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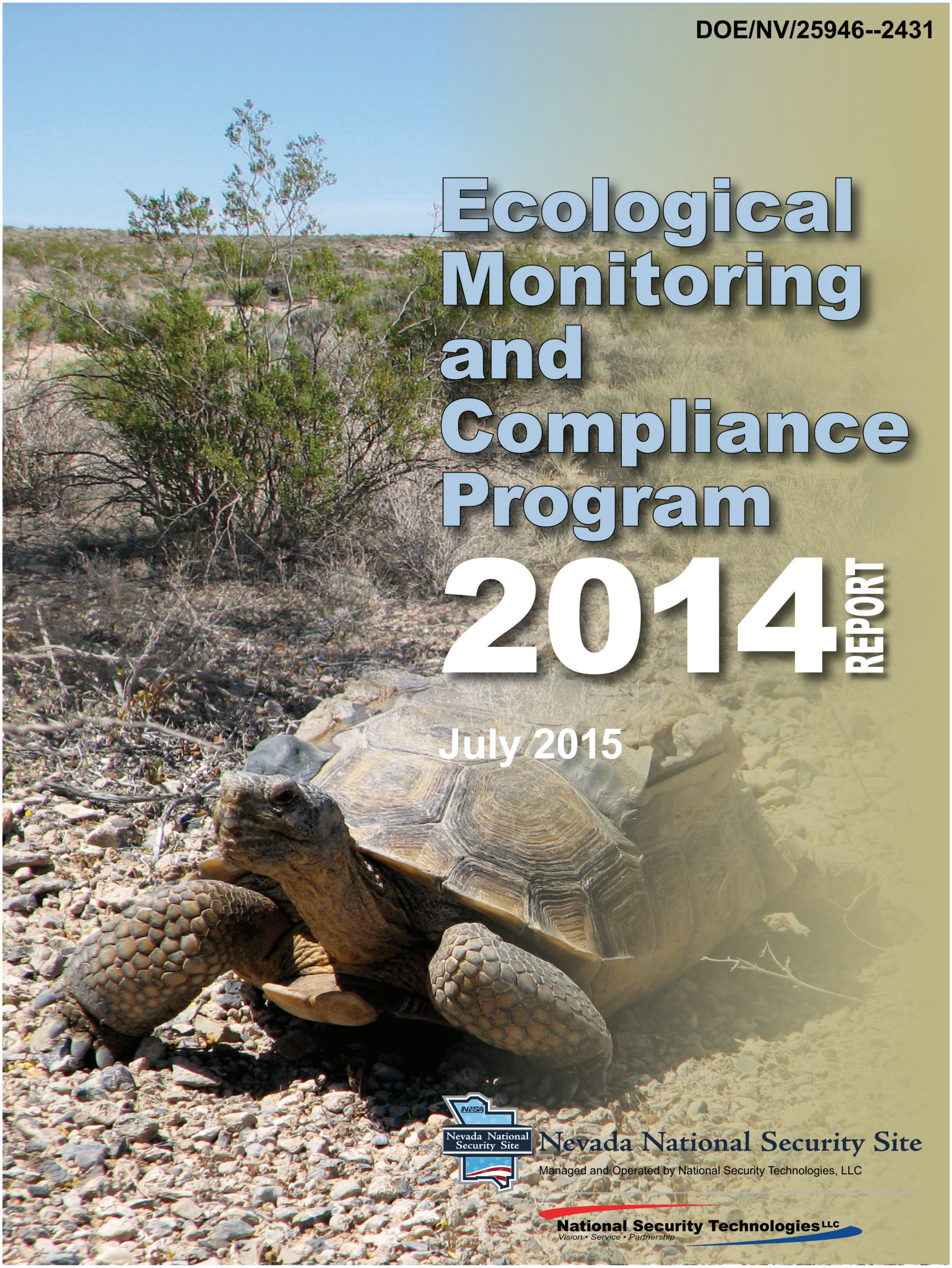


Ecological Monitoring and Compliance Program 2014 REPORT

July 2015

Nevada National Security Site

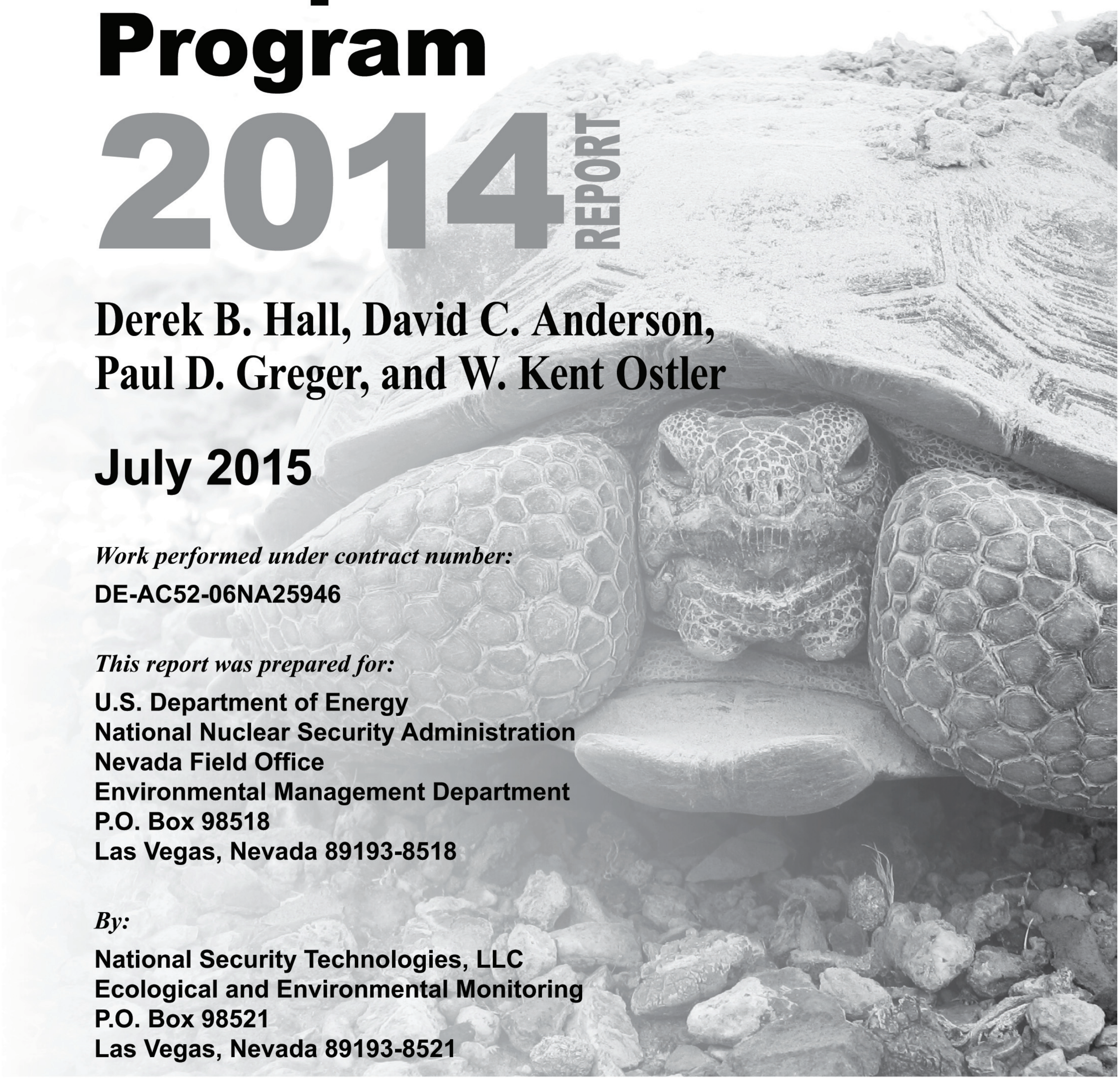
Managed and Operated by National Security Technologies, LLC

National Security Technologies LLC
Vision • Service • Partnership

DOE/NV/25946--2431

Ecological Monitoring and Compliance Program

2014 REPORT



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EXECUTIVE SUMMARY

The Ecological Monitoring and Compliance Program (EMAC), funded through the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO, formerly Nevada Site Office), monitors the ecosystem of the Nevada National Security Site (NNSS) and ensures compliance with laws and regulations pertaining to NNSS biota. This report summarizes the program's activities conducted by National Security Technologies, LLC (NSTec), during calendar year 2014. Program activities included (a) biological surveys at proposed activity sites, (b) desert tortoise compliance, (c) ecosystem monitoring, (d) sensitive plant species monitoring, (e) sensitive and protected/regulated animal monitoring, and (f) habitat restoration monitoring. During 2014, all applicable laws, regulations, and permit requirements were met, enabling EMAC to achieve its intended goals and objectives.

Sensitive and protected/regulated species of the NNSS include 42 plants, 1 mollusk, 2 reptiles, 236 birds, and 27 mammals. These species are protected, regulated, or considered sensitive according to state or federal regulations and natural resource agencies and organizations. The desert tortoise (*Gopherus agassizii*) and the western yellow-billed cuckoo (*Coccyzus americanus*) are the only species on the NNSS protected under the *Endangered Species Act*, both listed as threatened. However, only one record of the cuckoo has ever been documented on the NNSS, and there is no good habitat for this species on the NNSS. It is considered a rare migrant. Biological surveys for the presence of sensitive and protected/regulated species and important biological resources on which they depend were conducted for 18 projects. A total of 199.18 hectares (ha) was surveyed for these projects. Sensitive and protected/regulated species and important biological resources found during these surveys included a predator burrow, one sidewinder rattlesnake (*Crotalus cerastes),* two mating speckled rattlesnakes (*Crotalus mitchellii*), and several species of cacti. NSTec provided to project managers a written summary report of all survey findings and mitigation recommendations, where applicable.

Of the 18 projects on the NNSS, 15 occurred within the range of the threatened desert tortoise. Approximately 2.19 ha of desert tortoise habitat were disturbed. No desert tortoises were accidentally injured or killed by project activities, and no tortoises were killed by vehicles. On 13 occasions, tortoises were moved off the road and out of harm's way. Six tortoises were found and transmitters attached as part of an approved study to assess impacts of vehicles on tortoises on the NNSS. NSTec biologists continued to monitor 37 juvenile desert tortoises as part of a collaborative effort to study survival and temperament of translocated animals.

From 1978 until 2013, there has been an average of 11.2 wildland fires per year on the NNSS with an average of about 83.7 ha burned per fire. There were no wildland fires documented on the NNSS during 2014. Results from the wildland fuel surveys showed a very low risk of wildland fire due to reduced fuel loads caused by limited natural precipitation.

Limited reptile trapping and reptile roadkill surveys were conducted to better define species distribution on the NNSS. Sixteen reptiles were trapped representing five species. Combined with data from 2013, 183 road kills were detected, representing 11 snake and 8 lizard species. Selected natural water sources were monitored to assess trends in physical and biological parameters, and one new water source was found. Wildlife use at five water troughs and four radiologically contaminated sumps was documented using motion-activated cameras.

As part of the statewide effort to disseminate information throughout the botanical community, NSTec prepared a shape file with site-specific data for all 17 sensitive plants on the NNSS and provided it to the Nevada Natural Heritage Program for inclusion in their statewide database. No field surveys were conducted this year for sensitive plants on the NNSS due to poor growing conditions.

Surveys of sensitive and protected/regulated animals during 2014 focused on winter raptors, bats, wild horses (*Equus caballus*), mule deer (*Odocoileus hemionus*), desert bighorn sheep (*Ovis canadensis nelsoni*), and mountain lions (*Puma concolor*). Two permanent, long-term winter raptor survey routes were established and sampled in January and February. A total of 27 raptors representing 4 species were observed. The wild horse population increased from 30 to 41, with several yearlings recruiting into the population, possibly due to the death of a mountain lion known to prey on horse foals. Mule deer abundance and density measured with standardized deer surveys was similar to 2013 and appears to be stable. Desert bighorn sheep, including rams, ewes, and lambs, were detected using motion-activated cameras at four water sources. There are plans to conduct helicopter surveys to census the population during September 2015 and then capture and radio-collar up to 20 sheep during November 2015. Over 150 sheep scat samples have been collected for genetic analysis to try to determine how sheep on the NNSS are related to surrounding sheep populations. Information is presented about bird mortalities, *Migratory Bird Treaty Act* compliance, and a summary of nuisance animals and their control on the NNSS.

A total of 93 mountain lion images (i.e., photographs or video clips) were taken during 220,379 camera hours at 16 of 32 sites sampled and another 11,946 images of at least 29 species other than mountain lions were taken as well. A mountain lion telemetry study continued in 2014. NNSS7 was tracked from January 1 to November 15 using a global positioning system satellite transmitter. He consumed 21 mule deer, 17 desert bighorn sheep, 1 juvenile bobcat, and 3 coyotes. Mule deer were primarily taken in the summer and fall. No new mountain lions were captured. A minimum of four adult lions (two males, two females), a subadult male, and three kittens were known to inhabit the NNSS during 2014.

Two previously revegetated sites on the NNSS and one on the Tonopah Test Range (TTR) were monitored in 2014. The cover cap on the U-3ax/bl disposal unit, revegetated in 2000, and the 92-Acre Site at the Area 5 Radioactive Waste Management Complex, revegetated in 2011, were the restoration sites monitored on the NNSS. The Corrective Action Unit 407 Rollercoaster RADSAFE site, revegetated in 2000, was the restoration site monitored on the TTR. Plant cover and density were recorded at all sites except U-3ax/bl (qualitative monitoring), and reclamation success standards were evaluated, where applicable.

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ACRONYMS AND ABBREVIATIONS

A	area sampled
AIC	Akaike's Information Criterion
ASER	Annual Site Environmental Report
CAU	Corrective Action Unit
C	Celsius
CL	confidence limit
CL-L	lower confidence limit
CL-U	upper confidence limit
cm	centimeter(s)
CNTA	Central Nevada Test Area
D	density
df	degrees of freedom
DOE/NV	U.S. Department of Energy, Nevada Operations Office
EGIS	Ecological Geographic Information System
ELU	Ecological Landform Unit
EM	Environmental Monitor
EMAC	Ecological Monitoring and Compliance Program
ESW	Effective Strip Width
FWS	U.S. Fish and Wildlife Service
g	gram(s)
GIS	Geographic Information System
GPS	Global Positioning System
ha	hectare(s)
ICR	San Diego Zoo Institute for Conservation Research
INL	Idaho National Laboratory
kg	kilogram(s)
km	kilometer(s)
km^2	square kilometer(s)
L	transect length
LANL	Los Alamos National Laboratory
lpm	liter(s) per minute
m	meter(s)
m^2	square meter(s)

ACRONYMS AND ABBREVIATIONS (continued)

MCL	midline carapace length
MDC	minimum detectable concentration
mm	millimeter(s)
n	Sample Size
NAC	Nevada Administrative Code
NAD	North American Datum
NC	not collected
NDOW	Nevada Department of Wildlife
NNHP	Nevada Natural Heritage Program
NNPS	Nevada Native Plant Society
NNSA/NFO	U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office
NNSS	Nevada National Security Site
NOAA	National Oceanic and Atmospheric Administration
NSTec	National Security Technologies, LLC
NTTR	Nevada Test and Training Range
p	probability
pCi/g	picocurie(s) per gram
pCi/L	picocurie(s) per liter
POS	Post activity survey
PLS	Pure Live Seed
r^2	regression coefficient
RNCTEC	Radiological/Nuclear Countermeasures Test and Evaluation Complex
sd	standard deviation
spp.	species
TBD	to be determined
TCS	tortoise clearance survey
TTR	Tonopah Test Range
USACE	U.S. Army Corps of Engineers
USGS	U.S. Geological Survey
UTM	Universal Transverse Mercator
VHF	Very High Frequency

1.0 INTRODUCTION

In accordance with U.S. Department of Energy (DOE) Order DOE O 231.1B, "Environment, Safety, and Health Reporting," the Office of the Assistant Manager for Environmental Management of the U.S. Department of Energy, National Nuclear Security Administration Nevada Field Office (NNSA/NFO, formerly Nevada Site Office) requires ecological monitoring and biological compliance support for activities and programs conducted at the Nevada National Security Site (NNSS). National Security Technologies, LLC (NSTec), Ecological and Environmental Monitoring has implemented the Ecological Monitoring and Compliance Program (EMAC) to provide this support. 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 2014, all applicable laws, regulations, and permit requirements were met, enabling EMAC to achieve its intended goals and objectives.

