female	117	181	182	65	1	315	1300	985	5	5	4
4044	Female	146	213	215	69	2	484	2000	1516	4	4	4
4045	Female	129	191	192	63	1	400	1300	900	4	4	4
4004	Male	117	199	196	79	-3	303	1300	997	4	4	4
4007	Male	121	160	161	40	1	363	815	452	5	4	4
4011	Male	144	228	228	84	0	634	2000	1366	4	4	4
4025	Male	127	213	214	87	1	357	1400	1043	5	4	4
4034	Male	128	197	200	72	3	407	1400	993	4	4	4
4036	Male	132	199	197	65	-2	455	1300	845	4	4	4
	Average	**131**	**199**	**200**	**69**	**0.5**	**428**	**1452**	**1024**	**4.3**	**4.1**	**4.0**

plant species at the random points, which may not infer selection. Results do suggest that white bursage and Fremont's dalea are avoided. Ridgetops and wide, flat wash bottoms may be avoided while wash slopes are used in proportion to their availability. Gravel appeared to be avoided while cobble and a combination of gravel/cobble and sand/gravel were selected for.

Additionally, habitat features at 558 unique burrows were compared to the same features at random points. Preliminary results suggest that creosote bush and water jacket are selected for while blackbrush, white bursage, and Fremont's dalea are selected against. Ridgetops appear to be avoided for burrow locations. Substrates with sand/gravel, cobble, sand/gravel/cobble, and sand appeared to be selected for while gravel and gravel/cobble are selected against.

Habitat selection for burrow locations may be more important than habitat selection at aboveground locations because burrows are critical for tortoise survival (e.g., provide protection from predators, necessary for thermoregulation) and where they spend a majority of their time.

3.2.4 Coordination with Other Biologists and Wildlife Agencies

NNSS biologists interfaced with other scientists and ecosystem management agencies in 2025 for the following activities:

- Attended the Desert Tortoise Council 50th Annual Meeting and Symposium in February. This is an annual event that brings together experts to discuss tortoise conservation. An NNSS scientist gave a presentation titled, "Genetic Diversity in Mitochondrial Cytochrome B Gene and Control Region Sequences of *Gopherus agassizii* from Nevada National Security Site (NNSS)."

- Working on a manuscript titled, "Factors Influencing Survival of Translocated Juvenile Desert Tortoises of Known Sex in Southern Nevada" and contains results from the first 10 years of the study.

- Coordinated with FWS Desert Tortoise Recovery Office to potentially translocate displaced tortoises from other projects to the NNSS.

- Coordinated with FWS and other biologists managing construction of solar facilities to develop wildlife-friendly construction techniques for upcoming solar projects on the NNSS.

- Planned and hosted the Nevada Chapter of The Wildlife Society annual meeting in January in Las Vegas. The focus was on the need to ensure solar energy development in Nevada was done responsibly and in a wildlife-friendly manner.

- NNSS biologists participate in the DOE Endangered and Threatened Species Working Group which focuses on better understanding DOE's endangered species programs and common obstacles for species management and networking with other DOE site biologists.

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 NNSS 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 described 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 2025 focused on wildland fire fuel surveys, natural water source monitoring, and constructed water source monitoring, including contaminated sumps. Results from reptile studies are also included.

4.1 Wildland Fires, Fuel Surveys, and Recovery Plans

Wildland fires on the NNSS can cause significant ecological damage and require considerable financial resources for fire suppression and mitigation. Estimated costs for fire suppression efforts for the 2021 Cherrywood Wildland Fire were $457 per ha ($4.8 million total). Costs incurred from the Egg Point Fire in August 2002 (121 ha) were well over $1 million to replace one mile of burned power poles, and more than $200,000 for soil stabilization and revegetation of the burned area. The loss of wildlife habitat and ecosystem function is also a big problem, especially in mid-elevation areas where conversion to invasive annual grasslands degrades habitat and greatly increases the frequency of wildland fires in those areas. Because of these impacts there is a need to minimize the number and extent of wildland fires and assess the annual wildland fire risk. This section contains information about wildland fires that occurred on the NNSS during 2025, and methods and results of fuel surveys designed to assess annual wildland fire risk on the NNSS.

4.1.1 Wildland Fires in 2025

From 1978 to 2025, an average of 9.8 wildland fires per year and about 130 ha per fire have burned on the NNSS. Many 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 species [*Pinus monophylla/Juniperus osteosperma/Artemisia* species {spp.}] plant communities). These vegetation 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).

Ten wildland fires were documented on the NNSS in 2025. Eight were project related and two were caused by lightning. The lightning-caused Cat Canyon Fire was the largest and burned approximately 6,571 ha (3,628 ha on NNSS, 2,943 ha on Nevada Test and Training Range [NTTR]) in primarily sagebrush and pinyon-juniper habitat in Area 30 and onto the NTTR. One was a single tree fire, also caused by lightning and started on the same day as the Cat Canyon Fire, that burned about 0.1 ha in Area 20. The eight small fires were project related and contained in a small area (0.4 ha).

4.1.2 Wildland Fire Recovery Plans

A relatively new requirement identified in the Consolidated Emergency Management Plan (NFO-EOC-PLN-101) necessitates the development of recovery plans for specified fires based on their impact and magnitude of acreage burnt. Typically, NNSS biologists contribute information and recommendations to the recovery plan focused on impacts to species protected under the ESA; sensitive and protected/regulated plant and animal species; vegetation changes, conversion to annual grassland, and potential rehabilitation measures; and wind and water erosion potential. No recovery plans were developed during 2025.

4.1.3 Fuel Survey Methods

Beginning in 2004, surveys were initiated on the NNSS to identify wildland fire hazards. Vegetation surveys were conducted between April 23 and May 22, 2025, at sites located along and adjacent to major NNSS corridors to estimate the abundance of fuels produced by native and invasive annual and perennial 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 shrubs and trees) 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.

4.1.4 Fuel Survey Results

4.1.4.1 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] 2025). In the fall of 2011, most of the rain gauges on the NNSS were upgraded from weighing gauges to tipping-bucket style gauges with data transmitted directly to NOAA via telecommunications, rather than manually retrieving and processing the data (Hansen, personal communication 2012). In most cases, the new gauges were relocated nearby to facilitate data collection. The changes were made to reduce costs, improve data reliability, and improve access time to the data after precipitation events. As a result of these modifications, only 14 rain gauges remain from the original gauge stations. The Cane Spring, Tippipah Spring, and Rock Valley gauge stations were decommissioned. The Jackass Flats gauge was moved to Port Gaston in Area 26. The Little Feller 2 gauge was moved from the eastern part of Area 18 to the northwestern corner of Area 18. Precipitation data collected in 2025 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.

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 5 months was correlated (R= 0.770) with our estimations of the combined fuel loads. During 2025, the average precipitation from the remaining 14 rain gauge stations on the NNSS during December–April was 49.6 mm, which is about half of the long-term average (2004-2025) of 103.2 mm received on the NNSS.

4.1.4.2 Fuels

Due to the well below-average precipitation received during winter/spring 2024-2025, production of annual forbs and grasses was negligible in the low to middle elevations. Production of annual and perennial forbs and grasses was low to moderate at the higher elevations. Residual fine fuels were observed in 2025 and made up the bulk of the biomass at the low to middle elevations.

The fine-textured fuels index decreased from 2.37 in 2024 to 2.19 in 2025 which is above the long-term average (2004-2025) of 2.14 (Table 4-1). Fine fuels were comprised of a mix of native grasses and forbs and invasive annual grasses, mostly red brome and cheatgrass (*Bromus tectorum*). Brome production was negligible at the lower elevations and moderate at the middle elevations in 2025, especially in previously burned areas. At the higher elevations, native perennial grasses and forbs were common with moderate biomass production.

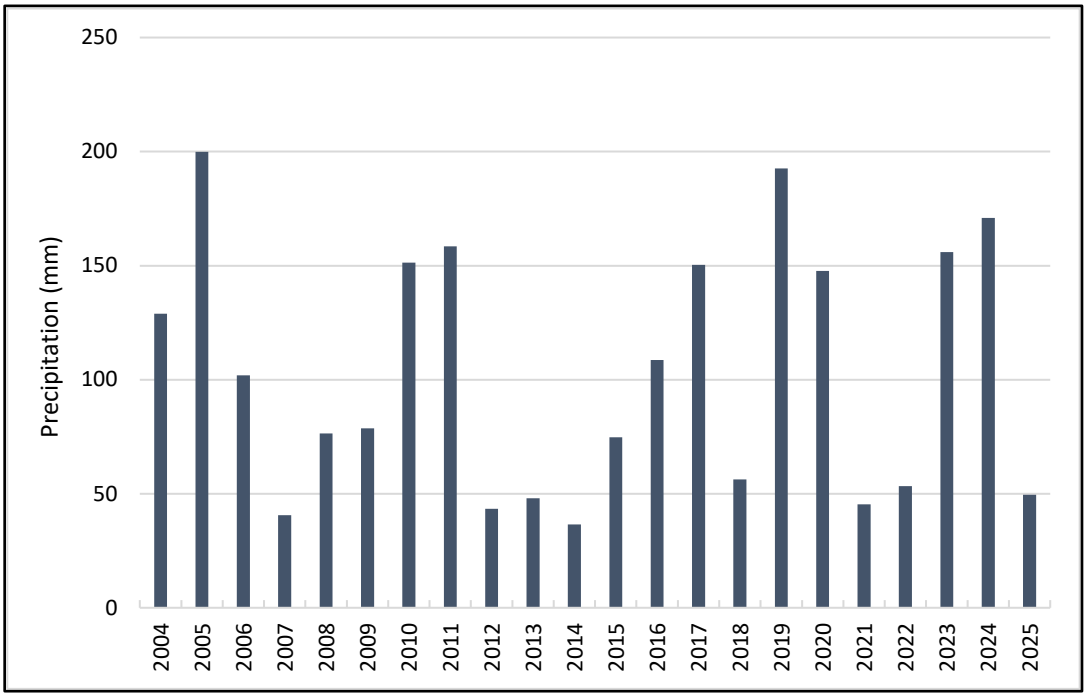

Figure 4-1. Average precipitation from December (previous year) through April for the years 2004 through 2025 (long-term average [2004-2025] 103.2 mm).

Table 4-1. Woody fuels, fine fuels and combined fuels index values for 2004–2025.

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
2021	2.56	2.14	4.70
2022	2.56	1.79	4.35
2023	2.56	2.19	4.75
2024	2.63	2.37	5.00
2025	2.62	2.19	4.82
Average 2004-2025	**2.58**	**2.14**	**4.71**

The coarse-textured or woody fuels index value decreased slightly from 2.63 in 2024 to 2.62 in 2025 (Table 4-1). This was an above-average value in comparison to the other index values since 2004. Woody values are not expected to change as much as fine fuel values due to the longer life span of shrub and tree species that comprise the woody fuels category. Pinyon pine trees in several areas along Pahute Mesa Road showed signs of stress or were dead, especially at the lower elevations where this species occurs, likely caused by prior drought conditions. This creates a substantial fuel load of highly flammable material. Trees in these areas will be monitored over the next few years to assess their status and thinning of dead material may be recommended.

The combined index value (fine fuels plus woody fuels) 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 decreased from 5.00 in 2024 to 4.82 in 2025 (Table 4-1). This is higher than the long-term average (2004-2025) value of 4.71, suggesting a higher-than-average fuel load for the NNSS in 2025.

The locations and results of the fine fuels, woody fuels and combined fuels surveys at 104 stations on the NNSS inspected during 2025 are shown in Figures 4-2, 4-3 and 4-4, respectively. The highest combined index values (Figure 4-4) and thus, the highest potential for wildland fires, occur in Fortymile Canyon (mostly previously burned areas), southern Yucca Flat (blackbrush), Buckboard Mesa (sagebrush), and northeast Big Burn Valley (pinyon-juniper). High amounts of fine fuels were found in Fortymile Canyon, southern Yucca Flat, and Mid Valley (Figure 4-2). High amounts of woody fuels were primarily found in the forested portions of Pahute Mesa, but also occurred along Stockade Wash Road, Cane Spring Road and upper Fortymile Canyon (Figure 4-3).

Photographs were taken from permanent locations for all 104 sites during the past 17 years. For example, Figure 4-5 shows photographs of Site 99 in Yucca Flat for the years 2022, 2023, 2024, and 2025. 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.

4.1.4.3 Invasive Plants

The three most commonly observed invasive annual grasses to colonize the NNSS are Arabian schismus found at low elevations; red brome, found at low to moderate elevations; and cheatgrass, found at all elevations (Table 4-2). Values in Table 4-2 only reflect plants germinated in 2025. Cheatgrass was the most common invasive plant found in 2025 occurring at 43.3% of the sampling locations. While it was predominantly found at middle to higher elevations it was found at lower elevation sites as well. Maximum cheatgrass biomass was observed in previously burned areas in Fortymile Canyon and Mid Valley. Red brome was only found at 12.5% of the sites, the second lowest recorded since 2007. Arabian schismus which only occurs at lower elevations was not found this year due to the drought.

Native annual and perennial forbs were not very abundant this year due to the below-average precipitation (Table 4-2). Desert globemallow was found at 33.7% of sampling locations (Table 4-2). This species is a native, perennial forb found throughout the NNSS. It likes disturbance and can form dense patches in road shoulders and previously burned areas. Precipitation history (Figure 4-1, Table 4-2) 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

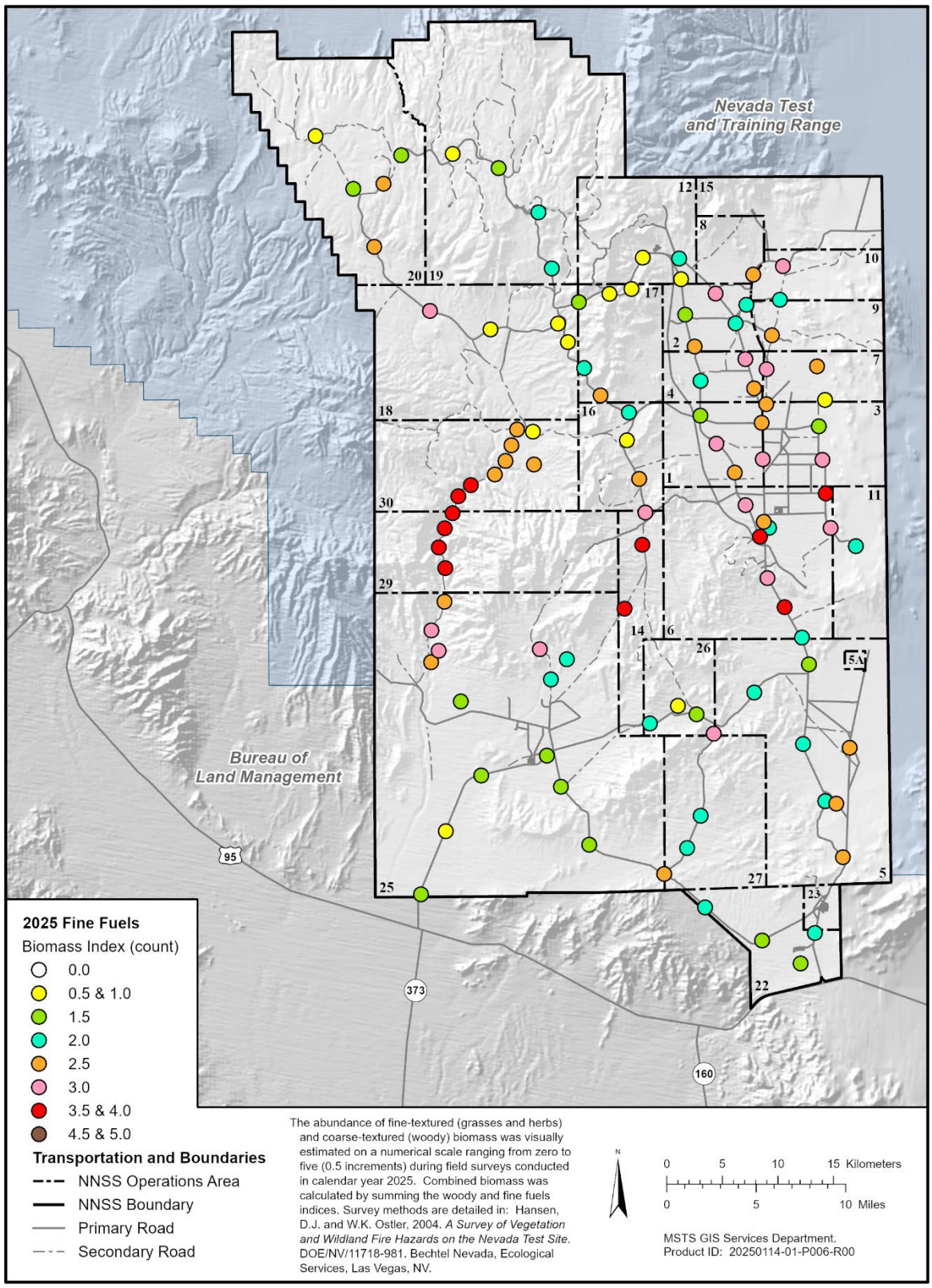

Figure 4-2. Index of fine fuels for 104 survey stations on the NNSS during 2025.

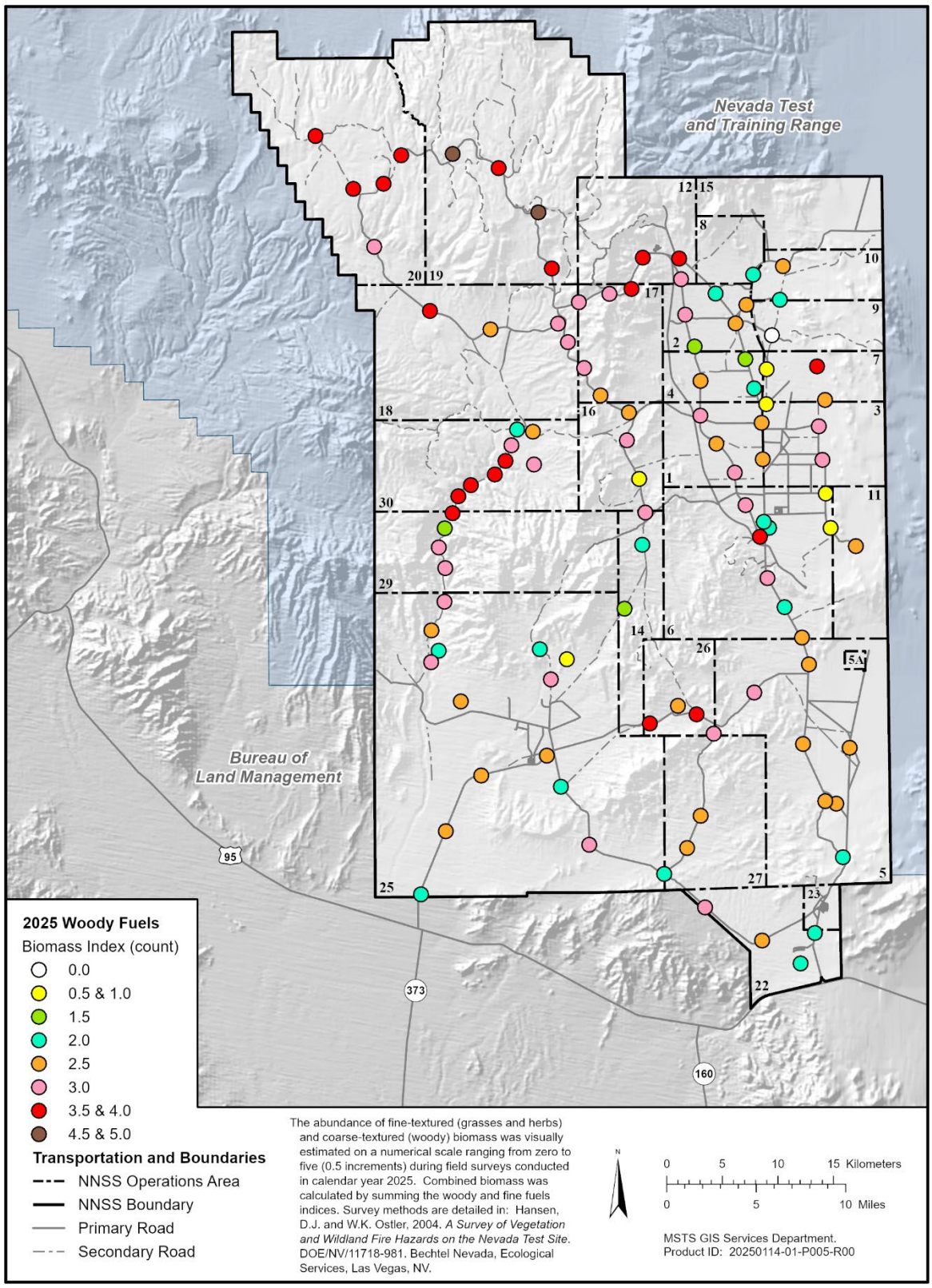

Figure 4-3. Index of woody fuels for 104 survey stations on the NNSS during 2025.

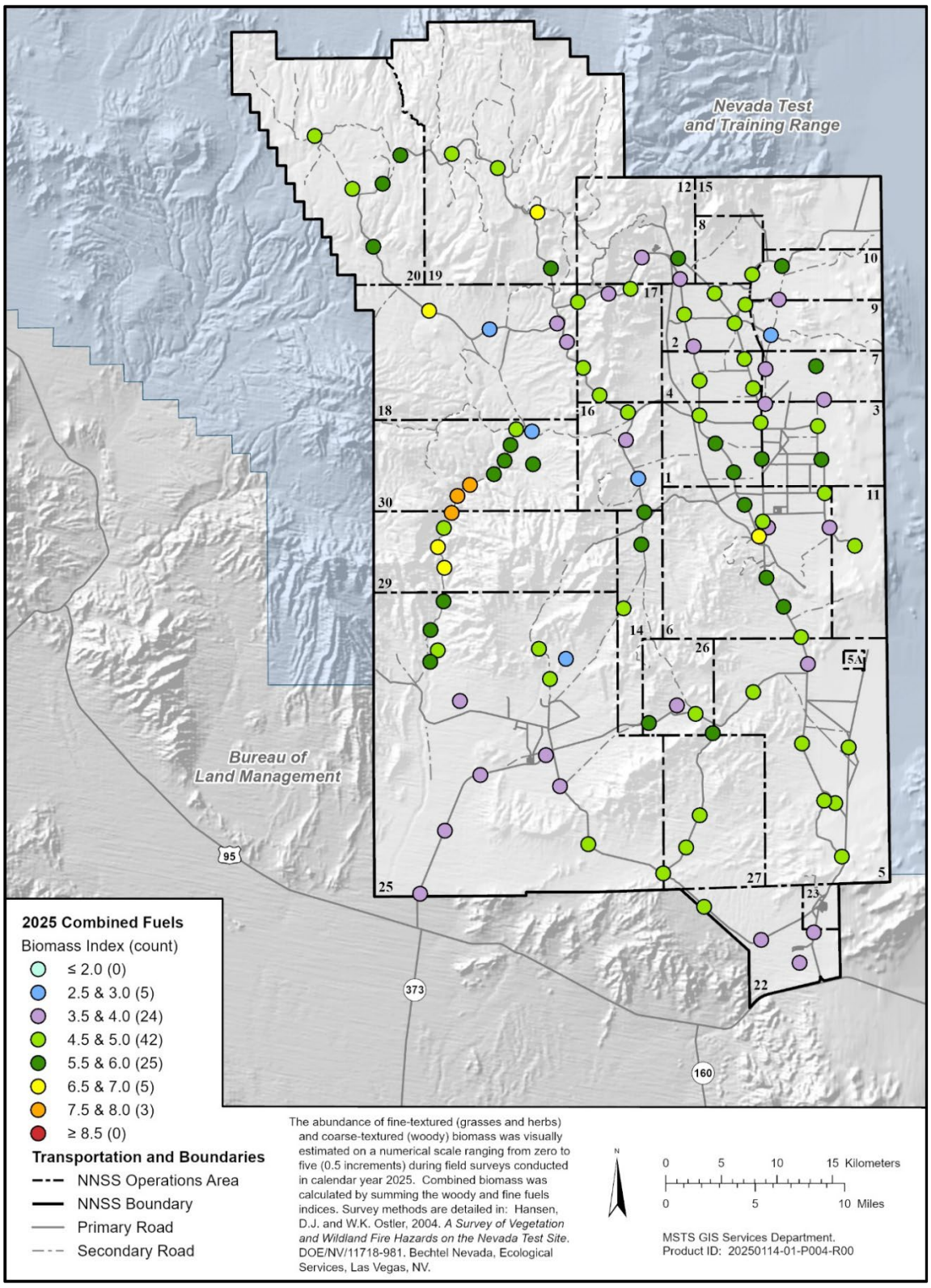

Figure 4-4. Index of combined fine fuels and woody fuels for 104 survey stations on the NNSS during 2025.

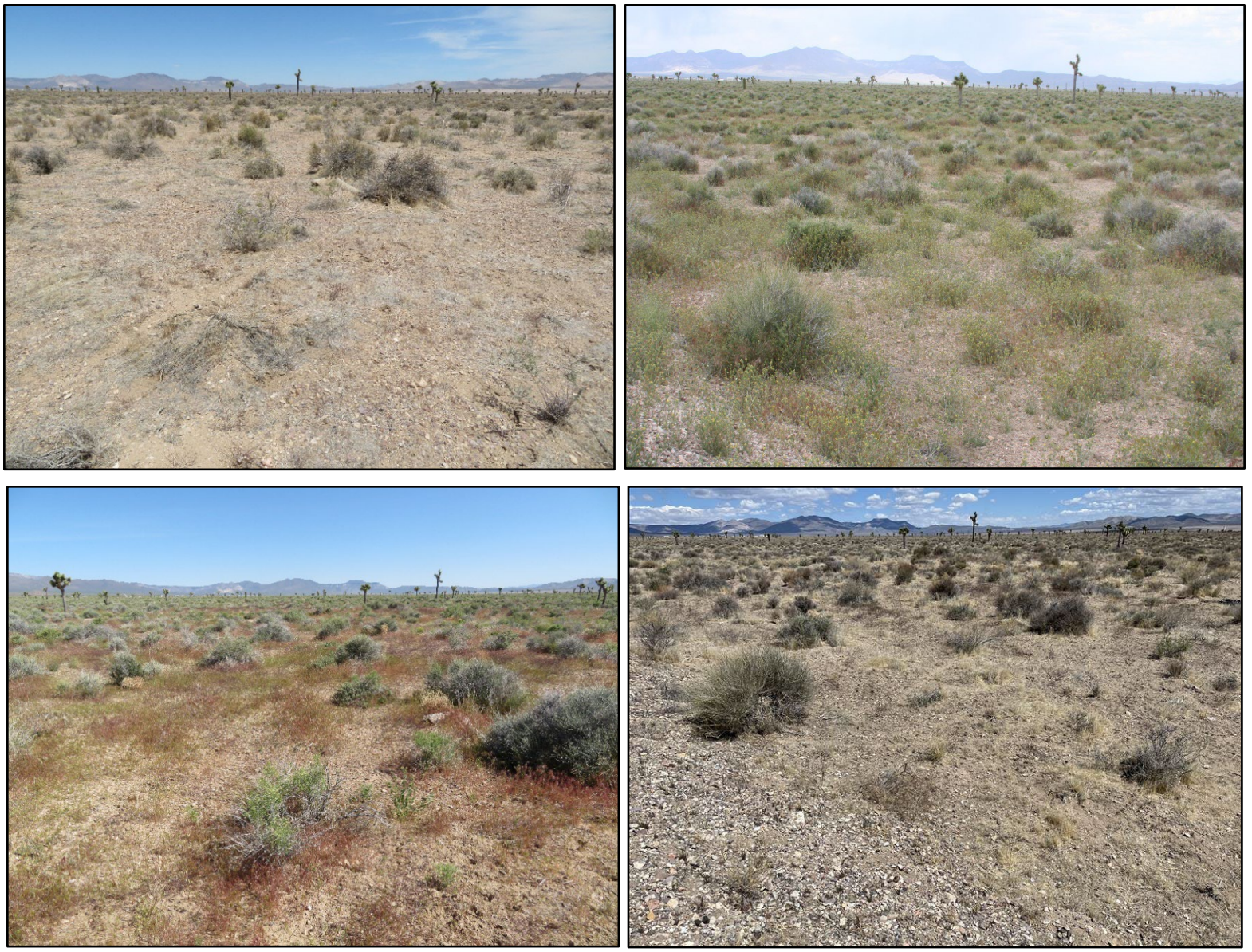

Figure 4-5. Site 99 on the west side of Yucca Flat in 2022, 2023, 2024, and 2025

(Photos by J.A. Hannon, May 10, 2022 [top left], D.B. Hall, May 16, 2023 [top right], F.K. Diaz, May 7, 2024 [bottom left], J.A. Hannon, May 29, 2025 [bottom right]).

Table 4-2. Precipitation history and percent presence of key plant species contributing to fine fuels at surveyed sites, 2007-2025 (* = not calculated).

Precipitation History	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Mean Precipitation (mm) (December–April)	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	45.3	53.3	155.9	171.0	**49.6**
Invasive Introduced Species																		
Bromus rubens (red brome)	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	18.3	31.7	58.7	60.6	**12.5**
Bromus tectorum (cheatgrass)	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	24.0	51.0	81.7	87.5	**43.3**
Erodium cicutarium (redstem stork's bill)	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	2.9	11.5	26.9	34.6	**8.7**
Schismus arabicus (Arabian schismus)	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	1.0	1.0	23.1	24.0	**0.0**
Native Species																		
Amsinckia tessellata (bristly fiddleneck)	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	1.0	26.0	58.7	45.2	**3.8**
Mentzelia albicaulis (whitestem blazingstar)	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	3.8	17.3	20.2	5.8	**1.0**
Chaenactis fremontii (pincushion flower)	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	0	8.7	6.7	5.8	**0.0**
Sphaeralcea ambigua (desert globemallow)	*	*	*	*	*	*	*	*	32.7	36.5	32.7	31.7	41.3	23.1	26.9	42.3	57.7	**33.7**

is generally greatest during periods of high precipitation which 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 response of some species, both invasive and native species, suggests that other variables, such as the timing of precipitation or temperatures required for germination, may also be contributing to plant response both in terms of plant abundance and biomass produced.

Colonization by invasive species such as cheatgrass, red brome, and Arabian schismus increases the likelihood of future wildland fires because they provide abundant fine fuels that grow under shrubs as well as in the interspace between shrubs which allows fire to spread from one shrub to another, thus creating a near continuous fuel layer. 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 even with reseeding or transplanting with native species and other rehabilitation efforts such as herbicide treatments 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 combined fuel load for 2025 is above average (mostly due to residual fuels from previous wet years) creating conditions conducive for wildland fires to occur, especially 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 red brome. Early detection and rapid fire suppression response by NNSS Fire and Rescue after fires are ignited is a key factor in minimizing wildland fire spread and severity.

4.1.4.4 Sahara Mustard (Brassica tournefortii)

Sahara mustard, also known as African or Asian mustard or wild turnip, is an invasive, introduced, annual weed that invades disturbed areas (e.g., roadsides, areas disturbed by heavy equipment, naturally disturbed areas) quickly with a single plant capable of propagating thousands of seeds (McDonald 2023). Sahara mustard has a quick life cycle, does not need a lot of soil moisture, and can flower as early as February in the Mojave Desert (U.S. Department of Agriculture Forest Service 2017). It seems to germinate and grow mainly during years of above-normal winter precipitation. The plant grows taller than native annuals and outcompetes native plants for light, water, and resources (McDonald 2023). The plants are robust and form dense stands where they invade. Berry et al. (2014) suggest it is an invasive "transformer" species, capable of transforming an ecosystem. Sahara mustard contains toxic oxalates and is not a good food plant (Abella and Berry 2016, Jacobson et al. 2009). Plants have spread throughout the Mojave Desert into tortoise habitat. Recovery of the tortoise includes improving forage quality and quantity by decreasing nonnative plants that create low diversity stands (Abella and Berry 2016). Eradication of Sahara mustard takes "consistent and repeated efforts" and "can be achieved after 3 to 4 years of consistent and timely control efforts" (McDonald 2023).

Sahara mustard has been known to occur in Area 25 since 2008. The plant has now been observed at four locations in Area 25: MX Racetrack, 2nd Street Helipad, Yucca Mountain Borrow Pit, and the access road to Yucca Mountain Borrow Pit (Figure 4-6). The invaded area is now known to be extensive at the MX Racetrack and 2nd Street Helipad, covering disturbed and pristine habitat in the range of the tortoise.

NNSS biologists began an eradication program in 2024. Biologists began hand-pulling plants in early 2024 to prevent the spread of seeds. In 2025, NNSS biologists began using herbicide in invaded, disturbed areas to target the seed bank. February 10-13, 2025, the NNSS Roads and Grounds department sprayed Rejuvra (indaziflam) herbicide at the MX Racetrack and 2nd Street HeliPad (Figure 4-7). Rejuvra

is a pre-emergent herbicide that prevents seeds in the seedbank from germinating and is known for its multi-year effectiveness (3-5 years). Thirty acres of habitat were treated along roads, pads cleared of native vegetation, and near abandoned buildings (Figure 4-7).

Sahara mustard did not germinate in the winter of 2024-2025 (November-January) because there was not enough precipitation. No plants were observed growing in early 2025. In November 2025, the NNSS received a lot of precipitation and Sahara mustard plants began germinating in December. Areas that were treated with Rejuvra did not have germination (Figure 4-8).

4.2 Reptile Studies

During 2025, a small study to investigate potential impacts of the Ribbon Cliff Wildland Fire on reptiles was conducted and 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.



Figure 4-6. Locations of known Sahara mustard populations in Area 25. Coordinates in UTM NAD83 (Zone 11, meters).

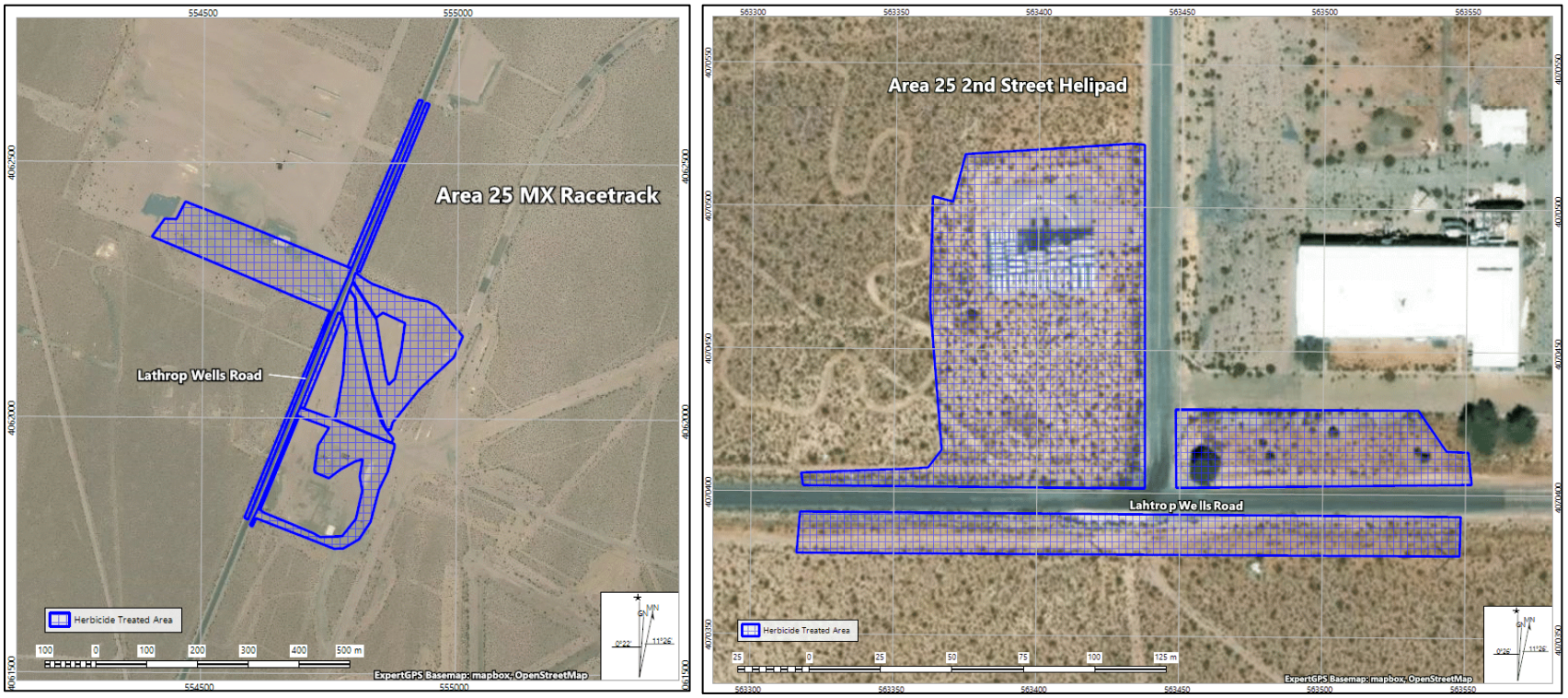

Figure 4-7. Areas treated with herbicide in February 2025 in Sahara mustard invaded areas. Coordinates in UTM NAD83 (Zone 11, meters).



Figure 4-8. Area treated with herbicide (left side of image) and area not treated (right side of image) at the 2nd Street Helipad location. Sahara mustard did not germinate in the herbicide treated area but did germinate, along with invasive Arabian schismus, in the untreated area.

(Photo by J.A. Hannon, January 6, 2026)

Of particular interest was the impacts of the fire to a known population of western red-tailed skinks (*Plestiodon gilberti rubricaudatus*) as well as other reptile species. On July 31, 2008, an adult skink was captured at Site #93 in a canyon in the northwest portion of Trail Ridge. In late August 2024, the Ribbon Cliff Wildland Fire burned through Site #93 and covered 3,228 ha, primarily in sagebrush habitat.

Three study sites were selected, two burned and one unburned. The two burned sites included Site #93 (Figure 4-9) and another site on the eastern slope of Trail Ridge (Figure 4-10). An unburned site (Figure 4-11) was also selected about 500 m north of Site #93 to compare with the burned sites. Twenty-four funnel traps (Figure 4-9) were set at each site for three consecutive nights July 14-16 and again September 29 through October 1. Captured animals were identified; many were measured, weighed, sexed, and marked; and then released. Animal observations were also recorded to compare between burned and unburned sites.

Results are found in Table 4-3. No western red-tailed skinks were captured at any site. Skinks are difficult to capture even when present; therefore, this does not mean they are not present or have been extirpated because of the fire (Hall et al. 2019). The greatest number of captures occurred at the burned East Trail Ridge site with eight western fence lizard (*Sceloporus occidentalis*) captures and one scorpion. Five



Figure 4-9. Known western red-tailed skink site (Site #93) that burned in the Ribbon Cliff Fire. Note the funnel trap on the left side of the photo.