This report summarizes the EMAC activities conducted by NSTec during calendar year 2014. Monitoring tasks during 2014 included six program areas: (a) biological surveys, (b) desert tortoise compliance, (c) ecosystem monitoring, (d) sensitive plant monitoring, (e) sensitive and protected/regulated animal monitoring, and (f) habitat restoration monitoring. The following sections of this report describe work performed under these six areas.

2.0 BIOLOGICAL SURVEYS

Biological surveys are performed at project sites where land-disturbing activities are proposed. The goal is to minimize adverse effects of land disturbance on sensitive and protected/regulated plant and animal species (Table 2-1), their associated habitat, and other important biological resources. Sensitive species are defined as species that are at risk of extinction or serious decline or whose long-term viability has been identified as a concern. They include species on the Nevada Natural Heritage Program (NNHP) Animal and Plant At-Risk Tracking List (NNHP 2015) and bat species ranked as moderate or high in the Revised Nevada Bat Conservation Plan Bat Species Risk Assessment (Bradley et al. 2006). Protected/regulated species are those that are protected or regulated by federal or state law. Many species are both sensitive and protected/regulated (Table 2-1). Important biological resources include cover sites, nest or burrow sites, roost sites, or water sources important to sensitive species. Survey reports document species and resources found and provide mitigation recommendations.

2.1 Sites Surveyed and Sensitive and Protected/Regulated Species Observed

During 2014, biological surveys for 18 projects were conducted on the NNSS (Figure 2-1 and Table 2-2). Five projects had multiple site locations. Scientists surveyed a total of 199.18 hectares (ha) for the projects (Table 2-2). Fifteen projects were within the range of the threatened desert tortoise (*Gopherus agassizii*). Sensitive and protected/regulated species and important biological resources found included a predator burrow, one sidewinder rattlesnake (*Crotalus cerastes),* two mating speckled rattlesnakes (*Crotalus mitchellii*), and several species of cacti (Table 2-2). NSTec provided written summary reports to project managers of survey findings and mitigation recommendations, where applicable (Table 2-2).

2.2 Potential Habitat Disturbance

Surveys are conducted for all activities that would disturb habitat, including new projects, routine maintenance activities, or cleanup activities at old industrial or nuclear weapons testing sites. These surveys are required whenever vegetation has re-colonized old disturbances and sensitive or protected/regulated species are known to occur in the area. For example, desert tortoises may move through revegetated earthen sumps and may be concealed under vegetation during activities where heavy equipment is used. Biological surveys and tortoise clearance surveys are conducted to ensure that desert tortoises are not in harm's way. Burrowing owls frequently inhabit burrows and culverts at disturbed sites, so surveys are conducted to ensure that adults, eggs, and nestlings are not harmed.

Of the 18 projects surveyed, 14 were within sites previously disturbed (e.g., road shoulders, old building sites, industrial waste sites, or existing well pads) (Table 2-2). Four projects were located totally or partially in areas that had not been previously disturbed. These projects could potentially disturb roughly 6.36 ha of land that were previously considered undisturbed (one project has been proposed, but the activity has not yet occurred). During vegetation mapping of the NNSS (Ostler et al. 2000), Ecological Landform Units (ELUs) were evaluated for importance. Some ELUs were identified as *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) (U.S. Department of Energy, Nevada Operations Office [DOE/NV] 1998). A single ELU could be classified as more than one type of these four types of important habitats. No projects occurred in areas designated as important habitats, so the total area disturbed in hectares since 1999 remained the same as last year; 9.46 (Pristine), 17.31 (Unique), 339.84 (Sensitive), and 87.05 (Diverse).

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

Plant Species	Common Names	Status[a]
Moss Species		
Entosthodon planoconvexus	Planoconvex cordmoss	S, H
Flowering Plant Species		
Arctomecon merriamii	White bearpoppy	S, M
Astragalus beatleyae	Beatley's milkvetch	S, H
Astragalus funereus	Black woollypod	S, H
Astragalus oophorus var. *clokeyanus*	Clokey eggvetch	S, W
Camissonia megalantha	Cane Spring suncup	S, M
Cymopterus ripleyi var. *saniculoides*	Sanicle biscuitroot	S, M
Eriogonum concinnum	Darin buckwheat	S, M
Eriogonum heermannii var. *clokeyi*	Clokey buckwheat	S, W
Frasera pahutensis	Pahute green gentian	S, M
Galium hilendiae ssp. *kingstonense*	Kingston Mountains bedstraw	S, H
Hulsea vestita ssp. *inyoensis*	Inyo hulsea	S, W
Ivesia arizonica var. *saxosa*	Rock purpusia	S, H
Penstemon fruticiformis ssp. *Amargosae*	Death Valley beardtongue	S, H
Penstemon pahutensis	Pahute Mesa beardtongue	S, W
Phacelia beatleyae	Beatley scorpionflower	S, M
Phacelia filiae	Clarke phacelia	S, M
Phacelia mustelina	Weasel phacelia	S, Ma
Agavaceae	Yucca (3 species), Agave (1 species)	CY
Cactaceae	Cacti (18 species)	CY
Juniperus osteosperma	Juniper	CY
Pinus monophylla	Pinyon	CY

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

Animal Species	Common Name	Status[a]
Mollusk Species		
Pyrgulopsis turbatrix	Southeast Nevada pyrg	S, A
Reptile Species		
Plestiodon gilberti rubricaudatus	Western red-tailed skink	S, IA
Gopherus agassizii	Desert tortoise	LT, S, NPT, A
Bird Species[b]		
Accipiter gentilis	Northern goshawk	S, NPS, IA
Alectoris chukar	Chukar	G, IA
Aquila chrysaetos	Golden eagle	EA, NP, IA
Buteo regalis	Ferruginous hawk	S, NP, IA
Callipepla gambelii	Gambel's quail	G, IA
Coccyzus americanus	Western yellow-billed cuckoo	LT, S, NPS, IA
Corvus brachyrhynchos	American crow	G, IA
Falco peregrinus	Peregrine falcon	S, NPE, IA
Haliaeetus leucocephalus	Bald eagle	EA, S, NPE, IA
Ixobrychus exillis hesperis	Western least bittern	S, NP, IA
Lanius ludovicianus	Loggerhead shrike	NPS, IA
Oreoscoptes montanus	Sage thrasher	NPS, IA
Phainopepla nitens	Phainopepla	S, NP, IA
Spizella breweri	Brewer's sparrow	NPS, IA
Toxostoma bendirei	Bendire's thrasher	S, NP, IA
Toxostoma lecontei	LeConte's thrasher	S, NP, IA
Mammal Species		
Antilocapra americana	Pronghorn antelope	G, IA
Antrozous pallidus	Pallid bat	M, NP, A
Cervus elaphus	Rocky Mountain elk	G, IA
Corynorhinus townsendii	Townsend's big-eared bat	S, H, NPS, A
Equus asinus	Burro	H&B, A
Equus caballus	Horse	H&B, A
Euderma maculatum	Spotted bat	S, M, NPT, A

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

Animal Species	Common Name	Status[a]
Lasionycteris noctivagans	Silver-haired bat	M, A
Lasiurus blossevillii	Western red bat	S, H, NPS, A
Lasiurus cinereus	Hoary bat	M, A
Lynx rufus	Bobcat	F, IA
Microdipodops megacephalus	Dark kangaroo mouse	NP, A
Microdipodops pallidus	Pale kangaroo mouse	S, NP, A
Myotis californicus	California myotis	M, A
Myotis ciliolabrum	Small-footed myotis	M, A
Myotis evotis	Long-eared myotis	M, A
Myotis thysanodes	Fringed myotis	S, H, NP, A
Myotis yumanensis	Yuma myotis	M, A
Ovis canadensis nelsoni	Desert bighorn sheep	G, IA
Odocoileus hemionus	Mule deer	G, A
Pipistrellus hesperus	Western pipistrelle	M, A
Puma concolor	Mountain lion	G, A
Sylvilagus audubonii	Audubon's cottontail	G, IA
Sylvilagus nuttallii	Nuttall's cottontail	G, IA
Tadarida brasiliensis	Brazilian free-tailed bat	NP, A
Urocyon cinereoargenteus	Gray fox	F, IA
Vulpes macrotis	Kit fox	F, IA

[a]Status Codes:
Endangered Species Act, U.S. Fish and Wildlife Service
LT - Listed Threatened
C - Candidate for listing

U.S. Department of Interior
H&B - Protected under *Wild Free Roaming Horses and Burros Act*
EA - Protected under *Bald and Golden Eagle Act*

State of Nevada – Animals
S - Nevada Natural Heritage Program – Animal and Plant At Risk Tracking List
NPE - Nevada Protected-Endangered, species protected under Nevada Administrative Code (NAC) 503
NPT - Nevada Protected-Threatened, species protected under NAC 503
NPS - Nevada Protected-Sensitive, species protected under NAC 503

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

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 - Nevada Natural Heritage Program (NNHP) – Animal and Plant At-Risk Tracking List
CY - Protected as a cactus, yucca, or Christmas tree

NNSS Sensitive Plant Ranking
H - High
M - Moderate
W - Watch
Ma - Marginal

Long-term Animal Monitoring Status for the NNSS
A - Active
IA - Inactive

The Revised Nevada Bat Conservation Plan – Bat Species Risk Assessment
H - High
M - Moderate

[b] All bird species on the NNSS are protected by the *Migratory Bird Treaty Act* except for chukar, Gambel's quail, English house sparrow, Rock dove, and European starling.

Sources used: NNHP 2015, Nevada Native Plant Society (NNPS) 2015, NAC 2015, U.S. Fish and Wildlife Service (FWS) 2015, Bradley et al. 2006

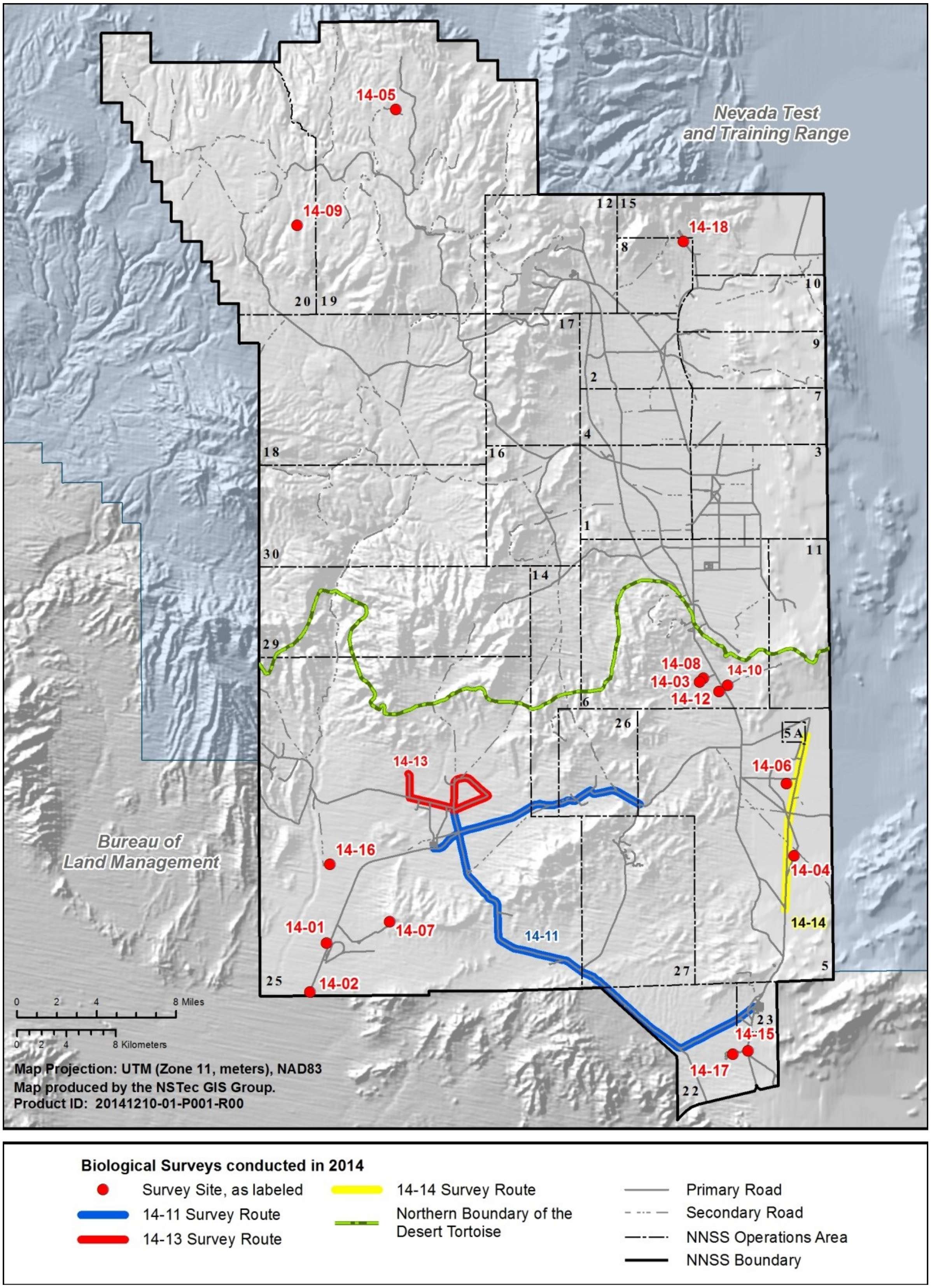

Figure 2-1. Biological surveys conducted on the NNSS during 2014

Table 2-2. Summary of biological surveys conducted on or near the NNSS during 2014

Project No.	Project	Important Species/Resources Found	Area Surveyed (ha)	Proposed Project Area in Undisturbed Habitat (ha)	Mitigation Recommendations
14-01	MX Silos	None	1.26	0	TCS required, EM needed
14-02	Lathrop Wells Gate	None	0.01	0	TCS required
14-03	DAF Lightning Protection	None	0.24	0	TCS required, EM needed
14-04	Desert FACE Power	None	0.30	0	TCS required
14-05	Grade Roads at Range 19	None	4.29	4.10	None
14-06	UGTA Sampling Wells RNM #1, #2	None	0.10	0	TCS required
14-07	X Tunnel Power Project	None	0.18	0.18	TCS required, EM needed
14-08	DAF Drainage	None	0.80	0	TCS required
14-09	U20AZ Drill Pad Construction	None	2.17	0	None
14-10	Tumbleweed Test Range	None	2.01	2.01	TCS required; Mitigation paid
14-11	Road Edge Mowing (Cane Springs, Jackass Flats, Lathrop Wells)	Predator burrow; Sidewinder Rattlesnake; 2 Speckled Rattlesnakes	108.80	0	TCS required, EM needed
14-12	WSI Security Exercise	None	0.88	0	POS required
14-13	Road Edge Mowing (F,G,H roads)	None	71.56	0	TCS required, EM needed
14-14	Road Edge Grading (5-01 road)	None	4.37	0	TCS required, EM needed
14-15	Area 22 Parking Areas	None	0.23	0	TCS required, EM needed
14-16	Area 25 Water Line Repair	None	0.03	0	TCS required
14-17	Building 22-1 Power	None	0.24	TBD	TCS required
14-18	Area 15 Road/Parking Lot Blading	None	1.71	0.07	None
		Total ha	**199.18**	**6.36**	

EM – Environmental Monitor; TCS – Tortoise Clearance Survey; POS – Post Activity Survey; TBD – to be determined

3.0 DESERT TORTOISE COMPLIANCE

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

The Desert Tortoise Compliance task of EMAC implements the terms and conditions of the 2009 Opinion, documents compliance actions taken by NNSA/NFO, and assists NNSA/NFO in FWS consultations. All terms and conditions listed in the Opinion were implemented by NSTec staff biologists in 2014, including (a) conducting clearance surveys at project sites within 1 day from the start of project construction, (b) ensuring that project managers have environmental monitors on site during site clearing and heavy equipment operation, (c) developing effects analysis for proposed disturbances to append to the Opinion, and (d) preparing an annual compliance report for NNSA/NFO submittal to the FWS.

3.1 Project Surveys and Compliance Documentation

During 2014, biologists conducted desert tortoise clearance surveys prior to ground disturbing activities for 15 proposed projects within the range of the desert tortoise on the NNSS. One project (14-07, X Tunnel Power Project) was submitted for FWS approval in 2014 and appended to our Opinion (Table 3-1 and Figure 3-1). Most of the remaining projects were in, or immediately adjacent to, roads, existing facilities, or other disturbances. No desert tortoises were observed in project areas.

Two projects were initiated that disturbed previously undisturbed desert tortoise habitat. Project 14-07 disturbed 0.18 ha of desert tortoise habitat in 2014 (Table 3-1). A second project 14-10, Tumbleweed Test Area at the Radiological/Nuclear Countermeasures Test and Evaluation Complex (RNCTEC), disturbed 2.01 ha and is still ongoing; however, payment for all of the RNCTEC Expansion projects was made in 2011.

Post-activity surveys to quantify the acreage of tortoise habitat actually disturbed were conducted for 14 projects during this reporting period (Table 3-1). All projects stayed within proposed project boundaries. Post-activity surveys are generally not conducted if the projects are located within previously disturbed areas or if the environmental monitor documented that the project stayed within its proposed boundaries.

Table 3-1. Summary of tortoise compliance activities conducted by site biologists during 2014

Project Number	Project	Compliance Activities 100% Coverage Clearance Survey	Tortoise Habitat Disturbed (Ha)
14-01	MX Silos	Yes, post-activity survey completed	0
14-02	Lathrop Wells Gate	Yes, post-activity survey completed	0
14-03	DAF Lightning Protection	Yes, post-activity survey completed	0
14-04	FACE power line	Yes, post-activity survey completed	0
14-06	UGTA Sampling Wells RNM #1, #2	Yes, post-activity survey completed	0
14-07	X Tunnel Power Project	Yes, post-activity survey completed	0.18
14-08	DAF Drainage	Yes, post-activity survey completed	0
14-10	Tumbleweed Test Range	Yes, post-activity survey completed	2.01
14-11	Road Edge Mowing (Cane Spring, Jackass flats, Lathrop Wells)	Yes, post-activity survey completed	0
14-12	WSI Security Exercises	Yes, post-activity survey completed	0
14-13	Road Edge Mowing (F,G, H)	Yes, post-activity survey completed	0
14-14	Road Edge Grading (5-01 Road)	Yes, post-activity survey completed	0
14-15	Area 22 Parking Areas	Yes, post-activity survey completed	0
14-16	Area 25 Water Line Repair	Yes, post-activity survey completed	0
14-17	Building 22-1 Power	Activity not yet started	
		TOTAL	2.19

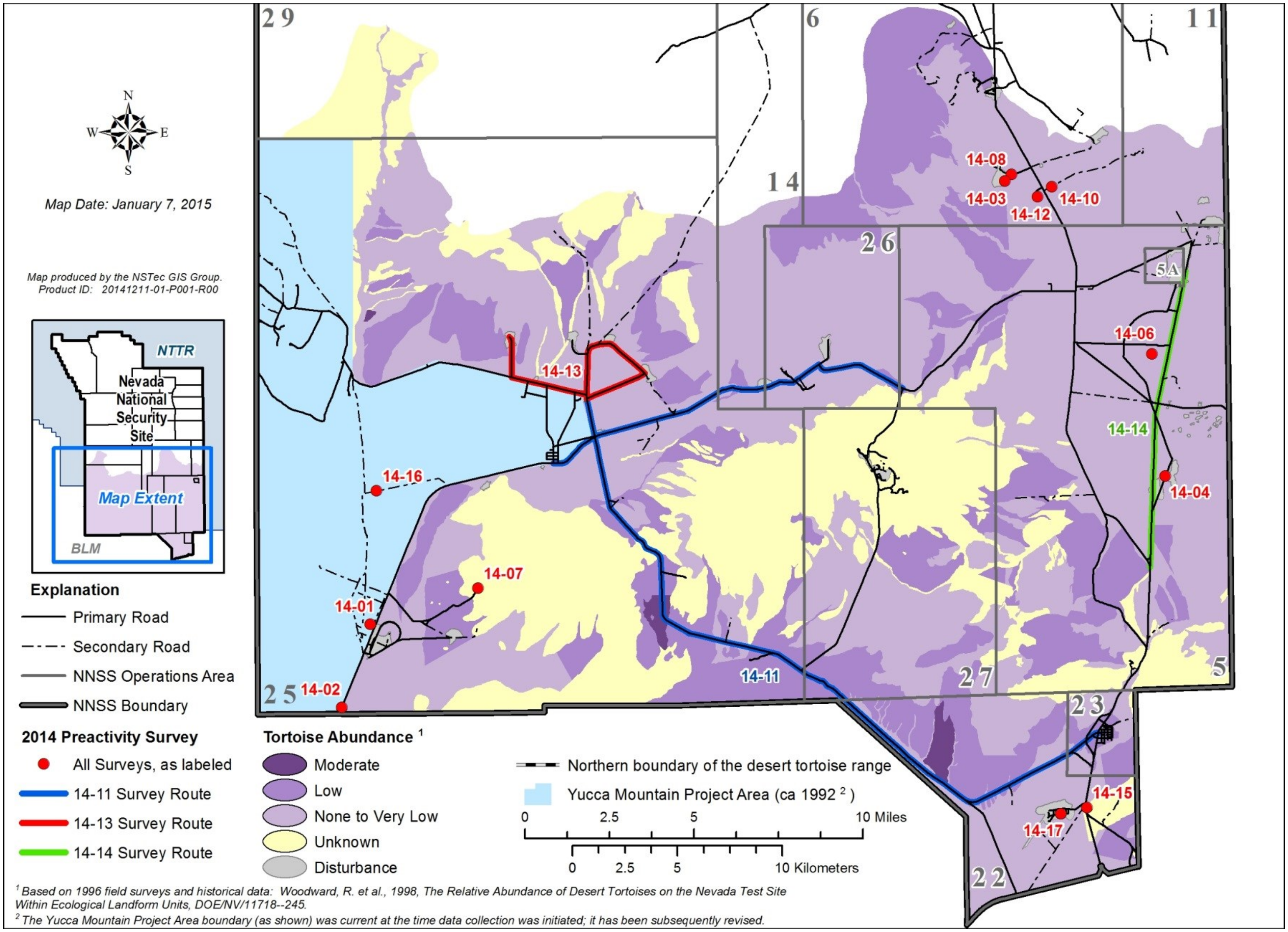

Figure 3-1. Biological surveys conducted in desert tortoise habitat on the NNSS during 2014

In January 2014, the annual report that summarized tortoise compliance activities conducted on the NNSS from January 1 through December 31, 2013, was submitted to the FWS. This report, required under the Opinion, contains (a) the location and size of land disturbances that occurred within the range of the desert tortoise during the reporting period; (b) the number of desert tortoises injured, killed, or removed from project sites; (c) a map showing the location of all tortoises sighted on or near roads on the NNSS; and (d) a summary of construction mitigation and monitoring efforts.

Compliance with the Opinion ensures that the desert tortoise is protected on the NNSS and that the cumulative impacts on this species are minimized (DOE/NV 1998). In the Opinion, the FWS determined that the "incidental take" 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. During this calendar year, the threshold levels established by the FWS for these parameters were not exceeded (Table 3-2). No desert tortoises were accidentally injured or killed by project activities. No tortoises were killed by vehicles during 2014. On 13 occasions, tortoises were moved off the road and out of harm's way. These are included in tortoise observations in Figure 3-2. Six tortoises were found and transmitters attached as part of an approved study to assess impacts of vehicles on tortoises on the NNSS (see Section 3.3.1, Desert Tortoise Road Study). The 13 tortoises that were moved from roads and an additional 4 that received transmitters bring the total take for Roads in the "Other" category to 76 for 2009 to 2014 (Table 3-2). The cumulative take of tortoises killed or injured on NNSS roads remains at seven from 2009 to 2014 (Table 3-2).

Table 3-2. Cumulative incidental take (2009–2014) and maximum allowed take for NNSA/NFO programs

Program	Number of Hectares Impacted (maximum allowed)	Number of Tortoises Anticipated to be Incidentally Taken (maximum allowed)	
		Killed/Injured	Other
Defense	2.27 (202)	0 (1)	0 (10)
Waste Management	0 (40)	0 (1)	0 (2)
Environmental Restoration	0 (4)	0 (1)	0 (2)
Non-Defense R&D	0 (607)	0 (2)	0 (35)
Work for Others	13.15* (202)	0 (1)	0 (10)
Infrastructure Development	3.41 (40)	0 (1)	0 (10)
Roads	0 (0)	7 (15)	76 (125)
Totals	**18.83 (1,095)**	**7 (22)**	**76 (194)**

*Project is not yet completed but is anticipated to disturb 42.2 hectares over the life of the project. The actual amount disturbed will be reported in each annual report.

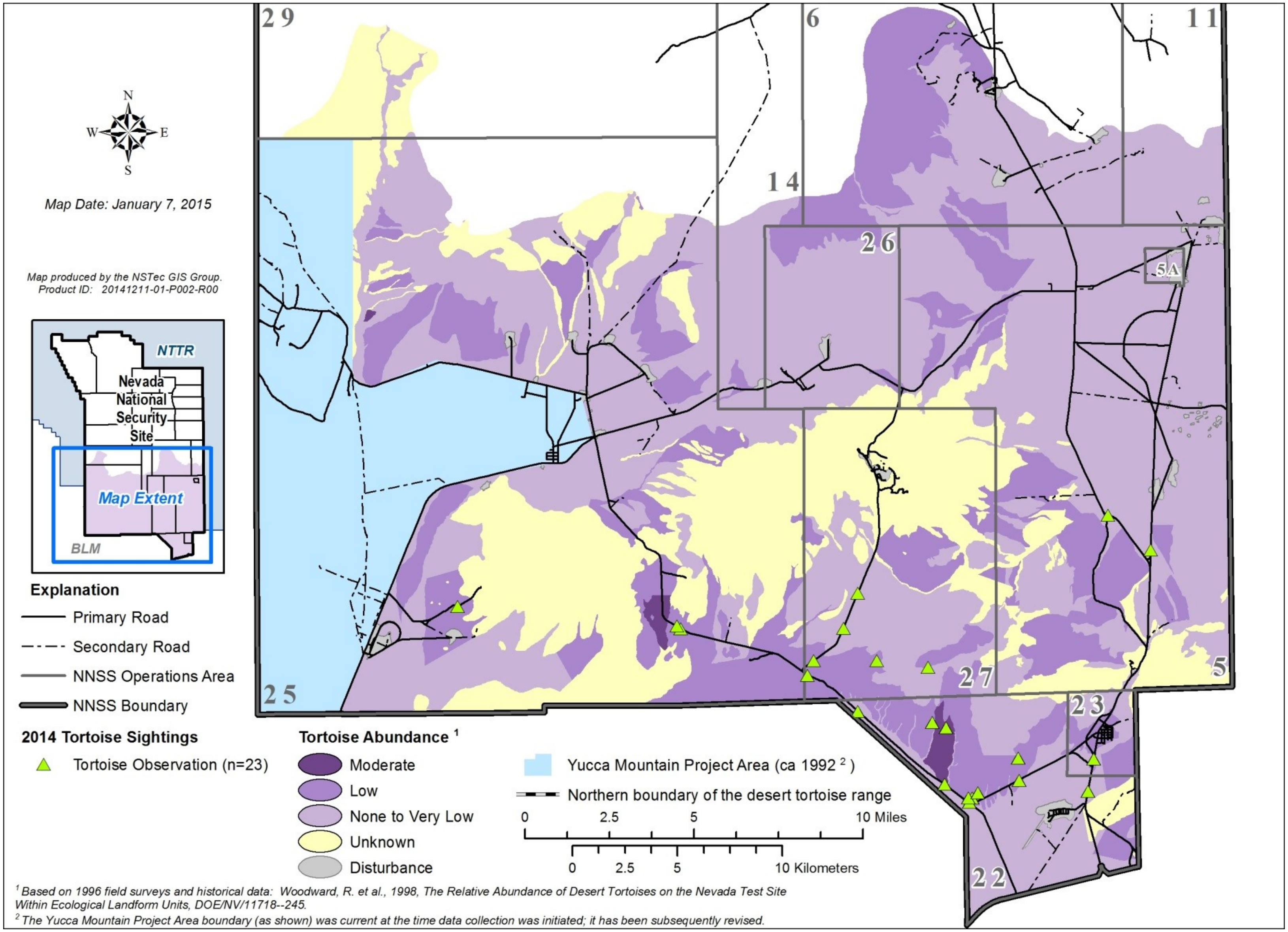

Figure 3-2. Observations of desert tortoises generally found along roads during 2014

3.2 Mitigation for Loss of Tortoise Habitat

Mitigation for the loss of tortoise habitat is required under the terms and conditions of the Opinion. The Opinion requires NNSA/NFO to perform one of two mitigation options: (a) prepay funds into the Desert Tortoise Mitigation Funds, or (b) prepay mitigation funds at the current rate, then revegetate disturbed habitat following specified criteria; once the revegetation is successful, the money paid for mitigation will be refunded. Two projects (14-07 and 14-10) disturbed tortoise habitat in 2014. Project 14-07 disturbed 0.18 ha, so a total of $386.95 was deducted from the Service-approved accrued funds for NNSS conservation programs. The other project disturbed 2.01 ha as part of the RNCTEC Expansion that was paid for in 2011.

3.3 Conservation Recommendation Studies

Three desert tortoise projects have been approved by the FWS and are being implemented by NNSS and U.S. Geological Survey (USGS) biologists. The following is a synopsis of activities conducted for each of these projects since 2012. One of the conservation recommendations of the Opinion (FWS 2009) states that NNSA/NFO:

> ***should develop a strategy to minimize road mortalities on the NNSS by focusing efforts on roads that have a history of mortality or that traverse higher density desert tortoise areas*** *(page 29 of the Opinion)***.**

In order to address this conservation recommendation, results from prior desert tortoise surveys and historical roadside observation/mortality data were analyzed using a Geographic Information System (GIS) to identify areas with higher densities of desert tortoises and areas that may be at higher risk for tortoise mortalities caused by vehicles along NNSS roads. This analysis suggested the need for a better understanding of desert tortoise activity near roads with high desert tortoise use and the effects of the zone of depression (up to 0.4 kilometers [km]) on tortoise abundance (Boarman and Sazaki 2006) in order to better develop the strategy to minimize road mortalities.

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

3.3.1 Desert Tortoise Road Study

A desert tortoise road study was initiated in May 2012. The main objectives of this study are to (a) determine fine-scale patterns of habitat use of desert tortoises found near roads on the NNSS and (b) assess the risk of desert tortoise road mortality on the NNSS. A secondary objective is to assess the health and condition of desert tortoises on the northern periphery of their range.

In 2012, 11 desert tortoises (4 males and 7 females) were found (Figure 3-3) during the tortoise activity period and fitted with very high frequency (VHF) and Global Positioning System (GPS) transmitters. During 2013, an additional seven desert tortoises (five males and two females) were captured (Figure 3-3) and transmitters were attached to their shells. All 18 desert tortoises were monitored with VHF transmitters through 2013 except GOAG 13, which was found dead on June 26, 2013, after being captured on May 14, 2013. It had been either killed or scavenged by a coyote or bobcat. Only 15 of the remaining 17 tortoises were monitored with the GPS transmitters due to the limited number of transmitters available.