(Photo by D.B. Hall, July 16, 2025)

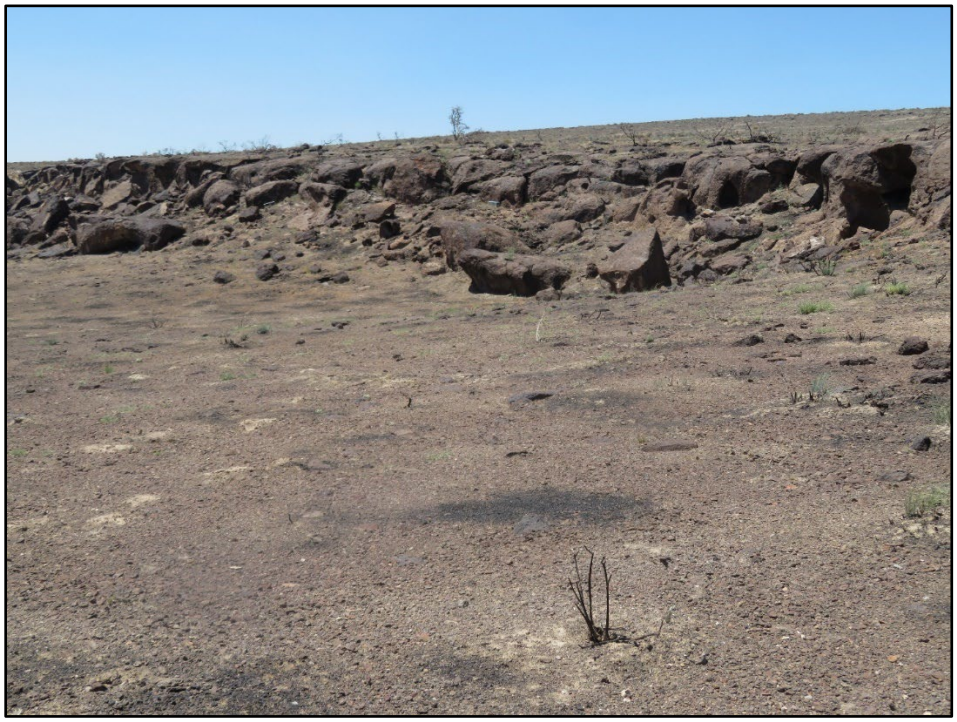

Figure 4-10. Burned site, eastern slope of Trail Ridge.

(Photo by D.B. Hall, July 16, 2025)



Figure 4-11. Unburned site, south of Site #93.

(Photo by D.B. Hall, July 16, 2025)

Table 4-3. Capture and observation results from 2025 for burned and unburned sites within the Ribbon Cliff Wildland Fire that burned in August 2024.

	Burned		Unburned
	Site #93	East Trail Ridge	South of Site #93
Captures			
Western fence lizard		8	2
Western whiptail lizard			1
Merriam's kangaroo rat			1
Scorpion	1	1	1
Observations			
Western fence lizard	2	2	3
Side-blotched lizard	1		
White-tailed antelope ground squirrel		1	

captures of four species were made at the unburned site, and one scorpion was captured at the burned Site #93 site. Three animal observations were made at each of the three sites with some differences in species observed. Overall, there was not a notable difference between burned and unburned sites. Surprisingly, the site where the highest number of animals was detected was the most impacted site, East Trail Ridge, which was largely devoid of vegetation (Figure 4-10). Apparently, the rocky habitat provided enough protection from the fire and good enough habitat for animals to survive. Several western fence lizard breeding males and one female were captured at this site compared to one breeding male and one female captured at the unburned site. These results are based on a limited amount of data so caution should be

exercised when making inferences across the entire burned area. Nevertheless, it is encouraging to see that animals survived the fire.

Opportunistic reptile observations included three sidewinder rattlesnakes (*Crotalus cerastes*), including a hatchling and two juveniles, that were moved away from facilities in Mercury (23-460 parking lot, 23-462 trench, near Mercury track) for human safety. A rare snake, the southwestern black-headed snake (*Tantilla hobartsmithii*) was extracted from a glue trap in Building 23-310 and released. Other snakes removed from facilities and released included a gopher snake (*Pituophis catenifer*) removed from inside P Tunnel and a ground snake (*Sonora semiannulata*) removed from a glue trap in Building 23-652. Several lizards were removed from glue traps in buildings in Mercury and released including a leopard lizard (*Gambelia wislizenii*), a western banded gecko (*Coleonyx variegatus*), a zebra-tailed lizard (*Callisaurus draconoides*), a desert spiny lizard (*Sceloporus magister*), four side-blotched lizards (*Uta stansburiana*), and a western whiptail lizard (*Cnemidophorus tigris*). Another western whiptail was removed from a glue trap at Area 5 Radioactive Waste Management Complex (RWMC) and released.

4.3 Natural Water Source Monitoring

Ten natural water sources (six springs, four rock tanks) were monitored with motion-activated cameras in 2025 to document the presence of mountain lions (*Puma concolor*) and other wildlife (Figure 4-12). Results are found in Table 6-4 with site numbers referenced in Figure 6-21 (see Section 6.11.1, Motion-Activated Cameras). General assessments were also made of each spring and the surrounding area to document major disturbances or changes to these important water sources. During 2025, Topopah Spring cave pool had a wet spot near the entrance and another wet spot at the back. Vegetation was heavily trampled primarily by feral burros at Twin Spring and Cottonwood Spring with numerous burro trails on the slopes leading to the springs. Vegetation at Captain Jack Spring was dense in the absence of feral horses (*Equus caballus*) using the perennial spring, and cattails (*Typha domingensis*) were very dense around Cane Spring. Gold Meadows Spring was dry most of the year but partially filled up in late fall.

Topopah Spring (#8) had the most images (7,078; 11 mammals, 9 birds) with 6,477 images of chukar (*Alectoris chukar*). This was a substantial decline from 9,542 chukar images taken in 2024 but still very high compared to most years. Five images of a spotted skunk (*Spilogales gracilis*) were recorded, which was the second consecutive year this species occurred here.

Twin Spring (#16) had 6,080 images of 10 mammals and 10 birds with numerous images of feral burro (3,723 images), desert cottontail rabbit (*Sylvilagus audubonii*; 928 images), chukar (755 images) and mule deer (220 images). The spotted skunk was detected for the first time at this location. A total of 58 images were taken with some images containing two individual skunks. Figure 4-13 shows an adult (lower right with white tail) and a juvenile (middle) indicating successful breeding. A total of 4,815 images of 5 mammal and 4 bird species was recorded at Cottonwood Spring (#4). Most of the images were of feral burros (4,517) followed by chukar (195) and desert bighorn sheep (*Ovis canadensis nelsoni*; 44).

Gold Meadows Spring (#13) had 785 images of 6 mammals and 7 birds. Feral horses were the most photographed animal (306 images) followed by black-tailed jackrabbits (*Lepus californicus*; 237 images). Captain Jack Spring (#10) had 478 images of 5 mammals, 8 birds, and one insect and was dominated by mule deer (387 images). At Cane Spring (#7) 126 images of 6 mammals and 1 bird were taken mostly of desert cottontail rabbit (204 images) followed by bobcat (11 images). In addition, the first desert bighorn sheep use of this site was documented when a solitary ram was photographed on December 20 (see Section 6.8 Desert Bighorn Sheep).

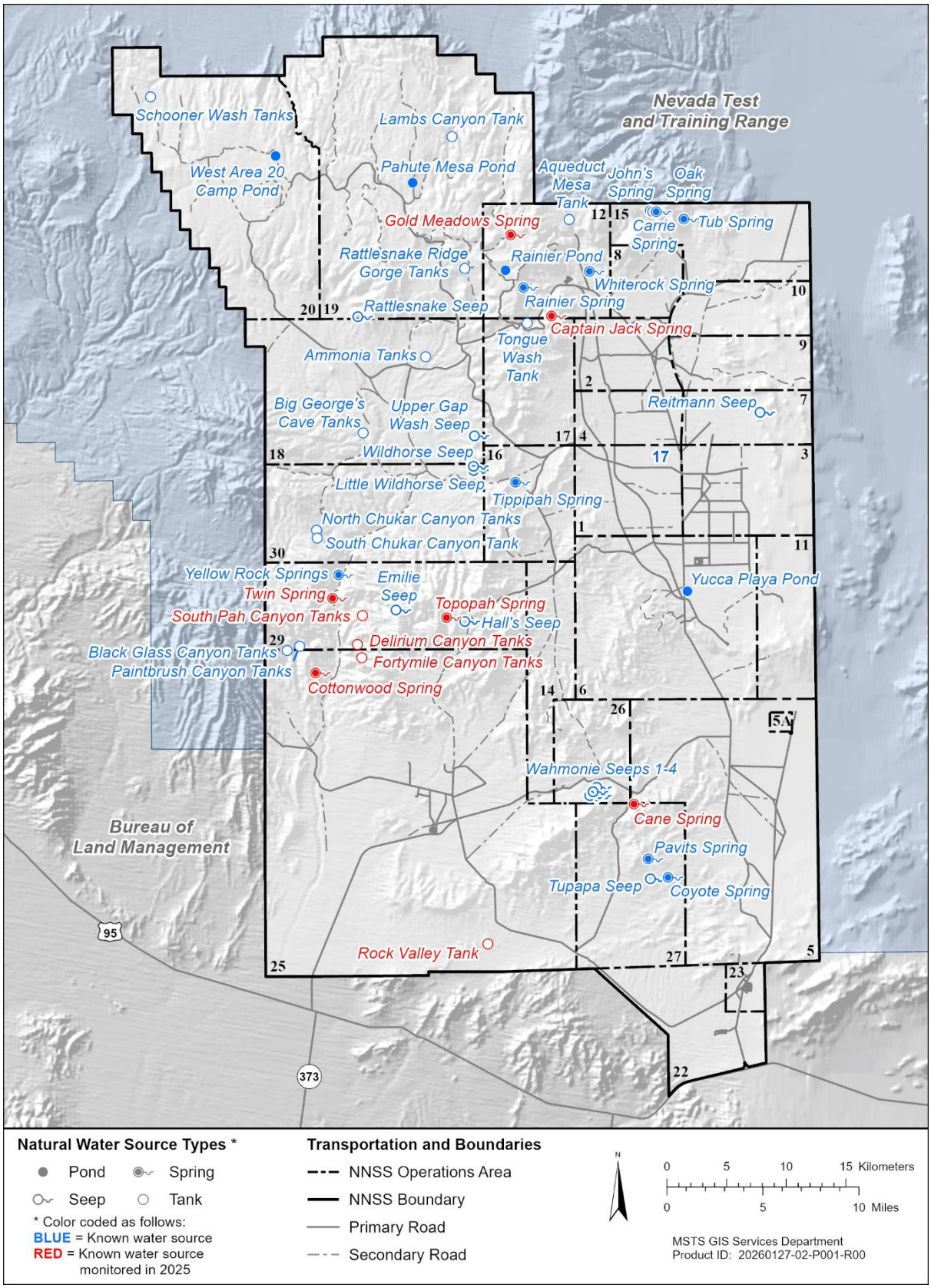

Figure 4-12. Natural water sources on the NNSS, including those monitored in 2025.



Figure 4-13. Spotted skunks at Twin Spring (#16).

(Photo by motion-activated camera, July 25, 2025)

The natural water source with the highest species richness was South Pah Canyon Tanks (#11) with 10 mammal and 11 bird species documented in 509 images. Pinyon jay (*Gymnorhinus cyanocephalus*) was the most photographed species (176 images) followed by chukar (119 images), desert bighorn sheep (65 images), and golden eagle (43 images; Figure 4-14). Five species of carnivore were detected including bobcat, gray fox (*Urocyon cinereoargenteus*), coyote, ring-tailed cat (*Bassariscus astutus*), and spotted skunk. A rare (only the seventh NNSS record) detection of a hermit thrush (*Catharus guttatus*) was recorded on October 6.

Delirium Canyon Tanks (#5) had 549 images of 5 mammals and 2 birds. Desert bighorn sheep dominated the site with 492 images taken followed by coyotes with 26 images. Fortymile Canyon Tanks (#9) had 4 mammal and 5 bird species detected in 61 images with desert bighorn sheep being the most photographed species (42 images). A total of 60 images (7 mammals, 2 birds, 1 reptile, 1 insect) were taken at Rock Valley Tank (#2), dominated by coyote (25 images) followed by badger; 13 images) and white-tailed antelope ground squirrel (*Ammospermophilus leucurus*; 10 images). A chuckwalla (*Sauromalus obesus*) was also photographed at this site on May 9 (Figure 4-15).

4.4 Constructed Water Source Monitoring

Four constructed water sources were monitored with motion-activated cameras to document the presence of mountain lions and other wildlife during 2025. These included one well pond (Camp 17 Pond), two water troughs installed to mitigate the loss of well ponds, and one radiologically contaminated sump (Figure 4-16).



Figure 4-14. Three golden eagles at South Pah Canyon Tanks (#11).

(Photo by motion-activated camera, June 29, 2025)



Figure 4-15. A chuckwalla at Rock Valley Tank (#2).

(Photo by motion-activated camera, May 9, 2025)

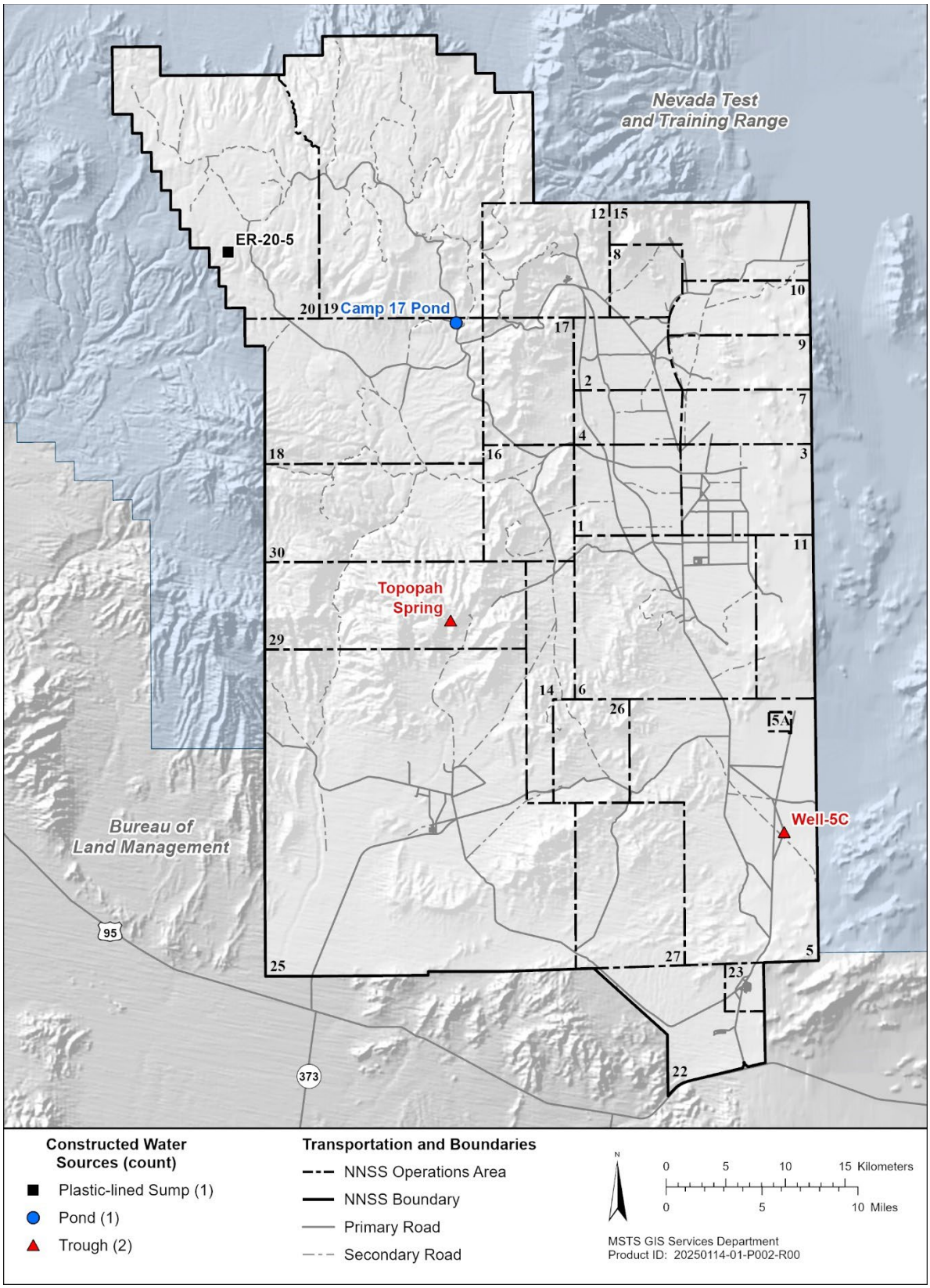

Figure 4-16. Constructed water sources monitored with motion-activated cameras for wildlife use during 2025.

A total of 42 species (9 mammals, 32 birds, 1 insect) were detected at Camp 17 Pond (#6) in 2.213 images (Table 6-4). Red-tailed hawk (*Buteo jamaicensis*; 544 images) was the dominant species followed by turkey vulture (*Cathartes aura*; 290 images), chukar (220 images), feral horse (172 images), mule deer (107 images), mourning dove (*Zenaida macroura*; 107 images), common raven (*Corvus corax*; 80 images), and coyote (69 images). Notably, 8 images of peregrine falcon (*Falco peregrinus*), 10 images of golden eagle (*Aquila chrysaetos*), and 6 images of varied thrush (*Ixoreus naevius*; only the fifth NNSS record) were photographed (Figure 4-17).

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. 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 Yard) 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



Figure 4-17. A rare (fifth NNSS record) detection of a varied thrush, Camp 17 Pond (#6).

(Photo by motion-activated camera, November 7, 2025)

cameras were set up at each trough during the fall of 2012 to document wildlife use. These cameras were also added to the network of cameras used for monitoring mountain lions and results for 2025 are included in Table 6-4 (see Section 6.11.1, Motion-Activated Cameras). Wildlife use with motion-activated cameras at Well C1 Trough, Area 6 LANL Trough, and Cane Spring Trough was discontinued after 2023 for a variety of reasons including light use, lack of water, or additional water away from trough from fillstand overflow.

Wildlife use at Well 5C trough (#3) was heavy with 1,179 images of 9 mammals, 13 birds, and 1 insect. Horned lark (*Eremophila alpestris*) was the most photographed species (617 images) followed by black-tailed jackrabbit (282 images) and common raven (68 images). Only 12 mourning dove images were taken compared to 707 images in 2024. An American coot (*Fulica americana*) was photographed 34 times in early October which is notable that see waterfowl at such a small body of water. Other notable occurrences were 2 images of bobcat, 10 images of kit fox, 24 images of coyote, 1 image of badger, 29 images of pronghorn antelope, 1 image of Cooper's hawk (*Accipiter cooperi*), 1 image of sage thrasher (*Oreoscoptes montanus*), 2 images of loggerhead shrike (*Lanius ludovicianus*), 8 images of Bell's or sagebrush sparrow (*Artemisiospiza* spp.*)*, and 4 images of Eurasian collared dove (*Streptopelia decaocto*). Wildlife use at Topopah Spring Trough (#23) was moderate with 390 images of 8 mammals and 6 birds. Chukar was the dominant species photographed (237 images) followed by rock squirrel (*Spermophilus variegatus*; 62 images).

In summary, the troughs are benefiting many wildlife species on the NNSS, especially certain bird species, ungulates, and coyotes. With few exceptions, 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 2025, a motion-activated camera was set up at one contaminated water source which is a sump constructed to retain groundwater and drilling fluids from Underground Test Area (UGTA) wells during drilling, well development, and groundwater testing. The sump was Environmental Restoration (ER) 20-5 (#12) (Figure 4-16). This camera was also added to the network of cameras used for mountain lion monitoring (see Section 6.11.1, Motion-Activated Cameras) (Table 6-4). Typically, discharge water and drilling fluids having ≥400,000 picocuries/liter 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 camera was set up to document wildlife use to assess the potential off-site transport of radionuclides by wildlife and the potential impact to the animals.

Wildlife use at ER 20-5 (#17) was very light with only 3 images of common ravens detected. This is likely due to the sump being dry most of the year compared with last year where it had water for several months. This contaminated water source will continue to be monitored to determine the 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 humans and 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 2025) available at https://nnss.gov/publication-library/environmental-publications/.

4.5 Coordination with Scientists and Ecosystem Management Agencies

NNSS biologists interfaced with other scientists and ecosystem management agencies in 2025 for the following activities:

- Participated in multiple conference calls for the Mojave Native Plant and Seeds of Success Program and the DOE Land and Natural Resource Management Working Group.
- Attended a workshop where updates were given on various projects associated with the Clark County Multiple Species Habitat Conservation Plan.
- Assisted U.S. Forest Service personnel in monitoring a long-term plot on Timber Mountain as part of the Forest Health Monitoring and Forest Inventory Analysis programs.
- By invitation, presented on plant and animal monitoring on the NNSS at the annual NNSA/NFO Native American Tribal Update Meeting.
- Helped lead the efforts of the NNSS Land Management Council.

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 is reviewed alongside the NDNH At-Risk Plant and Animal Track List (NDNH List). In 2025, the NDNH combined their Track and Watch Lists, greatly expanding the number of plants on the NDNH List. The Watch List was a list of known or thought to be rare plant species which needed additional information to map distributions and identify status, whereas the Track List contained species and their distributions that were actively being evaluated and mapped. The plants actively being tracked by the NDNH increased from 286 to 633. There are 54 plant species that were added to the Track List that require additional research by NNSS biologists (Table 5-1). Thirty-one of the species have been observed on the NNSS, 16 of the species have not been observed on the NNSS but similar subspecies (ssp.) or varieties (var.) have, and seven of the species have been observed on the NNSS at the species level but have not been identified down to the subspecies or variety level. One plant that has been of conservation concern on the NNSS since 1977, Kingston Mountains bedstraw (*Galium hilendiae* ssp. *kingstonense*), was removed from the Track List possibly due to taxonomic reasons. No changes will be made to the NNSS sensitive plant monitoring program until each species is evaluated for its status on the NNSS, in Nevada, and in other states. Currently there are 19 vascular plants and one non-vascular plant considered sensitive and warrant inclusion in the NNSS sensitive plant monitoring program (see Table 2-1).

5.1 Species Evaluations

5.1.1 Sand Cholla (Grusonia pulchella)

Sand cholla is a small, tuber-based cactus that is uniquely adapted for harsh desert conditions. The cactus is on the NDNH List and known to occur on the NNSS. Sand cholla was removed from the NNSS sensitive plant monitoring program in 2020 based on findings from 2019 and 2020 (Hall and Perry 2021), as well as the plant being found widespread throughout the NNSS during ELU mapping surveys in the late 1990s (Ostler et al. 2000). Biologists continue to monitor and request avoidance of the cactus during construction projects. One sand cholla plant was observed May 5, 2025, in Area 30 near the 30-10 Road to the Buggy Crater (UTM NAD83 554429 meters Easting [mE], 4096920 meters Northing [mN]). There are seven confirmed recent observations of sand cholla on the NNSS (Figure 5-1).

5.1.2 Lahontan Beardtongue (*Penstemon palmeri* var. *macranthus*)

There are three varieties (var.) of *Penstemon palmeri* found in the western U.S.: 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. It has been observed between 1,045 to 2,300 m elevation. Palmer's penstemon, on the other hand, is widespread throughout the western U.S. from lower to upper elevations (300-2,600 m) and is currently 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.

Table 5-1. List of plant species recently included in the NDNH List that requires additional research to determine status on the NNSS.

Scientific Name	Observed on the NNSS?
Agave utahensis var. eborispina	Y
Agave utahensis var. nevadensis	Y
Aliciella nyensis	Y
Aliciella ripleyi	Y
Astragalus calycosus var. monophyllidius	N
Astragalus calycosus var. scaposus	N
Astragalus lentiginosus var. borreganus	N
Astragalus lentiginosus var. chartaceus	N
Astragalus lentiginosus var. kennedyi	N
Astragalus lentiginosus var. kernensis	N
Astragalus lentiginosus var. latus	N
Astragalus lentiginosus var. scorpionis	N
Astragalus lentiginosus var. semotus	N
Astragalus lentiginosus var. sesquimetralis	N
Astragalus lentiginosus var. stramineus	N
Astragalus lentiginosus var. variabilis	Y
Astragalus mohavensis var. hemigyrus	N
Astragalus mohavensis var. mohavensis	Y
Astragalus oophorus var. lavinii	N
Astragalus oophorus var. lonchocalyx	N
Atriplex argentea var. longitrichoma	N
Camissonia kernensis ssp. gilmanii	Y
Chrysothamnus viscidiflorus spp. axillaris	N
Cryptantha dumetorum	Y
Cryptantha pterocarya var. stenoloba	Unknown

Table 5-1. List of plant species recently included in the NDNH List that requires additional research to determine status on the NNSS (continued).

Scientific Name	Observed on the NNSS?
Cymopterus aborigium	Y
Cymopterus gilmanii	Y
Cymopterus ripleyi var. ripleyi	Y
Echinocactus polycephalus var. xeranthemoides	Unknown
Ephedra funerea	Y
Ericameria watsonii	Y
Erigeron aphanactis var. congestus	Unknown
Erigeron concinnus var. condensatus	N
Eriogonum glandulosum	Y
Eriogonum saxatile	Y
Eriogonum umbellatum var. vernum	Y
Eriogonum umbellatum var. versicolor	Y
Frasera albomarginata var. induta	Unknown
Galium magnifolium	Y
Ipomopsis congesta var. nevadensis	Unknown
Ivesia arizonica var. arizonica	Y
Juncus acutus ssp. leopoldii	N
Keckiella rothrockii	Y
Lepidium montanum var. nevadense	N
Linanthus arenicola	Y
Mentzelia reflexa	Y
Mirabilis pudica	Y
Muilla coronata	Y
Nama depressum	Y

Table 5-1. List of plant species recently included in the NDNH List that requires additional research to determine status on the NNSS (continued).

Scientific Name	Observed on the NNSS?
Penstemon petiolatus	Y
Perityle intricate	Y
Peteria thompsonae	Y
Phacelia calthifolia	Y
Phacelia peirsoniana	Y
Phlox stansburyi ssp. superba	Unknown
Salvia dorrii var. clokeyi	N
Scopulophila rixfordii	Y
Senecio flaccidus var. douglasii	Unknown
Trifolium andersonii spp. monoense	N

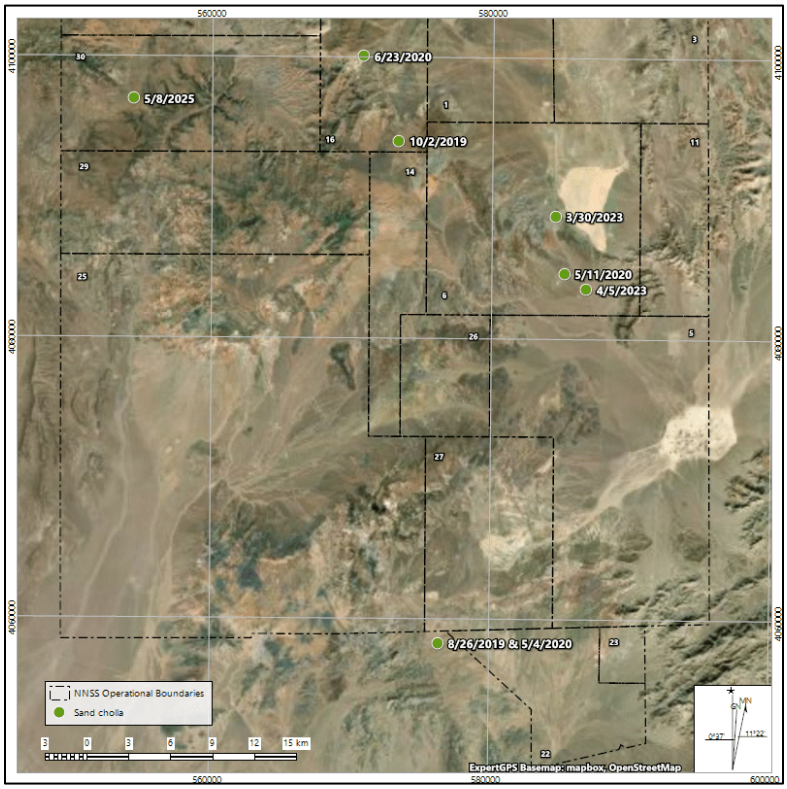

Figure 5-1. Sand cholla observations on the NNSS. Coordinates in UTM NAD83 (Zone 11, meters).

It has been confirmed that both Lahontan beardtongue and Palmer's penstemon grow on the NNSS and overlap in distribution. To document the distribution and threats, observations of both species are opportunistically recorded. Lahontan beardtongue is known from three locations:

- Pahute Mesa Road, observed June 14, 2025 – 564150mE, 4120112mN
- 19-01 Road, observed September 13, 2022 – 566218mE, 4120089mN
- Kawich Valley Road, observed July 21, 2020 – 564150mE, 4120112mN

NNSS biologists will continue to document and evaluate the plant's distribution, status on the NNSS, and threats.

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 identify existing or potential threats to populations. Long-term monitoring was not conducted in 2025. One Beatley milkvetch (*Astragalus beatleyae*) population was visited, and a post-fire survey was conducted for Clokey eggvetch (*Astragalus oophorus* var. *clokeyanus*) in association with the 2025 Cat Canyon Fire.

5.2.1 Beatley's Milkvetch (*Astragalus beatleyae*)

Beatley's milkvetch is a small, short-lived perennial herb which forms circular mats which bloom April through mid-July. Endemic to Nye County in Nevada, it has only been found on the NNSS and NTTR. Its type locality is on Pahute Mesa (UTM NAD83 545651 mE, 4126312 mN) in an area designated in 1986 as critical habitat. Due to the extensive monitoring and research on the plant from the 1970's through 2000's, as well as the moratorium on underground nuclear testing, the plant is currently not designated as requiring protection under federal or state law. It is currently included in the NNSS's sensitive plant monitoring program as a high-priority species.

One population of Beatley's milkvetch was visited on June 14, 2025, during a field trip that NNSS biologist's hosted for the NVNPS (ASBE-05a-BIG-VLY; 563459 mE, 4117048 mN). This population had not been visited since 2010. Over fifty plants were observed. Most of the plants were vegetative, with three in flower/fruit and five in fruit. The population is healthy and no threats were observed. The population is adjacent to an old dirt road, but the road is rarely traveled.

5.2.2 Clokey Eggvetch (Astragalus oophorus var. clokeyanus)

Clokey eggvetch is a small, grey-green to dark green perennial herb first collected in 1938 in the Spring Mountains in Southern Nevada (Anderson 1998). The name *Astragalus artipes* was misapplied to the 1938 collection by Clokey and later applied the name *A. oophorus* var. *clokeyanus* by Barneby "in honor of Clokey's honest mistake" (Smith 2002). The plant's pea flowers are bicolored, bright reddish-purple and white. The fruit, or seed pod, was described in Anderson's 1998 report *Distribution of Clokey's Eggvetch on the Nevada Test Site* as "strongly inflated, mottled reddish, unilocular pod with 23-28 ovules per pod".

To our knowledge, there are six varieties of egg milkvetch, all which occur in Nevada except Wilken's egg milkvetch, which is endemic to Colorado. Clokey and Egg milkvetch occur on the NNSS. Clokey eggvetch, Lavin's milkvetch, and Pink egg milkvetch are listed on the NDNH List. The six egg milkvetch varieties are below with associated U.S. state distributions:

- Pallid egg milkvetch (*A. oophorus* var. *caulescens*) – AZ, CO, NV, UT
- Clokey eggvetch (*A. oophorus* var. *clokeyanus*) – NV
- Lavin's milkvetch (*A. oophorus* var. *lavinii*) – CA, NV
- Pink egg milkvetch (*A. oophorus* var. *lonchocalyx*) – CA, NV
- Egg milkvetch (*A. oophorus* var. *oophorus*) – CA, NV
- Wilken's egg milkvetch (*A. oophorus* var. *wilkenii*) - CO

Clokey eggvetch was thought to have been restricted to the Spring Mountains until 1996 when intensive surveys began on the NNSS locating it on Pahute Mesa, in the Eleana Range, in the southern Belted Range, on Timber Mountain, and on Shoshone Mountain (Anderson 1998). The species was identified as a candidate plant under the ESA from 1980 through 1997, when the designation was dropped (Anderson 1998). The plant is not currently protected under federal or state law.

The species occurs in areas where natural periodic fires occur in single-leaf pinyon and Utah juniper habitat. Smith (2002) explained "[t]he species has been found in old burns" and "[w]hen fires do occur, some of the Astragalus oophorus var. clokeyanus sites may also occupy places attractive for staging suppression operations". The Cat Canyon Fire burned from July through August 2025. It burned 6,571 ha on the NNSS and the NTTR. The fire burned through parts of the Cherrywood Wildland Fire, which burned the area in 2021. The Cat Cayon Fire burned through Clokey eggvetch habitat on Timber Mountain (Figure 5-2). Nine populations within the burned area were surveyed on September 26, 2025. No Clokey eggvetch plants were found. September is outside the growing season for Clokey eggvetch, which sets seed by July, but two other *Astragalus* species were observed. *A. purshii* burned plants were observed and *A. lentiginosus* plants were growing post-fire. It is recommended to visit the plant populations during the growing season to determine any fire impacts.



Figure 5-2. Clokey eggvetch habitat burned by the Cat Cayon Fire on Timber Mountain.

(Photo by J.A. Hannon, September 26, 2025)

5.3 Coordination with Other Scientists

- NNSS biologists participated in the Joshua Tree Biological Working Group. The group is comprised of several government agencies committed to align research, monitoring, and management goals to protect and collect long-term data on Joshua trees. An NNSS biologist participated in the wildfire subgroup which focuses on the impacts of fires in Joshua tree habitat, proliferation of wildfire from cheatgrass invasions, and recovery of habitat post-burn.

- NNSS biologists hosted a field trip to sensitive plant populations on the NNSS for the NVNPS on June 14, 2025.

- An NNSS biologist attended the NVNPS meetings.

- NNSS biologists are working with the webhost for the Intermountain Region Herbarium Network to include images of all plant specimens housed in the NNSS herbarium. The website (https://intermountainbiota.org/portal/collections/index.php?catid=1) includes all cataloged plant specimens from the NNSS herbarium and is open for public use. NNSS biologists are working to image approximately 7,000 specimens.

6.0 SENSITIVE AND PROTECTED/REGULATED ANIMAL MONITORING

The NDNH At-Risk Plant and Animal Track List (NDNH 2026); NAC 503, "Hunting, Fishing and Trapping; Miscellaneous Protective Measures" (NAC 2026a); FWS Endangered Species home page (FWS 2026); 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. In 2025, NDNH combined their Watch and Track Lists greatly increasing the number of potentially sensitive plant and animal species whose status should be actively tracked in Nevada. This new list will be evaluated during 2026 to potentially revise the NNSS list of sensitive species. The current list with current designations based on the former Track List is found in the Table 2-1.

Surveys of sensitive and protected/regulated animals during 2025 focused on (a) Mercury weevil (*Miloderes mercuryensis*), (b) birds, (c) bats, (d) feral horses, (e) mule deer, (f) pronghorn antelope, (g) desert bighorn sheep, and (h) mountain lions. Information about the monarch butterfly (*Danaus plexippus*), other noteworthy wildlife observations, bird mortalities, and a summary of nuisance animals and their control on the NNSS is also presented.

6.1 Mercury Weevil

The Mercury weevil is categorized as G1 and S1 (critically imperiled) by NDNH due to its very small range and narrow habitat requirements. There are three specimens that were collected by Brigham Young University (BYU) in 1961 and 1962 (JAL10C, Ref. No. 21, 1/6/61, holotype; JAL8C, Rev. No. 130, 6/22/61, paratype; and JAL12C, 3/2/62, paratype; Monte L. Bean Museum Entomological Collection, BYU). Based on the code and study site description, an approximate location of these collections is 579650mE, 4059140mN UTM NAD83). Tanner (1966) also reports that three specimens were collected on the NNSS: one from desert globemallow, Area 5, in June 1964; one from spiny hopsage, Area 26, in June 1965; and one from a pit-can trap on the Jackass Flats approach road in a mixed plant association within the creosote bush-white bursage plant community on an unspecified date. He further states, "Holotype male in the U.S. National Museum. Two paratypes in the entomological collection at Brigham Young University." It is unknown if these represent three additional specimens or are the preceding specimens that were mislabeled. A search of the U.S. National Museum did not reveal any specimens of this species. An additional four specimens were found in the NNSS collection including three from Rock Valley (Area 25) as part of the International Biome Program Study in the early 1970's (International Biome Program, unpublished data) and one collected by E.L. Sleeper on March 24, 1970, 23 miles west of Indian Springs and 19 miles southeast of Lathrop Wells (now called Amargosa Valley) at an elevation of 2,900 feet. This last record is likely off the NNSS around Point of Rocks along U.S. Highway 95.

The weevil appears to be a sand dune obligate with limited dispersal ability (Nature Serve Explorer 2024). However, the Rock Valley and BYU study sites are not in sand dune areas. It is not currently protected by state or federal law. Nature Serve Explorer (2024) recommends that further surveys to determine presence and current distribution should be done and in contradiction to our data states, "There are only seven known specimens of this beetle. One at the type locality on the NNSS and six others in similar habitats further south in Clark County." (https://explorer.natureserve.org/Taxon/ELEMENT_GLOBAL.2.1154618/Miloderes_mercuryensis, site accessed February 9, 2026). It is possible that the specimens from Clark County may be a different species, but further research is needed to verify this (Van Dam and O'Brien 2015).

On October 28, 2024, Corey Lange (Bureau of Land Management [BLM] biologist) and an NNSS biologist conducted weevil surveys by sifting soil at sandy sites near the type locality in north Frenchman

Flat. A few dead body parts of *Arinolus* sp. millipedes and the abdomen of what appears to be a *Miloderes* weevil were found. This would likely be the Mercury weevil, but it could not be confirmed without a live specimen.

On March 26, 2025, Lange and an NNSS biologist conducted weevil surveys which entailed sifting soil at several sandy sites around the NNSS. Sampled sites included north of Frenchman Playa, northeast of ER5-5 well pad, wash along Shoshone Trail (west of Mercury Highway, Area 5) where a few invertebrates, sand cockroaches, and other beetles were found but no Mercury weevils. Possible, inconclusive Miloderes spp. remains were found at another site along the Shoshone Trail (587532mE, 4076680mN, UTM NAD83, Area 5). Sand cockroaches but no Mercury weevils were found at a site in Area 1. Two sites in Area 25 were sampled including southeast of the MX racetrack site where nothing was found and lower Topopah Wash (561035mE, 4069819mN, UTM NAD83) where several individuals of Amargosa Miloderes weevil (*Miloderes amargosensis*) were found. This is a new species record for the NNSS. Habitat consisted of fine blow sand with scattered creosote bush and white bursage plants along the edge of the wash. This species record was added to the invertebrate database, and Lange took several (5-7) voucher specimens for the BLM collection. Future surveys are planned to learn more about the distribution, taxonomy, and status of *Miloderes* spp. on the NNSS.

6.2 Monarch Butterfly

On December 12, 2024, FWS proposed to list the monarch butterfly as threatened under the ESA and designate critical (i.e., overwintering) habitat, all of which is in California. A final ruling has been delayed, and the species is not currently protected under the ESA. Monarchs can be found throughout Nevada in the spring and summer (June-late September), breeding on milkweed plants which are the monarch's larval host plant (Western Association of Fish and Wildlife Agencies 2019). There is no overwintering habitat (critical habitat) in Nevada. This species has been documented at four locations on the NNSS ranging from low elevation creosote bush-white bursage habitat to higher elevation sagebrush habitat from July to October. No new sightings were observed in 2025. Two species of milkweed, desert milkweed (*Asclepias erosa*) and Mexican whorled milkweed (*Asclepias fascicularis*), are known to occur on the NNSS in small, localized patches so summer habitat for monarchs is very limited. Milkweed locations are opportunistically being documented to determine their distribution on the NNSS.