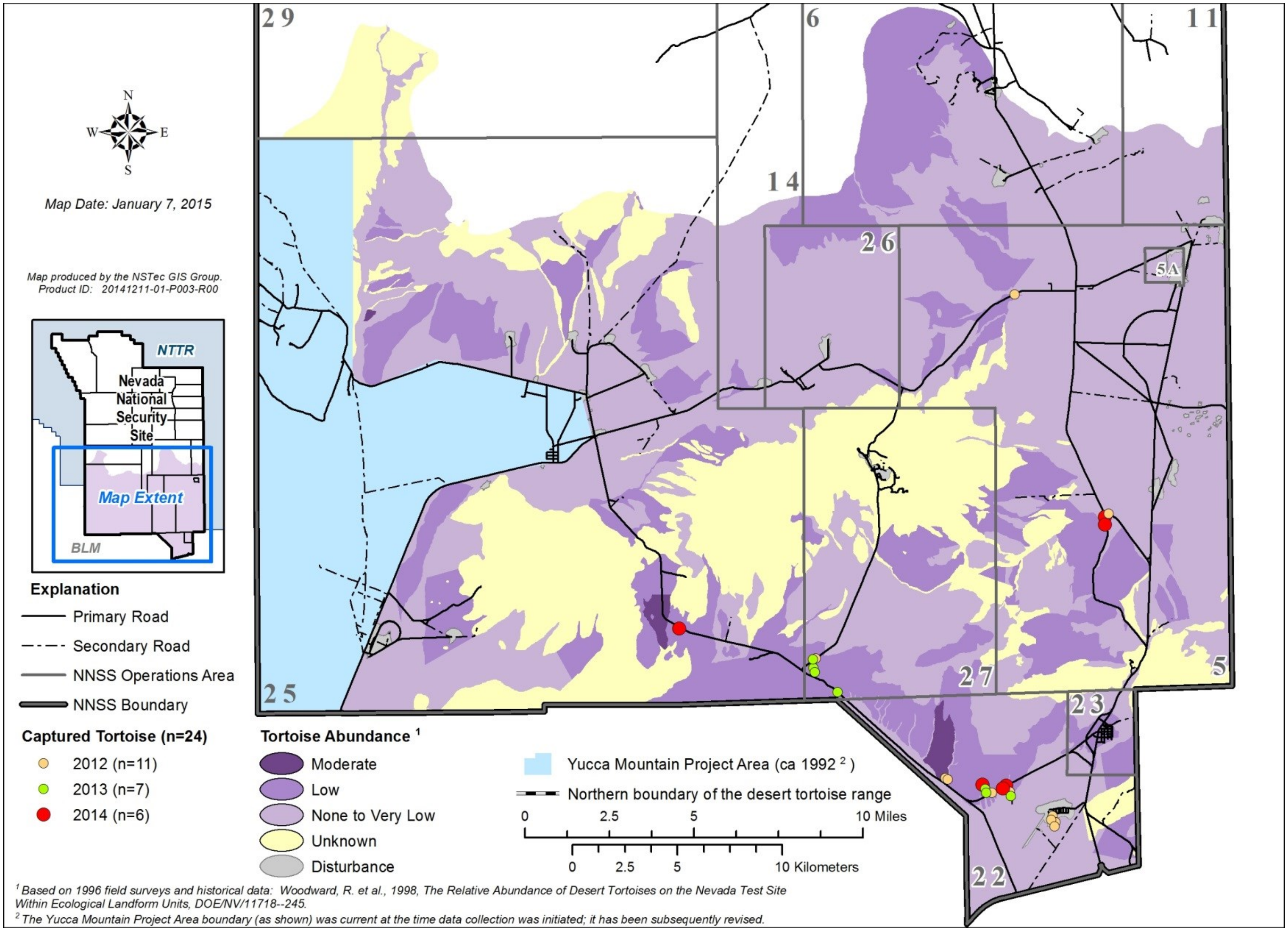

Figure 3-3. Initial desert tortoise capture locations during 2012 (yellow), 2013 (green), and 2014 (red) at the NNSS

During 2014, an additional six desert tortoises (four males, one female, and one unknown) were captured and radio-tagged (Figure 3-3). Four of these were captured opportunistically as a result of reports of desert tortoises spotted along roads by workers. One of the males (GOAG 24) was radio-tagged when it was found interacting with a tagged female tortoise. Two of the tortoises were considerably smaller than the other tortoises in the study, and they received a smaller/lighter GPS transmitter (i-gotU), which scientists from USGS had recommended. During 2014, a total of 23 radio-tagged tortoises were monitored at a frequency of roughly once per week during the active period (March through October) and once per month during the inactive period (November through February).

Table 3-3 lists capture information for each of the 24 tortoises in the study. Health assessments were conducted in September 2014 by biologists from the San Diego Zoo's Institute for Conservation Research for all tortoises that were accessible. All tortoises assessed were in good shape and had been able to survive the long drought period from winter to summer of 2014. Health assessment data will be reported when the project is completed. Additional animals that are captured in 2015 will be monitored if they are found along areas where radio-tagged tortoises currently do not occur. The current permit allows for up to 30 individuals to be captured and monitored. The 2015 season will be the last year for adding new individuals to the study. The processing and analysis of data from the GPS receivers attached to the tortoises is ongoing. The goal is to have a minimum of two years of data for each tortoise for analysis. When the data is fully processed and summarized, it will be provided to the Service.

Table 3-3. Desert tortoise capture information for the NNSS road mitigation project (MCL = midline carapace length; NC = not collected)

Tortoise ID	Capture Date	Capture Time	Body Condition Score	Bladder Voided	VHF Transmitter Frequency	Sex	Weight (g)	Size MCL (mm)
GOAG 1	5/10/2012	1110	4	No	162.215	F	3938	285
GOAG 2	5/15/2012	0900	6	No	162.187	F	1938	233
GOAG 3	5/17/2012	0945	5	Yes	162.511	M	4688	288
GOAG 4	5/24/2012	1100	4	No	162.472	F	3368	257
GOAG 5	5/29/2012	1100	4	No	162.692	F	2928	243
GOAG 6	6/01/2012	0645	5	No	162.231	M	2208	227
GOAG 7	6/11/2012	1055	5	No	162.805	F	2338	238
GOAG 8	6/13/2012	1000	4	No	162.551	F	2988	258
GOAG 9	6/26/2012	0825	4	No	162.787	F	2298	251
GOAG10	7/12/2012	0922	5	No	162.431	M	2264	230
GOAG11	9/27/2012	1220	5	No	162.131	M	3788	257
GOAG12	4/30/2013	0900	4	No	162.263	F	3958	277
GOAG13	5/14/2013	0815	3.5	Yes	162.071	M	1800	206
GOAG14	6/12/2013	0905	4	No	162.001	F	2168	214
GOAG15	8/14/2013	1000	4.5	No	162.861	M	4018	280
GOAG16	9/04/2013	1000	4	No	162.971	M	5538	307
GOAG17	9/05/2013	0740	4	No	162.071	M	4198	282
GOAG18	9/11/2013	1256	4	No	162.497	M	4020	277
GOAG19	5/14/2014	1245	4	No	161.612	F	2400	253
GOAG20	6/11/2014	720	3.5	No	161.668	U	950	180
GOAG21	7/01/2014	818	5	No	162.620	M	4115	306
GOAG22	8/27/2014	950	5	No	162.347	M	1605	215
GOAG23	9/08/2014	1500	4.5	No	161.552	M	3738	258
GOAG24	10/09/2014	1400	NC	No	161.669	M	NC	NC

3.3.2 Juvenile Translocation Study

In September 2012, 60 captive juvenile tortoises were translocated from the Desert Tortoise Conservation Center in Las Vegas to the southern edge of the NNSS in Area 22 to evaluate the survival of juvenile tortoises released in the wild. The NNSS provides one of the largest protected habitat areas in southern Nevada. The project is part of a long-term collaborative effort involving the FWS, NNSS, and the San Diego Zoo Institute for Conservation Research (ICR). Few studies have investigated translocated, juvenile tortoise survival, so data obtained from this study will be valuable to assess translocation as a possible means of recovery of the tortoise. Each tortoise had a VHF transmitter attached to its shell for tracking purposes (Figure 3-4). Regular monitoring was conducted during 2014—twice in January, twice in February, weekly March through October, once in November, and once in December. Tortoises were also monitored mid-January 2015. Mid-January 2014 monitoring results showed that 37 of 60 (62%) tortoises were still alive. Mid-January 2015 monitoring results showed that 31 of 60 (52%) were known to be alive. One male tortoise (#4003) went missing during August. The transmitter it was carrying either malfunctioned or the tortoise moved a very long distance. Five tortoises were found dead this year (Table 3-4). Four of the five dead tortoises were chewed up, apparently having been scavenged or predated. The remaining tortoise was found dead but had not been chewed on. Numerous ants were found on the carcass.

Figure 3-4. Juvenile tortoise (Scurry) with a VHF transmitter attached
(Photo by D. B. Hall, September 15, 2014)

Table 3-4. Mortality, sex, distance (m) between release site and winter burrows, total distance between monitored locations, and number of burrows used by 37 juvenile desert tortoises monitored during 2014 (Year 1 = 2012–2013, Year 2 = 2013–2014, Year 3 = 2014–2015)

Tortoise Number	Sex	Distance Release to Year 1 Winter Burrow	Distance Year 1 to Year 2 Winter Burrow	Distance Year 2 to Year 3 Winter Burrow	Total Distance between locations Winter 2014-15	Number of Burrows Used
4001	Female	60	57	Dead 5/29	NA	NA
4028	Female	49	32	Dead 3/11	NA	NA
4009	Female	32	2	0	73	2
4010	Female	533	703	59	1108	4
4014	Female	567	65	81	299	4
4021	Female	9	23	44	401	6
4030	Female	68	45	102	1191	4
4044	Female	102	293	53	1106	7
4045	Female	158	75	0	989	7
4046	Female	398	1	0	248	2
4049	Female	1136	89	0	576	2
4052	Female	810	1022	201	2363	4
4057	Female	2414	30	0	1438	9
4000	Male	119	2	Dead 9/23	NA	NA
4003	Male	2278	408	Missing 8/19	NA	NA
4013	Male	633	8	Dead 9/11	NA	NA
4035	Male	1171	2	Dead 6/23	NA	NA
4004	Male	183	67	0	268	3
4005	Male	156	49	60	819	4
4007	Male	42	148	0	275	2
4011	Male	240	121	126	2128	4
4018	Male	124	76	38	534	5
4019	Male	215	22	71	1636	6
4024	Male	704	121	29	753	5
4025	Male	1069	336	0	1100	6
4033	Male	89	3	57	1097	8
4034	Male	20	95	0	1204	5
4036	Male	19	612	0	850	9
4037	Male	147	60	0	1172	4
4038	Male	16	63	33	1159	6
4040	Male	62	505	79	1683	4
4041	Male	42	11	0	2089	4
4042	Male	43	70	1142	2291	7
4048	Male	37	2	92	1481	6
4053	Male	332	4	0	799	2
4055	Male	6132	179	0	1523	2
4050	Unknown	60	92	186	1104	6
	Average	488	150	79	1089	5

Table 3-4 contains information about the 37 juvenile tortoises monitored during 2014. On average, the distance between the release location and first winter burrow (i.e., the burrow a juvenile was in the first part of January) was 488 meters (m) (Range 9–6,132 m; standard deviation [sd] 1,036 m). The average distance between the first winter burrow and the second winter burrow was substantially less at 150 m (Range 1–1,022 m; sd 227 m). The average distance between the second winter burrow and the third winter burrow was 79 m (Range 0–1,142 m; sd 201 m). Nearly 84% (26 of 31) of tortoises wintered in burrows within 100 m of their last year's winter burrow with 45% (14 of 31) using the same winter burrow as the prior year.

The distance (m) between monitoring checks was calculated and is summarized in Table 3-4. This is not the total distance a tortoise moved during the year, but the distance between locations recorded during regular monitoring. Tortoises obviously moved on days between monitoring checks, which was not measured. For females the average distance was 890 m, and for males 1,203 m. A two-tailed, t-test was used to determine if this difference was statistically significant at $\alpha = 0.05$. It was not significant ($p = 0.19$). The average distance between locations for all 31 surviving tortoises by monitoring period was also calculated and is shown in Figure 3-5 along with precipitation (millimeters [mm]) by monitoring period. Peaks of movement occurred in April and May and again in late July through late September. The latter peak happened to coincide with some significant rainfall events.

During 2014, burrows were marked with unique numbers and data taken including Universal Transverse Mercator (UTM) coordinates (North American Datum [NAD] 83), burrow height, burrow width, burrow orientation, elevation, location, topographic position, vegetation cover and substrate. The number of unique burrows an individual used was calculated (Table 3-4) to give some idea of how many burrows these juveniles were using. It is important to note that we were only documenting tortoise locations weekly, and therefore we know we may not have documented all burrows used. The number of unique burrows marked and measured was 157. Average height of burrows was 8.9 mm (Range 5–31 mm; sd 3.0 mm) and average width of burrows was 17.2 mm (Range 9–58 mm; sd 5.1 mm). Burrow orientation showed significant differences, with eastern and southern exposures used more than expected ($\chi^2 = 20.7$; $p < 0.001$; degrees of freedom [df] = 3). Average elevation of burrows was 1,087 m (Range 1,055–1,193 m; sd 18.7 m).

Observations made from late January 2014 to early January 2015 on the 31 surviving juvenile tortoises totaled 1,262. Figure 3-6 illustrates the percentage of time tortoises were found in various locations. Three-fourths of observations were of tortoises either inside their burrows, in the burrow entrance, or on the burrow apron. The remaining one-fourth of observations found tortoises in the open or under vegetation. On two occasions, tortoises were under rock shelters (not included in Figure 3-6). Tortoises were found under 16 different vegetation species and under mixed shrub clumps. Figure 3-7 depicts the percentage of observations tortoises were found under vegetation by species. Most noteworthy is the dominance of blackbrush (*Coleogyne ramosissima*) with nearly 40% of observations of tortoises found under vegetation found under this particular species. The "Other" category included white bursage (*Ambrosia dumosa*) (4.5%), burrobrush (*Hymenoclea salsola*) (3.2%), Fremont's dalea (*Psorothamnus fremontii*) (2.7%), shinyleaf sandpaper plant (*Petalonyx nitidus*) (1.8%), spiny hopsage (*Grayia spinosa*) (1.4%), littleleaf ratany (*Krameria erecta*) (0.9%), fourwing saltbush (*Atriplex canescens*) (0.9%), broom snakeweed (*Gutierrezia sarothrae*) (0.5%), turpentinebroom (*Thamnosma montana*) (0.5%), desert almond (*Prunus fasciculata*) (0.5%), and brittlebush (*Encelia farinosa*) (0.5%).

Tortoises used burrows on wash slopes and in the wash bottom more than expected ($\chi^2 = 143.5$; $p < 0.001$; df = 4) (Figure 3-8). Vegetation cover at burrows was found at 92% of the burrows, suggesting this is an important factor in burrow selection for these juveniles (Figure 3-9). Vegetation species did not seem to be as important with 16 different species represented. Mixed shrub clumps seemed to be the dominant cover. White bursage (3.2%), fourwing saltbush (2.5%), burrobrush (1.9%), littleleaf ratany (1.3%), spiny

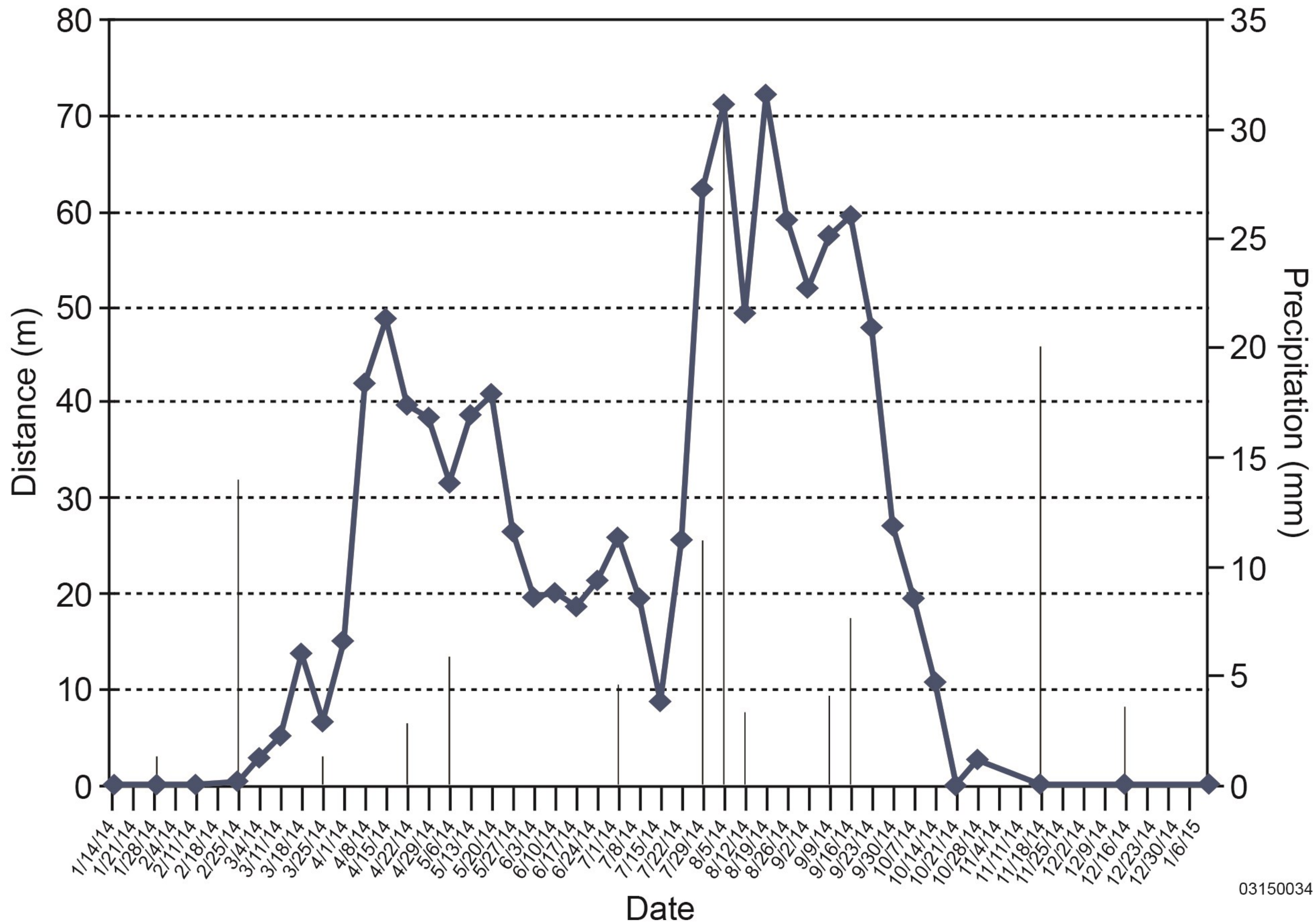

Figure 3-5. Average distance (m) between locations for 31 surviving tortoises and precipitation (mm) received by monitoring period, January 2014–2015

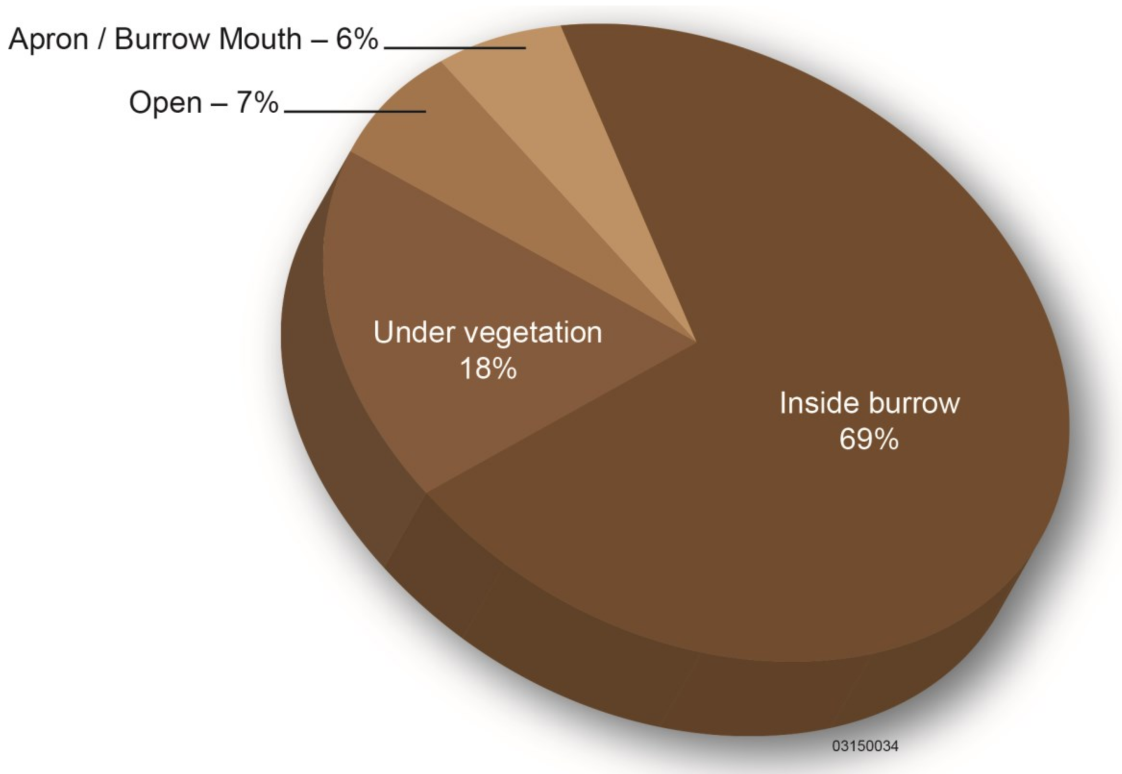

Figure 3-6. Percentage of observations (n = 1,260) of 31 juvenile tortoises by location, January 2014–2015

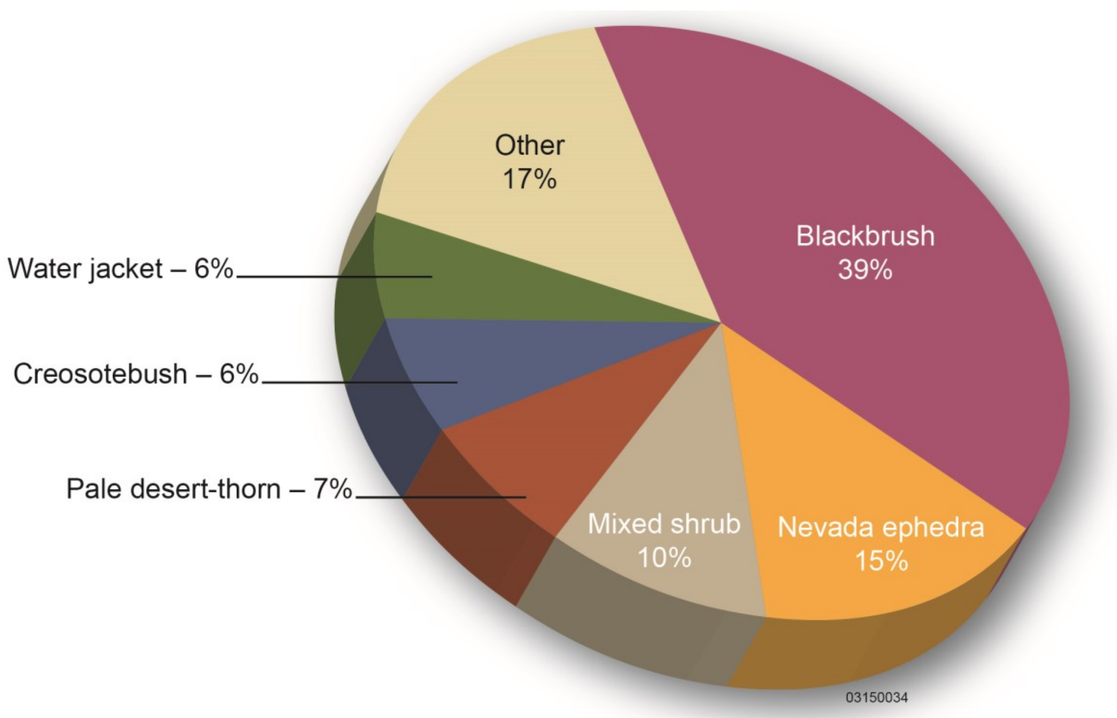

Figure 3-7. Percentage of observations (n = 221) of 31 juvenile tortoises found under vegetation by species, January 2014–2015

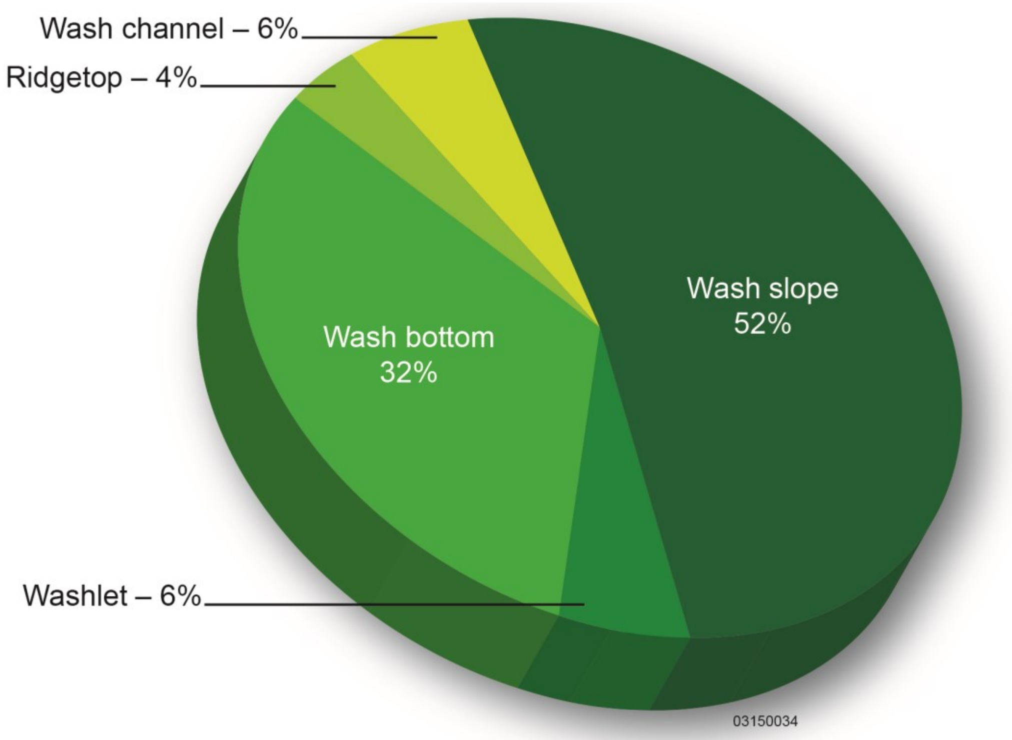

Figure 3-8. Percentage of juvenile tortoise burrows by topographic position, January 2014–2015 (n = 157)

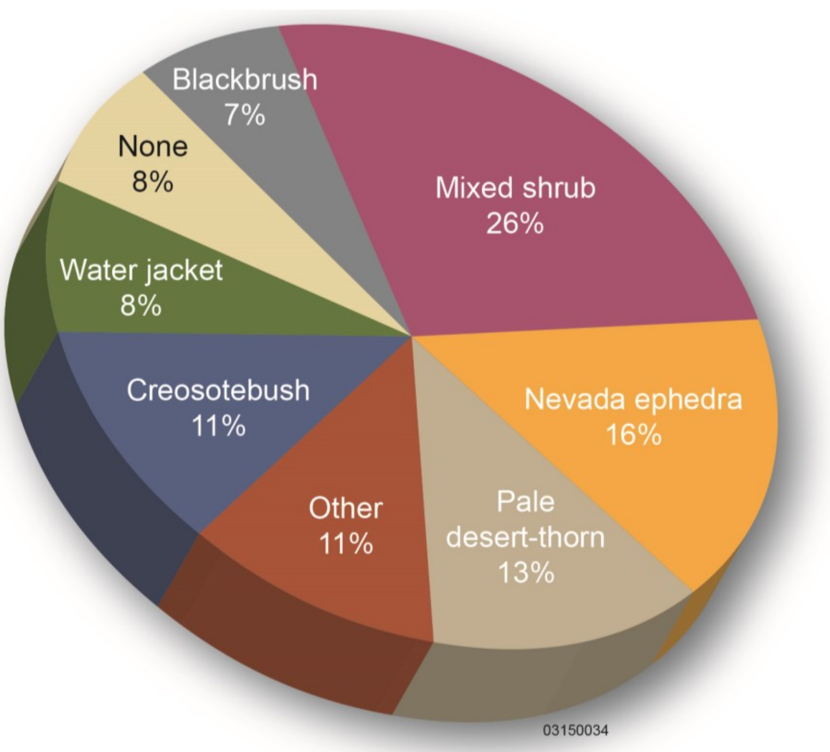

Figure 3-9. Percentage of juvenile tortoise burrows by vegetation cover at the burrow, January 2014–2015 (n = 157)

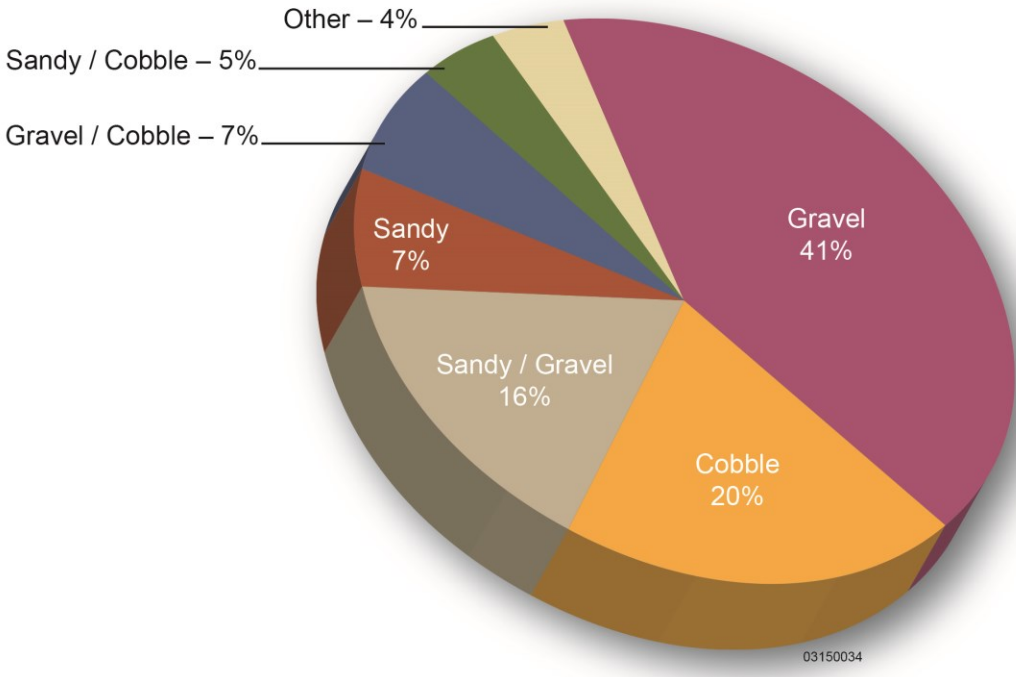

Figure 3-10. Percentage of juvenile tortoise burrows by substrate, January 2014–2015 (n = 157)

hopsage (1.3%), shinyleaf sandpaper plant (0.6%), and longspine horsebrush (*Tetradymia axillaris*) (0.6%) made up the other category.

Gravel was the dominant substrate at juvenile tortoise burrows (Figure 3-10). The other category included caliche (1.3%), cobble/rock (1.3%), sandy/gravel/cobble (0.6%), and desert pavement (0.6%). Gravel is defined as rocks <2.5 centimeters (cm) in size, cobble as rocks between 2.5 and 12.7 cm, and rock as >12.7 cm. Combined categories such as sandy/gravel means that both were about equal in abundance.