6.3 Birds

Bird monitoring on the NNSS during 2025 focused on Migratory Bird Treaty Act (MBTA) compliance, documenting bird mortalities, implementing the NNSS Avian Protection Plan (APP), conducting winter raptor surveys, surveying three breeding bird survey routes, and a western burrowing owl radio-tracking study.

6.3.1 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, English house sparrow, rock dove or pigeon, and the Eurasian collared dove. The chukar and Gambel's quail are also not protected under the MBTA but are regulated by Nevada state law as gamebirds.

U.S. Executive Order 13186 *Responsibilities of Federal Agencies to Protect Migratory Birds* (2001) 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 (2001). This MOU is currently being updated.

Actions taken to comply with the MBTA and MOU during 2025 included the following: 1) followed requirements in the two NNSS FWS permits pertaining to migratory birds, 2) conducted pre-activity surveys for proposed projects before surface-disturbing work or building demolitions to avoid harming birds or their nests, 3) found and protected two active nests from being disturbed, 4) removed a great-tailed grackle (*Quiscalus mexicanus*), a Brewer's blackbird (*Euphagus cyanocephalus*), and a yellow-rumped warbler (*Setophaga coronata*) from glue traps and released them, and 5) implemented the NNSS APP.

6.3.2 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, disease, and entrapment and in many instances the cause of death is unknown. Workers and biologists work together to observe and report mortalities. A total of 31 dead birds were documented on the NNSS in 2025 (Figure 6-1). Five birds were electrocuted including two red-tailed hawks, one great-horned owl (*Bubo virginianus*), and two common ravens. One great-horned owl was killed by a vehicle collision. One Say's phoebe died of entrapment on a glue trap. Six birds were found dead due to unknown causes; lesser nighthawk (*Chordeiles acutipennis*), eared grebe (*Podiceps nigricollis*), unknown duck, Brewer's blackbird, great-tailed grackle, and unknown bird. One common raven chick died and was scavenged or was killed by a predator. Seventeen birds apparently died from complications from coming into contact with drilling fluids at the new ER 20-13 plastic-lined sump. A soap-like additive (Quik-Foam®) used to facilitate the drilling process was used and it is likely that this substance caused the feathers to stick together, making it difficult for the birds to fly or thermoregulate causing the birds to die of drowning or exposure. The water is contaminated with tritium, so the sump was inaccessible to retrieve and examine the carcasses. Species impacted included one prairie falcon (*Falco mexicanus*), one American avocet (*Recurvirostra americana*), two blue-winged teal (*Anas discors*), seven unknown duck species, four horned larks, one brown-headed cowbird (*Molothrus ater*), and one unknown swallow.

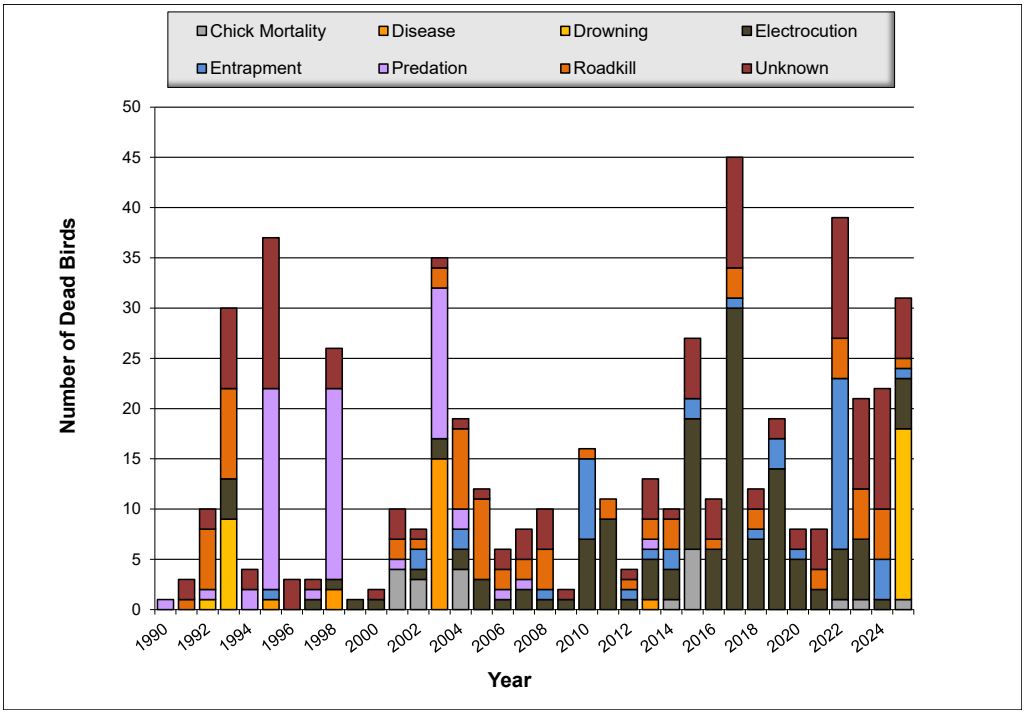

Figure 6-1. Records of reported bird deaths on the NNSS, 1990–2025.

6.3.3 Implementing the NNSS Avian Protection Plan (APP)

The NNSS 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 2025 the answers to these questions are:

1) 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. Biologists responded to 35 calls related to avian issues during 2025.

2) Reported mortalities/injuries were addressed in a timely manner and were usually investigated the same day or within a few days.

3) 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 2025 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 NNSS biologists to remove active nests at project sites in emergency situations and possess and transport carcasses of golden eagles and other bird species. No active nests were moved, all permit conditions were met, and an annual report summarizing 2025 activities was submitted to FWS. This included entering all bird 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 2025 activities was submitted to NDOW.

4) Several mortality reduction measures were taken. One great-tailed grackle, one Brewer's blackbird, and one yellow-rumped warbler were extracted from glue traps and released. A total of 171.7 ha of habitat was surveyed at 22 project sites for active bird nests before disturbance. Forty power poles along the DAH line in Yucca Flat were retrofitted with new wider crossarms and new configurations to make them more avian safe. Finally, several dead rabbits and snakes were removed from roads to reduce the potential for vehicle mortalities of scavenging birds. These measures were effective at reducing avian mortalities.

6.3.4 Winter Raptor Surveys

Winter raptor surveys were initiated during 2014, 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 2025 and were conducted by driving a standard route to identify all raptors observed (i.e., eagles, hawks, falcons, owls, and vultures). Two official routes were established on the NNSS: Southern NNSS, Route #60 (83 kilometers [km]), and Yucca Flat, Route #61 (75 km) (Figure 6-2). Data including common name, UTM coordinates

(NAD83), 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 for Route #60 were conducted on January 15 and February 10, and surveys for Route #61 were conducted on January 16 and February 12.

These surveys are conducted each year 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 (#60) is located primarily in the Mojave Desert portion of the NNSS while the Yucca Flat route (#61) 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 one raptor species, the red-tailed hawk, was detected during both surveys on the southern route. Observations of three raptor species including 15 red-tailed hawk, 4 prairie falcon, and 3 American kestrel (*Falco sparverius*) observations were detected on the northern route (Table 6-1). Common ravens and loggerhead shrikes were more prevalent on the Yucca Flat route than on the southern route. Data were entered into the Ecological Geographic Information System (EGIS) faunal database and given to NDOW for inclusion in their analyses.

6.3.5 Breeding Bird Surveys

Breeding bird survey routes were surveyed again in 2025 in coordination with NDOW following the United States Geological Survey (USGS) protocol (Hudson et al. 2017) for the North America Breeding Bird Surveys (BBS). These avian point count surveys are designed to comprehensively study bird populations and abundance using rigorous, standardized protocols. Three bird survey routes were sampled in the three major ecoregions on the NNSS (Figure 6-3). These included the NNSS South Route in the Mojave Desert (primarily creosote bush-white bursage vegetation), the NNSS Yucca Flat Route in the

Table 6-1. Results (number of observations) of winter 2025 raptor surveys on the NNSS.

Species	Southern NNSS (1/15/25)	Southern NNSS (2/10/25)	Yucca Flat (1/16/25)	Yucca Flat (2/12/25)
Red-tailed Hawk	3	3	8	7
Prairie Falcon	0	0	2	2
American Kestrel	0	0	2	1
Total Raptors	**3**	**3**	**12**	**10**
Common Raven	3	2	4	7
Loggerhead Shrike	1	2	2	5

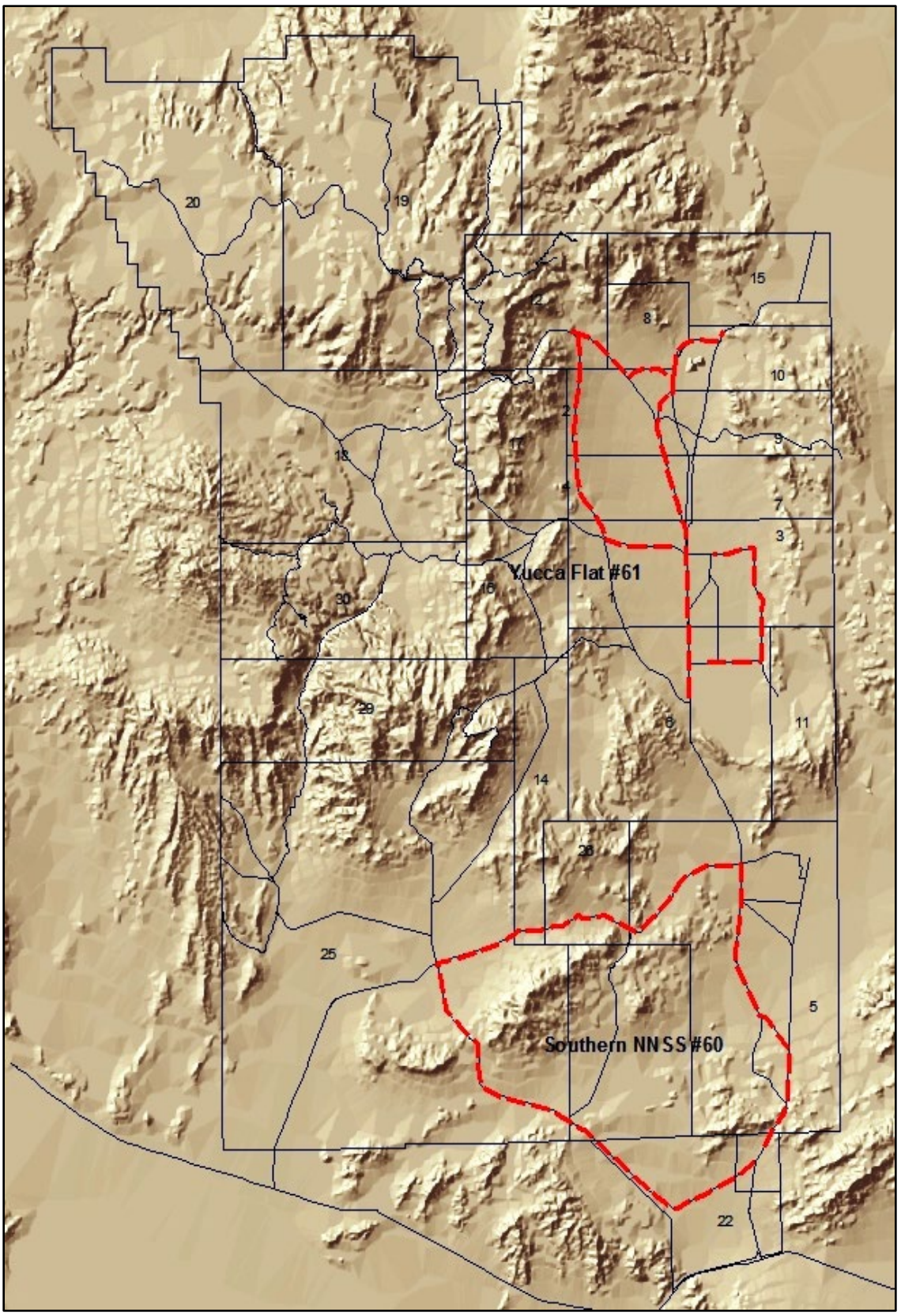

Figure 6-2. Winter raptor survey routes (red lines) on the NNSS.

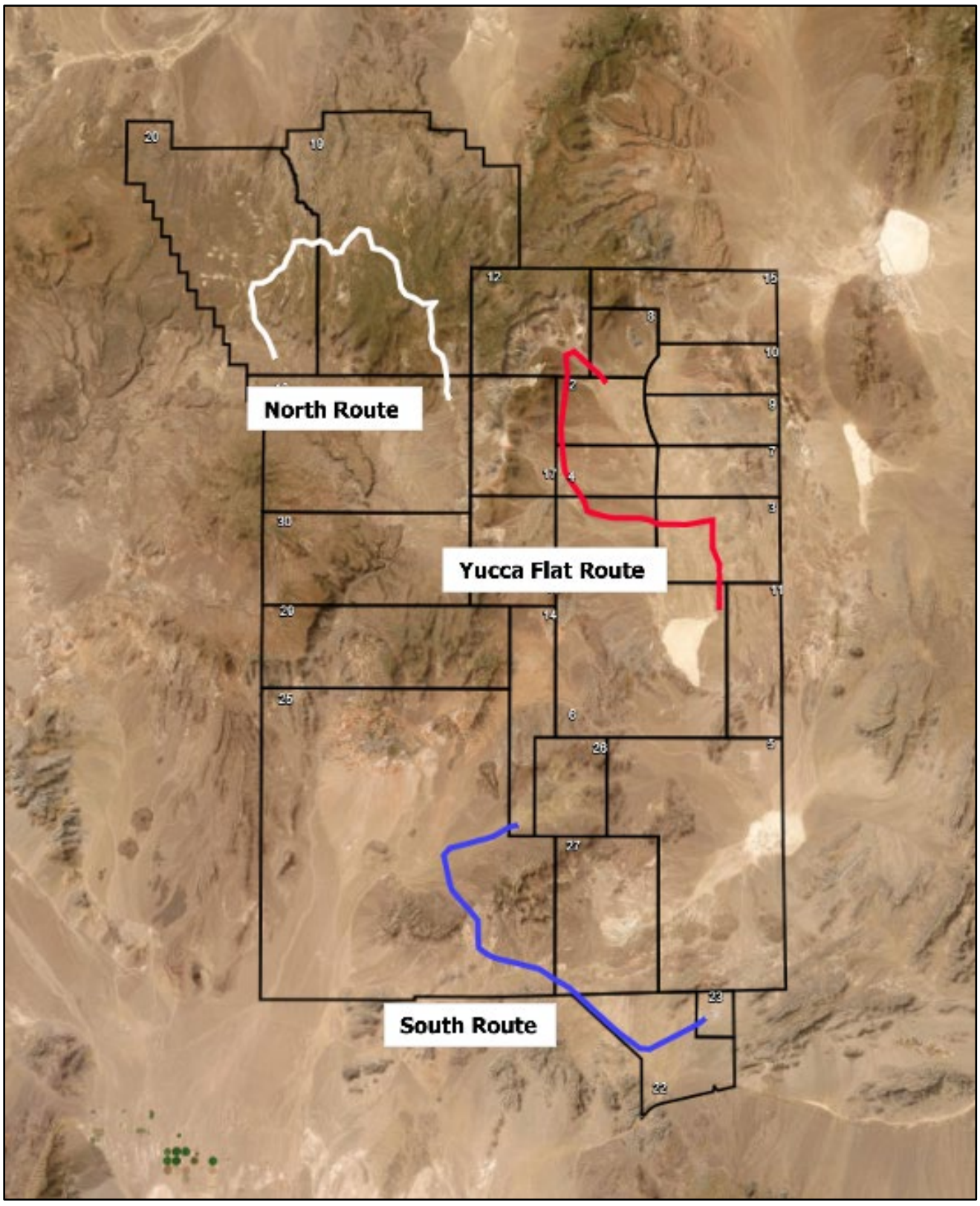

Figure 6-3. Location of three Breeding Bird Survey (BBS) routes surveyed during 2025.

Transition ecoregion (primarily blackbrush and salt desert vegetation), and the NNSS North Route in the Great Basin Desert (primarily sagebrush-singleleaf pinyon pine-Utah juniper vegetation). These routes are surveyed annually during peak breeding bird season, which is typically in June for most of North America. Data collected from these surveys will help NNSS biologists track long-term bird population trends and will also be made publicly available.

Each route is 39.2 km long with 50 points evenly spread out every 800 m. Surveys were conducted by driving to and stopping at each point to record every bird heard and seen during a three-minute period. Routes were conducted by two biologists where one drove the entire route and recorded data while the other identified birds by sight and sound. The South Route was surveyed during May, where peak breeding season for birds occurs earlier than June due to the hotter, drier climate. The other two routes were surveyed in June. Data collected were entered into the EGIS faunal database.

A total of 32 different species were detected, with 377 total birds detected (Table 6-2). Species richness was nearly the same as 2024 (33 species), but considerably fewer total birds were detected than in 2024 (566 birds). Fewer birds were expected given the lower moisture received this year across the NNSS. The North Route had the highest species richness, as expected, with 23 species. Black-throated sparrows (*Amphispiza bilineata*) were again the most common species (~29% of all birds counted, from ~33% in 2024). Species richness on the Yucca Flat and South Route were almost the same in 2025 (12 and 13, respectively). Noteworthy observations of sensitive species include 4 sagebrush sparrows (*Artemisiospiza nevadensis*; 3 on the North Route, 1 on the South Route), 11 pinyon jays on the North Route, and a LeConte's thrasher (*Toxostoma lecontei*) on the Yucca Flat Route. In April 2022, the pinyon jay was petitioned for listing under the ESA. In August 2023, FWS acknowledged the species may warrant ESA protection, but a formal determination has been delayed. This is a species of concern that will be followed with interest during future surveys.

6.3.6 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 winter range.

New technology has recently become available to use satellites and 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 collaboration with Dr. Courtney Conway (University of Idaho), seven PTT's were attached to owls in June 2019 with results summarized in Hall and Perry (2021) and (2022). Additional transmitters were purchased in 2021, however, multiple searches for owls at previously occupied burrows yielded no owls during 2021 and 2022, likely due to drought conditions. In 2023, one transmitter was attached to an adult male with results summarized in Hall and Perry (2024). Transmitters last for one to two years. No owls are being monitored currently. Multiple searches during 2025 found no breeding pairs of owls.

Table 6-2. Number of bird detections by species for three Breeding Bird Survey routes sampled in 2024 and 2025.

Species	North Route		Yucca Flat		South Route	
	2024	2025	2024	2025	2024	2025
Anna's Hummingbird	1	0	0	0	0	0
Ash-throated Flycatcher	4	7	25	3	6	16
Barn Owl	0	0	1	0	0	0
Bewick's Wren	0	2	0	0	0	0
Black-throated Gray-warbler	1	0	0	0	0	0
Black-throated Sparrow	33	41	74	13	79	57
Blue-gray Gnatcatcher	10	1	1	0	0	2
Brewer's Sparrow	7	0	0	0	0	0
Brown-headed Cowbird	1	0	0	0	0	0
Bushtit	7	24	0	0	0	0
Cactus Wren	0	0	1	0	0	0
Canyon Wren	0	1	0	0	0	0
Cassin's Kingbird	0	1	0	0	0	0
Chipping Sparrow	4	0	0	0	0	0
Chukar	0	3	0	0	0	0
Common Raven	1	10	16	0	1	1
Dusky Flycatcher	0	0	0	0	0	1
Gray Vireo	0	1	0	0	0	0
Green-tailed Towhee	2	2	0	0	0	0
Hairy Woodpecker	1	3	0	0	0	0
Horned Lark	0	44	48	19	8	5
House Finch	0	0	9	0	1	1
Juniper Titmouse	0	9	0	0	0	0
Lazuli Bunting	1	0	0	0	0	0
LeConte's Thrasher	0	0	0	1	0	0
Lesser Nighthawk	0	0	1	0	0	0
Loggerhead Shrike	1	0	24	1	2	0
Mountain Chickadee	0	3	0	0	0	0
Mourning Dove	2	1	28	0	6	0
Northern Harrier	0	0	0	1	0	0
Northern Mockingbird	1	0	20	0	14	0
Orange-crowned Warbler	0	0	0	0	0	1
Pinyon Jay	12	11	0	0	0	0
Red-tailed Hawk	0	1	4	0	1	1
Rock Wren	24	0	0	0	3	0
Sage Thrasher	0	0	2	0	0	0
Sagebrush Sparrow	0	3	0	0	0	1
Say's Phoebe	1	1	13	1	1	2
Scott's Oriole	1	0	0	1	0	0
Spotted Towhee	32	43	0	0	0	0
Western Kingbird	0	0	14	14	0	0
Western Meadowlark	4	0	1	3	0	0
Western Wood-Pewee	1	0	0	0	0	0
White-Crowned Sparrow	2	0	0	0	0	0
Woodhouse's Scrub Jay	8	9	0	0	0	0
Unknown Bird	0	6	0	3	0	2
Total	162	227	282	60	122	90
2025 Total	377					

6.4 Bat Monitoring

Bat monitoring in 2025 consisted of documenting roost sites or locations of bats found around buildings or in other areas and continued long-term acoustic sampling at sites within North American Bat Monitoring Program (NABat) priority grid cells.

6.4.1 Documenting Bat Locations

Bats were observed inside facilities a few times during 2025 but none were captured and apparently left on their own. In addition, nine images of bats were photographed at 2 of 17 sites monitored for mountain lions, both of which were water sources (Table 6-4).

6.4.2 NABat Acoustic Sampling

NABat is a multi-national, multi-agency coordinated bat monitoring program across North America made up of an extensive community of partners who use standardized protocols to gather data that allows for assessing population status and trends, informing responses to stressors, and sustaining viable populations. A 10 x 10-km grid was overlaid across North America, and certain grid cells were strategically selected for sampling. Four priority grid cells are located on the NNSS (Figure 6-4). Grid Cell 10662 is in the Mojave Desert ecoregion, Grid Cell 3494 is in the Fortymile Canyon area, Grid Cell 18854 is in northeastern Yucca Flat in the Transition ecoregion, and Grid Cell 7590 is on Pahute Mesa in the Great Basin Desert ecoregion. The placement of these grid cells is fortuitous because it allows us to sample a diverse assemblage of habitats, thus maximizing our chance of detecting all bat species that occur on the NNSS. Within each grid cell are four quadrants, and the intent is to sample within at least two of the four quadrants, preferably during May and June before the young become volant. The standard NABat monitoring protocol was followed for grid cell selection and sampling (Rodriguez et al. 2019).

We chose to use stationary acoustic monitoring as our primary sampling technique using Anabat Swift (Titley Scientific, Columbia, Missouri) passive full spectrum bat detectors. These detectors record the ultrasonic echolocation calls of bats which can be analyzed for species identification. One sampling location within two separate quadrants of each grid cell was selected based on specific habitat characteristics (Figure 6-4). The two locations within each grid cell were sampled concurrently with one bat detector per location. Detectors were attached to adjustable poles and raised to a height of 3 m and oriented toward the area of interest where bats were likely to pass through (Figure 6-5). Detectors were left out for a minimum of four consecutive nights but typically for a week. Acoustic files were downloaded and submitted to the NABat Data Processing Lab for analysis.

The two sampling locations for Grid Cell 10662 were Rock Valley Tank (southwest quadrant) (Figure 6-5) and a desert wash on the north side of Little Skull Mountain (northwest quadrant) (Figure 6-6). Both these locations are in creosote bush-white bursage habitat. Rock Valley Tank is a small, natural water source in a limestone formation and the other location is a typical Mojave Desert wash draining off Skull Mountain and Little Skull Mountain. Detectors operated from May 5 to May 12.

The two sampling locations for Grid Cell 18854 were a wash near Papoose Lake Road (southeast quadrant) (Figure 6-7) and south of Sedan Crater (northwest quadrant) (Figure 6-8). The wash location is in a drainage that flows from the west side of the Halfpint Range in blackbrush habitat with scattered Joshua trees. The location south of Sedan Crater is in highly disturbed habitat with sparse perennial vegetation and abundant annual grasses and forbs. There are also some structures in the area that may provide roosting habitat for bats. Detectors operated from May 12 to May 19.

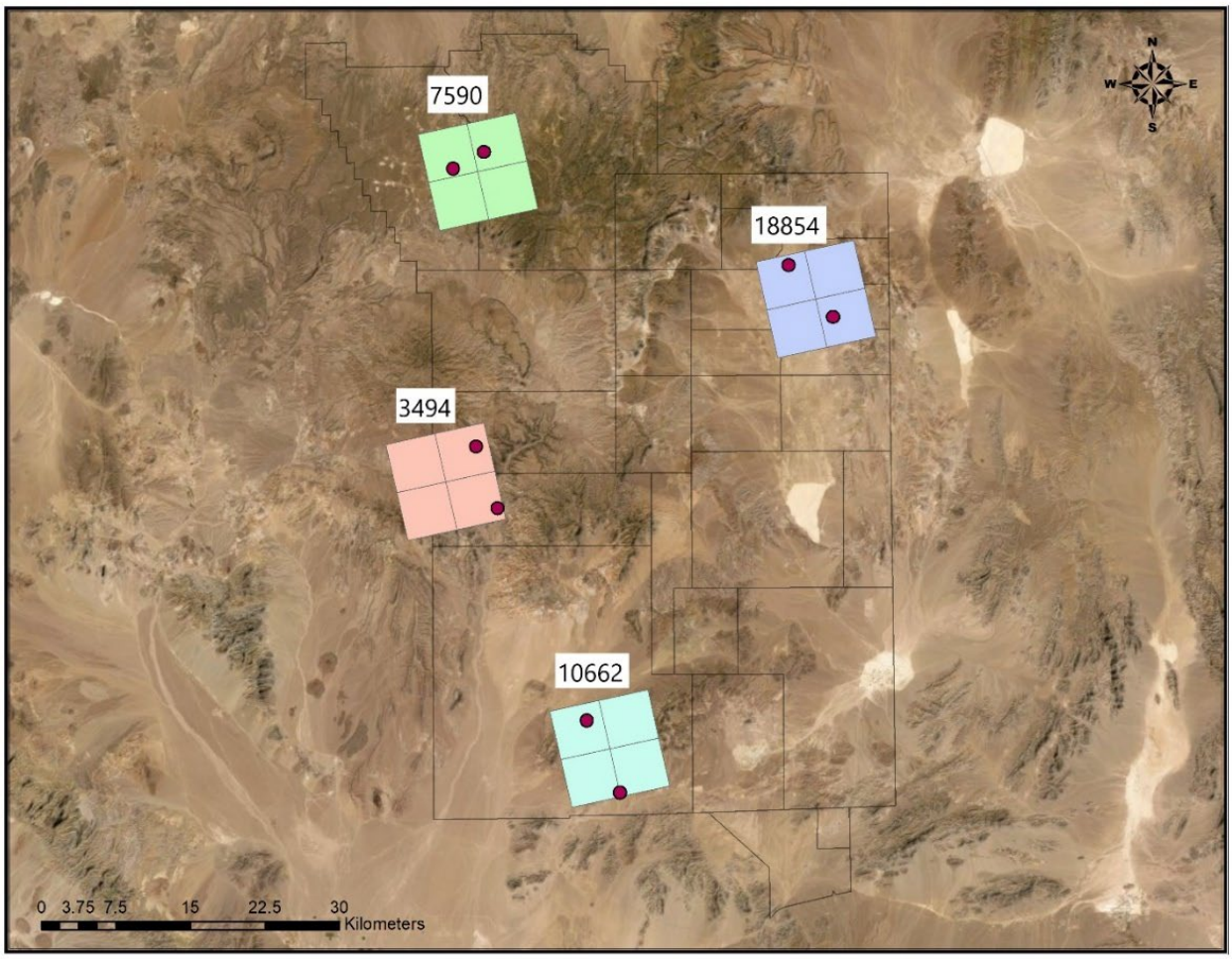

Figure 6-4. North American Bat Monitoring Program priority grid cells with four quadrants (colored numbered rectangles) and sampling locations (maroon dots).

The two sampling locations for Grid Cell 3494 were at Twin Spring (southeast quadrant) (Figure 6-9) and North Chukar Canyon Tanks (northeast quadrant) (Figure 6-10). Twin Spring is a natural spring with perennial water. Nearby is an abandoned mine adit that is a known Townsend's big-eared bat and fringed myotis (*Myotis thysanodes*) maternity colony. North Chukar Canyon Tanks are in a canyon that drains into Fortymile Canyon, surrounded by volcanic rock. It is an ephemeral water source but can hold water for a few months. There was water present while detectors operated from May 19 to May 28.

Two sampling locations for Grid Cell 7590 were Columbine Canyon (northeast quadrant) (Figure 6-11) and ER 20-6 sumps (northwest quadrant) (Figure 6-12). Columbine Canyon is in a small, narrow canyon in pinyon pine-Utah juniper-sagebrush habitat with adjacent cliff and rock features that provide potential bat roosting habitat. ER20-6 is a highly disturbed site surrounded by pinyon pine-Utah juniper-sagebrush habitat. There are several plastic-lined sumps that sometimes have water in them. The sumps were dry during sampling this year which occurred from June 16 to June 23. Data collected in 2025 has not been analyzed yet. Results will be included in the 2026 EMAC report.



Figure 6-5. Bat detector at Rock Valley Tank, Grid Cell 10662.

(Photo by D.B. Hall, May 5, 2025)



Figure 6-6. Bat detector in a typical Mojave Desert wash north of Little Skull Mountain, Grid Cell 10662.

(Photo by D.B. Hall, May 5, 2025)



Figure 6-7. Bat detector at wash in blackbrush habitat near Papoose Lake Road, Grid Cell 18854.

(Photo by D.B. Hall, May 12, 2025)



Figure 6-8. Bat detector south of Sedan Crater, Grid Cell 18854.

(Photo by D.B. Hall, May 12, 2025)



Figure 6-9. Bat detector location at Twin Spring, Grid Cell 3494.

(Photo by D.B. Hall, June 2, 2025)



Figure 6-10. Bat detector location at North Chukar Canyon Tanks, Grid Cell 3494.

(Photo by D.B. Hall, May 28, 2025)



Figure 6-11. Bat detector in Columbine Canyon, Grid Cell 7590.

(Photo by D.B. Hall, June 16, 2025)



Figure 6-12. Bat detector location at ER 20-6 Sumps, Grid Cell 7590.

(Photo by D.B. Hall, June 16, 2025)

6.5 Feral Horse Surveys

Formal feral horse surveys have not been conducted on the NNSS since 2014. Opportunistic surveys were conducted from 2017-2023 to get a general population estimate but were not conclusive. In 2024, NNSS biologists renewed feral horse monitoring and updated the protocol. Horses were surveyed again in 2025 during the summer for six days (two runs of three consecutive days) at Camp 17 Pond (Figure 6-13). Gold Meadows Spring was not surveyed this year due to having no water and little to no fresh horse sign. Past surveys have shown that horses are restricted to these two water sources during the hot, dry summer if no rain has been received because they provide the only reliable sources of drinking water during this time. Surveys this year entailed conducting visual observations at Camp 17 Pond and documenting all horses. Photos were taken of each individual horse to document identifying characteristics (e.g., unique facial blaze, overall color, color of stockings) and data were recorded onto a data sheet to identify each individual horse and track them over time. Horse photos taken by motion-activated cameras were also used to help identify and enumerate the number of horses.

A total of 30 unique horses were identified, including one foal (Figure 6-14), and a total of at least six bands were observed. A pair of lone gray stallions were observed, forming a bachelor group. Horse bands are dynamic and can change within a season. The number of adult horses found in 2025 is lower, but consistent with prior survey years (Figure 6-14). A contrast to prior years is fewer foals, and zero yearlings in 2025. Four adult horses and three foals from last year were missing, with all horses photographed this year having been identified previously. Whether the missing horses are dead or not is unknown. Biologists will continue to conduct horse monitoring and document survival of the foal or missing horses if seen in 2026. A total of 172 and 306 photos of horses were taken by motion-activated cameras at Camp 17 Pond and Gold Meadows Spring (Figure 6-15), respectively. A dead horse was found during the mule deer survey in Gold Meadows on October 6, 2025, but was too decomposed to identify it. It appeared to have been dead for several months of unknown cause.



Figure 6-13. Horses drinking at Camp 17 Pond.

(Photo by F.K. Diaz, July 24, 2025)

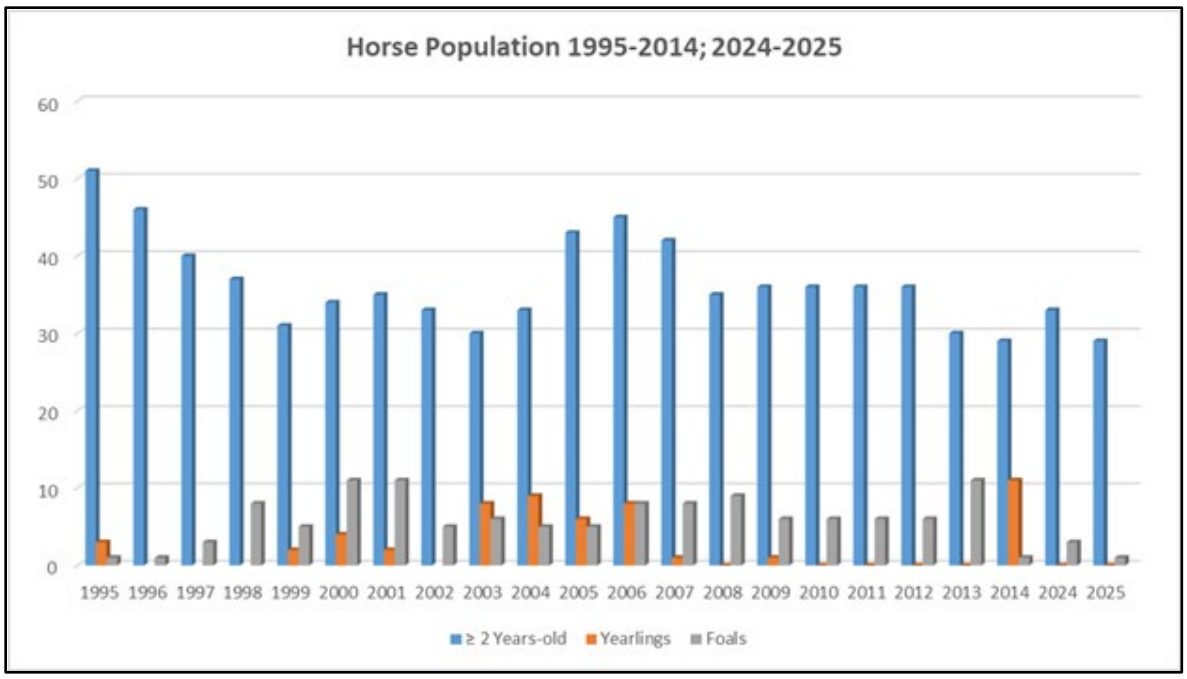

Figure 6-14. Total number of feral horses observed on the NNSS by year and age.



Figure 6-15. Horses and coyotes at Gold Meadows Spring.

(Photo by motion-activated camera, September 9, 2025)

6.6 Mule Deer Spotlight Surveys

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 2006–2025. In past years, monitoring has emphasized estimating relative abundance and density but since 2016 survey efforts have focused solely on relative abundance.

This year we used a new type of spotlight (Waypoint® 400, Streamlight, lithium-ion rechargeable). We compared this spotlight to the spotlight we have been using for the last several years (QBeam® 800-2301-0, Brinkmann) and found the Waypoint 400 to be brighter and illuminate to a farther distance. It also has the advantage of being smaller, lighter, cordless, and does not draw power from the vehicle battery which sometimes resulted in blown fuses.

6.6.1 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 using spotlights. Surveys were conducted at night starting around 0.5 hours after sunset, lasting approximately three hours. Deer were detected primarily by looking for eye shine, because the tapetum of the eye reflects green when exposed to light. One route (29 km) was centered around Rainier Mesa, and the second (30 km) was centered around the eastern portion of Pahute Mesa (Figure 6-16). 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 22-24 and October 6-8, 2025, a total of 40 observations of deer were observed on both routes combined, which equates to an average of 6.7 deer per night. This is a decline from 11.7 deer per night in 2024. There has been a decreasing trend ($y = -2.0567x + 47.294$, $r^2 = 0.66$) for the last 20 years with counts fluctuating widely (Figure 6-17). The trend for the entire study period (1989–2025, excluding 1995–1998 and 2001–2005) is trending downward slightly ($y = -0.4663x + 35.706$, $r^2 = 0.14$). Specific causes for the fluctuation in deer numbers are unknown and require further investigation. Mountain lion predation and drought appear to be major factors. During a mule deer study conducted from November 2019 to November 2022, 8 of 11 (73%) radio-collared mule deer that died during 2021 and 2022 were apparently killed by mountain lions. Additionally, no fawns were observed on the deer surveys during the drought years of 2021, 2022, and 2025 but were observed during the wetter years of 2023 and 2024. If fawn survival and thus recruitment is low and predation is high, deer populations will be negatively impacted, especially during periods of drought. Similar to 2024, the number of deer per 10 km in 2025 was higher on Pahute Mesa than Rainier Mesa (Figure 6-18). A total of 26 deer groups were detected and group size varied from one to five animals. Larger groups were found on Pahute Mesa than Rainier Mesa (1.7 and 1.3 deer/group, respectively).

6.6.2 Sex and Fawn/Doe Ratios

A mix of bucks and does were seen during the 2025 deer surveys including 28 buck, 9 doe, 0 fawn, and 3 of unknown sex and age observations. The deer sex ratio (number of bucks per 100 does) increased from 206 in 2024 to 311 in 2025 (Table 6-3). 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 far fewer males compared to females in the population than measured on the NNSS.

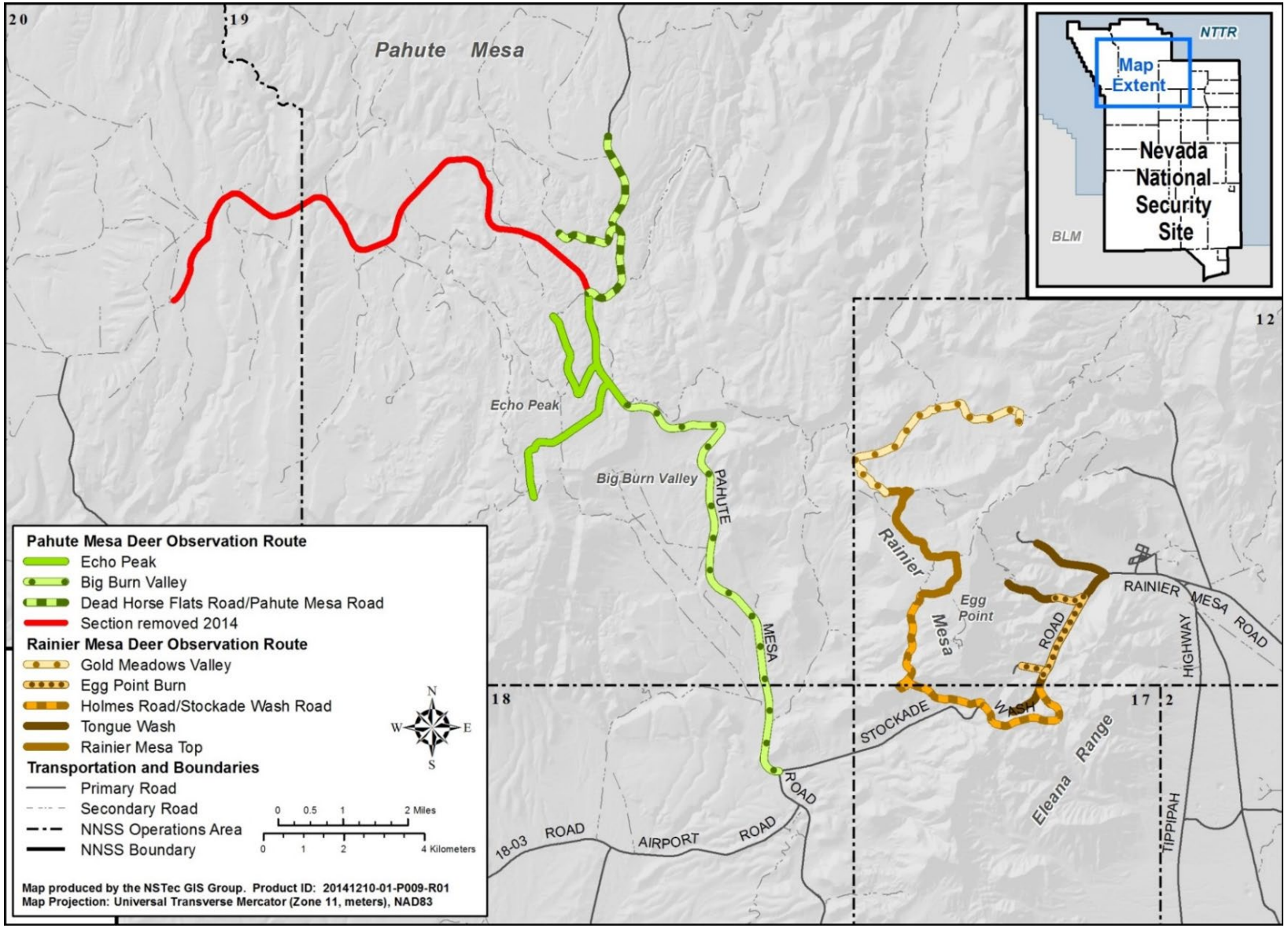

Figure 6-16. Road routes and sub-routes of two NNSS regions driven in 2025 to count deer and section removed due to road closure.

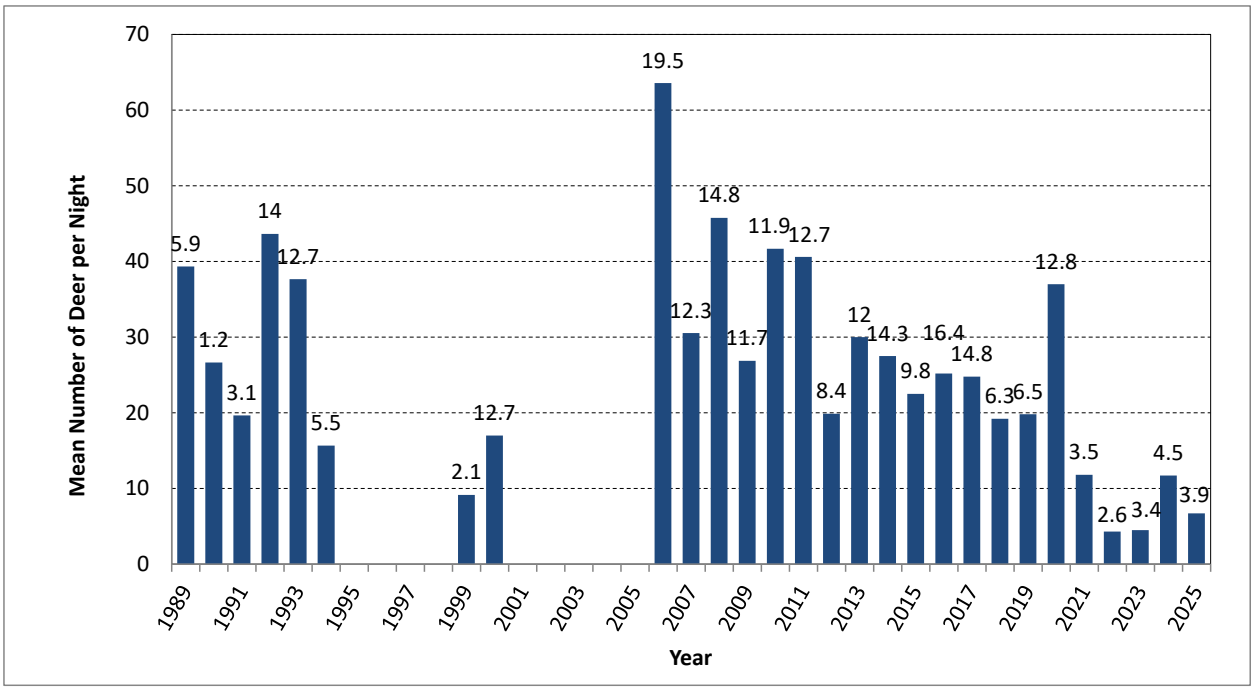

Figure 6-17. Trends in total deer count per night from 1989 to 2025 on the NNSS (surveys were not conducted during 1995–1998 or 2001–2005). Standard deviation values above bars.

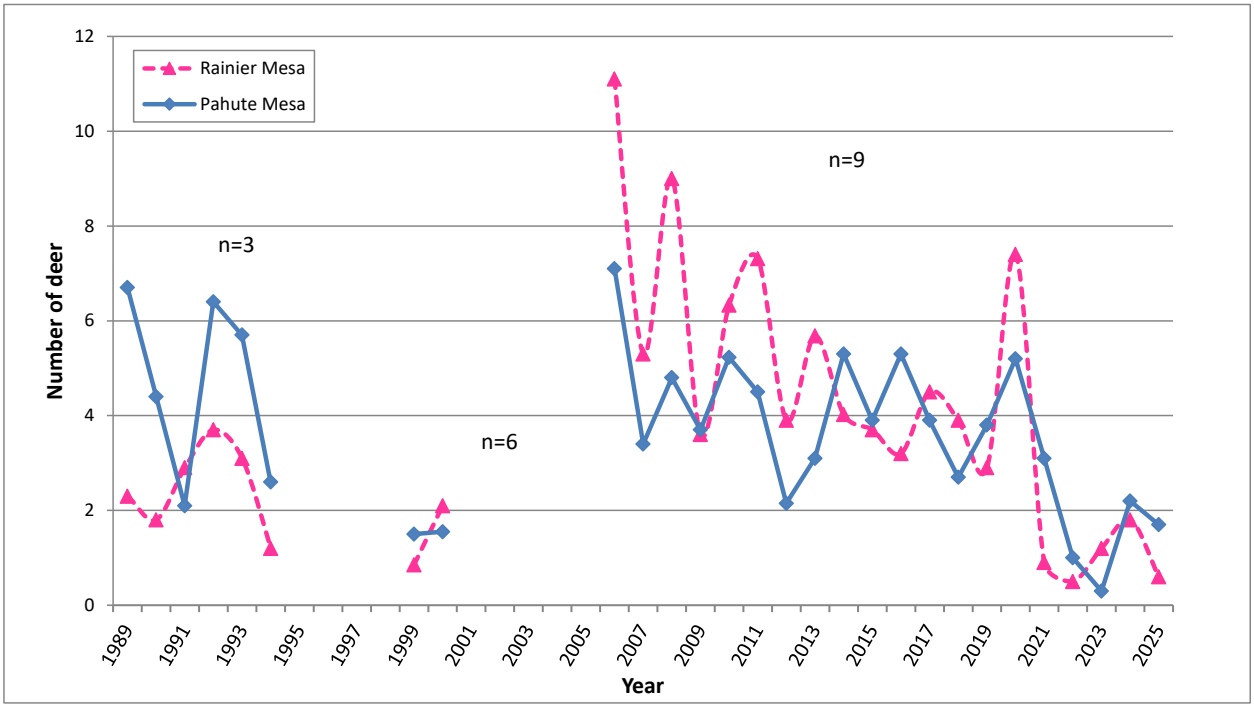

Figure 6-18. Mean number of mule deer per 10 km per night, counted on two routes (n = number of survey nights; exceptions n = 12 for 2012, n = 8 for 2013, n = 6 for 2015–2025).

Table 6-3. Mule deer classified by sex and age, with sex ratios, and fawn to doe ratios from 2006 to 2025 on the NNSS (12 survey nights for 2012, 8 for 2013, 6 for 2015–2025, 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
2021	71	46	9	16	511	0	0
2022	26	17	2	7	850	0	0
2023	27	11	8	6	138	2	25
2024	70	33	16	16	206	5	31
2025	40	28	9	3	311	0	0

The fawn/doe ratio (number of fawns per 100 does) was 0 in 2025 compared to 31 in 2024 (Table 6-3). The percentage of individuals unclassified to sex and age in 2025 was 7.5% which is lower than the average percentage of unclassified sex and age since 2006 (18.6%). 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. Deer that are greater than 200 m away from roads are difficult to detect using the spotlight technique.

6.7 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 generally 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 few 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. 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 a relatively recent 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 conducted from November 2019 to November 2022 to better understand the potential radiological dose to the off-site public via the hunter pathway for both species. This was a collaborative effort involving Dr. 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 NNSS biologists. NNSA/NFO and DOE Environmental Management Nevada Program (DOE EM/NV) 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 vegetation, and 8) assess the overall health, disease status, and genetics of NNSS mule deer and pronghorn.

Work on this study during 2025 focused on 1) analyzing movement patterns in relation to phenological changes in the vegetation, habitat use, and survival which will be summarized in a report anticipated to be completed in 2026 and 2) analyzing data and writing a draft report on the radiological results of the study which will be completed in early 2026.

6.8 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 in a paper published in the 2019 Desert Bighorn Council Transactions (Hall et al. 2019). A comprehensive USGS Open File Report on the study is being finalized for publication by Dr. Kathy Longshore (USGS). Conclusions from the radio-tracking study recommend continued monitoring of the NNSS sheep population. Additional captures of three ewes (NT30, NT31, NT32) on November 11, 2022, and subsequent tracking of these animals yielded even more data on location and movements and disease status of sheep on the NNSS. This study was done in collaboration with NDOW as part of a test and remove project to reduce the devastating impact of a disease that causes pneumonia in bighorn sheep. Oral, nasal, and blood samples were taken for disease testing, radio collars were attached, and the animals were then released. None of the animals tested positive for the disease. Animals were tracked during 2025. NT31 (10-year-old female) was killed by a mountain lion around January 13, 2025, just north of Cottonwood Spring. A camera trap captured several images of a mountain lion at Cottonwood Spring during that same time. NT32 (6-year-old female) was killed by a mountain lion around January 29, 2025, west of the Yucca Mountain crest. A total of 1,458 locations were recorded during 2025 for ewe NT30 who is still alive. She focused her activity on the ridge extending south from Yucca Mountain and in the rugged canyons and ridges on the east and west sides of Fortymile Canyon (Figure 6-19).

Sheep use at several water sources was also recorded using camera traps. Desert bighorn sheep were detected at seven water sources including one image of a ram at Cane Spring (#7) on December 20, 2025, at 12:08 pm (Figure 6-20). This is the first documented use of Cane Spring by a desert bighorn sheep which is a significant finding. Cane Spring is within a few miles of Skull Mountain where several sheep are known to occur and is the only known perennial water source in the area. Other locations where sheep were documented were Delirium Canyon Tanks (#5) (492 images of three ewes, one older lamb, one young lamb, and one young ram), South Pah Canyon Tanks (#11) (65 images of two ewes, one lamb, and one young ram), Twin Spring (#16) (51 images of Ewe NT3?, two unmarked ewes, three lambs, two rams), Cottonwood Spring (#4) (44 images of Ewe NT32, Ewe118, two older lambs, ram, young ram), Fortymile Canyon Tanks (#9) (42 images of Ewe118, seven ewes, older lamb, lamb, ram, young ram), and Rock Valley Tank (#2) (2 images of one ram). Combining these observations, at least 18 sheep (3 marked ewes, 7 unmarked ewes, 2 older lambs, 3 lambs, 2 mature rams, 1 young ram) were documented on the NNSS during 2025.

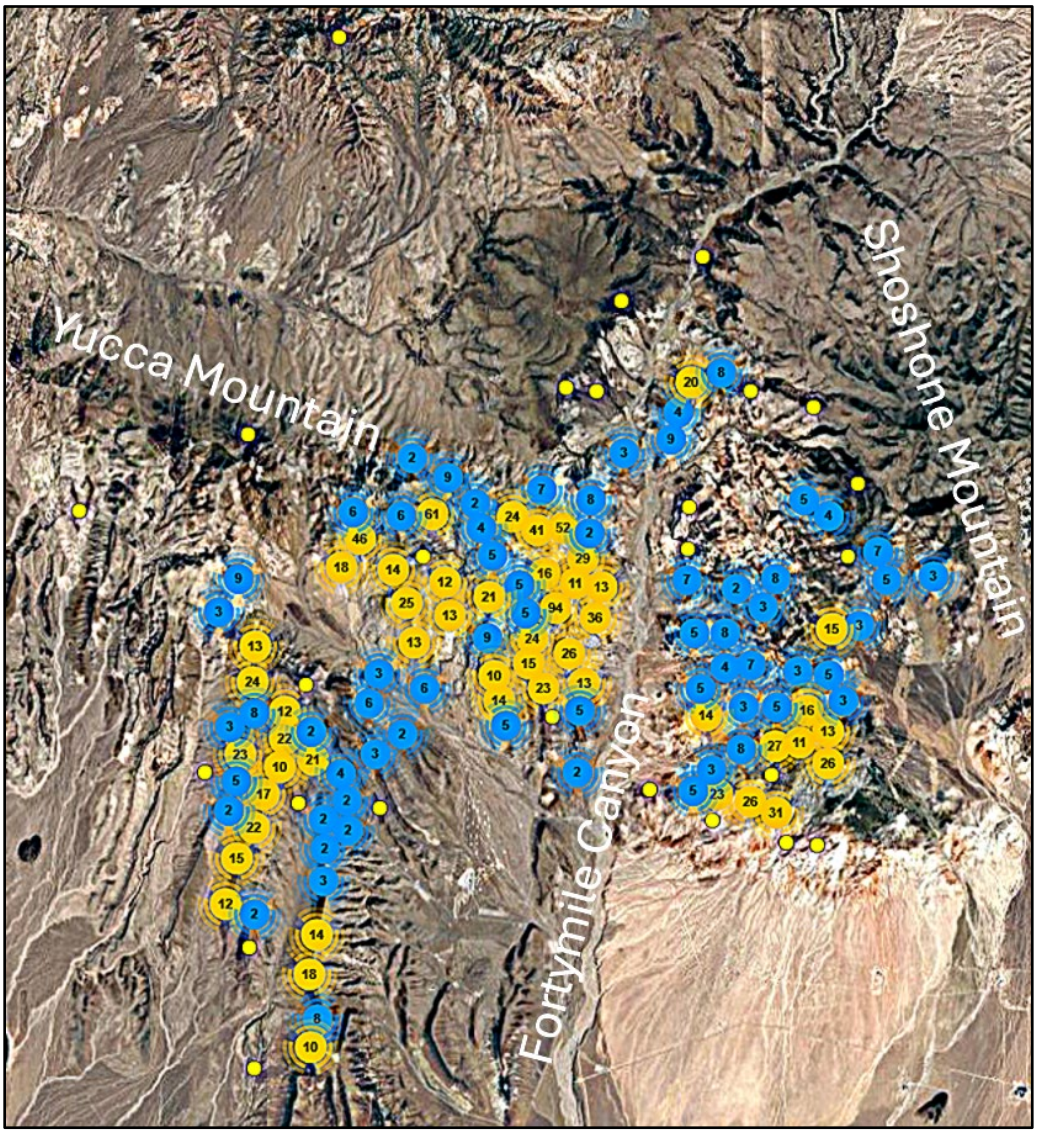

Figure 6-19. Locations of ewe NT30 (yellow dots) during 2025. Circles with numbers represent number of locations close to each other (e.g., orange circles indicate location clusters with the most locations and thus high activity areas).



Figure 6-20. Desert bighorn sheep ram at Cane Spring (#7).

(Photo by motion-activated camera, December 20, 2025)

6.9 Mountain Lion Monitoring

6.9.1 Motion-Activated Cameras

Few studies have examined mountain lion populations and their distribution in Southern Nevada, including the NNSS. Beginning in 2006, NNSS biologists 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. Remote, motion-activated cameras were used in 2025 at 17 sites (Figure 6-21 and Table 6-4). Sites were selected at locations with 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 2024 or early 2026 due to the accessibility and scheduling of camera trap visits.

A total of 233 mountain lion images (i.e., photographs or video clips) were taken during 130,512 camera hours across all sites (Figure 6-21 and Table 6-4). This equates to about 1.8 mountain lion images per 1,000 camera hours. This is a substantial drop from 3.2 images per 1,000 camera hours recorded in 2024, and it is unknown if this represents an actual decline in mountain lion numbers or just a detectability issue based on animal movements and behavior. Mountain lions were detected at 12 of the 17 sites, including 10 water sources and 2 canyons (Figure 6-21). Table 6-5 contains the camera trap results by month and location. Figure 6-22 depicts a male mountain lion with a desert bighorn sheep in its jaws at Delirium Canyon Tanks (#5). Figure 6-23 is a photo of a mountain lion at South Pah Canyon Tanks (#11). Figure 6-24 shows a female mountain lion with three young cubs at Twin Spring (#16). An additional

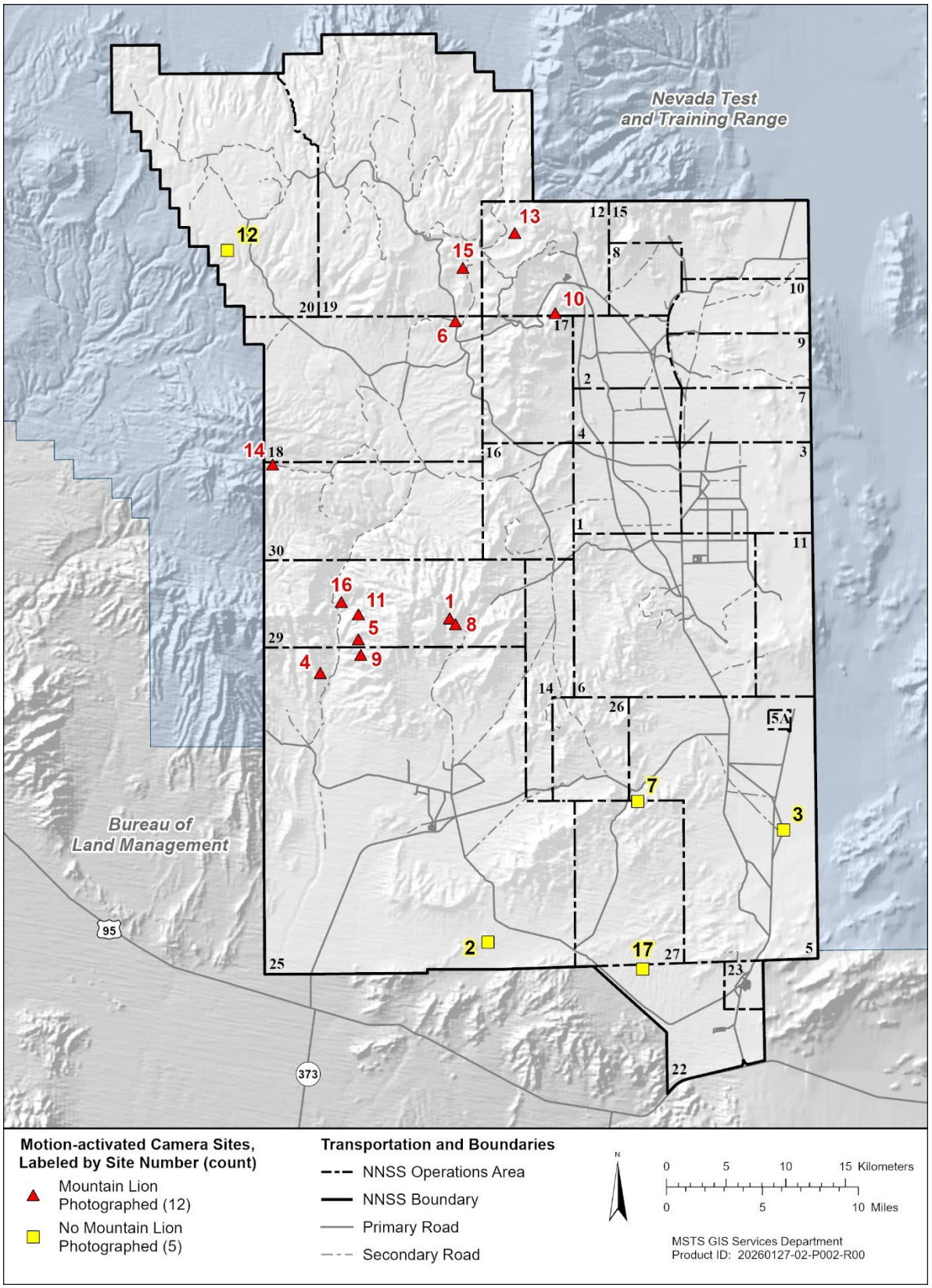

Figure 6-21. Locations of mountain lion photographic detections and camera traps on the NNSS during 2025.

Table 6-4. Results of mountain lion camera surveys during 2025 (a = non-continuous operation due to camera problems, dead batteries, full memory cards, etc.).

Location (Site Number)	Dates Sampled	Camera Hours	Mountain Lion Images (Number of Images per 1,000 Camera Hours)	Other Observations (Number of Images)
Twin Spring (#16)	1/7/25-1/5/26[a]	5,517	51 (9.2)	Bobcat (1), gray fox (1), coyote (15), spotted skunk (58), desert bighorn sheep (51), mule deer (220), feral burro (3,723), desert cottontail rabbit (928), desert woodrat (85), white-tailed antelope ground squirrel (66), golden eagle (6), barn owl (1), turkey vulture (12), mourning dove (1), chukar (755), greater roadrunner (8), common raven (63), Bell's or sagebrush sparrow (2), Say's phoebe (4), house finch (100)
Camp 17 Pond (#6)	12/18/24-12/22/25[a]	5,930	30 (5.1)	Bobcat (8), coyote (69), mule deer (107), feral horse (172), desert cottontail rabbit (23), black-tailed jackrabbit (13), desert woodrat (1), kangaroo rat (62), bat (1), peregrine falcon (8), golden eagle (10), Cooper's hawk (191), red-tailed hawk (544), great-horned owl (4), turkey vulture (290), mourning dove (107), chukar (220), common raven (80), great blue heron (1), Wilson's snipe (2), varied thrush (6), spotted sandpiper (40), pinyon jay (4), greater roadrunner (1), scrub jay (16), northern flicker (9), western tanager (11), northern mockingbird (6), western bluebird (4), lark sparrow (41), chipping sparrow (12), Townsend's solitaire (22), spotted towhee (1), American robin (51), horned lark (28), brown-headed cowbird (21), house finch (8), Say's phoebe (2), dark-eyed junco (11), yellow-rumped warbler (1), European starling (4), tarantula hawk (1)
Captain Jack Spring (#10)	12/18/24-12/22/25[a]	8,856	44 (5.0)	Bobcat (2), gray fox (18), badger (1), mule deer (387), rock squirrel (1), turkey vulture (2), mourning dove (1), chukar (57), pinyon jay (1), scrub jay (3), common raven (1), greater roadrunner (1), kingbird (2), tarantula hawk (1)

Table 6-4. Results of mountain lion camera surveys during 2025 (a = non continuous operation due to camera problems, dead batteries, full memory cards, etc.) (continued).

Location (Site Number)	Dates Sampled	Camera Hours	Mountain Lion Images (Number of Images per 1,000 Camera Hours)	Other Observations (Number of Images)
Delirium Canyon Tanks (#5)	1/6/25-1/6/26	8,755	41 (4.7)	Bobcat (1), gray fox (7), coyote (26), desert bighorn sheep (492), rock squirrel (14), chukar (7), greater roadrunner (2)
Cottonwood Spring (#4)	1/7/25-1/5/26	8,710	20 (2.3)	Bobcat (3), gray fox (4), coyote (21), desert bighorn sheep (44), feral burro (4,517), great-horned owl (2), chukar (195), common raven (24), greater roadrunner (5)
Topopah Spring (#8)	12/18/24-12/23/25[a]	5,789	10 (1.7)	Bobcat (57), gray fox (17), coyote (49), badger (7), spotted skunk (5), mule deer (4), desert cottontail rabbit (36), rock squirrel (234), cliff chipmunk (12), white-tailed antelope ground squirrel (39), desert woodrat (44), red-tailed hawk (2), great-horned owl (2), mourning dove (35), chukar (6,477), greater roadrunner (11), scrub jay (9), Bell's or sagebrush sparrow (6), white-crowned sparrow (5), spotted towhee (27)
Topopah Spring Trough (#1)	12/18/24-12/23/25	8,876	13 (1.5)	Bobcat (16), gray fox (16), coyote (15), badger (3), mule deer (19), desert cottontail rabbit (6), black-tailed jackrabbit (1), rock squirrel (62), mourning dove (6), chukar (237), pinyon jay (4), scrub jay (2), black phoebe (1), Say's phoebe (2)
South Pah Canyon Tanks (#11)	1/6/25-1/5/26	8,735	9 (1.0)	Bobcat (1), gray fox (2), coyote (1), ring-tailed cat (1), spotted skunk (26), desert bighorn sheep (65), rock squirrel (9), cliff chipmunk (4), white-tailed antelope ground squirrel (7), bat (8), golden eagle (43), great-horned owl (2), mourning dove (27), chukar (119), pinyon jay (176), scrub jay (1), white-crowned sparrow (1), common poorwill (5), hermit thrush (5), dark-eyed junco (5), rock wren (1)
Gold Meadows Spring (#13)	12/18/24-12/22/25	8,857	7 (0.8)	Bobcat (7), coyote (68), mule deer (28), feral horse (306), black-tailed jackrabbit (237), rock squirrel (6), great-horned owl (2), mourning dove (2), common raven (128),

Table 6-4. Results of mountain lion camera surveys during 2025 (a = non continuous operation due to camera problems, dead batteries, full memory cards, etc.) (continued).

Location (Site Number)	Dates Sampled	Camera Hours	Mountain Lion Images (Number of Images per 1,000 Camera Hours)	Other Observations (Number of Images)
				pinyon jay (1), mountain bluebird (2), western bluebird (1), common poorwill (1)
East Cat Canyon (#14)	12/18/24-12/22/25	8,857	4 (0.5)	Bobcat (3), gray fox (37), coyote (11), mule deer (14), feral burro (176), black-tailed jackrabbit (3), kangaroo rat (26), red-tailed hawk (1), chukar (1), rock wren (1), lizard (1)
Rattlesnake Ridge Gorge (#15)	12/18/24-12/22/25	8,857	3 (0.3)	None
Fortymile Canyon Tanks (#9)	1/7/25-1/6/26	8,726	1 (0.1)	Bobcat (2), gray fox (5), coyote (2), desert bighorn sheep (42), golden eagle (4), great-horned owl (1), chukar (1), Say's phoebe (3), black-throated sparrow (1)
Cane Spring (#7)	1/6-12/23/25[a]	6,771	0 (0.0)	Bobcat (11), coyote (6), badger (1), mule deer (1), desert bighorn sheep (1), desert cottontail rabbit (104), northern flicker (2)
Well 5C Trough (#3)	1/6-12/22/25[a]	7,390	0 (0.0)	Bobcat (2), kit fox (10), coyote (24), badger (1), pronghorn antelope (29), feral burro (6), black-tailed jackrabbit (282), white-tailed antelope ground squirrel (4), kangaroo rat (1), red-tailed hawk (28), Cooper's hawk (1), mourning dove (12), American coot (34), sage thrasher (1), common raven (68), loggerhead shrike (2), great-tailed grackle (7), brown-headed cowbird (35), Bell's or sagebrush sparrow (8), horned lark (617), Eurasian collared dove (4), European starling (2), yellow butterfly (1)
Rock Valley Tank (#2)	1/6-12/23/25[a]	4,976	0 (0.0)	Bobcat (2), kit fox (1), coyote (25), badger (13), desert bighorn sheep (2), black-tailed jackrabbit (2), white-tailed antelope ground squirrel (10), greater roadrunner (1), horned lark (2), chuckwalla (1), swallowtail butterfly (1)

Table 6-4. Results of mountain lion camera surveys during 2025 (a = non continuous operation due to camera problems, dead batteries, full memory cards, etc.) (continued).

Location (Site Number)	Dates Sampled	Camera Hours	Mountain Lion Images (Number of Images per 1,000 Camera Hours)	Other Observations (Number of Images)
Area 22, Juvenile Desert Tortoise Site 2 (#17)	1/6/25-1/5/26[a]	6,053	0 (0.0)	Kit fox (2), coyote (2), black-tailed jackrabbit (14), white-tailed antelope ground squirrel (1), kangaroo rat (2), western burrowing owl (1)
ER 20-5 Plastic-lined Sump (#12)	12/18/24-12/22/25	8,857	0 (0.0)	Common raven (3)

Table 6-5. Number of mountain lion images taken with camera traps by month and location, December 2024 through January 2026 (orange = number of mountain lion images; yellow = camera operational, no mountain lion images; green = camera not operational).

Camera Location (Site number)	Dec-24	Jan-25	Feb-25	Mar-25	Apr-25	May-25	Jun-25	Jul-25	Aug-25	Sep-25	Oct-25	Nov-25	Dec-25	Jan-26
Cottonwood Spring (#4)		13	4	2								1		
Fortymiule Canyon Tanks (#9)		1												
Delirium Canyon Tanks (#5)		1			4		3	5	28					
South Pah Canyon Tanks (#11)				1		1	4		1	1		1		
Twin Spring (#16)		14	4			13	4	2	14					
Topopah Spring (#8)	3	2				2				3				
Topopah Spring Trough (#1)	1	1	1			1	7	2						
East Cat Canyon (#14)		2					2							
Captain Jack Spring (#10)	1	3			3	5			14	15		3		
Camp 17 Pond (#6)	5	5	2					4	7	2	3	2		
Rattlesnake Ridge Gorge (#15)			1	1					1					
Gold Meadows Spring (#13)		1					1	3	1		1			



Figure 6-22. Male mountain lion with desert bighorn sheep lamb at Delirium Canyon Tanks (#5).

(Photo by motion-activated camera, July 11, 2025)



Figure 6-23. Mountain lion at South Pah Canyon Tanks (#11).

(Photo by motion-activated camera, May 27, 2025)



Figure 6-24. Female mountain lion with three juveniles at Twin Spring (#16).

(Photo by motion-activated camera, August 23, 2025)

mountain lion sighting was documented on the hill above the E Tunnel pad during mule deer spotlight surveys at 1950 hours on October 6, 2025.

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 five individuals (adult male, adult female, three cubs) were documented in 2025 from the 17 camera traps. This compares to a minimum of four individuals in 2024 and 2023, three individuals in 2022 and 2021, four individuals in 2020, three individuals in 2019 and 2018, four individuals in 2017, five individuals in 2016, three individuals in 2015, four individuals in 2014 and 2013, and six individuals in 2012.

To investigate temporal activity of mountain lions, camera detection data from all 20 years (2006–2025) were combined. Mountain lions were detected every month with peak occurrences during August (n = 264), September (n = 292), and November (n = 302) (Figure 6-25). The number of images taken during summer and fall (June–November) (n = 1,387) accounted for two-thirds of all images compared with the number of images taken during winter and spring (December–May) (n = 688) (Figure 6-25). Nearly three-fourths of mountain lion images were taken between 1700 to 0500 hours with peak activity between 2100 and 2200 hours Pacific Standard Time (Figure 6-26). From 2011 to 2025, 1.8 times as many images were taken when it was dark (n = 1,222) compared with when it was light (n = 662).

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 24,622 images of at least 73 species other than

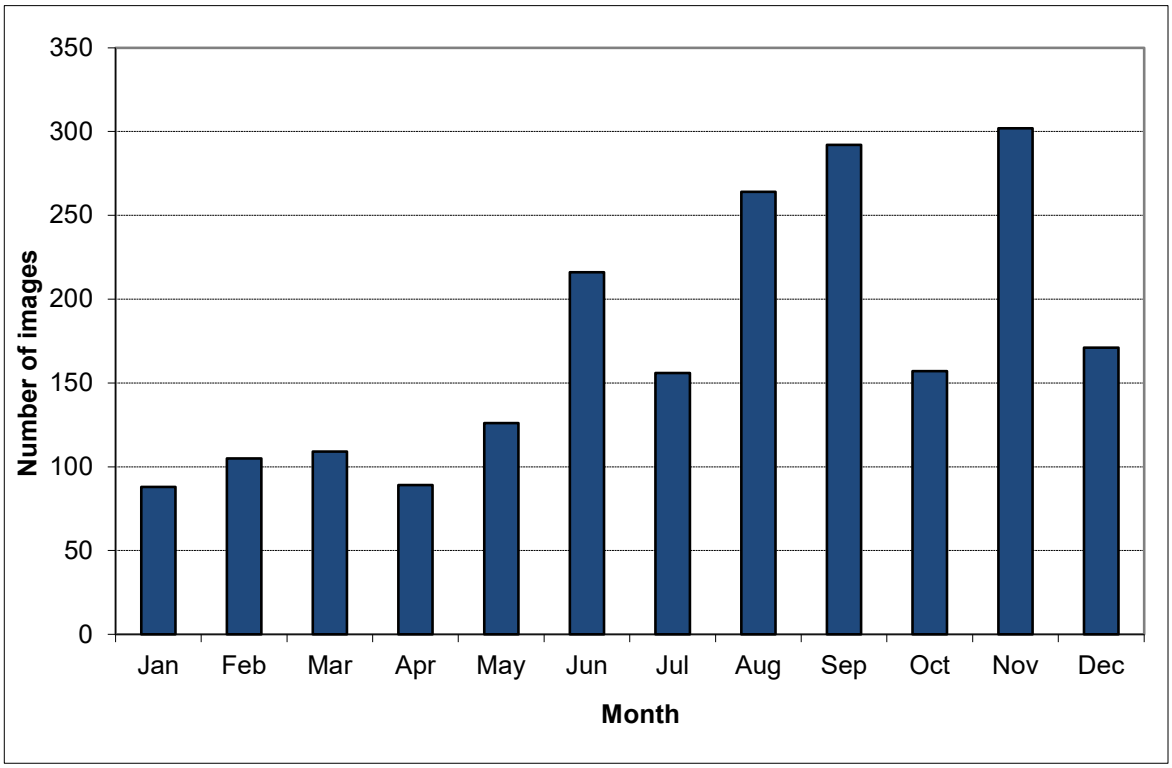

Figure 6-25. Number of mountain lion images by month for camera sites where mountain lions were detected from 2006 through 2025 (n = 2,075).

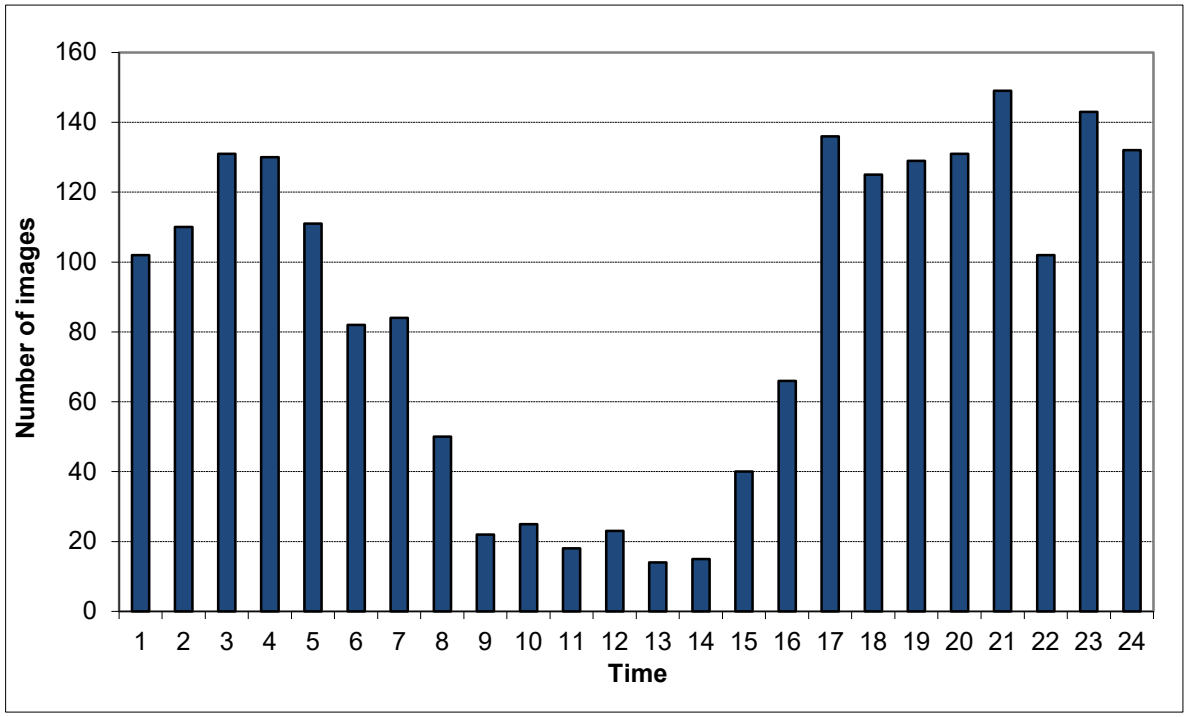

Figure 6-26. Number of mountain lion images by time of day (Pacific Standard Time) for camera sites where mountain lions were detected from 2006 through 2025 (n = 2,070).

mountain lions were taken during 130,512 camera hours across all sites which is about 189 images per 1,000 camera hours.

Other than feral burros (see Section 6.13), the most photographed species (33% of all images) was chukar (8,069 images at 10 of 17 sites). About 80% of these were taken at Topopah Spring. Only 191 images of mourning doves were taken at 8 of 17 sites, a big decline from 2024 when 2,230 images were taken at 12 of 17 sites. This might be explained by the dry year in 2025. Mule deer were photographed 780 times at 8 of 17 sites in 2025 compared to 1,837 times at 8 of 17 sites in 2024. Twin Spring (#16), Camp 17 Pond (#6), and Captain Jack Spring (#10) were important water sources for mule deer during 2025. Pronghorn antelope were detected in 29 images at one site (Well 5C Trough#3). Some of the rarer, more elusive, or species of interest documented from camera surveys were desert bighorn sheep (see Section 6.9), bobcat (found at 14 of 17 sites), gray fox (found at 9 of 17 sites), kit fox (found at 3 of 17 sites), golden eagle (found at 3 of 17 sites), badger (found at 5 of 17 sites), spotted skunk (found at 2 of 17 sites), peregrine falcon (found at 1 of 17 sites), pinyon jay (found at 5 of 17 sites), Cooper's hawk (found at 2 of 17 sites), and greater roadrunner (*Geococcyx californianus*; found at 7 of 17 sites) (Table 6-4). Greater roadrunner observations have increased the last few years, and they are widely distributed across the NNSS. Noteworthy observations of some of the more common species included 367 images of common ravens at 7 of 17 sites and 334 images of coyotes at 14 of 17 sites. Greatest use and highest species richness were documented at water sources (both natural and constructed) which emphasizes the importance of various water sources for several wildlife species, particularly during the drier summer months.

6.10 Radiological Sampling

Sampling for radionuclides in game species (e.g., mule deer, pronghorn antelope, cottontail rabbit, waterfowl, mourning dove) was performed 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. Many of 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 2025, seven tissue samples were collected and analyzed from one desert cottontail rabbit, two mule deer, and four pronghorn antelope. 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. No manmade radionuclides were detected in any of these samples.