On average, tortoises used five unique burrows (Range 2–9; sd = 2) (Table 3-4). Five burrows were used by multiple tortoises. Sharing of burrows was documented for four tortoises at two burrows (4037 and 4041 shared Burrow#814 for about three weeks late March to early April; 4042 and 4048 shared Burrow#815 from January to early March).

Evidence of foraging was documented on 26 individual tortoises 94 times during 1,262 observations (7.4%) of 31 juveniles between January 2014 and January 2015. Foraging was detected between March 11 and September 30, 2014, with peaks in April, August, and September (Figure 3-11). Very little annual plant production occurred during the spring, but 44 mm of rain fell in August and another 12 mm in September, which resulted in a flush of vegetative growth in late summer. This may explain the peaks of foraging in August and September. Desert globemallow (*Sphaeralcea ambigua*) was most frequently eaten (14.9%). It was eaten in April, May, June, August, and September. Although few annuals were available, desert globemallow germinated and resprouted with winter rains, so it was green from April into late June when it dried up. The August rain caused the globemallow to green back up and provided a good food source for the tortoises. Other species eaten were beavertail pricklypear (*Opuntia basilaris*) (2.1%), water jacket (*Lycium andersonii*) (1.1%), Mojave woodyaster (*Xylorhiza tortifolia*) (1.1%), Indian ricegrass (*Achnatherum hymenoides*) (1.1%), Fremont's dalea (1.1%), and bluedick (*Dichelostemma capitatum*) (1.1%). Dry annuals were also detected including red brome (*Bromus rubens*). On two separate occasions, kit fox scat (April 22) and scat from an unknown species (September 15) was eaten by two different tortoises. Most (71.3%) of the time, it was not possible to identify what the tortoises had eaten.

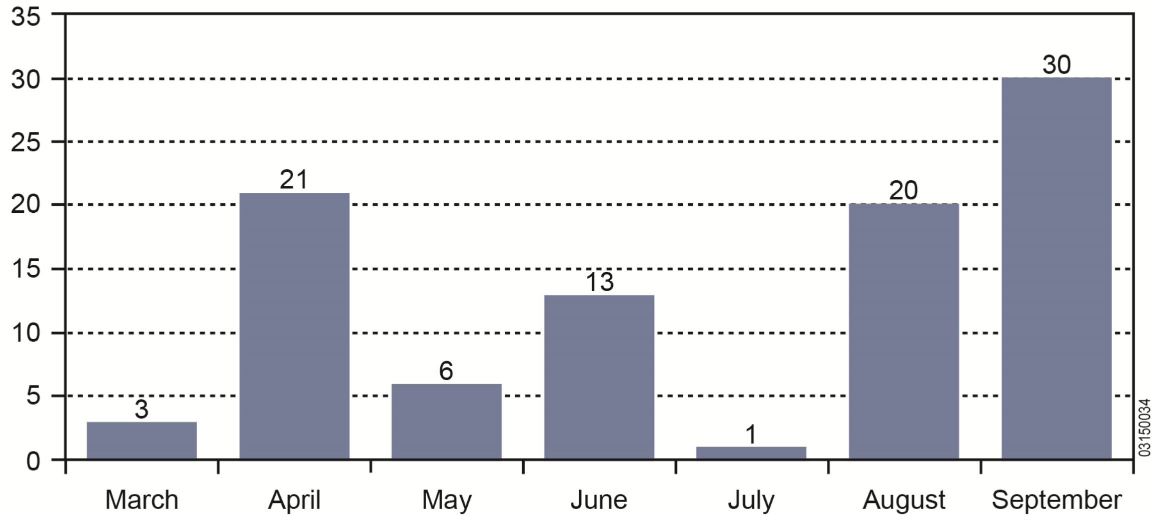

Figure 3-11. Number of times evidence of foraging was detected by month for 31 juvenile tortoises, January 2014–2015 (n = 94). (No evidence of foraging was detected in October, November, December, January, or February.)

During the month of September 2014, each tortoise was given a detailed health assessment, weighed and measured, and assigned a body condition score. Blood samples were also taken and analyzed for the presence of antibodies (i.e., ELISA test) to two pathogens known to cause upper respiratory disease in desert tortoises, *Mycoplasma agassizii* and *M. testudineum*. Similar health assessments were performed during September 2013 and before the tortoises were released in August and September 2012. This allows for comparison of growth rates, weight change, and overall health and body condition score over time. Blood from 2012 has not been analyzed yet. Weights for most tortoises were taken with transmitters attached in September 2013, so an estimated weight without transmitters was calculated by subtracting the average weight of 6-month (13 grams [g]) and 12-month (26 g) transmitter attachments from September 2014 measurements.

Of the 60 released, 30 were male, 29 were female, and the gender of 1 was unknown. Of the 31 still known to be alive in mid-January 2015, 20 are male and 11 are female. Thus, male survival is 67% and female survival is 38%, 28 months post-release. This suggests that in our translocated captive juveniles, female juvenile tortoises experience higher mortality than males. Given the importance of females surviving to adulthood to reproduce, this may be a critical life stage for females, and if female juveniles are not making it to sexual maturity, this could be a factor in declining tortoise populations. This warrants further study particularly in wild tortoise populations.

Table 3-5 contains data on mid-carapace length (MCL) (mm) and weight for the juvenile tortoises between fall 2012 and September 2014. The average pre-release MCL of 28 females and 30 males was 126 mm and 131 mm, respectively, with an overall average of 128 mm for 59 tortoises (MCL was not measured on one tortoise). Average pre-release weight of 29 females and 30 males was 413 g and 447 g, respectively, with an overall average weight of 427 g for all 60 tortoises (one tortoise was of unknown gender). Average pre-release MCL of 17 tortoises that died during the first year (September 2012–September 2013) was the same as the 43 that survived (128 mm). Average pre-release weight of 17 tortoises that died during the first year and 43 survivors was 447 g and 420 g, respectively. Of the 17 tortoises that died during the first year, 11 were female, 5 were male, and 1 was of unknown gender. Of the 10 tortoises that died during the second year (September 2013–September 2014), 7 were female and 3 were male. Another male (#4000) was found dead in late September 2014 (Year 3) after the health assessments were completed.

Table 3-5. Mid-carapace length (mm) and weight (g) without transmitters for 60 juvenile tortoises, September 2012–2014 (* = dead; ** = estimated weight)

Tortoise Number	Sex	Pre-release MCL (mm) (2012)	Year 1 MCL (mm) (Sep 2013)	Year 2 MCL (mm) (Sep 2014)	Pre-release Weight w/o (g) (2012)	Year 1 Weight w/o (g) (Sep 2013)	Year 2 Weight w/o (g) (Sep 2014)
4001	Female	105	106	*	221	223**	*
4002	Female	148	*	*	622	*	*
4008	Female	115	*	*	265	*	*
4009	Female	138	138	138	472	444**	565
4010	Female	Unknown	143	144	590	606**	662
4012	Female	149	*	*	752	*	*
4014	Female	136	138	140	485	446**	521
4015	Female	123	122	*	356	235**	*
4016	Female	124	*	*	370	*	*
4017	Female	103	103	*	202	194	*
4021	Female	120	120	120	329	290	341
4022	Female	104	*	*	246	*	*
4028	Female	146	146	*	548	490**	*
4029	Female	127	129	*	414	412**	*
4030	Female	148	150	151	562	630	673
4031	Female	102	*	*	202	*	*
4032	Female	111	*	*	294	*	*
4039	Female	117	*	*	315	*	*
4043	Female	111	112	*	249	271**	*
4044	Female	146	145	146	484	555**	610
4045	Female	129	129	132	400	437**	504
4046	Female	126	130	137	476	465**	619
4047	Female	128	127	*	400	297	*
4049	Female	106	106	107	238	231**	272
4051	Female	119	*	*	316	*	*
4052	Female	115	120	125	325	345**	405
4054	Female	145	*	*	656	*	*
4056	Female	149	*	*	758	*	*
4057	Female	132	134	148	435	481**	650
4000	Male	99	101	102	205	222**	238
4003	Male	114	119	*	309	361**	*
4004	Male	117	116	116	303	244**	288
4005	Male	140	140	140	564	534**	596
4006	Male	144	*	*	606	*	*
4007	Male	121	120	121	363	338**	352
4011	Male	144	150	157	634	579**	793
4013	Male	135	134	*	421	366**	*
4018	Male	105	105	105	213	183**	234
4019	Male	150	150	158	654	636**	838
4020	Male	126	127	*	383	437**	*
4023	Male	146	*	*	519	*	*
4024	Male	146	148	154	565	645**	815
4025	Male	127	128	128	357	325**	429
4026	Male	132	*	*	473	*	*
4027	Male	115	*	*	291	*	*
4033	Male	126	130	129	430	418**	452
4034	Male	128	130	134	407	401**	495
4035	Male	135	136	*	458	469**	*
4036	Male	132	135	136	455	490**	521
4037	Male	105	106	108	223	224	251
4038	Male	132	134	140	457	486	573
4040	Male	140	140	142	493	489**	595
4041	Male	119	118	120	322	300**	370
4042	Male	124	126	127	387	372	447
4048	Male	135	138	147	480	516	662
4050	Male	138	139	142	502	502	573
4053	Male	150	151	153	681	670**	712
4055	Male	151	155	162	602	690**	804
4070	Male	147	*	*	652	*	*
4058	Unknown	108	*	*	257	*	*

Two-tailed t-tests were used to test for significant differences at α = 0.05. Pre-release MCL and weight did not differ significantly between males and females (p = 0.21 and p = 0.38, respectively). The average growth in MCL for survivors during the first year was 1.0 mm for females (n = 17) and 1.5 mm for males (n = 25). This difference was not significant (p = 0.41) The average growth for survivors between the first and second year (September 2013–September 2014) was 3.2 mm for females (n = 11) and 2.9 mm for males (n = 21). This difference was not significant (p = 0.83). The average weight change for survivors during the first year was −7 g for females (n = 18) and 1 g for males (n = 25). This difference was not significant (p = 0.54). The average weight change for survivors between the first and second year was 81 g for females (n = 11) and 84 g for males (n = 21). This difference was not significant (p = 0.87). Regardless of gender, pre-release MCL and weight did not significantly impact first-year survival (p = 0.98 and p = 0.60, respectively). In summary, tortoises grew very little during the first year as measured by MCL and weight. In fact, females actually lost weight. In contrast, tortoises grew about 3 mm and increased in weight on average over 80 g during the second year. This might be due to better forage availability based on timing and amount of precipitation or that tortoises expended more energy the first year as they "settled in" their new habitat after being raised in captivity.

Overall body condition scores have all been in the healthy range, between 4 and 5, since the time of release with no clear pattern of decline or increase in body condition score (Table 3-6). Three tortoises (4007 and 4038 [males] and 4016 [female]) in 2012 had mild serous discharge from the nares, and several tortoises have had sunken eyes and some swelling around the eyes. ELISA test results for 2013 and 2014 are reported in Table 3-6. In 2013, seven tortoises tested positive for *M. agassizii* while in 2014, four tested positive. Two juveniles that tested positive in 2013 died during the next year whereas nine that tested negative died. One juvenile changed from negative to positive and two changed from positive to negative. In 2013, nine tortoises tested positive for *M. testudineum* while in 2014, three tested positive. Two juveniles that tested positive in 2013 died during the next year whereas eight that tested negative died. No tortoises went from negative to positive, and two went from positive to negative. These data suggest that mortality is not due to poor health or upper respiratory disease.

The biggest factor for survival appears to be gender with higher survival of males than females. This has been observed by other researchers as well (Hall 2014). Size, weight, overall health, and presence of *Mycoplasma* do not seem to have any significant impact on survival. While it is impossible to determine if a tortoise was scavenged or preyed upon, a majority of dead tortoises have shown signs of being chewed on by mammalian predators. Given the healthy status and low disease prevalence in the juveniles, it seems unlikely that they are dying and then being scavenged. This suggests that most of the mortality is due to predation. Coyote (*Canis latrans*) and kit fox (*Vulpes macrotis*) tracks have been observed on multiple occasions while conducting tortoise monitoring, and these canids appear to be the main predators killing juvenile tortoises. The disparity between male and female mortality remains unknown. Why predators seek out female tortoises unknown. Why predators seek out female tortoises more than males is a question yet to be answered. Given the fact that coyotes and kit foxes use olfaction as their dominant sense, it is possible that females are giving off scent that makes them easier to detect or perhaps something about their behavior makes them more susceptible to predation. More research is needed to help understand the interaction between tortoises and their predators.

All juveniles were at their winter 2013–2014 burrow by October 21, 2013, and nearly three-fourths of them were there by October 1, 2013. For the 2014–2015 winter burrows, all juveniles were at the burrows by November 17, 2014, and just over half of them were there by October 1, 2014. All but two juveniles (94%) were at their 2014–2015 winter burrow by October 23, 2014. NSTec will continue monitoring the remaining juveniles for a minimum of 1–5 years. Data analysis and publications will be a joint effort between NNSA/NFO and ICR.

Table 3-6. Body condition score and ELISA test results for 60 juvenile tortoises, September 2012–2014 (* = dead)

Tortoise Number	Sex	Pre-release Body Condition (2012)	Year 1 Body Condition (Sep 2013)	Year 2 Body Condition (Sep 2014)	Year 1 ELISA Status *M. agassizii* (Sep 2013)	Year 2 ELISA Status *M. agassizii* (Sep 2014)	Year 1 ELISA Status *M. testudineum* (Sep 2013)	Year 2 ELISA Status *M. testudineum* (Sep 2014)
4001	Female	5	4	*	Negative	*	Negative	*
4002	Female	4	*	*	*	*	*	*
4008	Female	4	*	*	*	*	*	*
4009	Female	4	5	5	Negative	Negative	Negative	Negative
4010	Female	4	5	5	Negative	Negative	Positive	Positive
4012	Female	4	*	*	*	*	*	*
4014	Female	5	5	4	Positive	Positive	Suspect	Suspect
4015	Female	4	4	*	Positive	*	Suspect	*
4016	Female	5	*	*	*	*	*	*
4017	Female	5	5	*	Negative	*	Negative	*
4021	Female	5	5	5	Negative	Negative	Negative	Negative
4022	Female	4	*	*	*	*	*	*
4028	Female	5	4	*	Negative	*	Negative	*
4029	Female	4	4	*	Negative	*	Negative	*
4030	Female	4	5	5	Negative	Negative	Negative	Negative
4031	Female	4	*	*	*	*	*	*
4032	Female	4	*	*	*	*	*	*
4039	Female	5	*	*	*	*	*	*
4043	Female	4	4	*	Negative	*	Negative	*
4044	Female	4	5	5	Negative	Negative	Negative	Negative
4045	Female	4	5	4	Negative	Negative	Positive	Positive
4046	Female	4	4	4+	Positive	Negative	Negative	Negative
4047	Female	5	5	*	Negative	*	Positive	*
4049	Female	4	4	4	Negative	Negative	Suspect	Negative
4051	Female	4	*	*	*	*	*	*
4052	Female	4	Unknown	4+	Negative	Negative	Negative	Negative
4054	Female	5	*	*	*	*	*	*
4056	Female	4	*	*	*	*	*	*
4057	Female	4	4	4	Negative	Negative	Negative	Negative
4000	Male	5	4	5	Negative	Negative	Negative	Negative
4003	Male	4	4	*	Negative	*	Negative	*
4004	Male	4	4	4+	Negative	Negative	Negative	Negative
4005	Male	5	5	5	Positive	Positive	Suspect	Negative
4006	Male	4	*	*	*	*	*	*
4007	Male	5	4	4	Positive	Positive	Suspect	Negative
4011	Male	4	5	5	Negative	Negative	Negative	Negative
4013	Male	4	4	*	Positive	*	Positive	*
4018	Male	4	4	4	Negative	Negative	Positive	Positive
4019	Male	4	4	4	Negative	Negative	Negative	Negative
4020	Male	5	4	*	Negative	*	Negative	*
4023	Male	4	*	*	*	*	*	*
4024	Male	5	5	5	Negative	Negative	Negative	Negative
4025	Male	5	5	4	Negative	Negative	Negative	Negative
4026	Male	4	*	*	*	*	*	*
4027	Male	4	*	*	*	*	*	*
4033	Male	4	4	4	Negative	Negative	Negative	Negative
4034	Male	4	4	4	Negative	Negative	Positive	Negative
4035	Male	4	4	*	Negative	*	Negative	*
4036	Male	4	4	5	Negative	Negative	Negative	Negative
4037	Male	4	4	5	Positive	Negative	Suspect	Negative
4038	Male	4	4	5	Negative	Negative	Negative	Suspect
4040	Male	4	4	4	Negative	Negative	Negative	Negative
4041	Male	4	4	5	Negative	Positive	Negative	Suspect
4042	Male	4	4	4	Negative	Negative	Positive	Suspect
4048	Male	5	4	5	Negative	Negative	Positive	Negative
4050	Male	4	4	4+	Negative	Negative	Negative	Negative
4053	Male	4	5	4	Negative	Negative	Positive	Suspect
4055	Male	4	4	5	Negative	Negative	Negative	Negative
4070	Male	4	*	*	*	*	*	*
4058	Unknown	4	*	*	*	*	*	*

3.3.3 USGS Rock Valley Study

As part of continuing research pertaining to desert tortoises, the USGS in collaboration with the FWS, ICR, and Penn State University is using three fenced 9 ha enclosures in Rock Valley for a portion of their epidemiology study. The three Rock Valley enclosures are located along the southern boundary of the NNSS in Area 25. In the spring of 2013, 15 tortoises were placed in each plot to reside in the plots for a year. Each tortoise was fitted with a proximity sensor, which is activated when two tortoises come within a specified distance of each other. This allows scientists to document tortoise interactions and social structure. In the spring of 2014, the second phase was initiated, when up to five additional tortoises were placed in the enclosures, for a total of 20 per enclosure. This will serve as a model for how translocated tortoises may interact with residents. Additional manipulations may be necessary and are planned in the succeeding years (2015–2018). NNSS staff biologists did not assist with any activities during 2014 on this project.