6.11 Nuisance and Potentially Dangerous Wildlife

During 2025, NNSS biologists documented 91 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 (35 calls), bats (3 calls), other mammals (31 calls), reptiles (18 calls, including 3 rattlesnake removals), and invertebrates (4 calls). Mitigation measures taken typically involved relocating the animals away from people, instructing workers to leave the animal in place, or disposing of dead animals. An adult badger that was digging in the Area 23 landfill was captured and relocated to Camp 17 Pond in early October.

Safety presentations were also given in person 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. A recurring major problem is that a few

employees continue to feed wildlife, especially coyotes. This led to a worker being bit, which resulted in one coyote having to be captured and euthanized. It was tested for rabies and the results were negative.

6.12 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). Burros were not mentioned by Jorgensen and Hayward (1965) but were discussed in Collins et al. (1982). They 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 bulls is to the north, possibly in the Groom or Kawich Range. During 2025, no elk were documented on the NNSS.

Feral burros appear to be increasing in number and expanding their range on the NNSS. A total of 8,422 images of feral burros were taken at 4 of 17 camera trap locations in Frenchman Flat, Fortymile Canyon, and for the third consecutive year in East Cat Canyon (#14). A herd of 11 burros was observed near this camera during the December camera check. Most photos were taken at Cottonwood Spring (#4; 4,517 images)) and Twin Spring (#16; 3,723 images) where they are causing heavy damage to both springs which may require fencing to maintain the integrity of the springs. Burros have also been observed in recent years in Mercury Valley. The first documented burro killed by a mountain lion on the NNSS was recorded at Twin Spring (#16) on May 26. Burros have few natural predators, so this is encouraging.

6.13 Coordination with Biologists and Wildlife Agencies

NNSS biologists interfaced with other biologists and wildlife agencies in 2025 for the following activities:

- Participated in the Nevada Bat Working Group meeting in December.
- Participated on the Springsnail Conservation Team.
- Participated on multiple conference calls for the DOE Migratory Bird Working Group.
- Attended the Nevada Partners-in-Flight spring meeting.
- Gave multiple “hands-on” wildlife presentations using taxidermied animal specimens to school children at local elementary schools.
- Co-authored publication, “Long-term Benefits of Burns for Large Mammal Habitat Undermined by Large, Severe Fires in the American West.” (Mills et al. 2025).

7.0 HABITAT RESTORATION IMPLEMENTATION AND MONITORING

NNSS biologists conduct revegetation activities at disturbances on and off the NNSS in support of NNSA/NFO and DOE EM/NV activities and continue to evaluate those efforts. The objectives of revegetation include: 1) establish a perennial vegetation community on waste closure covers to prevent water from infiltrating into buried waste through evapotranspiration, 2) establish a perennial vegetation community in disturbed areas (e.g., burned areas) to outcompete invasive annual grasses, reduce the risk of wildland fires, restore ecosystem function, and create wildlife habitat, 3) support the intent of U.S. Executive Order 13112, "Invasive Species," (1999) and U.S. Executive Order 13751, "Safeguarding the Nation from the Impacts of Invasive Species," (2016) to prevent the introduction and spread of non-native species and restore native species to disturbed sites, and 4) revegetation may qualify as mitigation for the loss of desert tortoise habitat under the current Opinion.

Activities conducted in 2025 included: 1) qualitative vegetation assessment at the U-3ax/bl closure cover (Corrective Action Unit [CAU] 110) (Area 3 Radioactive Waste Management Site) and West Cover at the 92-Acre Site (CAU 111) (Area 5 RWMC), 2) revegetating and monitoring seeding success at North South Cover (CAU 111) and Cells 8/16 Cover (Area 5 RWMC), 3) monitoring revegetation success and planting transplants at South Cover (CAU 111, Area 5 RWMC), 4) monitoring revegetation success at Cell 21 Cover (CAU 577) and North North Cover (CAU 111, Area 5 RWMC), 5) monitoring revegetation success at Cells 19/20 Cover (CAU 577, Area 5 RWMC), 6) assessing revegetation success at East and West Covers (CAU 577, Area 5 RWMC), 7) assessing revegetation success on Cell 18 Cover (Area 5 RWMC), 8) monitoring results from a research study to evaluate the effectiveness of different herbicide treatments to control cheatgrass after the Cherrywood Wildland Fire, 9) aerially applying herbicide over large, previously burned areas to create firebreaks in cheatgrass dominated areas and monitoring results, and 10) monitoring seeding success in a revegetated area in the Area 16 Burn.

7.1 U-3ax/bl Closure Cover (CAU 110)

The installation of an evapotranspiration cover on U-3ax/bl closure site 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 cover has been monitored to document the vigor of the plant community that has established and to identify any remedial actions that may be necessary to ensure it persists. Quantitative monitoring has included measurements of plant density and cover completed annually from the spring of 2001 through 2013, and every five years since. Qualitative assessments are completed during the interim years and entail a visual assessment of plant vigor, overall status of the plant community, notation of any signs of stress with individual plant species, and documenting wildlife activity, primarily the presence of small mammal burrows.

Precipitation in the vicinity of U3-ax/bl was about half of the long-term average for the period December 2024 to April 2025, which created unfavorable conditions for plant growth. A qualitative assessment of the vegetation was made on July 9, 2025, by walking a meandering transect across the cover. The vigor of perennial plant species was assessed based on current year's growth, whether plants were flowering, and if plants showed signs of stress (i.e., dead stems or leaves).

Nevada jointfir is now the most abundant shrub species on the closure cover (Figure 7-1) surpassing shadscale (*Atriplex confertifolia*) which has been the most abundant for many years. Numerous dead or partially dead shadscale plants were observed while most of the Nevada jointfir appeared healthy. A few fourwing saltbush (*Atriplex canescens*) and winterfat plants were observed. No perennial plant seedlings



Figure 7-1. Overview of plant community that has established on U3-ax/bl (CAU 110) over the last 25 years.

(Photo by D.B. Hall, July 9, 2025)



Figure 7-2. Unseeded portion on the periphery of U3-ax/bl (CAU 110) occupied by invasive weeds (left). Revegetated closure cover is on the right.

(Photo by D.B. Hall, July 9, 2025)

were seen. No perennial grasses have been found on the closure cover for several years and none were found again this year. A few Russian thistle (*Salsola tragus*) plants were found on the cover, but no other annuals were found. Russian thistle and saltlover (*Halogeton glomeratus*) were found in moderate densities in the unseeded portion on the periphery of the cover (Figure 7-2), highlighting the importance of seeding to establish a perennial vegetation community.

During the vegetation surveys, small mammal activity on the cover was evaluated. Several burrow complexes were noted with part of these apparently inactive. Trapping for small mammal removal is not recommended. No rabbits were observed or evidence of herbivory on the vegetation. A flock of 15-20 horned larks was observed on the cap.

7.2 Area 5 RWMC Reference Area

A reference area was established about 800 m east of the Area 5 RWMC (Figure 7-3). Plant data from this area will be used as a standard to compare revegetation success on all cover caps in the Area 5 RWMC. Ten, 100-m long, permanent transects were established in this area and sampled June 8 and 10, 2021 (drought conditions) and May 13, 2023 (above-normal precipitation). Plant density was sampled using 1-m x 1-m sampling quadrats placed at 5-m intervals along the transect for a total of 20 square meters (m^2) sampled per transect. All plant species found inside the quadrat were counted and summed by species. Due to high numbers, Arabian schismus density was counted in the upper right quadrant (0.25 m^2) and then multiplied by four to get number of plants/m^2. New seedlings encountered in 2023 were differentiated from mature plants to evaluate the seedbank effect. The average number of plants per m^2 by species were calculated (Table 7-1). In addition, plant cover was measured using an optical cover scope that projects a point straight downward on the ground and whatever that point intercepts (e.g., plant species, litter, bare ground, gravel [0.5–8.0 cm], cobble [8.0–25.0 cm], or rock [>25.0 cm]) gets recorded. Data from four points (45, 135, 225, and 315 degrees), every four meters, for a total of 100 points were recorded for each transect. These data were summarized, and average percent cover was calculated (Table 7-2). Only live plants or current year's annual plants were recorded for both density and cover. Average perennial plant density and percent perennial plant cover was calculated for the two years (one dry, one wet). Average values used to evaluate revegetation success are 1.04 plants/m^2 and 9.9%. A site is considered successfully revegetated if during the fifth-year post-revegetation perennial plant density and percent perennial plant cover is 60% of that found in the reference area.



Figure 7-3. Area 5 RWMC Reference Area.

(Photo by D.B. Hall, May 13, 2023)

Table 7-1. Plant density (plants/m^2) by species and lifeform on the Area 5 RWMC Reference Area, June 2021 (drought conditions) and May 2023 (above-normal precipitation) (S = seedling, Total = mature plants and seedlings combined).

Lifeform/Species	Reference Area (2021)	Reference Area (2023)
Perennial Shrubs		
White bursage	0.08	0.09
Fourwing saltbush	0.00	0.00
Shadscale saltbush	0.19	0.17; 0.01 S; 0.18 Total
Cattle saltbush	0.00	0.00
Nevada jointfir	0.06	0.06
Winterfat	0.01	0.02
Creosote bush	0.04	0.03
Littleleaf ratany (Not seeded)	0.43	0.31
Shockley's goldenhead (Not seeded)	0.01	0.00
Water jacket (Not seeded)	0.02	0.02
Spiny hopsage (Not seeded)	0.00	0.01
TOTAL	**0.84**	**0.71; 0.01 S; 0.72 Total**
Perennial Grasses		
Indian ricegrass	0.10	0.07; 0.26 S; 0.33 Total
Squirreltail	0.00	0.00
TOTAL	**0.10**	**0.07; 0.26 S; 0.33 Total**
Perennial Forbs		
Desert marigold	0.00	0.00
Palmer's penstemon	0.00	0.00
Desert globemallow	0.00	0.00
Desert pepperweed	0.00	0.00
Astragalus (Not seeded)	0.00	0.08
TOTAL	**0.00**	**0.08**
TOTAL PERENNIALS	**0.94**	**0.86; 0.27 S; 1.13 Total**
Annual Grasses		
Arabian schismus	0.00	14.88
Cheatgrass	0.01	2.04
Red brome	0.00	1.17
Unknown brome	0.00	0.00
Sixweeks fescue	0.00	2.21
Common wheat	0.00	0.00
TOTAL	**0.01**	**20.30**
Annual Forbs		
Saltlover	0.00	0.00
Roundleaf oxytheca	0.16	0.68
Others	0.00	30.03
TOTAL	**0.16**	**30.71**
TOTAL ANNUALS	**0.17**	**51.01**

Table 7-2. Percent cover by species and category on the Area 5 RWMC Reference Area, June 2021 (drought conditions) and May 2023 (above-normal precipitation).

Category/Species	% Cover (2021)	% Cover (2023)
Perennial Shrubs		
White bursage	0.4	0.1
Shadscale saltbush	2.4	2.4
Nevada jointfir	1.1	1.1
Spiny hopsage	0.1	0.0
Winterfat	0.1	0.1
Littleleaf ratany	3.3	3.7
Creosote bush	1.1	2.3
Water jacket	0.3	0.9
Beaked spiny polygala	0.0	0.1
TOTAL	**8.8**	**10.7**
Perennial Grasses		
Indian ricegrass	0.1	0.2
TOTAL	**0.1**	**0.2**
Perennial Forbs Total	**0.0**	**0.0**
TOTAL PERENNIALS	**8.9**	**10.9**
Annual Grasses		
Cheatgrass	0	0.4
Red brome	0	0.2
Arabian schismus	0	1.4
TOTAL	**0.0**	**2.0**
Annual Forbs		
Nevada cryptantha	0.0	0.2
Esteve's pincushion	0.0	0.4
Gilia species	0.0	0.2
Devil's spineflower	0.0	0.3
Pacific blazingstar	0.0	1.0
Roundleaf oxytheca	0.0	0.2
Smooth desertdandelion	0.0	0.1
Purplemat	0.0	0.1
TOTAL	**0.0**	**2.5**
TOTAL ANNUALS	**0.0**	**4.5**
TOTAL VEGETATIVE COVER	**8.9**	**15.4**
Rock (>25 cm)	0.0	0
Cobble (8-25 cm)	0.2	0
Gravel (0.5-8 cm)	38.5	61.6
Bare ground	33.8	15.3
Litter	18.6	7.7
ABIOTIC TOTAL	**91.1**	**84.6**

Overall plant density and percent plant cover, especially the grasses and annual forbs, was expectedly higher during 2023, due to the above-average winter/spring precipitation compared to 2021 under drought conditions. Additionally, annual forb species richness (i.e., number of species) was substantially higher in 2023 than in 2021 (30 versus 1).

7.3 92-Acre Site (CAU 111) Closure Covers

The 92-Acre Site (CAU 111) is located at the Area 5 RWMC and consists of four closure covers: South Cover, North South Cover, North North Cover, and West Cover. West Cover was under construction during 2025 to prepare it for revegetation in 2026. North South Cover was revegetated during spring 2025 and seedling density and percent cover were measured. South Cover was revegetated during spring 2024 and plant density was measured along with planting transplants. North North Cover was revegetated during spring 2023 and sampled for plant density and cover. Precipitation received at the 92-Acre Site for the period December 2024 to April 2025 was about half of normal, resulting in unfavorable growing conditions.

7.3.1 North South Cover

This closure cover (3.7 ha) (Figure 7-4) was used for a revegetation trial from 2017-2018 and has several plants still alive from the seeding and transplants, mostly fourwing saltbush. There are also some large fourwing saltbush and numerous shadscale saltbush plants alive from revegetation efforts completed in 2011. It was decided to not seed the areas that have existing perennial vegetation (roughly 30% of the cover) and seed the remaining bare areas which is about 2.6 ha.

The cover was revegetated during fall 2024 and spring 2025 which included site preparation, seeding, hydromulching, and irrigation. Seedling density was measured to assess success and compared to the Area 5 RWMC Reference Area. Site preparation (Figure 7-4) entailed adding 23–30 cm of topsoil on top of the closure cover to bury any existing weed seedbank and provide a good growing medium for seedlings. The soil was then ripped perpendicular to the predominant slope to a depth of approximately 30–45 cm to alleviate soil compaction. Additionally, a rabbit-proof fence was erected around the closure cover to prevent herbivory, especially on young seedlings.

The cover was seeded with a native seed mix comprised of eight shrub, two grass, and three forb species at a rate of 30 pounds (lbs) of pure live seed per acre (PLS/ac) (Table 7-3). Prior to seeding, the creosote bush and white bursage seed was rinsed for a 24-hour period, allowed to dry, mixed together with the desert marigold, cheesebush, and winterfat seed, and stored in bags. The seed was broadcast seeded onto the ground using a drill seeder calibrated to apply the specified rate of seed. A custom-built chain harrow was dragged behind the seeder to cover the seed to an appropriate depth (Figure 7-5). Hand seeding was also performed because of calibration and debris in the seed mix that did not allow the seeder to put out as much seed as necessary. Following seeding, a wood mulch plus soil binder product (Profile Promatrix™) was applied over the seeded area (Figure 7-6) at a rate of 2,240 kilograms/hectare (kg/ha)for the purposes of soil moisture retention, erosion control, and addition of organic matter to the soil. An irrigation system using six big gun sprinklers was installed and supplemental irrigation was applied for seedling germination and plant establishment (Table 7-4, Figure 7-7). The sprinklers did not reach all the way to the edges of the cover, so a water truck was used to spray these areas.

Seedling density and percent plant cover were measured on June 3-4, 2025, on six, permanent, 100-m long transects in the seeded area and three, 100-m long transects in the non-seeded area. Due to high numbers, Arabian schismus and saltlover density was counted in the upper right quadrant (0.25 m^2) and then multiplied by four to get number of plants/m^2. Only live plants or current year's annual plants were recorded for both density and cover. Typically, plant cover is not measured until the third year because



Figure 7-4. North South Cover showing existing large shrubs left intact and areas to be revegetated with the addition of soil to bury the weed seedbank.

(Photo taken September 11, 2024, by D.B. Hall)

Table 7-3. Seed mix used to revegetate North South Cover including species, number of pure live seeds per square meter (m^2), and number of pounds of pure live seed per acre.

Lifeform	Common Name	Species (Variety)	Number of pure live seeds/m2	Pounds of pure live seed/acre
Shrub	White bursage	*Ambrosia dumosa*	63	3.0
Shrub	Fourwing saltbush	*Atriplex canescens*	48	3.5
Shrub	Shadscale saltbush	*Atriplex confertifolia*	64	4.0
Shrub	Cattle saltbush	*Atriplex polycarpa*	99	0.5
Shrub	Nevada jointfir	*Ephedra nevadensis*	44	9.0
Shrub	Cheesebush	*Hymenoclea salsola*	30	1.1
Shrub	Winterfat	*Krascheninnikovia lanata*	17	0.6
Shrub	Creosote bush	*Larrea tridentata*	99	5.0
Grass	Indian ricegrass	*Achnatherum hymenoides (Owens CA)*	60	1.5
Grass	Squirreltail	*Elymus elymoides (Mono CA)*	47	1.0
Forb	Desert marigold	*Baileya multiradiata*	52	0.2
Forb	Palmer penstemon	*Penstemon palmeri (Cedar)*	30	0.2
Forb	Desert globemallow	*Sphaeralcea ambigua*	49	0.4
		TOTAL	702	30.0



Figure 7-5. Broadcast seeding North South Cover with drill seeder and chain harrow.

(Photo taken February 18, 2025, by D.B. Hall)



Figure 7-6. Applying wood mulch with soil binder using a hydromulcher at North South Cover.

(Photo taken February 19, 2025, by D.B. Hall)

Table 7-4. Total amount of irrigation applied and natural precipitation received during select months at North South Cover in 2025.

Month	Irrigation (mm)	Natural Precipitation (mm)
March	38.1	18.5
April	63.5	0.0
June	25.4	0.0
August	38.1	1.5
Total	**165.1**	**20.0**



Figure 7-7. Irrigation system with big gun sprinklers at North South Cover with a water truck spraying the edge of the cover in the background.

(Photo taken April 22, 2025, by D.B. Hall)

plants are too small, but we wanted to track and compare cover on the non-seeded versus the seeded areas. Results from plant density and percent plant cover are found in Tables 7-5 and 7-6, respectively.

Overall, plant density on the North South Cover is much higher than on the reference area (9.39 versus 1.04 plants/m^2). Additionally, 10 of the 13 seeded species germinated, which is encouraging. The presence of saltlover is concerning and will be monitored closely because it could impact seedling establishment. Only 0.19 plants/m^2 were found in the non-seeded area, which is less than in the reference area. In addition, high densities of Arabian schismus and saltlover were found. Percent perennial plant cover was lowest in the seeded area (0.2%) which is expected due to the small stature of seedlings. As these grow and mature, plant cover should increase. Compared to the reference area, percent perennial plant cover in the non-seeded area was substantially lower (3.3% versus 9.9%) and requires the addition of more plants which will be accomplished by planting transplants on both the seeded and non-seeded areas in the spring of 2026. Percent cover of saltlover and Arabian schismus was high (nearly 25% combined).

7.3.2 South Cover

This closure cover (7.2 ha) was revegetated during spring 2024. Plant density was measured in June 2024 and April 2025 (Figure 7-8) along 15, permanent, 100-m long transects and compared to plant density in the Area 5 RWMC Reference Area (Table 7-7). Due to high numbers, Arabian schismus and saltlover density was counted in the upper right quadrant (0.25 m^2) and then multiplied by four to get number of plants/m^2. Only live plants or current year's annual plants were recorded. Overall, plant density on the South Cover is much higher than on the reference area (15.92 versus 1.04 plants/m^2), and all 12 seeded species were still detected, which is highly encouraging. High saltlover density is concerning and will be monitored closely but does not seem to have impacted seedling survival over the last year.

A total of 7,765 transplants were planted on South Cover (Figure 7-9) March 3-6 and 10-12. This included 2,553 gallon-size creosote bush (Figure 7-10), 2,860 gallon-size white bursage (Figure 7-10), and 2,352 white bursage in super cells (small, plastic tube about 5 cm in diameter by 25 cm tall). All transplants for all sites were grown by contracted nurseries from seed hand-collected by NNSS biologists in Area 5 around the RWMC. The cover was irrigated during February with approximately 44.5 mm to ensure that soil moisture was high to facilitate planting and increase transplant survival. Two hundred of each species and size were marked with stake chasers of different colors to track plant survival. Short-term plant survival and vigor were measured on April 17. Plants were counted as either dead or alive and a vigor rating (0 – Dead, 1 – Barely alive, 2 – Moderate, 3 – Thriving, and 4 – Excellent) was assigned. Creosote bush survival was 93.7% with an average vigor of 1.7. White bursage (super cell) survival was 85.0% with an average vigor of 1.1, and white bursage (gallon) survival was 79.1% with an average vigor of 1.2. Transplants added 0.14 plants/m^2 to the overall plant density making a total of 15.92 plants/m^2. An additional 47.8 mm of irrigation was applied in August 2025 to increase transplant survival.

7.3.3 North North Cover

This cover (1.7 ha) was revegetated during spring 2023, and plant density was measured in June 2023 along five, permanent, 100-m long transects. Numerous creosote bush and white bursage seedlings germinated after late summer rains in 2023 alongside good plant densities and cover from seeding; therefore, it was decided not to plant transplants on this closure cover as previously planned. Plant density and percent cover were measured in June 2024 and April 2025 along the same transects as in 2023 (Figures 7-11, 7-12). Only live plants or current year's annual plants were recorded for both density and cover. Density and cover results are found in Tables 7-8 and 7-9, respectively, along with density data from 2023 and 2024 and the 2023 reference area density and cover data. Perennial plant density declined substantially from 2023 to 2025 (21.16 to 2.38 plants/m^2) but is still more than double the density in the

Table 7-5. Plant density (plants/m^2) by species and lifeform on North South Cover seeded and non-seeded areas compared to the Area 5 RWMC Reference Area (S = seedling, Total = mature plants and seedlings combined).

Lifeform/Species	North South Cover Seeded (2025)	North South Cover Non-seeded (2025)	Reference Area (2023)
Perennial Shrubs			
White bursage	0.13 S	0.00	0.09
Fourwing saltbush	1.17 S	0.12	0.00
Shadscale saltbush	0.03 S	0.07	0.17; 0.01 S; 0.18 Total
Cattle saltbush	6.86 S	0.00	0.00
Nevada jointfir	0.71 S	0.00	0.06
Cheesebush	0.03 S	0.00	0.00
Winterfat	0.00	0.00	0.02
Creosote bush	0.01 S	0.00	0.03
Littleleaf ratany (not seeded)	0.00	0.00	0.31
Spiny hopsage (not seeded)	0.00	0.00	0.01
Water jacket (not seeded)	0.00	0.00	0.02
TOTAL	**8.94 S**	**0.19**	**0.71; 0.01 S; 0.72 Total**
Perennial Grasses			
Indian ricegrass	0.27 S	0.00	0.07; 0.26 S; 0.33 Total
Squirreltail	0.13 S	0.00	0.00
TOTAL	**0.4 S**	**0.00**	**0.07; 0.26 S; 0.33 Total**
Perennial Forbs			
Desert marigold	0.05 S	0.00	0.00
Palmer's penstemon	0.00	0.00	0.00
Desert globemallow	0.00	0.00	0.00
Astragalus spp.	0.00	0.00	0.08
TOTAL	**0.05 S**	**0.00**	**0.08**
TOTAL PERENNIALS	**9.39 S**	**0.00**	**0.86; 0.27 S; 1.13 Total**
Annual Grasses			
Arabian schismus	0.43	71.73	14.88
Cheatgrass	0.00	0.00	2.04
Red brome	0.00	0.00	1.17
Sixweeks fescue	0.00	0.00	2.21
TOTAL	**0.43**	**71.73**	**20.30**
Annual Forbs			
Saltlover	6.73	39.53	0.00
Russian thistle	0.37	0.05	0.00
Others	0.01	0.03	30.71
TOTAL	**7.11**	**39.61**	**30.71**
TOTAL ANNUALS	**7.54**	**111.34**	**51.01**

Table 7-6. Percent plant cover by species and category on North South Cover seeded and non-seeded areas compared to the Area 5 RWMC Reference Area (S = seedling).

Category/Species	North South Cover Seeded (2025)	North South Cover Non-seeded (2025)	Reference Area (2023)
Perennial Shrubs			
White bursage	0.0	0.0	0.1
Fourwing saltbush	0.0	2.7	0.0
Shadscale saltbush	0.0	0.3	2.4
Cattle saltbush	0.2 S	0.0	0.0
Nevada jointfir	0.0	0.0	1.1
Cheesebush	0.0	0.0	0.0
Winterfat	0.0	0.0	0.1
Creosote bush	0.0	0.3	2.3
Littleleaf ratany (Not seeded)	0.0	0.0	3.7
Water jacket (Not seeded)	0.0	0.0	0.9
Beaked spiny polygala (Not seeded)	0.0	0.0	0.1
TOTAL	**0.2 S**	**3.3**	**10.7**
Perennial Grasses			
Indian ricegrass	0.0	0.0	0.2
Squirreltail	0.0	0.0	0.0
TOTAL	**0.0**	**0.0**	**0.2**
Perennial Forbs			
Desert marigold	0.0	0.0	0.0
Palmer's penstemon	0.0	0.0	0.0
Desert globemallow	0.0	0.0	0.0
TOTAL	**0.0**	**0.0**	**0.0**
TOTAL PERENNIALS	**0.2 S**	**3.3**	**10.9**
Annual Grasses			
Arabian schismus	0.0	10.3	1.4
Cheatgrass	0.0	0.0	0.4
Red brome	0.0	0.0	0.2
TOTAL	**0.0**	**10.3**	**2.0**
Annual Forbs			
Saltlover	5.0	12.0	0.0
Russian thistle	0.2	0.0	0.0
Other annual forbs	0.0	0.0	2.5
TOTAL	**5.2**	**12.0**	**2.5**
TOTAL ANNUALS	**5.2**	**22.3**	**4.5**
TOTAL VEGETATIVE COVER	**5.4**	**25.6**	**15.4**
Rock (>25 cm)	0.2	0.0	0.0
Cobble (8-25 cm)	1.3	0.3	0.0
Gravel (0.5-8 cm)	26.7	39.7	61.6
Bare ground	4.2	7.0	15.3
Wood mulch	61.8	0.0	0.0
Litter	0.5	27.3	7.7
TOTAL ABIOTIC	**94.7**	**74.3**	**84.6**



Figure 7-8. South Cover plant density sampling transect.

(Photo taken April 28, 2025, by D.B. Hall)



Figure 7-9. Transplanting plants on South Cover.

(Photo taken March 5, 2025, by D.B. Hall)



Figure 7-10. Transplanted creosote bush (upper) and white bursage (lower) plants on South Cover.

(Photos taken March 6, 2025, by D.B. Hall)

reference area (1.04 plants/m^2). Indian ricegrass and Nevada jointfir declined the most from 2024 to 2025. Of particular interest is the relatively good density of persistent white bursage and creosote bush that can be difficult to germinate and establish from seed. In contrast to the high densities of saltlover and Russian thistle in 2024, no annual forbs or grasses were detected in 2025, due to the drought conditions. Total perennial plant cover was 4.0% compared to 9.9% in the reference area. Percent cover of Indian ricegrass declined the most (10.2 to 0.4) and percent shrub cover declined from 7.2% to 3.6%. No annual forbs or grasses were detected. The western portion of the cover appears to have lower densities and percent cover of seeded species than the eastern portion, especially the *Atriplex* species (Figures 7-11, 7-12).

Table 7-7. Plant density (plants/m^2) by species and lifeform on South Cover (CAU 111) compared to the Area 5 RWMC Reference Area (S = seedling, T= transplant, Total = mature plants, seedlings and transplants combined).

Lifeform/Species	South Cover (2024)	South Cover (2025)	Reference Area (2023)
Perennial Shrubs			
White bursage	0.15 S	0.05, 0.10 T; 0.15 Total	0.09
Fourwing saltbush	1.72 S	1.29	0.00
Shadscale saltbush	0.34 S	0.24	0.17, 0.01 S; 0.18 Total
Cattle saltbush	12.71 S	9.03	0.00
Nevada jointfir	4.73 S	4.09	0.06
Winterfat	0.07 S	0.03	0.02
Creosote bush	0.46 S	0.32, 0.04 T; 0.36 Total	0.03
Littleleaf ratany (not seeded)	0.00	0.00	0.31
Spiny hopsage (Not seeded)	0.00	0.00	0.01
Water jacket (not seeded)	0.00	0.00	0.02
TOTAL	**20.18 S**	**15.05, .14 T; 15.19 Total**	**0.71, 0.01 S; 0.72 Total**
Perennial Grasses			
Indian ricegrass	0.27 S	0.06	0.07, 0.26 S; 0.33 Total
Squirreltail	1.87 S	0.07	0.00
TOTAL	**2.14 S**	**0.13**	**0.07, 0.26 S; 0.33 Total**
Perennial Forbs			
Desert marigold	1.59 S	0.54	0.00
Palmer's penstemon	0.31 S	0.03	0.00
Desert globemallow	0.05 S	0.03	0.00
Astrag alus species	0.00	0.00	0.08
TOTAL	**1.95 S**	**0.60**	**0.08**
TOTAL PERENNIALS	**24.27 S**	**15.78, 0.14 T; 15.92 Total**	**0.86, 0.27 S; 1.13 Total**
Annual Grasses			
Arabian schismus	0.61	1.01	14.88
Cheatgrass	0.16	0.00	2.04
Red brome	0.05	0.01	1.17
Foxtail barley	0.00	0.00	0.00
Sixweeks fescue	0.00	0.00	2.21
TOTAL	**0.83**	**1.02**	**20.30**
Annual Forbs			
Saltlover	3.76	22.48	0.00
Russian thistle	4.70	0.20	0.00
Others	0.07	0.00	30.71
TOTAL	**8.53**	**22.68**	**30.71**
TOTAL ANNUALS	**9.33**	**23.70**	**51.01**

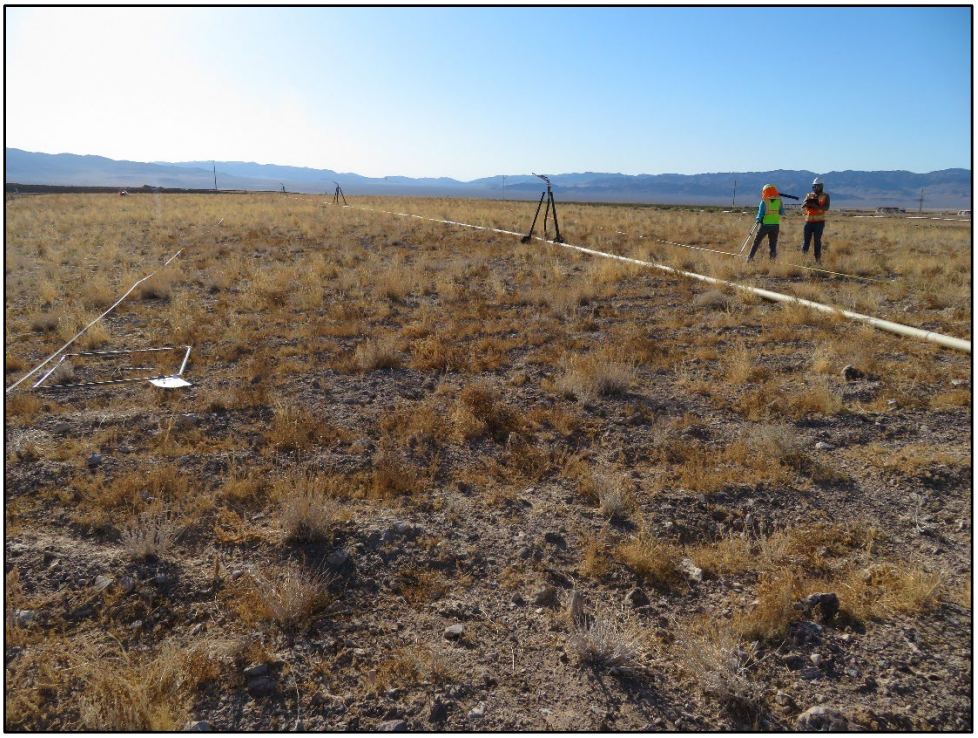

Figure 7-11. Plant density and cover sampling, western portion of the North North Cover.

(Photo taken April 22, 2025, by D.B. Hall)



Figure 7-12. Plant density and cover sampling, eastern portion of the North North Cover. (Green shrubs are cattle saltbush and fourwing saltbush)

(Photo taken April 22, 2025, by D.B. Hall)

Table 7-8. Plant density (plants/m^2) by species and lifeform on North North Cover (2023-2025) compared to the Area 5 RWMC Reference Area in 2023 (S = seedling, Total = mature plants and seedlings combined).

Lifeform/Species	North North Cover (2023)	North North Cover (2024)	North North Cover (2025)	Reference Area (2023)
Perennial Shrubs				
White bursage	0.43 S	0.85, 0.41 S; Total 1.26	0.84	0.09
Fourwing saltbush	0.23 S	0.19	0.12	0.00
Shadscale saltbush	0.00	0.01	0.00	0.17, 0.01 S; 0.18 Total
Cattle saltbush	1.45 S	0.96	0.93	0.00
Nevada jointfir	6.07 S	3.13, 0.01 S; 3.14 Total	0.38	0.06
Winterfat	0.03 S	0.04	0.00	0.02
Creosote bush	0.00	0.41 S; Total 0.41	0.03	0.03
Littleleaf ratany (not seeded)	0.00	0.00	0.00	0.31
Spiny hopsage (not seeded)	0.00	0.00	0.00	0.01
Water jacket (not seeded)	0.00	0.00	0.00	0.02
TOTAL	**8.21 S**	**5.18, 0.83 S; 6.01 Total**	**2.30**	**0.71, 0.01 S; 0.72 Total**
Perennial Grasses				
Indian ricegrass	11.13 S	4.22, 0.06 S; Total 4.280	0.06	0.07, 0.26 S; 0.33 Total
Squirreltail	0.55 S	0.06	0.00	0.00
TOTAL	**11.68 S**	**4.28, 0.06 S; 4.34 Total**	**0.06**	**0.07, 0.26 S; 0.33 Total**
Perennial Forbs				
Desert marigold	0.90 S	1.07, 0.02 S; Total 1.09	0.02	0.00
Palmer's penstemon	0.36 S	0.07	0.00	0.00
Desert globemallow	0.01 S	0.02, 0.01 S; Total 0.03	0.00	0.00
Astragalus spp.	0.00	0.00	0.00	0.08
TOTAL	**1.27 S**	**1.16, 0.03 S; 1.19 Total**	**0.02**	**0.08**
TOTAL PERENNIALS	**21.16 S**	**10.62, 0.92 S; 11.54 Total**	**2.38**	**0.86, 0.27 S; 1.13 Total**
Annual Grasses				
Arabian schismus	0.00	3.12	0.00	14.88
Cheatgrass	0.00	0.00	0.00	2.04
Red brome	0.00	0.00	0.00	1.17
Sixweeks fescue	0.00	0.00	0.00	2.21
TOTAL	**0.00**	**3.12**	**0.00**	**20.30**
Annual Forbs				
Saltlover	1.83	68.00	0.00	0.00
Russian thistle	0.21	20.05	0.00	0.00
Others	0.00	0.00	0.00	30.71
TOTAL	**2.04**	**88.05**	**0.00**	**30.71**
TOTAL ANNUALS	**2.04**	**91.17**	**0.00**	**51.01**

7.4 Cells 8/16 Cover

This closure cover (3.0 ha) was revegetated during spring 2025 which included site preparation, seeding, hydromulching, and irrigation. Seedling density was measured to assess success and compared to the Area 5 RWMC Reference Area. This cover was scheduled to be revegetated in spring 2024 but was delayed a year due to engineering design issues that required a lot of earth work to meet engineering specifications. Because of this, most of the site was scraped off with a road grader and it was decided not to add soil to bury the weed seedbank. Saltlover germinated and grew during the summer so the site was sprayed with Roundup® herbicide on September 11, 2024, at a rate of 22 ounces per acre (oz/ac) and 26.7 gallons of water per acre (gal/ac) in an attempt to kill the saltlover before it set seed. Herbicide was applied with a truck mounted spray bar (Figure 7-13), and the vehicle traveled at a rate of 7-10 miles per hour to adequately cover the site at the appropriate herbicide rate. The herbicide had limited effect and some saltlover still produced seed.

Table 7-9. Percent cover in 2024 and 2025 by species and category on North North Cover compared to the Area 5 RWMC Reference Area.

Category/Species	North North Cover (2024)	North North Cover (2025)	Reference Area (2023)
Perennial Shrubs			
White bursage	1.2	0.4	0.1
Fourwing saltbush	1.0	1.0	0.0
Shadscale saltbush	0.0	0.2	2.4
Cattle saltbush	3.0	1.6	0.0
Nevada jointfir	1.8	0.4	1.1
Winterfat	0.0	0.0	0.1
Creosote bush	0.2	0.0	2.3
Littleleaf ratany (Not seeded)	0.0	0.0	3.7
Water jacket (Not seeded)	0.0	0.0	0.9
Beaked spiny polygala (Not seeded)	0.0	0.0	0.1
TOTAL	**7.2**	**3.6**	**10.7**
Perennial Grasses			
Indian ricegrass	10.2	0.4	0.2
TOTAL	**10.2**	**0.4**	**0.2**
Perennial Forbs			
Desert marigold	3.8	0.0	0.0
Palmer's penstemon	0.4	0.0	0.0
TOTAL	**4.2**	**0.0**	**0.0**
TOTAL PERENNIALS	**21.6**	**4.0**	**10.9**
Annual Grasses			
Arabian schismus	0.0	0.0	1.4
Cheatgrass	0.0	0.0	0.4
Red brome	0.0	0.0	0.2
TOTAL	**0.0**	**0.0**	**2.0**
Annual Forbs			
Saltlover	6.4	0.0	0.0
Russian thistle	5.0	0.0	0.0
Other annual forbs	0.0	0.0	2.5
TOTAL	**11.4**	**0.0**	**2.5**
TOTAL ANNUALS	**11.4**	**0.0**	**4.5**
TOTAL VEGETATIVE COVER	**33.0**	**4.0**	**15.4**
Rock (>25 cm)	0.0	0.2	0.0
Cobble (8-25 cm)	0.6	1.6	0.0
Gravel (0.5-8 cm)	37.6	42.8	61.6
Bare ground	4.6	3.0	15.3
Straw mulch	10.6	5.2	0.0
Litter	13.6	43.2	7.7
TOTAL ABIOTIC	**67.0**	**96.0**	**84.6**



Figure 7-13. Spraying Roundup® herbicide to control saltlover, Cells 8/16.

(Photo by D.B. Hall, September 11, 2024)

In January 2025, the soil was ripped perpendicular to the predominant slope to a depth of approximately 30–45 cm to alleviate soil compaction. Additionally, a rabbit-proof fence was erected around the closure cover to prevent herbivory, especially on young seedlings. The cover was seeded with a native seed mix comprised of seven shrub, two grass, and three forb species at a rate of 30 lbs of PLS/ac (Table 7-10). The seed was ordered during fall 2023 in anticipation of seeding in February 2024, and the seed was stored in a warehouse in Mercury until February 2025. In January, the creosote bush and white bursage seed was rinsed for a 24-hour period, allowed to dry, mixed together with the desert marigold and winterfat seed, and stored in bags. The winterfat seed was hand collected on the NNSS in Jackass Flats (Area 25) during May 2023. Seed was broadcast seeded onto the ground using a drill seeder calibrated to apply the specified rate of seed. A custom-built chain harrow was dragged behind the seeder to cover the seed to an appropriate depth. Hand seeding was also performed because of calibration and debris in the seed mix that did not allow the seeder to put out as much seed as necessary. Following seeding, a wood mulch plus soil binder product (Profile Promatrix™) was applied over the western half of the cover at a rate of 2,240 kg/ha for the purposes of soil moisture retention, erosion control, and addition of organic matter to the soil. The eastern half of the cover was not mulched to test the effectiveness of mulch on seedling density (Figure 7-14). An irrigation system consisting of one wheel line was installed and supplemental irrigation was applied for seedling germination and plant establishment (Table 7-11, Figure 7-14). Mesh seedbags were filled with small amounts of seed and buried under a shallow layer of soil and mulch prior to irrigation. Bags were retrieved on April 15 and 29 and the number of germinated seeds by species was counted. Ungerminated seeds were placed in petri dishes and checked every couple of days for nine days. Germinated seeds by species were counted to verify the viability of the seed. Based on the results, it was determined that the seed was viable.

Table 7-10. Seed mix used to revegetate Cells 8/16 Cover including species, number of pure live seeds per square meter, and number of pounds of pure live seed per acre.

Lifeform	Common Name	Species (Variety)	Number of pure live seeds/m2	Pounds of pure live seed/acre
Shrub	White bursage	*Ambrosia dumosa*	80	3.8
Shrub	Fourwing saltbush	*Atriplex canescens*	44	3.2
Shrub	Shadscale saltbush	*Atriplex confertifolia*	77	4.8
Shrub	Cattle saltbush	*Atriplex polycarpa*	99	0.5
Shrub	Nevada jointfir	*Ephedra nevadensis*	39	8.0
Shrub	Winterfat	*Krascheninnikovia lanata*	17	0.6
Shrub	Creosote bush	*Larrea tridentata*	99	5.0
Grass	Indian ricegrass	*Achnatherum hymenoides*	80	2.0
Grass	Squirreltail	*Elymus elymoides (Toe Jam)*	47	1.0
Forb	Desert marigold	*Baileya multiradiata*	79	0.3
Forb	Palmer penstemon	*Penstemon palmeri (Cedar)*	45	0.3
Forb	Desert globemallow	*Sphaeralcea ambigua*	62	0.5
		TOTAL	768	30.0

Table 7-11. Total amount of irrigation applied and natural precipitation received during select months at Cells 8/16 Cover in 2025 (numbers in parentheses represent daily increments of irrigation applied).

Month	Irrigation (mm)	Natural Precipitation (mm)
March	29.0 (4.8)	18.5
April	47.8 (6.4)	0.0
June	47.8	0.0
August	47.8	1.5
Total	**172.4**	**20.0**

Seedling density was measured on June 3, 2025, on nine, 100-m long transects (Figure 7-15). Due to high numbers, saltlover density was counted in the upper right quadrant (0.25 m^2) and then multiplied by four to get number of plants/m^2. Only live plants or current year's annual plants were recorded. Seedling density was 1.90 seedlings/m^2 compared to 1.04 plants/m^2 in the reference area (Table 7-12). Saltlover density was high at 50.22 plants/m^2. Seedlings were checked opportunistically through the summer and by September very few survived even with the additional irrigation in June and August. The high densities and competition from saltlover were likely the reasons for low seedling densities and poor survival. Comparing seedling density in mulched versus not mulched areas revealed an apparent benefit of mulch on seedling density (3.11 seedlings/m^2 versus 1.13 seedlings/m^2). Due to the poor seedling

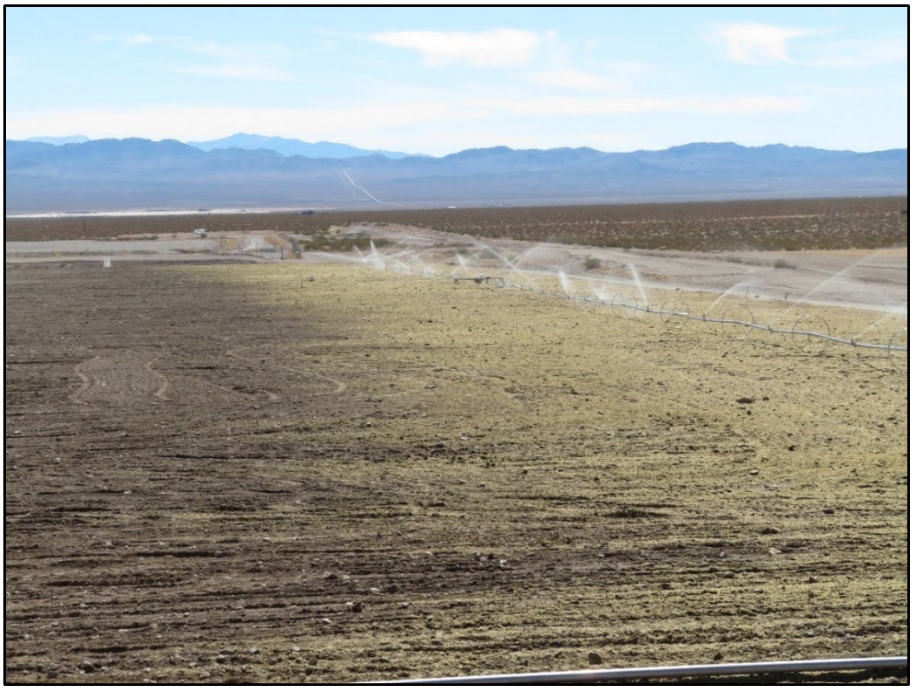

Figure 7-14. Irrigating Cells 8/16 Cover. Mulched area on the right, unmulched area on the left.

(Photo by D.B. Hall, March 4, 2025)

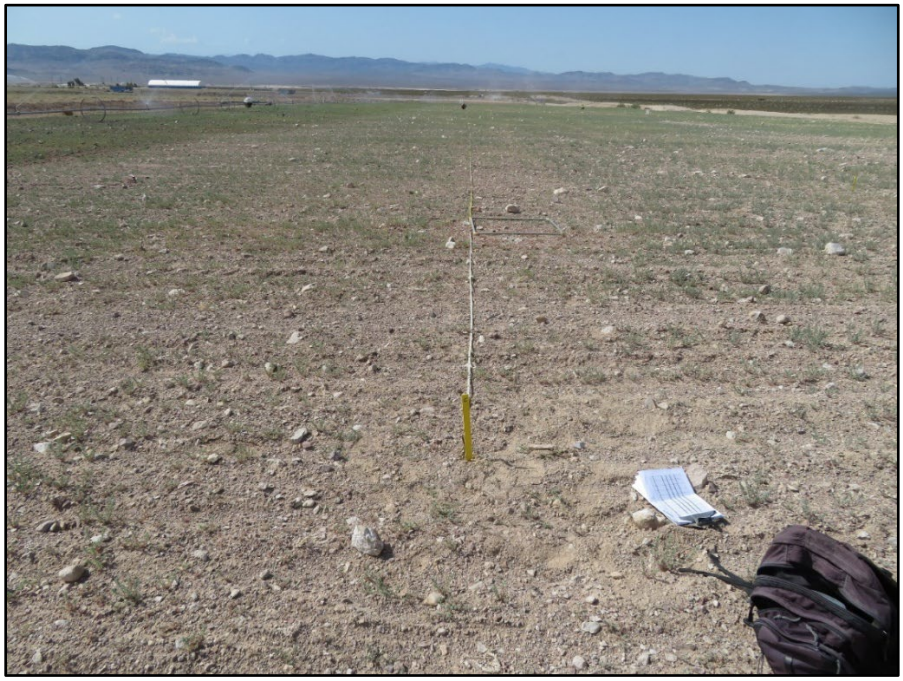

Figure 7-15. Sampling transect on Cells 8/16 Cover (green plants are saltlover).

(Photo by D.B. Hall, June 3, 2025)

Table 7-12. Seedling density (seedlings/m^2) by species and lifeform on Cells 8/16 Cover compared to the Area 5 RWMC Reference Area (S = seedling, Total = mature plants and seedlings combined).

Lifeform/Species	Cells 8/16 (2025)	Reference Area (2023)
Perennial Shrubs		
White bursage	0.02 S	0.09
Fourwing saltbush	0.17 S	0.00
Shadscale saltbush	0.00	0.17, 0.01 S; 0.18 Total
Cattle saltbush	0.65 S	0.00
Nevada jointfir	0.62 S	0.06
Cheesebush	0.00	0.00
Winterfat	0.1 S	0.02
Creosote bush	0.01 S	0.03
Littleleaf ratany (not seeded)	0.00	0.31
Spiny hopsage (not seeded)	0.00	0.01
Water jacket (not seeded)	0.00	0.02
TOTAL	**1.57**	**0.71, 0.01 S; 0.72 Total**
Perennial Grasses		
Indian ricegrass	0.33 S	0.07, 0.26 S; 0.33 Total
Squirreltail	0.00	0.00
TOTAL	**0.33**	**0.07, 0.26 S; 0.33 Total**
Perennial Forbs		
Desert marigold	0.00	0.00
Palmer's penstemon	0.00	0.00
Desert globemallow	0.00	0.00
Astragalus spp.	0.00	0.08
TOTAL	**0.00**	**0.08**
TOTAL PERENNIALS	**1.90**	**0.86, 0.27 S; 1.13 Total**
Annual Grasses		
Arabian schismus	0.20	14.88
Cheatgrass	0.01	2.04
Red brome	0.04	1.17
Sixweeks fescue	0.00	2.21
TOTAL	**0.25**	**20.30**
Annual Forbs		
Saltlover	50.22	0.00
Russian thistle	0.86	0.00
Others	0.01	30.71
TOTAL	**51.09**	**30.71**
TOTAL ANNUALS	**51.34**	**51.01**

survival and high saltlover densities, it was decided to remediate this site and revegetate it in a few years. In December, the site was bladed to remove the existing saltlover plants and then Rejuvra, a pre-emergent herbicide that has been proven to control saltlover (Hall and Perry 2024), was applied at a rate of 5 oz/ac. The site will be monitored over the next two to three years and reseeded in spring of 2028 or 2029. The lesson learned from this seeding failure shows the value of adding additional soil to bury the weed seedbank before seeding. Existing closure covers that have accumulated weeds also have a voluminous weed seedbank that when disturbed will germinate in large numbers and outcompete perennial seedlings growing from seeding efforts.

7.5 Cell 21 Cover

This closure cover (2.8 ha) was seeded during spring 2023 and transplants planted in spring 2024. Plant density was measured in June 2023 along eight, permanent, 100-m long transects. Numerous creosote bush and white bursage seedlings germinated after summer rains in 2023 alongside good plant densities from seeding. Nevertheless, it was decided to plant white bursage and creosote bush transplants on this cover to increase plant density and cover. Plant density and percent cover were measured in June 2024 and April 2025 (Figure 7-16) along the same transects as in 2023 and compared to the Area 5 RWMC Reference Area. Density and cover results are found in Tables 7-13 and 7-14, respectively. Overall perennial plant density decreased by more than half from 2024 to 2025 but is still much higher than in the reference area (11.27 versus 1.04 plants/m^2). Creosote bush and white bursage densities remain high. No annuals were detected.

Percent perennial plant cover on the cover was just more than half the cover in the reference area (5.2% versus 9.9%). Nevada jointfir and cattle saltbush comprised most of the perennial plant cover, and no annuals were detected.



Figure 7-16. Sampling transect at Cell 21 Cover.

(Photo by D.B. Hall, April 21, 2025)

Table 7-13. Plant density (plants/m^2) by species and lifeform on Cell 21 Cover compared to the Area 5 RWMC Reference Area (S = seedling, T = transplant, Total = mature plants, seedlings, and transplants combined).

Lifeform/Species	Cell 21 (2023)	Cell 21 (2024)	Cell 21 (2025)	Reference Area (2023)
Perennial Shrubs				
White bursage	0.36 S	0.89, 2.88 S, 0.03 T; 3.80 Total	2.29	0.09
Fourwing saltbush	0.18 S	0.19, 0.12 S; 0.31 Total	0.21	0.00
Shadscale saltbush	0.09 S	0.04	0.05	0.17, 0.01 S; 0.18 Total
Cattle saltbush	0.70 S	0.71, 0.02 S; 0.73 Total	0.72	0.00
Nevada jointfir	7.81 S	6.84, 0.13 S; 6.97 Total	5.82	0.06
Winterfat	0.05 S	0.03, 0.01 S; 0.04 Total	0.00	0.02
Creosote bush	0.03 S	0.13, 6.17 S, 0.06 T; 6.36 Total	2.03, 0.03 T; 2.06 Total	0.03
Littleleaf ratany (not seeded)	0.00	0.00	0.00	0.31
Spiny hopsage (not seeded)	0.00	0.00	0.00	0.01
Water jacket (not seeded)	0.00	0.00	0.00	0.02
TOTAL	**9.22 S**	**8.83, 9.33 S, 0.09 T; 18.22 Total**	**11.12, 0.03 T; 11.15 Total**	**0.71, 0.01 S; 0.72 Total**
Perennial Grasses				
Indian ricegrass	8.53 S	2.51, 1.21 S; 3.72 Total	0.09	0.07, 0.26 S; 0.33 Total
Squirreltail	0.11 S	0.01	0.00	0.00
TOTAL	**8.64 S**	**2.52, 1.21 S; 3.73 Total**	**0.09**	**0.07, 0.26 S; 0.33 Total**
Perennial Forbs				
Desert marigold	1.19 S	1.00, 0.03 S; 1.03 Total	0.030	0.00
Palmer's penstemon	0.02 S	0.01, 0.01 S; 0.02 Total	0.000	0.00
Desert globemallow	0.01 S	0.03, 0.03 S; 0.06 Total	0.000	0.00
Astragalus spp.	0.00	0.00	0.00	0.08
TOTAL	**1.22 S**	**1.04, 0.07 S; 1.11 Total**	**0.030**	**0.08**
TOTAL PERENNIALS	**19.08 S**	**12.39, 10.61 S, 0.09 T; 23.09 Total**	**11.24, 0.03 T; 11.27 Total**	**0.86, 0.27 S; 1.13 Total**
Annual Grasses				
Arabian schismus	0.00	2.85	0.00	14.88
Cheatgrass	0.00	0.01	0.00	2.04
Red brome	0.00	0.01	0.00	1.17
Sixweeks fescue	0.00	0.00	0.00	2.21
TOTAL	**0.00**	**2.86**	**0.00**	**20.30**
Annual Forbs				
Saltlover	0.30	121.58	0.00	0.00
Russian thistle	0.04	20.46	0.00	0.00
Others	0.01	0.25	0.00	30.70
TOTAL	**0.35**	**142.29**	**0.00**	**30.71**
TOTAL ANNUALS	**0.35**	**145.15**	**0.00**	**0.00**

In March 2024, 2,077 gallon-size transplants (1,044 creosote bush, 1,033 white bursage) were planted at Cell 21. The site was irrigated with 19.1 mm on April 30 and May 1 to increase transplant survival. Short-term transplant survival was evaluated on April 30. Plants were counted as either dead or alive and a vigor rating (see 7.3.2 South Cover) was assigned. Creosote bush and white bursage survival was 85% (170/200) and 70% (116/166), respectively, and the average plant vigor was 1.6 and 1.5, respectively. Transplant survival was measured again in April 2025 and creosote bush and white bursage survival was 19% (14/72) and 16% (31/191), respectively, while average plant vigor was 1.1 for both species. A lot fewer marked creosote bush plants were found in 2025, and it was observed that red stake chasers fade to white within one year.

Table 7-14. Percent plant cover by species and category on Cell 21 Cover compared to the Area 5 RWMC Reference Area (S = seedling, Total = mature plants, seedlings, and transplants combined).

Category/Species	Cell 21 (2024)	Cell 21 (2025)	Reference Area (2023)
Perennial Shrubs			
White bursage	1.2; 0.3 S; 1.5 Total	0.3	0.1
Fourwing saltbush	0.4	0.1	0.0
Shadscale saltbush	0.0	0.0	2.4
Cattle saltbush	0.5	1.0	0.0
Nevada jointfir	5.3	3.4	1.1
Winterfat	0.0	0.0	0.1
Creosote bush	0.9 S	0.4	2.3
Littleleaf ratany (Not seeded)	0.0	0.0	3.7
Water jacket (Not seeded)	0.0	0.0	0.9
Beaked spiny polygala (Not seeded)	0.0	0.0	0.1
TOTAL	**7.4; 1.2 S; 8.6 Total**	**5.2**	**10.7**
Perennial Grasses			
Indian ricegrass	2.3	0.0	0.2
Squirreltail	0.1	0.0	0.0
TOTAL	**2.4**	**0.0**	**0.2**
Perennial Forbs			
Desert marigold	1.8	0.0	0.0
TOTAL	**1.8**	**0.0**	**0.0**
TOTAL PERENNIALS	**11.6; 1.2 S; 12.8 Total**	**5.2**	**10.9**
Annual Grasses			
Arabian schismus	0.0	0.0	1.4
Cheatgrass	0.0	0.0	0.4
Red brome	0.0	0.0	0.2
TOTAL	**0.0**	**0.0**	**2.0**
Annual Forbs			
Saltlover	6.3	0.0	0.0
Russian thistle	1.5	0.0	0.0
Other annual forbs	0.4	0.0	2.5
TOTAL ANNUALS	**8.2**	**0.0**	**4.5**
TOTAL VEGETATIVE COVER	**21.0**	**5.2**	**15.4**
Rock (>25 cm)	0.1	0.0	0.0
Cobble (8-25 cm)	1.3	1.8	0.0
Gravel (0.5-8 cm)	34.9	50.5	61.6
Bare ground	15.1	8.0	15.3
Straw mulch	24.4	9.5	0.0
Litter	3.5	25.1	7.7
TOTAL ABIOTIC	**79.3**	**94.9**	**84.6**

7.6 Cells 19/20 Cover

This cover was seeded in spring 2022 and transplants planted in spring 2023. In March 2023, approximately 2,715 creosote bush and 2,453 white bursage plants were transplanted. Revegetation activities at this site in 2025 included monitoring plant density and cover and evaluating transplant survival.

Plant density was monitored in late May/early June in 2022, 2023, and 2024 and April 2025 (Figure 7-17) to evaluate revegetation success. Percent plant cover was also measured in 2024 and 2025. Thirteen, 100-m long transects were established uniformly across the cover cap and ten of these were randomly selected to be sampled and compared to the Area 5 RWMC Reference Area. Sampling also occurred along a 100-m long transect that was not irrigated to compare with irrigated portions of the cover. Plant density and percent cover results are found in Tables 7-15 and 7-16, respectively.

Overall, perennial plant density (plants from seed and transplants) declined by slightly more than half compared to 2024 but is still more than double that found in the reference area with good densities of creosote bush and white bursage. No annuals were detected due to the dry conditions. Perennial plant density in the non-irrigated area was 1.05 plants/m^2 compared to 2.45 plants/m^2 in the irrigated area.

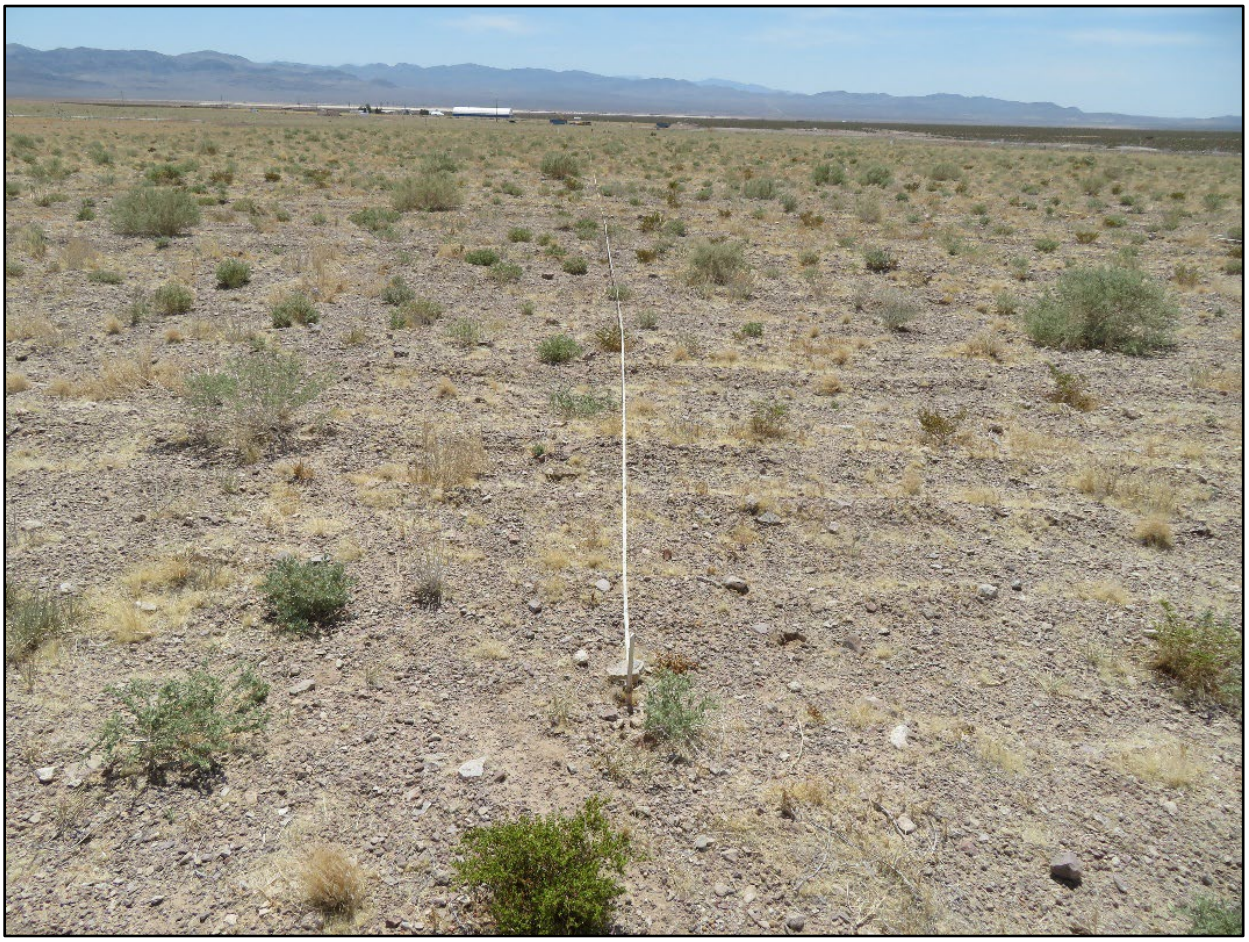

Figure 7-17. Sampling transect at Cells 19/20 Cover.

(Photo by D.B. Hall, April 24, 2025)

Table 7-15. Plant density (plants/m^2) by species and lifeform on Cells 19/20 Cover compared to the Area 5 RWMC Reference Area (S = seedling, T = transplant, Total = mature plants, seedlings, and transplants combined).

Lifeform/Species	19/20 Closure Cover (2022)	19/20 Closure Cover 2023	19/20 Closure Cover 2024	19/20 Closure Cover 2025	Reference Area 2023
Perennial Shrubs					
White bursage	<0.01 S	0.01 S, 0.05 T; 0.06 Total	0.01, 0.05 S, 0.04 T; 0.10 Total	0.04, 0.05 T; 0.09 Total	0.09
Fourwing saltbush	<0.01 S	0.23, 0.03 S; 0.26 Total	0.22, 0.01 S; 0.23 Total	0.24	0.00
Shadscale saltbush	0.00	0.40 S; 0.40 Total	0.48	0.45	0.17, 0.01 S; 0.18 Total
Cattle saltbush	<0.01 S	0.04, 0.02 S; 0.06 Total	0.05	0.05	0.00
Nevada jointfir	0.76 S	0.89, 1.53 S; 2.42 Total	2.42	1.48	0.06
Winterfat	0.01 S	0.05	0.01	0.00	0.02
Creosote bush	0.01 S	0.04S, 0.06T; 0.10 Total	0.02, 0.02 S, 0.11 T; 0.15 Total	0.02, 0.08 T; 0.10 Total	0.03
Littleleaf ratany (not seeded)	0.00	0.00	0.00	0.00	0.31
Spiny hopsage (not seeded)	0.00	0.00	0.00	0.00	0.01
Water jacket (not seeded)	0.00	0.00	0.00	0.00	0.02
TOTAL	**0.79 S**	**1.21, 2.03 S, 0.11 T; 3.35 Total**	**3.21, 0.08 S, 0.15 T; 3.44 Total**	**2.28, 0.13 T; 2.41 Total**	**0.71, 0.01; 0.72 Total**
Perennial Grasses					
Indian ricegrass	0.94 S	0.58, 4.31 S; 4.89 Total	0.84, 0.01 S; 0.85 Total	0.04	0.07, 0.26 S; 0.33 Total
Squirreltail	4.44 S	1.07, 0.45 S; 1.52 Total	0.29	0.00	0.00
TOTAL	**5.38 S**	**1.65, 4.76 S; 6.41 Total**	**1.13, 0.01 S; 1.14 Total**	**0.04**	**0.07, 0.26 S; 0.33 Total**
Perennial Forbs					
Desert marigold	0.00	0.01, 0.03 S; 0.04 Total	0.04	0.00	0.00
Palmer's penstemon	0.00	0.01, 0.21 S; 0.22 Total	0.05	0.00	0.00
Desert globemallow	0.00	0.01	0.05, 0.02 S; 0.07 Total	0.00	0.00
Astragalus spp.	0.00	0.01	0.00	0.00	0.08
TOTAL	**0.00**	**0.04, 0.24 S; 0.28 Total**	**0.14, 0.02 S; 0.16 Total**	**0.00**	**0.08**
TOTAL PERENNIALS	**6.17 S**	**2.90, 7.03 S, 0.11 T; 10.04 Total**	**4.48, 0.11 S, 0.15 T; 4.74 Total**	**2.32, 0.13 T; 2.45 Total**	**0.86, 0.27 S; 1.13 Total**
Annual Grasses					
Arabian schismus	1.63	19.68	175.34	0.00	14.88
Cheatgrass	<0.01	0.03	0.01	0.00	2.04
Red brome	<0.01	0.02	0.00	0.00	1.17
Unknown brome	<0.01	0.00	0.00	0.00	0.00
Sixweeks fescue	0.00	0.58	0.00	0.00	2.21
Common wheat	0.01	0.00	0.00	0.00	0.00
TOTAL	**1.65**	**20.31**	**175.35**	**0.00**	**20.30**
Annual Forbs					
Saltlover	<0.01	2.74	70.30	0.00	0.00
Russian thistle	<0.01	0.14	2.65	0.00	0.00
Roundleaf oxytheca	0.00	0.00	0.00	0.00	0.68
Others	0.00	1.08	0.02	0.00	30.03
TOTAL	**0.01**	**3.96**	**72.97**	**0.00**	**30.70**
TOTAL ANNUALS	**1.66**	**24.26**	**248.32**	**0.00**	**51.00**

Table 7-16. Percent plant cover by species and category on Cells 19/20 Cover compared to the Area 5 RWMC Reference Area.

Category/Species	Cell 21 (2024)	Cell 21 (2025)	Reference Area (2023)
Perennial Shrubs			
White bursage	0.4	0.4	0.1
Fourwing saltbush	1.3	0.6	0.0
Shadscale saltbush	1.2	1.6	2.4
Cattle saltbush	0.9	0.8	0.0
Nevada jointfir	2.4	2.4	1.1
Winterfat	0.0	0.0	0.1
Creosote bush	0.6	0.4	2.3
Littleleaf ratany (Not seeded)	0.0	0.0	3.7
Water jacket (Not seeded)	0.0	0.0	0.9
Beaked spiny polygala (Not seeded)	0.0	0.0	0.1
TOTAL	**6.8**	**6.2**	**10.7**
Perennial Grasses			
Indian ricegrass	0.9	0.1	0.2
Squirreltail	0.4	0.0	0.0
TOTAL	**1.3**	**0.1**	**0.2**
Perennial Forbs			
Desert marigold	0.1	0.0	0.0
Palmer's penstemon	0.2	0.0	0.0
Freckled milkvetch	0.1	0.0	0.0
TOTAL	**0.4**	**0.0**	**0.0**
TOTAL PERENNIALS	**8.5**	**6.3**	**10.9**
Annuals			
Arabian schismus	21.9	0.0	1.4
Cheatgrass	0.0	0.0	0.4
Red brome	0.0	0.0	0.2
Saltlover	2.9	0.0	0.0
Russian thistle	0.3	0.0	0.0
Other annual forbs	0.0	0.0	2.5
TOTAL ANNUALS	**25.1**	**0.0**	**4.5**
TOTAL VEGETATIVE COVER	**33.6**	**6.3**	**15.4**
Rock (>25 cm)	0.0	0.1	0.0
Cobble (8-25 cm)	0.5	0.3	0.0
Gravel (0.5-8 cm)	37.0	41.7	61.6
Bare ground	11.9	13.9	15.3
Straw mulch	0.0	NA	0.0
Litter	17.0	37.7	7.7
TOTAL ABIOTIC	**66.4**	**93.7**	**84.6**

Percent perennial plant cover is 64% of cover in the reference area and no annual plants were detected. Percent perennial plant cover in the non-irrigated area was only 2.0, well below cover in the irrigated area (6.3%) and the reference area (9.9%) whereas plant density was similar in the irrigated and non-irrigated area. Irrigation is highly recommended to increase species richness and perennial plant cover.

Transplant survival was monitored in April 2025. Transplants were counted as either dead or alive and a vigor rating (See 7.3.2 South Cover) was assigned. Overall transplant survival was high, 78.8% and 76.0% for creosote bush and white bursage, respectively. Average plant vigor was 1.9 for creosote bush and 1.8 for white bursage.

7.7 East and West Cover (CAU 577)

Revegetation of the East (5.2 ha) and West (7.0 ha) Covers was accomplished during the spring of 2021. Activities during 2025 focused on sampling plant density and percent cover on these covers during late April. Plant density and percent plant cover was monitored on ten, randomly selected transects on East Cover, seven on west-west portion of West Cover, and six on west-east portion of West Cover and compared to the Area 5 RWMC Reference Area. This is the fifth year of sampling including the year of revegetation; therefore, it is time to evaluate revegetation success. We define revegetation success as perennial plant density and percent perennial plant cover on the revegetated site is at least 60% of perennial plant density and percent perennial plant cover as the reference area. If success criteria are met, annual sampling will shift to a qualitative approach similar to U-3ax/bl and quantitative sampling will be conducted every fifth year or so. If success criteria are not met, remedial actions will be considered such as adding more transplants or reseeding.

Perennial plant density on the East Cover (Table 7-17, Figure 7-18) is 4.2 plants/m^2 which is four times higher than perennial plant density on the reference area. Five shrubs and no perennial grasses or forbs were found with cattle saltbush being the most abundant. Indian ricegrass, squirreltail and desert marigold had high densities the first year but did not persist. Commercially available cultivars (i.e., varieties) of Indian ricegrass (Paloma) and squirreltail (Toe Jam) were used which have great viability but do not appear to be adapted to the Area 5 RWMC environs. These results have caused us to try and use native collections of these perennial grasses when available. Long-term persistence of these species will be evaluated. Some seedlings were recorded in the wet years of 2023 and 2024, which was encouraging, especially the creosote bush and white bursage. Of the 1,036 pure live seeds/m^2 planted in 2021, only 4.2 plants/m^2 have become established. Annual forbs were found in much higher densities on the reference area compared to the cover with higher species richness. Fortunately, saltlover was only found in low densities on the cover which could be attributed to the high degree of competition from good perennial plant germination and establishment. High densities of Arabian schismus were recorded most years but not in 2025 which was a dry year, and it does not appear that the high density negatively impacted seeded plant density. Arabian schismus has a very shallow root system, low biomass, and tends to go dormant quickly so it does not deplete soil moisture like other invasives such as bromes (*Bromus* spp.) and saltlover. In addition, roots of the seeded plants occurred deeper in the soil profile than roots of Arabian schismus and thus were not competing for the same soil moisture.

Average percent cover of perennial species on the East Cover (Table 7-18) was nearly double that measured in the reference area (19.0% versus 9.9%) and dominated by cattle saltbush with some fourwing saltbush and a little bit of white bursage and Nevada jointfir. Littleleaf ratany, shadscale saltbush, and creosote bush provided most of the perennial cover in the reference area. No annual plant cover was

Table 7-17. Plant density (plants/m^2) by lifeform and species for the East Cover and the Area 5 RWMC Reference Area (S = seedling, Total = mature plants and seedlings combined).

Lifeform/Species	East Closure Cover (2021)	East Closure Cover (2022)	East Closure Cover (2023)	East Closure Cover (2024)	East Closure Cover (2025)	Reference Area (2023)
Perennial Shrubs						
White bursage	0.32 S	0.16	0.04	0.09, 0.50 S; 0.59 Total	0.12	0.09
Fourwing saltbush	0.71 S	0.62	0.49	0.36	0.24	0.00
Shadscale saltbush	0.02 S	0.01	0.01	0.00	0.00	0.17, 0.01 S; 0.18 Total
Cattle saltbush	4.45 S	4.34	3.68	3.88	3.65	0.00
Nevada jointfir	2.00 S	1.36	0.49, 0.01 S; 0.50 Total	0.40	0.18	0.06
Winterfat	0.14 S	0.06	0.03	0.02	0.01	0.02
Creosote bush	0.01 S	0.01	0.01	0.01, 0.04 S; 0.05 Total	0.00	0.03
Littleleaf ratany (Not seeded)	0.00	0.00	0.00	0.00	0.00	0.31
Water jacket (Not seeded)	0.00	0.00	0.00	0.00	0.00	0.02
Spiny hopsage (Not seeded)	0.00	0.00	0.00	0.00	0.00	0.01
TOTAL	**7.65 S**	**6.56**	**4.75, 0.01 S; 4.76 Total**	**4.76, 0.54 S; 5.30 Total**	**4.20**	**0.71, 0.01 S; 0.72 Total**
Perennial Grasses						
Indian ricegrass	4.32 S	0.13	0.00	0.00	0.00	0.07, 0.26 S; 0.33 Total
Squirreltail	3.14 S	0.00	0.00	0.00	0.00	0.00
TOTAL	**7.46 S**	**0.13**	**0.00**	**0.00**	**0.00**	**0.07, 0.26 S; 0.33 Total**
Perennial Forbs						
Desert marigold	4.01 S	0.59	0.01	0.00	0.00	0.00
Palmer's penstemon	0.00	0.00	0.00	0.00	0.00	0.00
Desert globemallow	0.00	0.00	0.00	0.02, 0.06 S; 0.08 Total	0.00	0.00
Desert pepperweed	0.00	0.00	0.00	0.00	0.00	0.00
Astragalus (Not seeded)	0.00	0.00	0.00	0.00	0.00	0.08
TOTAL	**4.01 S**	**0.59**	**0.01**	**0.08**	**0.00**	**0.08**
TOTAL PERENNIALS	**19.12 S**	**7.28**	**4.76, 0.01 S; 4.77 Total**	**4.78, 0.60 S; 5.38 Total**	**4.20**	**0..86, 0.27 S; 1.13 Total**
Annual Grasses						
Arabian schismus	25.89	139.60	118.92	231.94	0.76	14.88
Cheatgrass	0.59	0.00	1.39	0.38	0.00	2.04
Red brome	0.11	0.00	0.09	0.01	0.00	1.17
Unknown brome	0.00	0.02	0.00	0.00	0.00	0.00
Sixweeks fescue	1.03	0.00	0.18	0.00	0.00	2.21
TOTAL	**27.62**	**139.62**	**120.58**	**232.33**	**0.76**	**20.30**
Annual Forbs						
Saltlover	0.20	0.55	0.86	0.00	0.00	0.00
Others	0.16	0.01	0.25	0.05	0.00	30.71
TOTAL	**0.36**	**0.56**	**1.11**	**0.05**	**0.00**	**30.71**
TOTAL ANNUALS	**27.98**	**140.18**	**121.69**	**232.38**	**0.76**	**51.01**



Figure 7-18. Sampling transect East Cover.

(Photo by D.B. Hall, April 24, 2025)

detected on the cover. Based on density and cover results, the East Cover has been successfully revegetated. Qualitative vegetation assessments will be performed over the next five years.

The West Cover was divided into the west-east and west-west portions due to different germination irrigation amounts applied during March 2021. The west-east and west-west received 50.8 mm and 31.8 mm of irrigation, respectively. Perennial plant density in the west-east portion was higher (2.87 plants/m^2; Figure 7-19) than in the west-west portion (2.31 plants/m^2; Figure 7-20). This has been the case since 2021 (Table 7-19) which is attributed to the increased germination irrigation in 2021. This is two to three times higher than perennial plant density on the reference area. Seven shrubs and no perennial grasses or forbs were found with cattle saltbush being the most abundant. Like the East Cover, Indian ricegrass, squirreltail and desert marigold had high densities the first year but did not persist. Some seedlings were recorded in the wet years of 2023 and 2024, which was encouraging, especially the white bursage and creosote bush. Saltlover and Arabian schismus have been found in high densities in previous years, especially the wet years of 2023 and 2024, but no annual plants were found this year due to the dry conditions. Even with relatively high densities of saltlover and Arabian schismus, perennial plant density is still higher than in the reference area.

Average percent cover of perennial species on the West Closure Cover (Table 7-18) was about 1.8 times higher than that measured in the reference area (17.7% versus 9.9%) and dominated by cattle saltbush with some fourwing saltbush, Nevada jointfir, and white bursage. Littleleaf ratany, shadscale saltbush, and creosote bush provided most of the perennial cover in the reference area.

Table 7-18. Average percent plant cover by species and category for the East and West Covers (CAU 577) and the Area 5 RWMC Reference Area.