3.4 Coordination with Other Biologists and Wildlife Agencies

During February 19–22, 2014, an NSTec biologist attended the Desert Tortoise Council's 40^{th} annual meeting and symposium. This meeting was held in Las Vegas, Nevada, and included numerous presentations on desert tortoise biology, ecology, and recovery efforts.

4.0 ECOSYSTEM MONITORING

Ecological Services 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 site biologists to be the most feasible mapping unit by which sensitive plant and animal habitats can be described. In 2000 and 2001, topical reports describing the classification of vegetation types on the NNSS were published and distributed (Ostler et al. 2000, Wills and Ostler 2001). Ten vegetation alliances and 20 associations were reported to occur on the NNSS.

In addition to ELU mapping, ecosystem monitoring also entails monitoring a wide variety of terrestrial and aquatic habitats and non-sensitive and protected/regulated species. Efforts during 2014 focused on wildland fire fuels surveys, sun spider (*solifugae*) species updates, reptile trapping and roadkill sampling to fill in data gaps in reptile distributions, natural wetlands monitoring, and constructed water source monitoring. West Nile Virus surveillance was not conducted this year.

4.1 Vegetation Survey for Wildland Fire Hazard Assessment

Wildland fires on the NNSS require considerable financial resources for fire suppression and mitigation. For example, costs for fire suppression on or near the NNSS can cost as much as $198 per ha (Hansen and Ostler 2004). Costs incurred from the Egg Point Fire in August 2002 (121 ha) were well over $1 million to replace 1 mile of burned power poles, and more than $200,000 for soil stabilization and revegetation of the burned area. No wildland fires were documented on the NNSS during 2014.

4.1.1 Fuel Survey Methods

Beginning in 2004, and in response to DOE O 231.1B, surveys were initiated on the NNSS to identify wildland fire hazards. Vegetation surveys were conducted in April and May 2014 at sites located along and adjacent to major NNSS corridors to estimate the abundance of fuels produced by native and invasive plants. Information about climate and wildland fire-related information reported by other government agencies was also identified and summarized as part of the wildland fire hazards assessment. Survey findings and fuels assessment maps were compiled and reported to the NNSS Fire and Rescue Department.

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

4.1.2 Fuel Survey Results

4.1.2.1 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 extend back more than 30 years (National Oceanic and Atmospheric Administration [NOAA] 2013). In the fall of 2011, most of the rain gauges on the NNSS were upgraded from weighing gauges to tipping-bucket style gauges with data transmitted directly to NOAA via telecommunications, rather than manually retrieving and processing the data (Hansen 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 2014 reflect the changes and attempt to match, as closely as possible, data collected historically. Mean values were recalculated to account for periods when gauges were not functional.

In order to assess whether the spring of the year would be relatively wet, normal, or dry, a simple measure of precipitation was needed. Precipitation during the months of December, January, February, March, and April was selected because of its simplicity and ease of calculation (Figure 4-1). While it is recognized that precipitation from other months is also important, as is the influence of temperature, winds, and relative humidity, precipitation during these months represents the period that most influences plant growth on the NNSS as observed along the survey route. This period occurs before the beginning of the fire season in June so it allows one to make a prediction of the fuels that may be present. During the 10 years (2004–2013) of conducting fire fuel evaluations, the mean precipitation during these 5 months is correlated (R = 0.770) with our estimations of the combined fuel loads. During 2014, the average precipitation from the remaining 14 rain gauge stations on the NNSS during December–April was 3.66 cm, or about 35.0% of the normal amount (i.e., the average precipitation for the last 30 years—10.46 cm). Temperatures were near normal during these months.

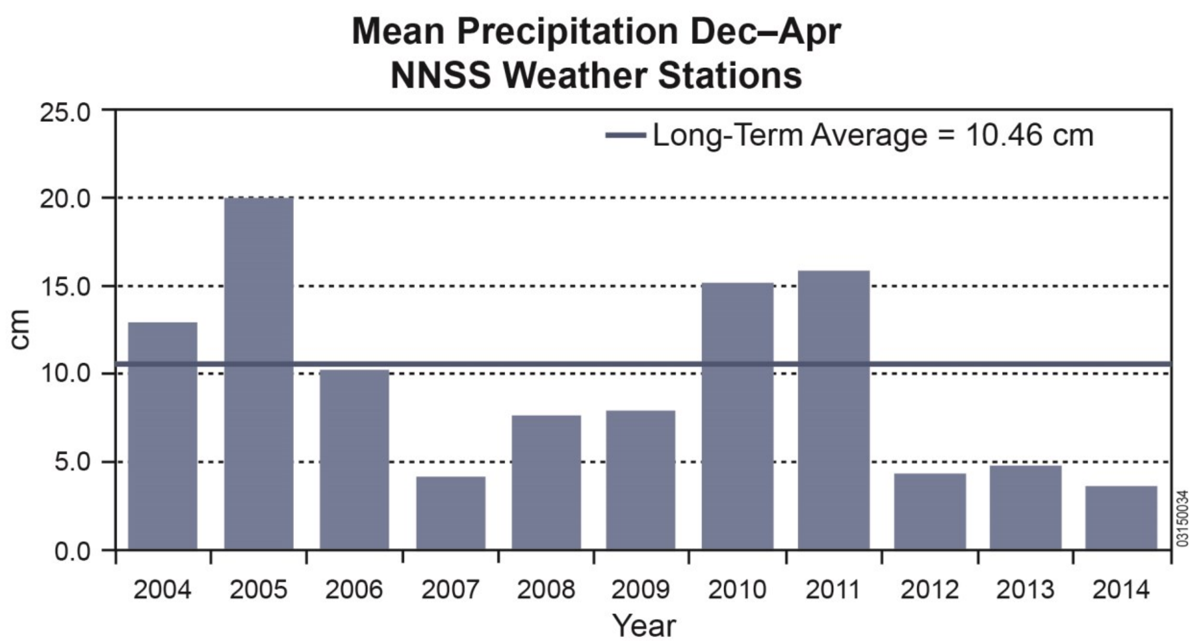

Figure 4-1. Average precipitation (cm) from December (previous year) through April for the years 2004 through 2014

4.1.2.2 Fuels

Because of the below-normal precipitation that occurred during the spring of 2014, few annual or perennial plant seeds germinated. Perennial herbaceous grasses and forbs had little, if any, production during the spring of 2014.

The woody fuels index value was slightly lower in 2014 (2.44) compared to 2013 (2.49), as foliar canopy cover decreased slightly (Table 4-1). This was the second lowest ranking since 2004 when index values were initiated. The fine fuels index also decreased in 2014 (1.39) compared to 2013 (2.03) and was the lowest recorded (Table 4-1).

The combined index values (fine fuels plus woody fuels) for 2014 correspond to the potential for fuels on the NNSS to support wildland fires once fuels are ignited. The higher the index, the greater the potential for wildland fires to spread. The NNSS average combined index value for fine fuels and woody fuels for 2014 was 3.83, the lowest since 2004 (Table 4-1), suggesting below normal fuels for the NNSS. However, most fuels in the spring of 2014 appeared to be well cured and highly susceptible to ignition due to the low moisture content in the residual fuels and the low relative humidity of air from the below-normal precipitation on the NNSS.

Table 4-1. Woody fuels, fine fuels and combined fuels index values for 2004–2014

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

Figure 4-2 shows the mean combined fuel index values. The droughts of 2007 and 2012 significantly reduced the amount of fine fuels and to a lesser extent woody fuels produced those years, but the values for 2014 are below both of those drought years.

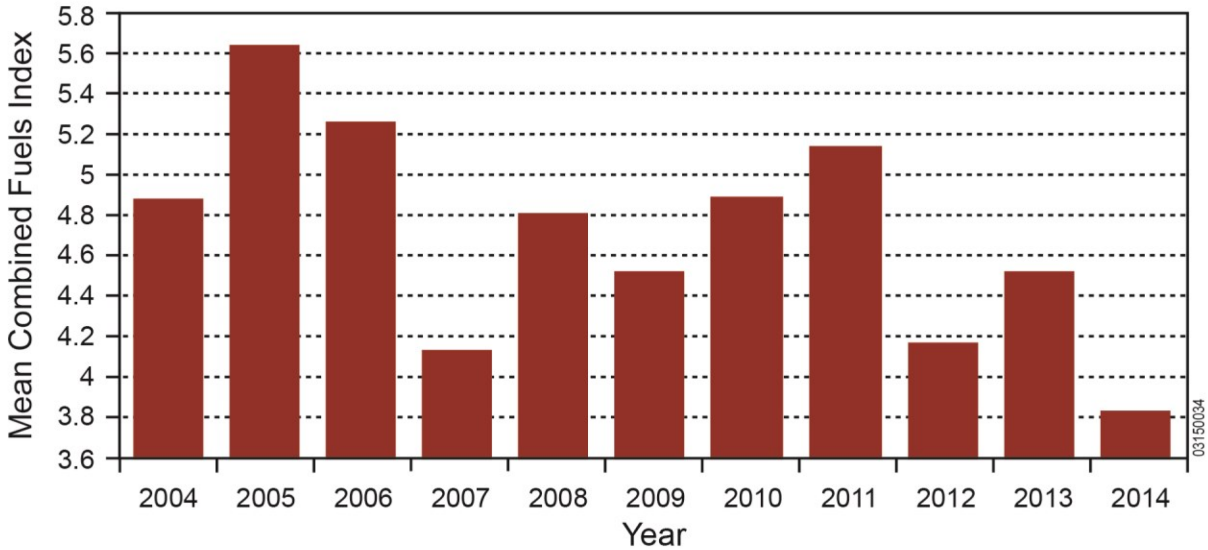

Figure 4-2. Mean combined fuels index for the years 2004 to 2014

The locations and results of the fine fuels, woody fuels, and combined fuels surveys at 104 stations on the NNSS inspected during 2014 are shown in Figures 4-3, 4-4, and 4-5, respectively. High combined index values occurred in Fortymile Canyon and eastern Pahute Mesa.

Photographs were taken from permanent locations for all 104 sites during the past 10 years. Figure 4-6 shows photographs of Site 99 in Yucca Flat for the last 4 years. 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.

As in past years, sites dominated by blackbrush and annual grasses appeared to respond to precipitation with greater variation in the amount of fine fuels and woody fuels than other vegetation community types (e.g., Creosote bush [*Larrea tridentata*] or pinyon/juniper [*Pinus monophylla*/*Juniperus osteosperma*]). This resulted in increases in fine fuels at these sites compared to sites in the Mojave Desert (southern one-third of the NNSS) or the Great Basin Desert (northern one-third of the NNSS). Fine fuels produced in 2014 were almost completely lacking in most areas of the NNSS due to drought conditions. Although production was low, germination and growth of fine fuels during 2014 was greatest at the middle elevations. Overall, the hazards of residual fuels contributing to wildland fires are lower than average, but the dry condition of both fine and woody fuels make them more susceptible to ignition by lightning or other sources. Once ignited, high ambient temperatures and high winds contribute to the spread of fire in areas where the abundance of fuels is sufficient to carry the flames of the fire. Rapid response by NNSS Fire and Rescue after fires are ignited is a key factor in minimizing wildland fire spread and severity.