	East Cover				West East Cover				West West Cover				Reference Area
Category/Species	2022 Average %Cover	2023 Average %Cover	2024 Average % Cover	2025 Average % Cover	2022 Average %Cover	2023 Average %Cover	2024 Average %Cover	2025 Average % Cover	2022 Average %Cover	2023 Average %Cover	2024 Average %Cover	2025 Average %Cover	2023 Average %Cover
Perennial Shrubs													
White bursage	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.1	0.1
Fourwing saltbush	0.5	1.0	2.9	1.1	0.8	0.7	3.0	1.7	0.8	1.0	2.4	3.4	0.0
Shadscale saltbush	0.0	0.0	0.3	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	2.4
Cattle saltbush	5.5	11.3	17.3	17.7	2.6	9.7	18.7	14.5	3.5	11.0	17.0	14.1	0.0
Nevada jointfir	0.1	0.0	0.0	0.1	0.2	0.5	0.5	0.7	0.5	0.6	1.6	0.9	1.1
Winterfat	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.1
Creosote bush	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
Littleleaf ratany (Not seeded)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.7
Water jacket (Not seeded)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
Beaked spiny polygala (Not seeded)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
TOTAL	**6.1**	**12.3**	**20.6**	**19.0**	**3.7**	**11.0**	**22.3**	**16.8**	**4.9**	**12.6**	**21.0**	**18.6**	**10.7**
Perennial Grasses													
Indian ricegrass	0.0	0.0	0.0	0.0	2.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.2
TOTAL	**0.0**	**0.0**	**0.0**	**0.0**	**2.0**	**0.0**	**0.0**	**0.0**	**0.8**	**0.0**	**0.0**	**0.0**	**0.2**
Perennial Forbs													
Desert marigold	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TOTAL	**0.1**	**0.0**	**0.0**	**0.0**	**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
TOTAL PERENNIALS	**6.2**	**12.3**	**20.6**	**19.0**	**5.8**	**11.0**	**22.3**	**16.8**	**5.7**	**12.6**	**21.0**	**18.6**	**10.9**
Annual Grasses													
Arabian schismus	16.5	10.3	17.4	0.0	8.7	6.0	16.5	0.0	0.2	2.0	6.1	0.0	1.4
Cheatgrass	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4
Red brome	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2
TOTAL	**16.5**	**10.3**	**17.5**	**0.0**	**8.8**	**6.0**	**16.5**	**0.0**	**0.2**	**2.0**	**6.1**	**0.0**	**2.0**
Annual Forbs													
Saltlover	0.1	0.3	0.0	0.0	0.1	1.2	0.0	0.0	0.6	3.1	0.9	0.0	0.0
Russian thistle	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other annual forbs	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5
TOTAL	**0.1**	**0.3**	**0.0**	**0.0**	**0.1**	**1.3**	**0.0**	**0.0**	**0.6**	**3.1**	**0.9**	**0.0**	**2.5**
TOTAL ANNUALS	**16.6**	**10.6**	**17.5**	**0.0**	**8.9**	**7.3**	**16.5**	**0.0**	**0.8**	**5.1**	**7.0**	**0.0**	**4.5**
TOTAL VEGETATIVE COVER	**22.8**	**22.9**	**38.1**	**19.0**	**14.7**	**18.4**	**38.8**	**16.8**	**6.5**	**17.7**	**28.0**	**18.6**	**15.4**
Rock (>25 cm)	0.0	0.1	0.1	0.2	0.0	0.2	0.0	0.2	0.2	0.1	0.0	0.0	0.0
Cobble (8-25 cm)	0.3	0.3	0.9	0.3	0.6	2.2	0.3	0.0	0.2	0.4	0.6	0.0	0.0
Gravel (0.5-8 cm)	31.5	52.2	35.3	54.2	27.9	40.5	47.2	48.2	45.5	44.9	41.3	51.6	61.6
Bare ground	16.5	11.4	14.8	3.5	16.5	17.3	3.8	5.0	14.4	23.0	20.7	6.4	15.3
Straw mulch	19.0	4.2	2.8	0.0	30.6	13.5	1.5	1.0	24.8	8.9	1.7	0.7	0.0
Total Litter	9.9	8.9	8.0	22.8	9.7	8.0	8.3	28.8	8.4	5.0	7.7	22.7	7.7
TOTAL ABIOTIC	**77.2**	**77.1**	**61.9**	**81.0**	**85.3**	**81.7**	**61.2**	**83.2**	**93.5**	**82.3**	**72.0**	**81.4**	**84.6**



Figure 7-19. West-east portion of the West Cover (CAU 577).

(Photo by D.B. Hall, April 14, 2026)



Figure 7-20. West-west portion of the West Cover (CAU 577).

(Photo by D.B. Hall, April 14, 2026)

Table 7-19. Plant density (plants/m^2) by lifeform and species for the West Cover (CAU 577) and the Area 5 RWMC Reference Area (2023) (S = seedling, Total = mature plants and seedlings combined).

Lifeform/Species	West-west Cover (2021)	West-west Cover (2022)	West-west Cover (2023)	West-west Cover (2024)	West-west Cover (2025)	West-east Cover (2021)	West-east Cover (2022)	West-east Cover (2023)	West-east Cover (2024)	West-east Cover (2025)	Reference Area (2023)
Perennial Shrubs											
White bursage	0.08 S	0.06	0.03	0.04, 0.01 S; 0.05 Total	0.01	0.33 S	0.16	0.06	0.07, 0.48 S; 0.55 Total	0.04	0.09
Fourwing saltbush	0.43 S	0.35	0.26, 0.01 S; 0.27 Total	0.26	0.22	0.72 S	0.51	0.40	0.33	0.16	0.00
Shadscale saltbush	0.01 S	0.02	0.01	0.00	0.01	0.03 S	0.01	0.01	0.00	0.00	0.17, 0.01 S; 0.18 Total
Cattle saltbush	1.96 S	1.67	1.43, 0.06 S; 1.49 Total	1.61, 0.07 S; 1.68 Total	1.59	3.20 S	2.70	2.28	2.18	2.01	0.00
Nevada jointfir	2.06 S	1.47	0.89, 0.01 S; 0.90 Total	0.74	0.46	2.24 S	1.68	1.03	0.84	0.66	0.06
Winterfat	0.06 S	0.03	0.03	0.01	0.01	0.10 S	0.03	0.03	0.03	0.00	0.02
Creosote bush	0.02 S	0.02	0.01	0.04 S; 0.04 Total	0.01	0.05 S	0.02	0.01	0.02, 0.03 S; 0.05 Total	0.00	0.03
Littleleaf ratany (Not seeded)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.31
Shockley's goldenhead (Not seeded	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Water jacket (Not seeded)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Spiny hopsage (Not seeded)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01
TOTAL	**4.62 S**	**3.61**	**2.66, 0.08 S; 2.74 Total**	**2.66, 0.12 S; 2.78 Total**	**2.31**	**6.67 S**	**5.11**	**3.82**	**3.47, 0.51 S; 3.98 Total**	**2.87**	**0.71, 0.01 S; 0.72 Total**
Perennial Grasses											
Indian ricegrass	11.17 S	1.36	0.01	0.00	0.00	10.99 S	2.39	0.03	0.02	0.00	0.07, 0.26 S: 0.33 Total
Squirreltail	1.02 S	0.09	0.00	0.00	0.00	3.23 S	0.01	0.00	0.00	0.00	0.00
TOTAL	**12.19 S**	**1.45**	**0.01**	**0.00**	**0.00**	**14.22 S**	**2.40**	**0.03**	**0.02**	**0.00**	**0.07, 0.26 S: 0.33 Total**
Perennial Forbs											
Desert marigold	1.07 S	0.30	0.00	0.00	0.00	3.64 S	0.53	0.03	0.01, 0.02 S; 0.03 Total	0.00	0.00
Palmer's penstemon	0.00	0.00	0.00	0.00	0.00	0.06 S	0.00	0.00	0.00	0.00	0.00
Desert globemallow	0.01 S	0.01	0.00	0.01, 0.01 S; 0.02 Total	0.00	0.03 S	0.02	0.00	0.01, 0.02 S; 0.03 Total	0.00	0.00
Desert pepperweed	0.00	0.00	0.00	0.00	0.00	0.01 S	0.01	0.00	0.00	0.00	0.00
Astragalus (Not seeded)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08
TOTAL	**1.08 S**	**0.31**	**0.00**	**0.02**	**0.00**	**3.74 S**	**0.56**	**0.03**	**0.02, 0.04 S; 0.06 Total**	**0.00**	**0.08**
TOTAL PERENNIALS	**17.89 S**	**5.37**	**2.67, 0.08 S; 2.75 Total**	**2.67, 0.13 S; 2.80 Total**	**2.31**	**24.63 S**	**8.07**	**3.88**	**3.51, 0.55 S; 4.06 Total**	**2.87**	**0.86, 0.27 S; 1.13 Total**
Annual Grasses											
Arabian schismus	2.37	0.26	22.57	99.74	0.00	39.39	0.75	94.57	175.07	0.00	14.88
Cheatgrass	0.06	0.00	0.04	0.02	0.00	0.68	0.19	3.06	1.27	0.00	2.04
Red brome	0.04	0.00	0.01	0.03	0.00	0.23	0.11	0.26	0.25	0.00	1.17
Unknown brome	0.00	0.00	0.00	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00
Sixweeks fescue	0.01	0.00	0.01	0.00	0.00	0.61	0.00	0.12	0.00	0.00	2.21
Common wheat	0.00	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.00	0.00
TOTAL	**2.47**	**0.26**	**22.63**	**99.79**	**0.00**	**40.92**	**1.19**	**98.01**	**176.59**	**0.00**	**20.30**
Annual Forbs											
Saltlover	0.69	10.61	31.86	55.17	0.00	0.61	2.46	4.07	1.49	0.00	0.00
Others	0.17	0.09	0.52	0.10	0.00	0.18	0.07	0.34	0.09	0.00	30.71
TOTAL	**0.86**	**10.70**	**32.38**	**55.27**	**0.00**	**0.79**	**2.53**	**4.41**	**1.58**	**0.00**	**30.71**
TOTAL ANNUALS	**3.33**	**10.96**	**55.01**	**155.06**	**0.00**	**41.71**	**3.72**	**102.42**	**178.17**	**0.00**	**51.01**

Based on plant density and percent plant cover results, the West Cover has been successfully revegetated. Qualitative vegetation assessments will be performed over the next five years.

7.8 Cell 18 Cover

Revegetation of Cell 18 Cover (1.8 ha) began in fall 2020. Activities in 2025 included vegetation sampling to determine transplant survival, plant density, and percent plant cover.

7.8.1 Transplant Survival

Approximately 3,850 plants (1,461 creosote bush, 2,389 white bursage) were transplanted in April 2021. Due to low first-year survival, an additional 4,500 plants (1,200 creosote bush, 3,300 white bursage) were transplanted in April 2022. In March 2024, 2,107 plants (1,054 creosote bush, 1,053 white bursage) were transplanted. Thus, a total of 10,457 transplants (3,715 creosote bush, 6,742 white bursage) have been planted at Cell 18. The area was divided into six separate parcels with various treatments (Figure 7-21). These included North Acre Cap, South Acre Cap, East Cap, North Edge, South Edge, and Southeast Triangle. North Acre Cap and South Acre Cap are one-acre parcels on the north and south side of the cover that were fully irrigated. The North Acre Cap was seeded with locally collected white bursage and creosote bush seed and the South Acre Cap was seeded with commercially purchased white bursage and creosote bush seed to compare seeding success. East Cap is a 0.8-acre parcel on the east edge of the cap and was fully irrigated. North Edge is on the side slope of the closure cover on the north side that was partially irrigated on the southern-third portion of the slope. South Edge is on the side slope of the closure cover on the southern side that was seeded by hand and partially irrigated using a water truck spraying the side slope opportunistically. Southeast Triangle is in the southeastern corner of the site, mostly off the closure cover, that was partially irrigated. North Acre Cap, South Acre Cap, and East Cap are all considered to be on the cover cap while North Edge, South Edge, and Southeast Triangle are off the cap. Transplants were planted in all areas during 2021 but only on the cover cap in 2022 and 2024. Some transplants were marked with stake chasers that were color coded for species and year planted to evaluate survival. After a few years the stake chasers degrade and it is difficult to track some marked plants.

In April/early May 2023, 2024, and 2025, marked transplants were evaluated to determine transplant survival and assess vigor of surviving plants. Plants were counted as either dead or alive and a vigor rating (See 7.3.2 South Cover) was assigned. Percent survival and average vigor rating by species, year planted, and area were calculated (Table 7-20). Due to being drought-deciduous, it was difficult to determine if white bursage was dead or just dormant, whereas creosote bush is evergreen which made it easier to distinguish dead from living plants.

Sampling results in 2023 showed a combined species survival of 25.1% from the 2021 planting efforts including 28.7% and 21.4% survival of creosote bush (1.8 vigor) and white bursage (1.5 vigor); respectively. In 2024, combined species survival was 27.0% including 27.6% and 0.0% survival of creosote bush (1.4 vigor) and white bursage (0.0 vigor), respectively. In 2025, combined species survival was 29.5% including 28.7% and 50.0% survival of creosote bush (1.9 vigor) and white bursage (0.3 vigor), respectively. Percent survival and plant vigor of both species was much higher on the cover cap than off the cover cap in all years because of the different irrigation treatments.

For the plants transplanted in 2022, combined species survival in 2023 was 16.9%: 21.4% for creosote bush (1.9 vigor) and 16.1% for white bursage (1.8 vigor). In 2024, combined species survival was 7.4%: 0.0% for creosote bush (0.0 vigor) and 7.4% for white bursage (2.3 vigor). In 2025, combined species

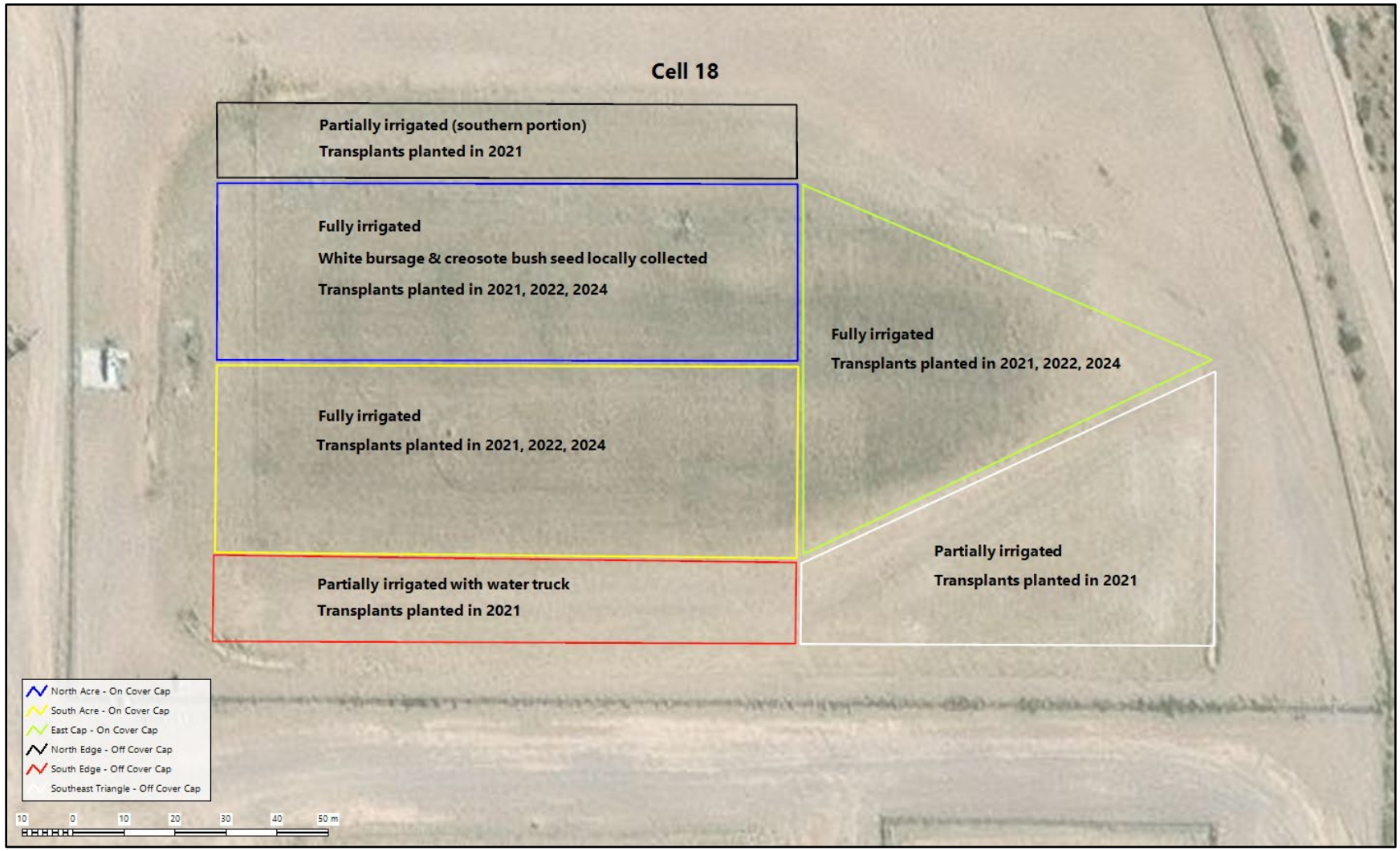

Figure 7-21. Cell 18 Cover and associated treatments. All areas were seeded with the same commercially sourced seed mix, except for North Acre where locally collected white bursage and creosote bush seed was used. Irrigation using a wheel line was applied on the closure cover, with some partial irrigation off the closure cover, and some irrigation using a water truck along the southern edge.

Table 7-20. Results from 2023-2025 transplant survival monitoring including percent survival and average vigor information by area and species at Cell 18 Cover. Blue, green, and peach shaded columns represent data from transplants planted in 2021, 2022, and 2024; respectively. NA = Not applicable because transplants were only planted on the cap area in 2022 and 2024.

Area/Species	2021 Plants % Survival (2023 Data)	2021 Plants % Survival (2024 Data)	2021 Plants % Survival (2025 Data)	2021 Plants Average Vigor (2023 Data)	2021 Plants Average Vigor (2024 Data)	2021 Plants Average Vigor (2025 Data)	2022 Plants % Survival (2023 Data)	2022 Plants % Survival (2024 Data)	2022 Plants % Survival (2025 Data)	2022 Plants Average Vigor (2023 Data)	2022 Plants Average Vigor (2024 Data)	2022 Plants Average Vigor (2025 Data)	2024 Plants % Survival (2024 Data)	2024 Plants Average Vigor (2024 Data)	2024 Plants % Survival (2025 Data)	2024 Plants Average Vigor (2025 Data)
North Acre (Creosote bush)	63.2	44.4	40.0	2.0	1.0	2.1	21.4	0.0	80.0	1.7	0.0	2.0	97.7	1.7	50.0	1.8
North Acre (White bursage)	32.0	0.0	66.7	2.5	0.0	1.5	23.1	11.8	12.7	1.8	2.8	1.8	89.4	1.7	72.7	1.8
South Acre (Creosote bush)	42.9	50.0	42.9	2.0	2.0	2.0	21.3	0.0	66.7	2.0	0.0	2.8	93.6	1.6	64.7	2.1
South Acre (White bursage)	25.0	0.0	0.0	1.7	0.0	0.0	6.1	3.2	2.0	1.7	1.8	2.3	84.8	1.6	68.9	1.7
East Cap (Creosote bush)	80.0	71.4	72.7	2.4	2.1	2.9	21.4	0.0	83.3	2.0	0.0	2.1	82.4	1.4	0.0	0.0
East Cap (White bursage)	50.0	0.0	0.0	1.8	0.0	0.0	16.9	5.7	7.8	1.8	2.2	2.1	71.4	1.5	42.0	1.7
North Edge (Creosote bush)	21.2	17.6	20.0	1.9	1.8	2.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
North Edge (White bursage)	0.0	0.0	0.0	0.0	0.0	0.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
South Edge (Creosote bush)	0.0	0.0	0.0	0.0	0.0	0.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
South Edge (White bursage)	15.4	0.0	0.0	1.0	0.0	0.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Southeast Triangle (Creosote bush)	8.9	15.6	17.1	2.4	1.4	2.1	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Southeast Triangle (White bursage)	14.8	0.0	0.0	1.8	0.0	0.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
TOTAL																
Creosote bush	28.7	27.6	28.7	1.8	1.4	1.9	21.4	0.0	75.9	1.9	0.0	2.3	90.5	1.6	44.4	1.3
White bursage	21.4	0.0	50.0	1.5	0.0	0.3	16.1	7.4	7.9	1.8	2.3	2.1	81.1	1.6	59.9	1.7
Cap	49.0	55.3	50.0	2.1	0.9	1.4	16.9	7.4	11.4	1.8	2.3	2.2	85.8	1.6	57.4	1.5
Off Cap	11.7	14.8	17.1	1.2	0.5	0.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Creosote bush (Cap)	65.9	55.3	50.0	2.1	1.7	2.3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Creosote bush (Off Cap)	12.6	15.3	17.1	1.4	1.1	1.4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
White bursage (Cap)	36.4	0.0	50.0	2.0	0.0	0.5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
White bursage (Off Cap)	10.5	0.0	0.0	0.9	0.0	0.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

survival was 11.4%; 75.9% for creosote bush (2.3 vigor) and 7.9% for white bursage (2.1 vigor). Survival after two months for plants transplanted in March 2024 was 90.5% for creosote bush and 81.1% for white bursage (85.8% combined) and average vigor was 1.6 for both species. Combined survival in 2025 was 57.4%; 44.4% for creosote bush (1.3 vigor) and 59.9% for white bursage (1.7 vigor).

Competition from high saltlover densities is thought to be a major factor in the relatively low transplant survival for plants planted in 2021 and 2022. Many of the creosote bush transplants were also quite small at the time they were planted. Several plants of both species, especially weak struggling ones, were covered in gnats during the 2024 sampling which may be a possible source of mortality. Higher percent survival in plants planted in 2024 is attributed to the decreased competition from saltlover after the Rejuvra herbicide was applied in December 2023 (see Section 7.8.2).

7.8.2 Plant Density and Percent Plant Cover

Plant density and percent plant cover were measured in April 2025 along multiple 40-m long permanent transects that were established in each of the six aforementioned areas. A 1-m x 1-m quadrat was placed at seven locations, every five meters, on alternating sides of each transect and the number of plants, including from seed and transplants planted in 2021, 2022, and 2024, were counted by species. Due to high numbers, Arabian schismus and saltlover density was counted in the upper right quadrant (0.25 m^2) and then multiplied by four to get number of plants/m^2. New seedlings encountered in 2022-2025 were differentiated from mature plants to evaluate the seedbank effect. An average number of plants per square meter by species was then calculated for each area and summed for the areas on the cover cap (Table 7-21) and areas off the cover cap. Only the values for the cover cap are reported in the table. Density data from 2021-2025 sampling are also included in Table 7-21. Percent cover was measured with the optical cover scope following the same methods as in the reference area. Data from four points (45, 135, 225, and 315 degrees), every four meters starting at two meters, for a total of 40 points were recorded for each transect on the cover cap. Cover data were not collected off the cover cap. Average percent cover by species and category are reported in Table 7-22 and compared to the 2022, 2023, and 2024 values.

Perennial plant density on the cap was 0.62 plants/m^2 compared to 1.04 plants/m^2 (average between dry and wet year) in the reference area. This equates to 60% of the perennial plant density in the reference area. Four shrub species from seeding and creosote bush and white bursage transplants were recorded with no perennial grasses or forbs found. Perennial plant density decreased from 0.76 to 0.62 plants/m^2 between 2024 and 2025, and no annual grasses or forbs were recorded in 2025 due to a combination of dry conditions and the pre-emergent herbicide Rejuvra applied in December 2023 (Hall and Perry 2024). For comparison, plant density was 0.2 plants/m^2 in the areas off the cover cap.

Perennial plant cover on the cover cap nearly tripled from 2.0 to 5.7 between 2023 and 2024, and percent cover of saltlover and Arabian schismus decreased from 19.6 to 0.8. These differences were due to the positive effects of the pre-emergent herbicide Rejuvra applied in December 2023 which prevented germination of saltlover and Arabian schismus. This created a competitive release for the perennials that did not have to compete with the invasive weeds for soil moisture. With the above-normal precipitation in 2024, the perennial shrubs were able to thrive. Perennial plant cover increased slightly from 5.7% to 6.0% from 2024 to 2025 and includes mostly cattle saltbush with some fourwing saltbush, Nevada jointfir and shadscale as well as creosote bush and white bursage transplants. This is 61% of perennial plant cover in the reference area (9.9% average of dry and wet year). Based on density and cover results, the Cell 18 Closure Cover (Figure 7-22) has been successfully revegetated. Quantitative data will still be collected for the next few years to track the long-term effects of the herbicide treatment which was instrumental in achieving revegetation success on this site.

Table 7-21. Plant density (plants/m^2) by lifeform and species for the Cell 18 Cover and the Area 5 RWMC Reference Area (S = seedling, T = transplant, Total = mature plants, seedlings, and transplants combined).

Lifeform/Species	ON CAP Total (May 2021)	ON CAP Total (March 2022)	ON CAP Total (May 2023)	ON CAP Total (May 2024)	ON CAP Total (April 2025)	Reference Area 2023
Perennial Shrubs						
White bursage	0.05 S, 0.16 T; 0.21 Total	0.03 T	0.04 T	0.01, 0.01 S, 0.10 T; 0.12 Total	0.09T	0.09
Fourwing saltbush	0.33 S	0.06	0.08	0.09	0.07	0.00
Shadscale saltbush	0.11 S	0.02	0.03, 0.02 S; 0.05 Total	0.03	0.03	0.17, 0.01 S; 0.18 Total
Cattle saltbush	0.13 S	0.08	0.03	0.05	0.04	0.00
Nevada jointfir	2.05 S	0.53, 0.04 S; 0.57 Total	0.31, 0.01 S; 0.32 Total	0.37	0.34	0.06
Winterfat	0.10 S	0.01	0.00	0.00	0.00	0.02
Creosote bush	0.01 S, 0.10 T; 0.11 Total	0.02 T	0.02 T	0.01 S, 0.09 T; 0.09 Total	0.05 T	0.03
Littleleaf ratany (Not seeded)	0.00	0.00	0.00	0.00	0.00	0.31
Shockley's goldenhead (Not seeded)	0.00	0.00	0.00	0.00	0.00	0.00
Water jacket (Not seeded)	0.00	0.00	0.00	0.00	0.00	0.02
Spiny hopsage (Not seeded)	0.00	0.00	0.00	0.00	0.00	0.01
TOTAL	**2.78 S, 0.26 T; 3.04 Total**	**0.7, 0.04 S, 0.05 T; 0.79 Total**	**0.45, 0.03 S, 0.06 T; 0.54 TOTAL**	**0.55, 0.02 S, 0.19 T; 0.76 Total**	**0.48, 0.14T; 0.62 TOTAL**	**0.71, 0.01 S; 0.72 Total**
Perennial Grasses						
Indian ricegrass	7.51 S	0.08	0.04 S; 0.04 Total	0.00	0.00	0.07, 0.26 S; 0.33 Total
Squirreltail	2.25 S	0.00	0.00	0.00	0.00	0.00
TOTAL	**9.76 S**	**0.08**	**0.04 S; 0.04 Total**	**0.00**	**0.00**	**0.07, 0.26 S; 0.33 Total**
Perennial Forbs						
Desert marigold	0.21 S	0.00	0.00	0.00	0.00	0.00
Palmer penstemon	6.60 S	0.00	0.00	0.00	0.00	0.00
Desert globemallow	0.05 S	0.00	0.00	0.00	0.00	0.00
Freckled milkvetch (Not seeded)	0.01 S	0.00	0.00	0.00	0.00	0.08
TOTAL	**6.87 S**	**0.00**	**0.00**	**0.00**	**0.00**	**0.08**
TOTAL PERENNIALS	**19.41 S, 0.26 T; 19.67 Total**	**0.78, 0.04 S, 0.05 T; 0.87 Total**	**0.45, 0.07 S, 0.06 T; 0.58 TOTAL**	**0.55, 0.02 S, 0.19 T; 0.76 Total**	**0.48, 0.14T; 0.62 TOTAL**	**0.86, 0.27 S; 1.13 Total**
Annual Grasses						
Arabian schismus	1.23	3.31	71.11	1.62	0.00	14.88
Cheatgrass	0.02	0.00	0.15	0.00	0.00	2.04
Red brome	0.01	0.00	0.07	0.00	0.00	1.17
Sixweeks fescue	0.00	0.00	0.00	0.00	0.00	2.21
TOTAL	**1.26**	**3.31**	**71.33**	**1.62**	**0.00**	**20.30**
Annual Forbs						
Saltlover (alive)	19.10	23.03	179.31	5.66	0.00	0.00
Saltlover (dead)	0.00	16.02	NA	NA	0.00	NA
Prickly Russian thistle	0.20	0.09	0.36	0.08	0.00	0.00
Other species	0.70	0.13	2.11	0.00	0.00	30.71
TOTAL	**20.00**	**39.27**	**181.78**	**5.74**	**0.00**	**30.71**
TOTAL ANNUALS	**21.26**	**42.58**	**221.05**	**7.36**	**0.00**	**51.01**

Table 7-22. Average percent cover by species and category for the Cell 18 Cover and the Area 5 RWMC Reference Area (T = transplants).

Category/Species	Cell 18 Cover Cap March 2022	Cell 18 Cover Cap May 2023	Cell 18 Cover Cap May 2024	Cell 18 Cover Cap April 2025	Reference Area May 2023
Perennial Shrubs					
White bursage	0.0	0.0	0.1	0.1 T	0.1
Fourwing saltbush	0.0	0.4	1.1	1.0	0
Shadscale saltbush	0.0	0.1	0.7	0.4	2.4
Cattle saltbush	0.0	1.3	2.7	4.0	0
Nevada jointfir	0.0	0.1	0.8	0.2	1.1
Winterfat	0.0	0.0	0.1	0.0	0.1
Creosote bush	0.0	0.1	0.2	0.3 T	2.3
Littleleaf ratany (Not seeded)	0.0	0.0	0.0	0.0	3.7
Water jacket (Not seeded)	0.0	0.0	0.0	0.0	0.9
Beaked spiny polygala (Not seeded)	0.0	0.0	0.0	0.0	0.1
TOTAL	**0.0**	**2.0**	**5.7**	**6.0**	**10.7**
Perennial Grasses					
Indian ricegrass	0.0	0.0	0.0	0.0	0.2
Squirreltail	0.0	0.0	0.0	0.0	0.0
TOTAL	**0.0**	**0.0**	**0.0**	**0.0**	**0.2**
Perennial Forbs					
Desert marigold	0.0	0.0	0.0	0.0	0.0
Palmer's penstemon	0.0	0.0	0.0	0.0	0.0
Desert globemallow	0.0	0.0	0.0	0.0	0.0
Freckled milkveth	0.0	0.0	0.0	0.0	0.0
TOTAL	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
TOTAL PERENNIALS	**0.0**	**2.0**	**5.7**	**6.0**	**10.9**
Annual Grasses					
Arabian schismus	0.3	6.2	0.0	0.2	1.4
Cheatgrass	0.0	0.0	0.0	0.0	0.4
Red brome	0.0	0.0	0.0	0.0	0.2
TOTAL	**0.3**	**6.2**	**0.0**	**0.2**	**2.0**
Annual Forbs					
Saltlover	0.0	13.4	0.8	0.0	0.0
Russian thistle	0.3	0.0	0.2	0.0	0.0
Other annual forbs	0.0	0.5	0.0	0.0	2.5
TOTAL	**0.3**	**13.9**	**1.0**	**0.0**	**2.5**
TOTAL ANNUALS	**0.6**	**20.1**	**1.0**	**0.2**	**4.5**
TOTAL VEGETATIVE COVER	**0.6**	**22.1**	**6.7**	**6.2**	**15.4**
Rock (>25 cm)	0.0	0.0	0.0	0.2	0.0
Cobble (8-25 cm)	0.2	0.2	0.2	0.8	0.0
Gravel (0.5-8 cm)	26.6	30.1	43.4	57.0	61.6
Bare ground	17.7	20.8	13.5	8.8	15.3
Straw mulch	15.4	3.6	3.4	0.3	0.0
Litter	39.5	23.3	32.8	26.8	7.7
TOTAL ABIOTIC	**99.4**	**78.0**	**93.3**	**93.9**	**84.6**

7.9 Plant Disease

A reddish-brown substance was noted on several plants of various species (e.g., Nevada jointfir, cattle saltbush, white bursage, and creosote bush) on both transplants and plants from seed on several of the revegetated cover caps. It is unknown what the cause is but may be some sort of rust or plant pathogen. The status of this potential plant pathogen will be assessed during future monitoring activities.



Figure 7-22. Successfully revegetated Cell 18 Cover.

(Photo by D.B. Hall, April 21, 2025)

7.10 Cheatgrass Control Research Trial

The Cherrywood Wildland Fire burned more than 8,094 ha in the western portion of the NNSS in May 2021. This was the third wildland fire in this area since 2011. One of the major contributing factors to this increased fire frequency is the abundance of cheatgrass, an invasive annual grass. Cheatgrass is problematic for many reasons. It can germinate and grow at colder soil temperatures than many native species so by the time the native species germinate and start growing, the cheatgrass has used up most of the available soil moisture which results in native seedlings struggling to survive. Cheatgrass also has a high germination rate even with little precipitation, grows quickly, and is able to produce a large amount of biomass in a short period of time. Because it is an annual, it dries out early in the season when the soil moisture declines, resulting in abundant, highly flammable fine fuel that is easily ignited and carries fire readily. It can grow almost anywhere but thrives in areas of disturbance, especially previously burned areas. The cheatgrass biomass is problematic not just for the year in which it germinates but also because the residual biomass can persist for multiple years. The best way to control cheatgrass in the long term is to establish a perennial vegetative community that will outcompete it (Clements et al. 2017). For short-term control, herbicides such as imazapic (e.g., Panoramic) (1-year control) or indaziflam (e.g., Rejuvra) (3-5 year control) work best. The optimal strategy is to use a combination of herbicide treatments followed by seeding.

NNSS biologists conducted a research trial to evaluate the effectiveness of different herbicide and seeding treatments to control cheatgrass and establish a perennial vegetative community within the Cherrywood Wildland Fire burned area. It is anticipated that results will be used to guide future fire rehabilitation efforts and/or proactively protect important areas from burning by reducing the fuel load and creating

firebreaks. The study location is near the East Cat Canyon Road/North Timber Peak spur road (southeast corner of study area at UTM NAD83 555553mE, 4101365mN).

Five treatments were implemented and a control, with three replicates of each in a completely randomized design for a total of 18 plots (Figure 7-23). Treatments included: 1) Rejuvra (liquid Indaziflam) applied by hand at 5.0 oz/ac plus 8 oz/ac Efficax (surfactant) plus 25 gal water/ac, 2) Panoramic (liquid imazapic) applied by hand at 8 oz/ac plus 8 oz/ac Efficax (surfactant) plus 10 gal water/ac, 3) Open Range G (granular imazapic) applied with hand spreader at 10 lbs/ac, 4) seeding a wildland seed mix by hand at a rate of 20 lbs of PLS/ac (Table 7-23) and covering the seed with hand rakes, and 5) seeding the same wildland seed mix as previous by hand at the same rate and not covering the seed. Control plots had no treatment. An additional fire-resistant vegetation treatment (i.e., greenstrip) was implemented in a different but nearby area by hand-seeding a mix of Immigrant forage kochia (*Kochia prostrata*) at a rate of 0.5 lbs PLS/ac and Siberian wheatgrass (*Agropyron fragile*) at a rate of 10 lbs PLS/ac. All plots were 20 m by 20 m (400 m^2 or ~0.1 ac). Plots were staked on November 10, 2021, seeded on November 15, 2021, and herbicide was applied on November 16, 2021.

A follow-up seeding treatment was applied to the herbicide treated and control plots on October 31, 2022, to evaluate if there were residual herbicide effects on seedling germination. The first eight meters of each herbicide-treated and control plot were hand seeded with the same seed mix used before (Table 7-23) at a rate of 14.3 lbs PLS/ac. Seed was then covered using hand rakes.

Plots were sampled in May 2022, May 2023, May 2024, and May 2025 for plant density (Table 7-24) and percent cover (Table 7-25). Five, 20-m long, permanent transects were established in each plot. Plant density by species was recorded in five, 1-m^2 quadrats on each transect. Due to the high densities of cheatgrass, individual cheatgrass plants were counted only in the upper right quadrant of the 1-m^2 quadrat. Values were multiplied by four and are reported as plants/m^2. Percent cover was measured with the optical cover scope as described in Section 7.2 and was recorded at nine locations every two meters starting at the 2-m mark, with four points at each location for a total of 36 points per transect. Photographs of each plot were taken during sampling each year.

Very few seedlings of seeded species were recorded in May 2022 and May 2023 so only the herbicide treated and control plots were sampled in May 2024 and May 2025 (Tables 7-24 and 7-25). This highlights the challenge of establishing a perennial vegetative community in this area. After four years there is still a clear pattern of cheatgrass density and percent cover being lowest in Rejuvra treated plots. Panoramic and Open Range treatments reduced cheatgrass in the first year and to a lesser degree in the second year, but by the third and fourth year cheatgrass cover and density in these plots were similar to that in the control plots (Figure 7-24). Density of James' galleta (*Pleuraphis jamesii*) was lower in Rejuvra plots than the control plots but percent cover was higher. Typically, galleta plants were more productive and healthier in Rejuvra plots. James' galleta appeared to benefit from the reduction of cheatgrass and not having to compete for limited soil moisture (i.e., competitive release). Density and percent cover of desert globemallow was higher in Rejuvra plots than control plots. Annual forb density, cover and species richness was higher in Rejuvra plots than in control plots. Results showed Rejuvra had the best multi-year control of cheatgrass which had a positive impact on several perennials and is recommended to be used on a large scale to create firebreaks in cheatgrass dominated areas such as previous burns like the Cherrywood Wildland Fire. Plots will continue to be monitored for at least another year or two to test the longevity of cheatgrass control for all herbicides. Further analysis will also be conducted to determine herbicide impacts on native annual and perennial plants.

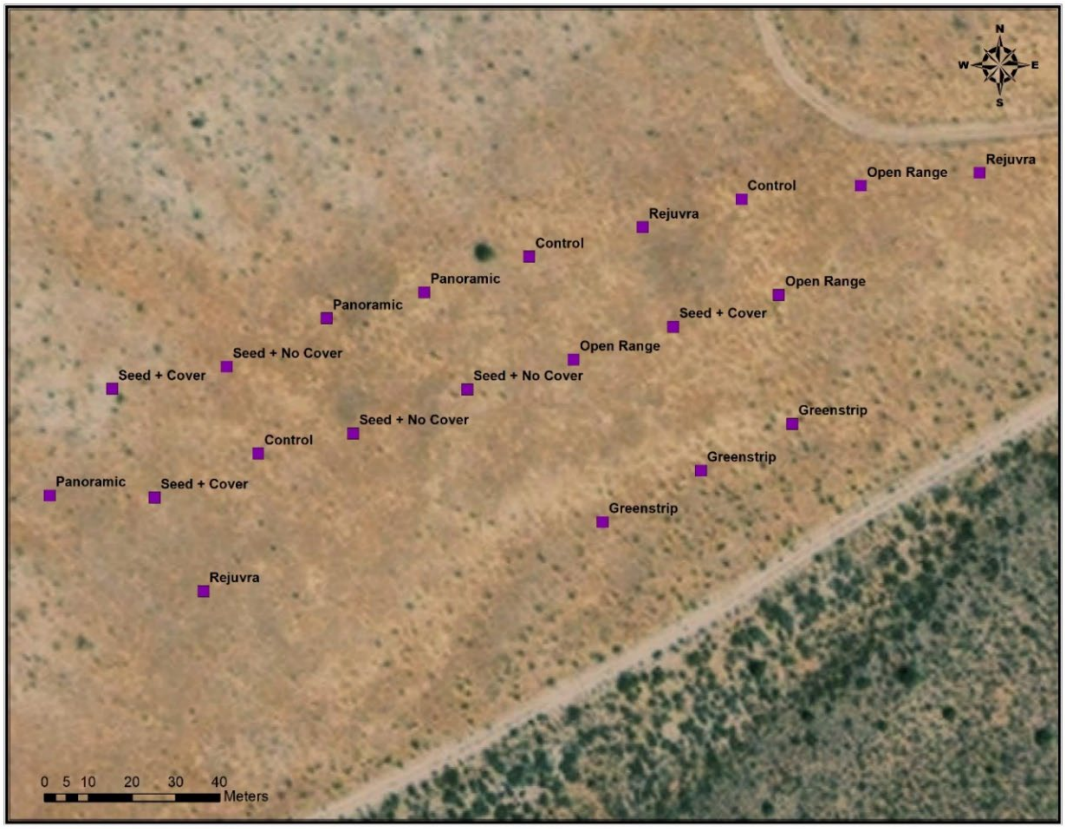

Figure 7-23. Plot layout for cheatgrass control research trial.

Table 7-23. Seed mix used in cheatgrass control research trial.

Lifeform	Species	PLS lbs/acre	PLS seeds/m2
Shrub	*Artemisia nova*	0.2	45
Shrub	*Artemisia tridentata tridentata*	0.1	62
Shrub	*Atriplex canescens*	2.0	27
Shrub	*Chrysothamnus viscidiflorus*	0.2	39
Shrub	*Ephedra nevadensis*	4.6	23
Shrub	*Ephedra viridis*	3.6	22
Shrub	*Ericameria nauseosa leiosperma*	0.2	34
Shrub	*Purshia glandulosa*	4.5	23
Grass	*Achnatherum hymenoides Paloma*	1.1	44
Grass	*Achnatherum speciosa*	1.0	43
Grass	*Elymus elymoides Toe Jam*	1.0	47
Grass	*Poa secunda sandbergii*	0.3	78
Forb	*Linum perenne*	0.5	36
Forb	*Penstemon palmeri Cedar*	0.3	45
Forb	*Sphaeralcea ambigua*	0.4	49
	TOTAL	20.0	617

Table 7-24. Plant density (plants/m^2) by species and lifeform by treatment, May 2022-May 2025.

	Panoramic				Open Range				Rejuvra				Control			
Species/Lifeform	2022	2023	2024	2025	2022	2023	2024	2025	2022	2023	2024	2025	2022	2023	2024	2025
Perennial shrubs	0.03	0.01	0.05	0.07	0.00	0.04	0.11	0.08	0.08	0.05	0.05	0.04	0.05	0.04	0.08	0.04
James' galleta	0.91	0.57	0.65	0.85	1.28	1.20	0.65	1.24	0.63	0.49	0.28	0.49	0.88	0.89	0.63	0.79
Perennial grasses	NA	NA	0.65	0.85	NA	NA	0.71	1.25	NA	NA	0.29	0.52	NA	NA	0.63	0.79
Desert globemallow	0.07	0.05	0.05	0.01	0.04	0.04	0.07	0.00	0.23	0.27	0.37	0.07	0.04	0.56	0.44	0.05
Whitemargin sandr	7.24	5.91	11.61	0.83	3.40	4.37	10.47	2.24	8.21	5.35	15.28	8.16	0.69	15.72	19.40	0.95
Lewis flax	NA	NA	0.01	0.01	NA	NA	0.11	0.00	NA	NA	0.03	0.00	NA	NA	0.01	0.00
Perennial forbs	7.32	6.01	11.89	0.87	3.47	4.47	10.68	2.24	8.59	6.03	15.79	8.25	0.83	16.31	19.91	1.00
Cheatgrass	8.56	33.92	51.41	76.11	9.28	61.76	53.60	66.35	19.63	8.85	5.01	18.61	129.60	152.32	78.99	80.91
Bristly fiddleneck	3.93	61.63	3.41	1.32	0.44	14.11	2.84	0.08	0.69	0.51	0.36	0.29	39.91	24.37	1.85	0.89
Annual forbs	3.93	69.03	6.00	1.57	1.01	16.16	7.51	0.24	1.29	0.89	2.09	5.87	42.47	27.20	6.71	1.95
Species Richness	6.00	13.00	14.00	9.67	4.00	13.00	16.00	6.67	10.00	11.00	11.00	9.00	7.00	14.00	12.00	7.67
Ann Forb Species Ri	1.00	10.00	9.00	4.33	1.00	5.00	6.00	2.33	4.00	3.00	3.00	4.00	3.00	7.00	5.00	3.67

Table 7-25. Percent plant cover by species and lifeform by treatment, May 2022-May 2025.

	Panoramic				Open Range				Rejuvra				Control			
Species/Lifeform	2022	2023	2024	2025	2022	2023	2024	2025	2022	2023	2024	2025	2022	2023	2024	2025
Perennial Shrubs	0.6	0.8	0.4	0.2	1.1	0.6	1.3	0.8	0.9	0.6	1.5	1.7	1.3	1.1	1.7	2.1
James' galleta	1	1.5	5.6	3.2	1.1	2.4	5.7	5.7	0	1.3	3.3	3.9	0.2	1.5	4.8	2.6
Perennial grasses	NA	NA	5.6	3.2	NA	NA	5.9	5.7	NA	NA	3.3	3.9	NA	NA	4.8	2.6
Cheatgrass	0.6	6.5	27.4	22.2	1.3	14.1	30.2	22.2	12.2	2.2	7.2	9.4	24.8	34.1	39.7	19.3
Bristly fiddleneck	0.9	11.3	7.4	0.2	0.4	1.7	5.7	0.0	0.8	0.4	0.6	0.2	3.9	6.3	2.8	0.0
Whitemargin sandmat	2.1	1.9	2.6	0.0	0.2	0.2	1.9	0.0	1.8	0.7	3.1	1.1	0.2	3.1	5.0	0.0
Desert globemallow	NA	NA	0.0	0.0	NA	NA	0.4	0.0	NA	NA	4.1	0.4	NA	NA	2.8	0.0
Perennial forbs	2.1	1.9	5.2	0.0	0.2	0.4	2.3	0.0	1.8	2.1	7.8	1.3	0.2	4.4	8.4	0.0
Annual forbs	3	12.1	12.4	0.2	0.6	1.7	29.9	0.0	3.3	1	7.2	1.9	4.3	7.8	10.8	0.2
Litter	47.6	14.5	16.6	44.4	56.5	20.3	12.2	51.3	38.2	16.7	11.7	16.3	39.1	18.7	17.2	51.3
Total Abiotic	95	77.4	49.1	74.3	95.9	80.8	30.5	71.3	83.6	92.8	73.0	81.7	69.4	51.1	34.8	75.9

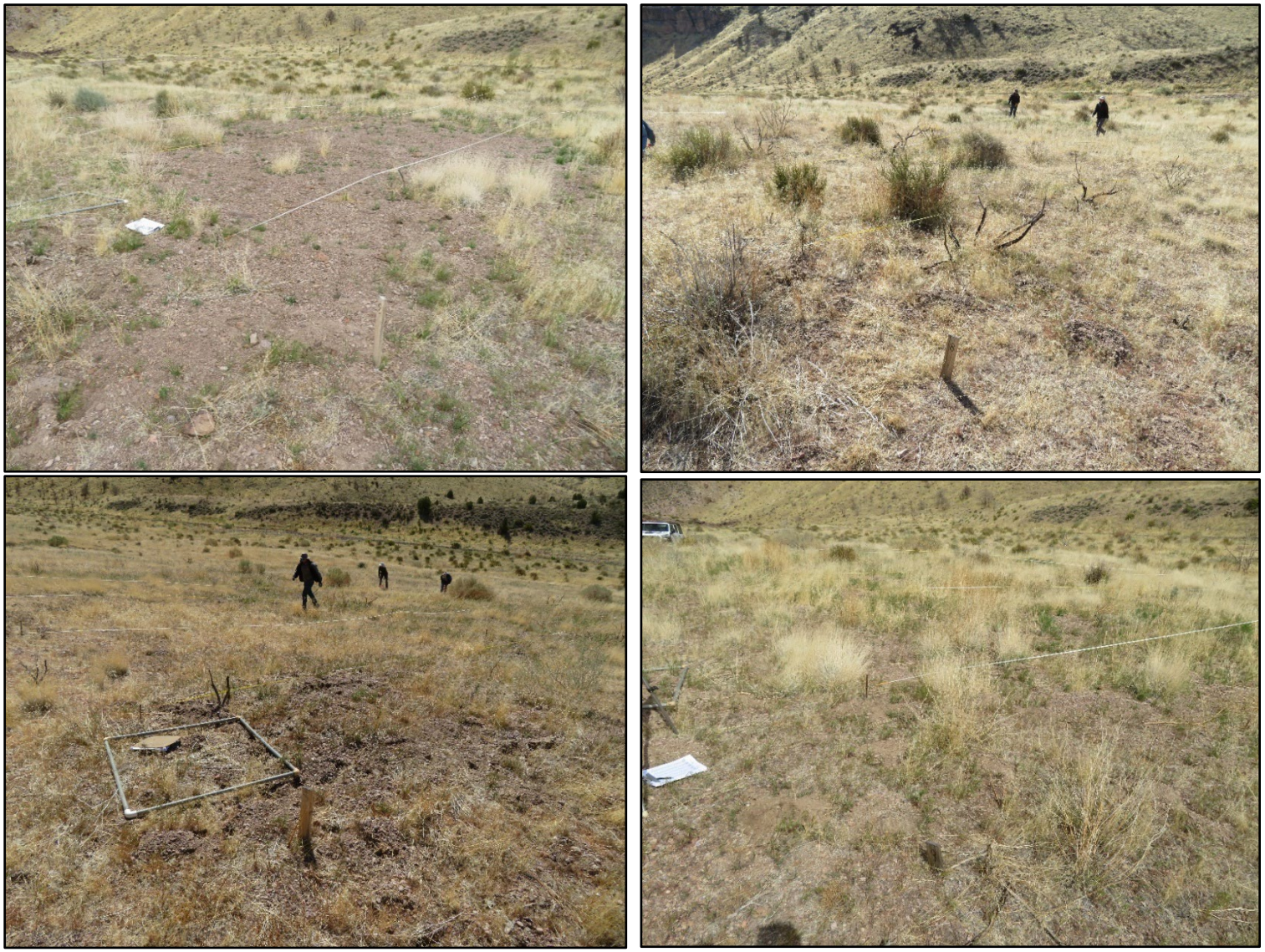

Figure 7-24. Plot comparison (Rejuvra, upper left; control, upper right; Panoramic, lower left; Open Range, lower right).

(Photos by D.B. Hall, May 5-6, 2025)

7.11 Aerial Herbicide Operation Rejuvenation

Thousands of hectares on the NNSS have been converted to annual grasslands dominated by cheatgrass and red brome, primarily from wildland fires. These areas are at high risk of burning again due to the abundant, flammable fine fuel the annual grasses create, especially during years of normal or above-normal precipitation. Fire suppression activities are expensive and somewhat limited in these areas for many reasons, including inaccessibility (e.g., rugged terrain, remoteness), presence of unexploded ordnance, and radiological concerns. Prevention is the best way to minimize the spread and negative impacts of wildland fire. A useful technique is to strategically create wide firebreaks in these annual grasslands to prevent fire spread if a fire is ignited. Usually, firebreaks are made with heavy equipment (e.g., road grader, bulldozer) but this is cost-prohibitive and impractical in many rugged areas. Aerial application of herbicides to create firebreaks on a large scale is a novel approach for the NNSS.

A collaborative effort (Operation Rejuvenation) between NNSS and Nellis Air Force Base biologists was planned and implemented in 2023 to treat large areas with the pre-emergent herbicide, Rejuvra, to create firebreaks in annual grasslands on the NNSS and NTTR. The plane can spray a 100-foot-wide swath with each pass, and it was determined that two parallel passes would create a sufficient firebreak with a combined width of 200 feet per firebreak. Based on results from the Cheatgrass Control Research Trial, aerial application was a technique worth evaluating. The Ohio Air Reserve Unit is a U.S. Air Force program that has unique capabilities utilizing a C-130 transport plane and high-capacity spray system to carry out missions world-wide such as spraying to control mosquitoes after hurricanes, spraying for invasive plant species, and other military missions. To keep their crew trained and equipment functional they need to conduct training missions. We were able to utilize this asset, only paying for the herbicide, resulting in huge cost savings. Because results from Operation Rejuvenation were successful the first year, additional treatments to create firebreaks will continue into the future.

7.11.1 Operation Rejuvenation 2023

In early November 2023, firebreaks on the NNSS were strategically placed in Mid Valley and the Timber Mountain/Buckboard Mesa area (Figure 7-25) by treating 1,884 ac with herbicide using the C-130 during 6.7 hours of flight time. Current aerial imagery was used to maximize the placement of firebreaks in annual grass dominated areas. The spray mix included Rejuvra at 5 oz/ac, Grounded (surfactant/adjuvant) at 8 oz/ac, spray dye at 8 oz/ac, and water at 7 gal/ac. An additional 2,334 ac were sprayed on the NTTR.

Research plots (10-m x 10-m) on the NNSS were established to determine the efficacy of the treatment. Control plots were covered with plastic sheeting during spraying operations to prevent herbicide from hitting the ground while treated plots were left uncovered. Plastic sheeting was deployed a few days before spraying and removed within a day or two after spraying. Spray dye (green colorant) was used to verify the spray pattern and coverage. The green colorant dissipates after about 5-7 days and is not visible after that. Paired treated and control plots replicated three times at each site were established in Mid Valley (UTM NAD83 573023mE, 4090457mN), near Buggy crater (UTM NAD83 554416mE, 4096985mN), and on the North Timber Mountain spur road (UTM NAD83 554132mE, 4102731mN). These plots were sampled for plant density by species in May 2024 and May 2025 (Table 7-26) along permanent transects in 12, 1-m^2 quadrats per plot and percent plant cover by species (Table 7-27) was measured along the same transects at 48 points per plot to evaluate the effectiveness of this technique on controlling cheatgrass and its impacts on other species.

In 2025, cheatgrass density was much lower in treatment plots than control plots at all three study sites with less than four plants/m^2 at the Mid Valley (Figure 7-26) and Buggy sites. Perennial forb density was similar in treatment and control plots at all three sites. Annual forb density was lower in treatment plots than in control plots at the Mid Valley and Buggy sites and nearly equal at the North Timber Mountain

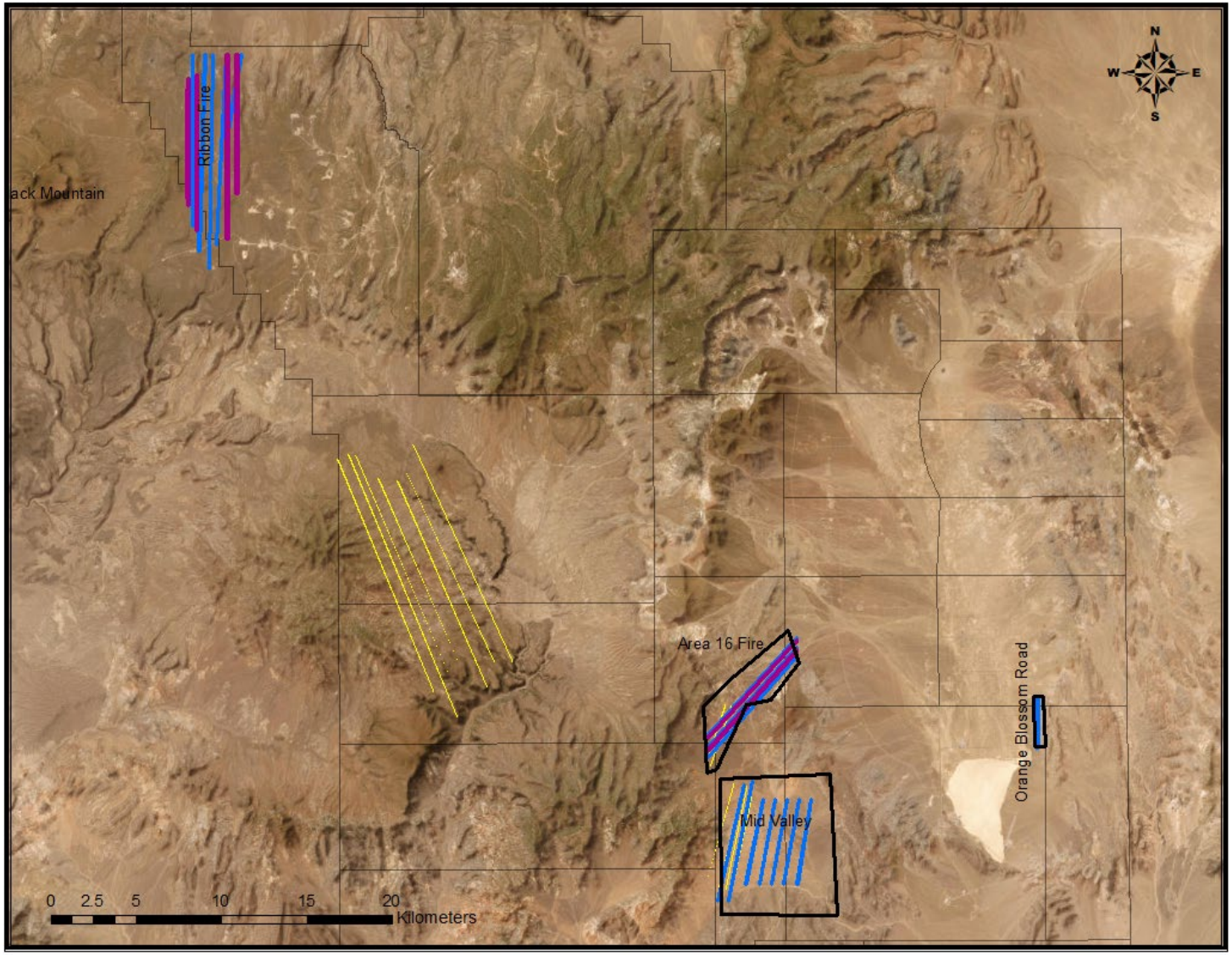

Figure 7-25. Location of areas treated with aerially applied herbicide during Operation Rejuvenation in 2023 (yellow lines), 2024 (blue lines), and 2025 (purple lines).

Table 7-26. Plant density (plants/m^2) for Mid Valley, Buggy, and North Timber Mountain Spur Road study plots by species and lifeform for Rejuvra-treated and control plots, May 2024 and 2025.

	Mid Valley				Buggy				North Spur Road			
Species/Lifeform	Treatment 2024	Control 2024 Plants/m2	Treatment 2025	Control 2025 Plants/m2	Treatment 2024	Control 2024 Plants/m2	Treatment 2025	Control 2025 Plants/m2	Treatment 2024	Control 2024 Plants/m2	Treatment 2025	Control 2025 Plants/m2
Cheatgrass	57.78	155.56	1.44	116.78	53.75	124.55	3.44	58.33	179.55	210.78	32.33	67.11
Red brome	0.06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Annual Grasses	**57.84**	**155.56**	**1.44**	**116.78**	**53.75**	**124.55**	**3.44**	**58.33**	**179.55**	**210.78**	**32.33**	**67.11**
Rubber rabbitbrush	0.00	0.11	0.03	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Yellow rabbitbrush	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.06	0.00	0.00	0.00	0.00
Blackbrush	0.00	0.03	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Desert bitterbrush	0.00	0.00	0.00	0.00	0.06	0.03	0.06	0.06	0.03	0.00	0.00	0.08
EPNE/EPVI	0.00	0.00	0.00	0.00	0.22	0.06	0.11	0.03	0.00	0.00	0.03	0.00
Virgin River brittlebush	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.08	3.31	0.06	0.28
Shrubs	**0.00**	**0.14**	**0.03**	**0.14**	**0.28**	**0.15**	**0.17**	**0.15**	**0.11**	**3.31**	**0.09**	**0.36**
Indian ricegrass	0.00	0.03	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00
Desert needlegrass	0.03	0.31	0.06	0.31	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00
Squirreltail	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.14	0.06	0.08	0.06
James' galleta	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.53	0.11	1.42	0.19
Sandberg bluegrass	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.06	0.00
Perennial Grasses	**0.03**	**0.34**	**0.06**	**0.31**	**0.03**	**0.00**	**0.09**	**0.00**	**1.95**	**0.17**	**1.56**	**0.25**
Wiggins' cholla	0.03	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Desert globemallow	3.97	2.64	1.61	1.28	4.31	3.72	2.58	1.44	0.78	0.94	0.56	0.39
Cold-desert phlox	0.08	1.83	0.08	0.64	0.00	0.36	0.03	0.14	0.17	0.22	0.06	0.25
Freckled milkvetch	0.31	0.44	0.08	0.31	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Engelmann's hedgehog cactus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.03	0.00
Matted buckwheat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.03	0.00
Perennial Forbs/Cactus	**4.39**	**4.91**	**1.80**	**2.23**	**4.31**	**4.08**	**2.61**	**1.58**	**1.04**	**1.16**	**0.68**	**0.64**
Redstem stork's bill	56.33	51.78	10.67	31.33	18.03	14.47	15.44	25.50	0.28	0.33	0.86	0.58
Birdnest buckwheat	0.00	0.33	0.00	0.00	0.03	0.19	0.00	0.00	1.17	0.31	0.22	0.00
Western tansymustard	1.86	0.75	1.83	0.17	0.00	0.00	0.00	0.00	2.78	0.86	1.53	1.28
Pacific blazingstar	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tall tumblemustard	0.06	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hoary tansyaster	0.08	0.00	0.11	0.06	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Bristly fiddleneck	0.06	0.00	0.00	0.14	0.19	0.39	0.08	0.11	0.67	0.86	0.00	0.94
Esteve's pincushion	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Great Basin woollystar	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	0.00	0.00	0.00
Gilia species	0.00	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00
Desert indianwheat	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.22	0.00	0.00	0.00
Moth combseed	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.64	0.00	0.00	0.00
Fineleaf hymenopappus	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.14	0.00	0.19	0.00
New Mexico thistle	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.00	0.00	0.00
Astragalus species	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.14	0.00
Umbellifereae	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00
Annual Forbs	**58.39**	**53.02**	**12.61**	**31.70**	**18.31**	**15.53**	**15.52**	**25.61**	**8.93**	**2.44**	**3.00**	**2.80**

Table 7-27. Percent plant cover for Mid Valley, Buggy, and North Timber Mountain Spur Road study plots by species and lifeform for Rejuvra-treated and control plots, May 2024 and 2025.

	Mid Valley				Buggy				North Spur Road			
Species/Category	Treatment 2024	Control 2024	Treatment 2025	Control 2025	Treatment 2024	Control 2024	Treatment 2025	Control 2025	Treatment 2024	Control 2024	Treatment 2025	Control 2025
Cheatgrass	10.4	9.7	0.7	22.9	23.6	54.2	1.4	19.4	51.4	51.4	19.4	22.2
Red brome	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Annual Grasses	**11.1**	**9.7**	**0.7**	**22.9**	**23.6**	**54.2**	**1.4**	**19.4**	**51.4**	**51.4**	**19.4**	**22.2**
Rubber rabbitbrush	0.7	2.1	1.4	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Blackbrush	0.0	0.7	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Desert bitterbrush	0.0	0.0	0.0	0.0	1.4	0.7	2.8	0.0	1.4	4.2	1.4	2.1
EPNE/EPVI	0.0	0.0	0.0	0.0	3.5	4.9	3.5	2.1	0.7	0.7	0.7	0.0
Fourwing saltbush	0.0	0.0	0.0	0.0	0.7	0.0	0.7	0.0	0.0	0.0	0.0	0.0
Virgin River brittlebush	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.7
Shrubs	**0.7**	**2.8**	**1.4**	**5.6**	**5.6**	**5.6**	**7.0**	**2.1**	**2.1**	**5.6**	**2.1**	**2.8**
Indian ricegrass	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Desert needlegrass	0.0	2.1	0.0	1.4	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0
James' galleta	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.6	0.7	10.4	0.7
Squirreltail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.7	0.0	1.4
Perennial Grasses	**0.0**	**2.1**	**0.0**	**2.1**	**0.0**	**0.0**	**1.4**	**0.0**	**8.3**	**1.4**	**10.4**	**2.1**
Desert globemallow	6.3	2.8	1.4	0.0	21.5	13.2	6.3	1.4	0.0	1.4	0.0	0.0
Cold-desert phlox	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0
Matted buckwheat	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0
ASLE	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wiggins' cholla	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Perennial Forbs/Cactus	**7.0**	**2.8**	**2.1**	**0.0**	**21.5**	**13.2**	**6.3**	**1.4**	**0.7**	**2.1**	**0.0**	**0.0**
Redstem stork's bill	10.4	3.5	3.5	0.0	3.5	2.1	4.9	0.7	0.0	0.0	1.4	0.0
Western tansymustard	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	2.1	0.0	0.7
Bristly fiddleneck	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.7
Annual Forbs	**10.4**	**3.5**	**3.5**	**0.0**	**3.5**	**2.1**	**4.9**	**0.7**	**0.7**	**3.5**	**1.4**	**1.4**
Litter	60.5	70.1	56.3	49.3	17.4	8.3	31.9	52.8	16.7	18.8	47.2	55.6
Bare ground	0.7	0.7	6.9	2.1	0.0	0.0	2.8	1.4	2.1	2.1	0.0	2.8
Gravel	9.7	8.3	29.2	18.1	27.8	16.0	44.4	20.8	9.7	9.0	6.9	7.6
Cobble	0.0	0.0	0.0	0.0	0.7	0.0	0.0	1.4	0.0	0.0	2.1	0.0
Rock	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	8.3	6.3	10.4	5.6
Abiotic	**70.9**	**79.1**	**92.4**	**69.5**	**45.9**	**25.0**	**79.1**	**76.4**	**36.8**	**36.2**	**66.6**	**71.6**



Figure 7-26. Reduced cheatgrass density and cover in Rejuvra treated plot (upper) compared to a control plot (lower) at the Mid Valley site.

(Photo by D.B. Hall, May 7, 2025.)

spur road site. This was influenced predominantly by redstem stork's bill (*Erodium cicutarium*), a non-native annual. Excluding redstem stork's bill, annual forb density was higher in treated plots than in control plots at Mid Valley site and similar at the other two sites. Cheatgrass density declined substantially at all three sites in both treatment and control plots between 2024 and 2025 due to the drought conditions experienced in 2025. However, the percent decline was higher in the treatment plots because of the effects of the herbicide. Furthermore, in 2023 some cheatgrass plants had already germinated before the herbicide was applied and those plants were not impacted by the pre-emergent herbicide, so they were present and recorded during the monitoring in 2024.

In 2025, percent cheatgrass cover was much lower in plots treated with Rejuvra compared to the control at Mid Valley and Buggy sites but comparable to each other at the North Spur Road site. Percent perennial forb cover was higher in treatment plots than in control plots at Mid Valley and Buggy sites with desert globemallow being the dominant species. Percent annual forb cover was higher in treatment plots than in control plots at Mid Valley and Buggy sites and equal at the North Spur road site. This was influenced predominantly by redstem stork's bill. Percent cheatgrass cover was typically lower in 2025 than in 2024 due to the drought conditions in 2025 and wet conditions in 2024, except for at the Mid Valley site where cheatgrass cover nearly doubled in the control plots between 2024 and 2025. Percent perennial and annual forb cover generally declined between 2024 and 2025 due to the drought conditions in 2025.

7.11.2 Operation Rejuvenation 2024

In November 2024, several additional 200-foot-wide firebreaks were established in Mid Valley, Area 16 Fire burn, Orange Blossom Road, and the Ribbon Cliff Wildland Fire burn (Figure 7-25) by treating 1,690 ac with the C-130 plane. We modified our methods based on lessons learned from 2023. We included imazapic herbicide at 4 oz/ac (all areas but recent Ribbon Cliff Wildland Fire burn) which is both a short-term (one year) pre-emergent and weak post-emergent, increased the amount of water used from seven to nine gallons per acre for better distribution, and placed firebreaks in lower-relief topography so the plane could fly lower to the ground for a more uniform spray pattern and less wind drift. Like 2023, paired treated and control plots were established; Mid Valley Southeast, Orange Blossom Road, and Ribbon Cliff Northeast to evaluate the efficacy of this technique on controlling cheatgrass and its impacts on other species. These plots were monitored for plant density (Table 7-28) and cover (Table 7-29) by species in May 2025.

Paired treated and control plots replicated three times at each site were established in Mid Valley Southeast (UTM NAD83 573410mE, 4086979mN), Orange Blossom Road (UTM NAD83 590045mE, 4093362mN), and Ribbon Cliff Northeast (UTM NAD83 542416mE, 4130521mN). These plots were sampled for plant density (Table 7-28) and percent plant cover by species (Table 7-29) using the same methods used in 2023.

Cheatgrass density was lower in treatment plots than control plots at all three sites with the most pronounced difference at Mid Valley Southeast site. We believe these differences would have been more dramatic with normal or above-normal precipitation. Perennial and annual forb density was slightly higher in the control plots than the treatment plots at all three sites. Cheatgrass cover was only recorded at the Mid Valley Southeast site and was higher in the control plots than the treatment plots (7.6 versus 0.0 percent). Percent perennial forb cover (desert globemallow) was only documented at Ribbon Cliff Northeast site at 0.7% in the control plots compared to 0.0% in the treatment plots. Percent annual forb cover was only documented at Mid Valley Southeast site at 0.7% in the treatment plots compared to 0.0% in the control plots. It is difficult to discern much from these data given the poor growing conditions caused by the drought although a pattern of reduced cheatgrass in treatment plots is evident in both density and percent cover data.

Table 7-28. Plant density (plants/m^2) for Mid Valley Southeast, Orange Blossom Road, and Ribbon Cliff Northeast study plots by species and lifeform for herbicide-treated and control plots, May 2025.

	Mid Valley Southeast		Orange Blossom Road		Ribbon Cliff Northeast	
	Treatment	Control	Treatment	Control	Treatment	Control
Species/Category	2025	2025	2025	2025	2025	2025
Cheatgrass	0.00	20.67	0.00	0.28	0.28	1.53
Annual Grasses	**0.00**	**20.67**	**0.00**	**0.28**	**0.28**	**1.53**
Water jacket	0.06	0.11	0.11	0.03	0.00	0.00
Fourwing saltbush	0.00	0.00	0.03	0.00	0.00	0.00
Ericameria species	0.56	0.14	0.00	0.00	0.00	0.00
Nevada jointfir	0.25	0.03	0.00	0.00	0.14	0.42
Cheesebush	0.03	0.00	0.00	0.00	0.00	0.00
Winterfat	0.06	0.00	0.00	0.00	0.00	0.00
Virgin River brittlebush	0.06	0.00	0.00	0.00	0.00	0.00
Turpentinebroom	0.00	0.06	0.00	0.00	0.00	0.00
Shrubs	**1.02**	**0.34**	**0.14**	**0.03**	**0.14**	**0.42**
Indian ricegrass	0.00	0.06	0.00	0.00	0.00	0.03
Desert needlegrass	0.94	0.58	0.00	0.00	0.00	0.00
Desert fluffgrass	0.00	0.03	0.00	0.00	0.00	0.00
James' galleta	0.00	0.00	0.00	0.00	0.00	0.75
Perennial Grasses	**0.94**	**0.67**	**0.00**	**0.00**	**0.00**	**0.78**
Desert globemallow	0.03	0.39	0.00	0.08	0.42	0.69
Perennial Forbs/Cactus	**0.03**	**0.39**	**0.00**	**0.08**	**0.42**	**0.69**
All Perennials	**1.96**	**1.51**	**0.14**	**0.11**	**0.56**	**1.89**
Hoary tansyaster	0.00	0.03	0.00	0.00	0.00	0.00
Astragalus species	0.00	0.00	0.00	0.00	0.00	0.17
Bristly fiddleneck	0.00	0.03	0.00	0.00	0.00	0.00
Birdnest buckwheat	0.06	0.11	0.00	0.03	0.00	0.08
Annual Forbs	**0.06**	**0.17**	**0.00**	**0.03**	**0.00**	**0.25**

7.11.3 Operation Rejuvenation 2025

In November 2025, several additional 200-foot-wide firebreaks were established in north Mid Valley (Figure 7-27), Area 16 Fire burn, and Ribbon Cliff Wildland Fire burn (Figure 7-25) by treating 1,373 ac with herbicide using the C-130 plane. The same methods as last year were used. Like 2023 and 2024, paired treated and control plots replicated three times were established; Mid Valley North (UTM NAD83 571824mE, 4093989mN) and Ribbon Cliff Well 20-12 (UTM NAD83 540844mE, 4125962mN) to evaluate the efficacy of this technique on controlling cheatgrass and its impacts on other species. These plots will be monitored for plant density and percent plant cover over the next few years.

An environmental assessment (NNSA/NFO 2025) was completed for this activity during 2025 with a Finding of No Significant Effect to ensure compliance with the National Environmental Policy Act. Herbicide application in 2023 and 2024 was covered under a categorical exclusion for research purposes.

Table 7-29. Percent plant cover for Mid Valley Southeast, Orange Blossom Road, and Ribbon Cliff Northeast study plots by species and lifeform for herbicide-treated and control plots, May 2024 and 2025.

	Mid Valley Southeast		Orange Blossom Road		Ribbon Cliff Northeast	
	Treatment	Control	Treatment	Control	Treatment	Control
Species/Category	2025	2025	2025	2025	2025	2025
Cheatgrass	0.0	7.6	0.0	0.0	0.0	0.0
Annual Grasses	**0.0**	**7.6**	**0.0**	**0.0**	**0.0**	**0.0**
Water jacket	1.4	1.4	2.1	2.1	0.0	0.0
Fourwing saltbush	0.0	0.0	1.4	0.7	0.0	0.0
Ericameria species	5.6	6.9	0.0	0.0	0.0	0.0
Nevada jointfir	0.7	1.4	0.0	0.0	0.0	0.0
Cheesebush	0.7	0.0	0.0	0.0	0.0	0.0
Virgin River brittlebush	1.4	0.0	0.0	0.0	0.0	0.0
Shrubs	**9.8**	**9.7**	**3.5**	**2.8**	**0.0**	**0.0**
Desert needlegrass	9.7	4.9	0.0	0.0	0.0	0.0
Perennial Grasses	**9.7**	**4.9**	**0.0**	**0.0**	**0.0**	**0.0**
Desert globemallow	0.0	0.0	0.0	0.0	0.0	0.7
Perennial Forbs/Cactus	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.7**
All Perennials	**19.5**	**14.6**	**3.5**	**2.8**	**0.0**	**0.7**
Bottlebush	0.7	0.0	0.0	0.0	0.0	0.0
Annual Forbs	**0.7**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
Litter	16.0	35.4	41.0	39.6	4.2	4.2
Bare ground	2.8	7.6	11.1	16.0	7.6	11.8
Gravel	61.1	34.7	44.4	41.0	87.5	83.3
Cobble	0.0	0.0	0.0	0.7	0.0	0.0
Rock	0.0	0.0	0.0	0.0	0.7	0.0
Total Abiotic	**79.9**	**77.7**	**96.5**	**97.3**	**100.0**	**99.3**

7.12 Area 16 Burn Seeding Project

In July 2020, the Area 16 Fire burned approximately 1,267 ha in predominantly blackbrush habitat between Tippipah Highway and Mid Valley Road. To establish a native perennial vegetation community to outcompete cheatgrass and reduce the risk of a wildland fire destroying power infrastructure, approximately 4.5 ha were seeded adjacent to an active powerline in December 2023. It is too expensive to revegetate the entire burned area, and therefore a seeding location was strategically selected to protect important infrastructure and habitat. The site was prepared by dragging a heavy chain harrow across the area to be seeded using a utility task vehicle (UTV). This technique loosens the surface, which facilitates seed coverage and promotes germination. Following harrowing, seed was broadcast on the surface using a drill seeder pulled behind the UTV. A light chain harrow dragged behind the seeder covered the seed. The seed mix was composed of nine shrub, three perennial grass, and three perennial forb species, seeded at a rate of 20 lbs of PLS/ac. The seeded area and a nonseeded control area were monitored in May 2024 and 2025 for plant density and percent plant cover to evaluate success. In 2025, an average of 0.53 seeded plants/m^2 were found with the dominant plant being Lewis Flax (*Linum perenne*) at 0.25 plants/m^2 with a few desert globemallow, Nevada jointfir, low rabbitbrush, and Indian ricegrass plants.



Figure 7-27. Aerial application of Rejuvra using the C-130 plane in north Mid Valley area.

(Photo by D.B. Hall, November 20, 2025)

7.13 Coordination with Habitat Restoration Practitioners

NNSS biologists interfaced with other habitat restoration practitioners in 2025 for the following activities:

- Participated in multiple conference calls for the DOE Invasive Species Working Group.
- Gave a presentation entitled “Operation Rejuvenation: Using Rejuvra to Reduce Wildland Fire Risk and Boost Revegetation Success on the Nevada National Security Site” at the North American Invasive Species Management Association annual conference in Lake Tahoe in November.
- Hosted a visit by Harry Quicke (ENVU [Rejuvra manufacturer] representative) on May 28 to show him the results of our cheatgrass and saltlover control efforts using Rejuvra.

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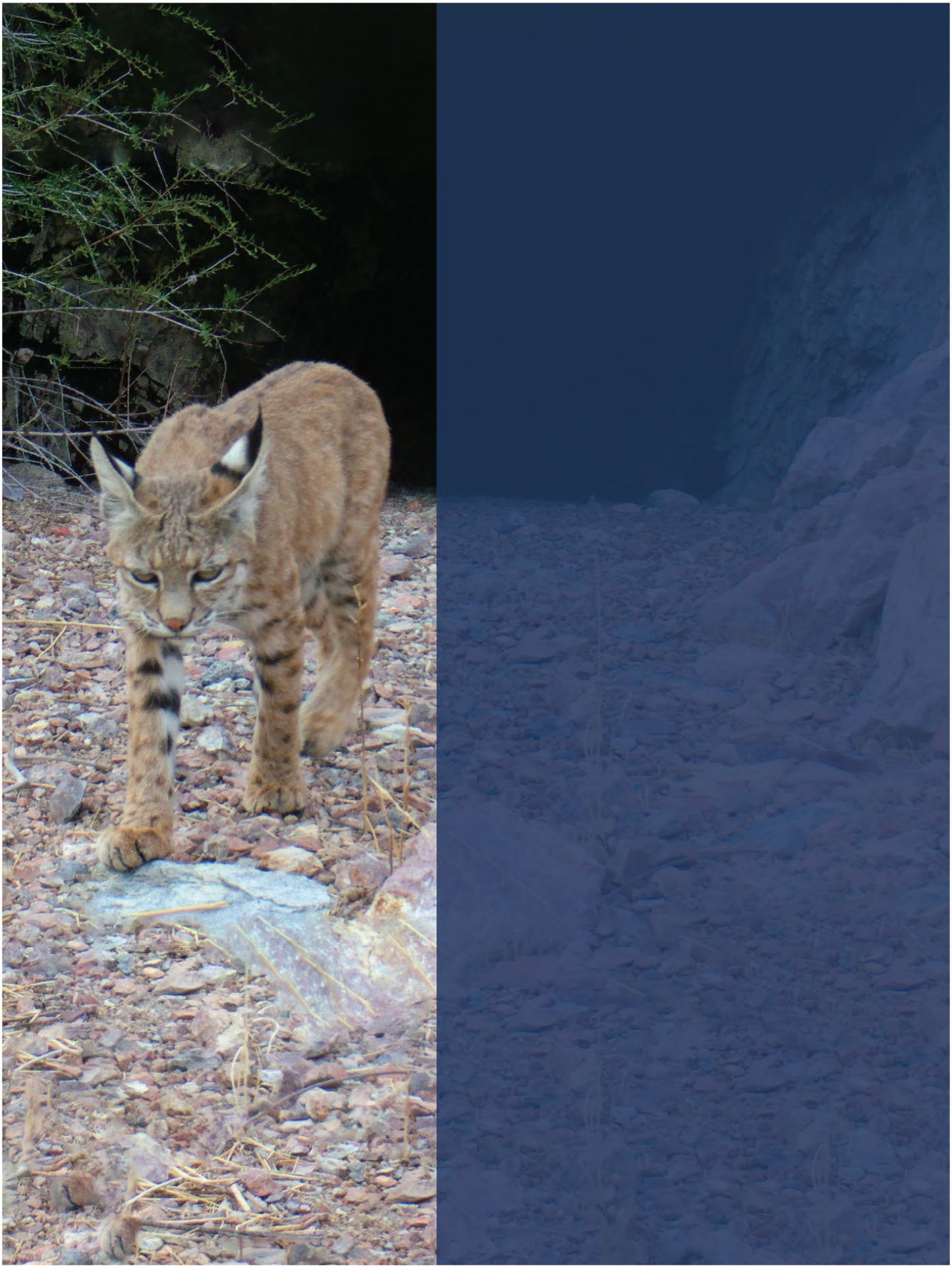



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