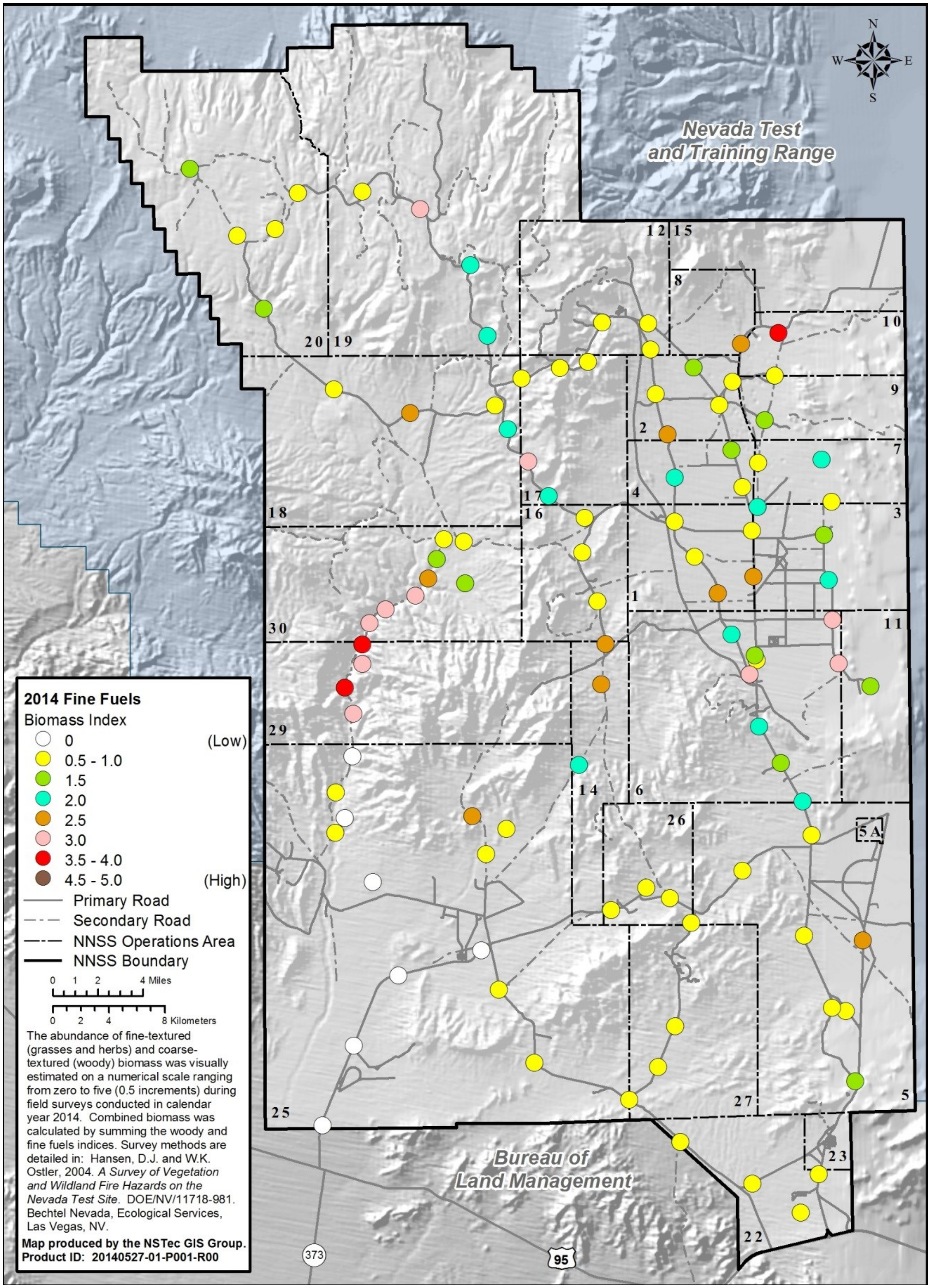

Figure 4-3. Index of fine fuels for 104 survey stations on the NNSS during 2014

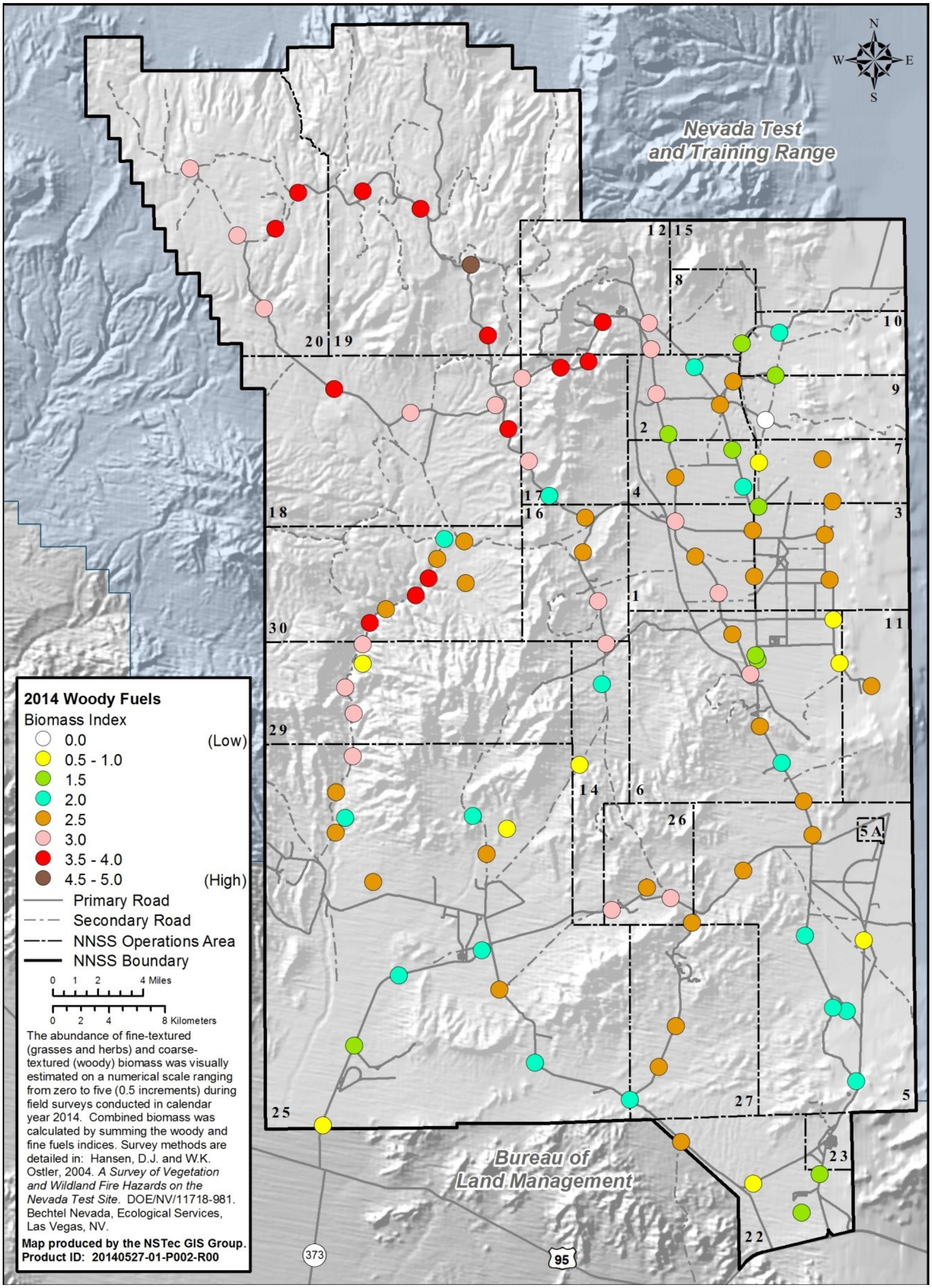

Figure 4-4. Index of woody fuels for 104 survey stations on the NNSS during 2014

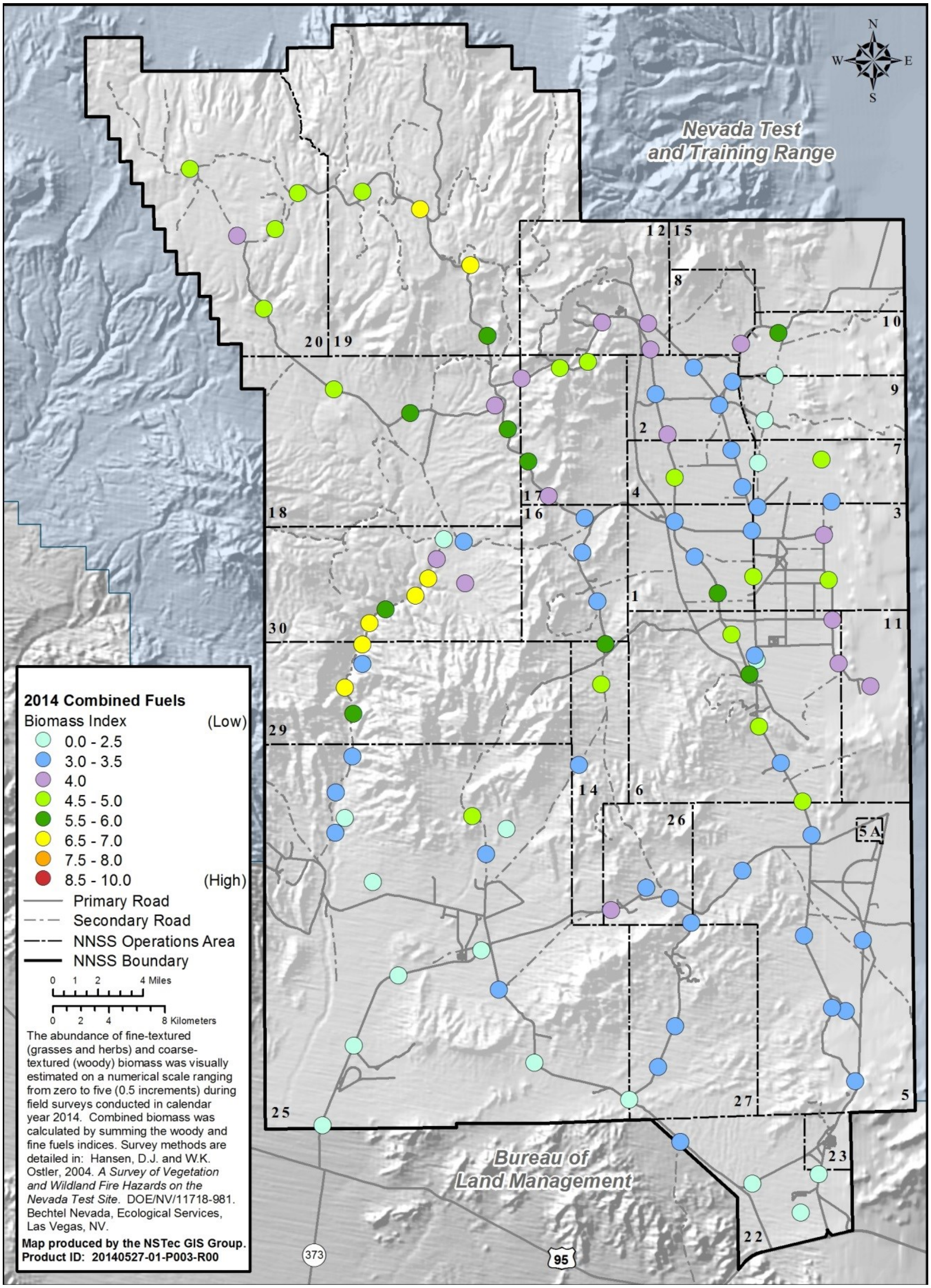

Figure 4-5. Index of combined fine fuels and woody fuels for 104 survey stations on the NNSS during 2014

Figure 4-6. Site 99 on the west side of Yucca Flat in 2011–2014

(Photos by W. K. Ostler, April 26, 2011 [top left]; April 10, 2012 [top right]; April 22, 2013 [bottom left]; and April 12, 2014 [bottom right])

4.1.2.3 Invasive Plants

The three most commonly observed invasive annual plants to colonize burned areas on the NNSS are Arabian schismus (*Schismus arabicus*), found at low elevations; red brome, found at low to moderate elevations; and cheatgrass (*Bromus tectorum*), found at middle to high elevations (Table 4-2). Most of the invasive annual plants failed to germinate during the spring of 2014. Cheatgrass was the most common invasive plant occurring on over 61% of the study sites although most plants were stunted due to lack of adequate rainfall. Both red brome (28.8) and Arabian schismus (6.7) had low germination over the NNSS. Precipitation history (Figure 4-2, shown previously) is also important in determining the percent presence of species across the NNSS. During periods of low precipitation, most annual species have low percent presence (i.e., the number of sites in which the plant was observed to be present and growing). Percent presence is generally greatest during periods of high precipitation, and appears to be a good indication of germination. Higher percent presence is also expected to occur when regional storms provide precipitation to a greater number of operational areas across the NNSS. However, the responses of some species, both invasive and native species, suggest that other variables, such as the timing of precipitation or temperatures required for germination, may also be contributing to plant response.

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

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

Precipitation History	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Mean Precipitation (cm) (December–April)	12.90	19.99	10.19	4.06	7.65	7.87	15.14	15.85	4.34	4.80	3.66
Invasive Introduced Species											
Bromus rubens (red brome)	51.7	64.4	67.8	0	63.0	63.2	58.5	62.3	0	19.2	28.8
Bromus tectorum (cheatgrass)	40.3	54.0	60.7	0	59.2	66.0	67.0	79.2	17.0	70.2	61.5
Erodium cicutarium (redstem stork's bill)	5.2	6.2	24.6	0	21.3	27.4	33.0	42.4	0.9	37.5	33.7
Schismus arabicus (Arabian schismus)	4.7	2.8	5.2	0	11.4	9.4	3.8	11.3	0	9.6	6.7
Native Species											
Amsinckia tessellata (bristly fiddleneck)	34.0	62.0	16.1	0	63.0	48.1	67.9	63.2	1.8	41.3	26.0
Mentzelia albicaulis (whitestem blazingstar)	49.8	8.1	0	0	2.4	18.9	51.9	16.0	3.7	6.7	20.2
Chaenactis fremontii (pincushion flower)	27.0	8.0	0	0	1.4	11.3	13.2	0.5	0	6.7	2.9

4.2 Sun Spiders (*Solifugae*)

NSTec biologists collaborated with scientists from the Denver Museum of Science and Nature with field collections of sun spiders (*Solifugae*) during 2011. The results are herein summarized. The initial list of 28 species was described by Muma (1963). Many of these were new species to science when first described from the NNSS (Table 4-3). Subsequent sampling identified nine new species records for the NNSS; in addition, a new species was recently described: *Hemerotrichia kaboomii* (Brookhart and Cushing 2008). This species appears to be relatively widespread on the NNSS from Mercury Valley to Yucca Flat. Two species of solfugids (*Chanbria* species [spp.], *Horrabates* spp.) at present are still only identified to genus and must await additional taxonomic investigation to determine more specific naming.

Table 4-3. Revised species list of sun spiders (*Solifugae*) for the NNSS with descriptive locations

Family/Species	Muma's species (1963)	Muma's species collected in 2011	New species at NNSS in 2011	Descriptive Locations for Specimens
Ammotrechidae				
Ammotrechula borregoensis			X	Cane Spring
Ammotrechula dolabra	X			Cane Spring, West Mercury Valley
Ammotrechula lacuna	X			Cane Spring and Area 10
Ammotrechula pilosa	X			
Branchia potens	X	X		Frenchman Flat
Eremobatidae				
Chanbria spp.	X			
Eremobates ascopulatus			X	Area 18, Buckboard Mesa Road
Eremobates ctenidiellus	X			
Eremobates mormonus	X			
Eremobates scopulatus	X	X		Cane Spring, South Yucca Flat
Eremobates similis	X			
Eremobates socal			X	Mercury
Eremobates vicinus	X	X		Frenchman Flat, Area 6 Wet & Wild Complex
Eremobates zinni	X	X		Mercury Valley, Frenchman Flat, Cane Spring, South Yucca Flat
Eremochelis arcellus			X	Area 18 Buckboard Mesa Road
Eremochelis imperialis			X	Mercury, Mercury Valley
Eremochelis insignitus			X	Mercury, Mercury Valley, Cane Spring
Eremochelis plicatus			X	Mercury Valley
Eremocosta titania			X	Mercury, Mercury Valley
Eremorhax pulcher	X	X		Mercury Valley, Frenchman Flat, South Yucca Flat
Eremorhax titania	X			
Hemerotrecha branchi	X	X		Mercury, Cane Spring, Control Point Area 6
Hemerotrecha californica	X			
Hemerotrecha denticulata	X			
Hemerotrecha fruitana	X			
Hemerotrecha kaboomi*			X	Mercury Valley, Frenchman Flat, South Yucca Flat
Hemerotrecha nevadensis			X	Mercury
Hemerotrecha proxima	X	X		Area 18 near Camp 17 Pond, Area 1, Area 6
Hemerotrecha serrata	X	X		Mercury Valley, Area 18, Buckboard Mesa Road
Horribates spp.	X			
Therobates arcus	X			
Therobates attritus	X			Yucca Flat, Areas 1 and 4.
Therobates bidepressus	X			Yucca Flat, Area 1
Therobates branchi	X			
Therobates cameronensis	X			Frenchman Flat
Therobates flexacus	X			Cane Spring, Frenchman Flat
Therobates nudus	X			Yucca Flat, Area 1, 28 miles north of Mercury
Therobates plicatus	X			
Total species	28	8	10	

** A new species first described from NNSS*

4.3 Reptile Sampling

The purpose of additional reptile sampling is to fill in data gaps for species that have not been documented recently or are rare on the NNSS. The field mapping effort for reptile distributions continued this year by trapping at new and historical sites and conducting road surveys looking for road kills. Opportunistic reptile observations were also documented. Work continued on a draft topical report about reptile distributions on the NNSS.

4.3.1 Reptile Trapping

Trapping involved setting a combination of at least 50 unbaited can and funnel traps at a site and trapping for 2 to 4 weeks. Four sites were trapped including two historical sites (Brigham Young University West Mercury Valley Plot and Frenchman Flat 001) and two new sites. Two sites were in west Mercury Valley and two sites were in Frenchman Flat. Trapping occurred for approximately 1,000 trap days. Total captures were limited to 27 individual reptiles and included 5 side-blotched lizards (*Uta stansburiana*), 6 western whiptails (*Cnemidophorus tigris*), 8 desert banded geckos (*Coleonyx variegatus*), 1 desert iguana (*Dipsosaurus dorsalis*), 5 desert horned lizards (*Phrynosoma platyrhinos*) and 2 western shovel-nosed snakes (*Chionactis occipitalis*).

4.3.2 Roadkill Surveys

Reptile road kills were documented at various locations around the NNSS. However, semi-standardized surveys were limited to paved roads in the southern third of the NNSS and were conducted by driving slowly along a 67 km route at least weekly between April and September 2014. Road kills were located, identified, weighed, and measured. Combined data from 2013 to 2014 detected 19 species of roadkill reptiles, with 84 snakes and 99 lizards (Table 4-4). Figure 4-7 shows where most of the road kills occurred in the southern portion of the NNSS. Two years of sampling suggests a roadkill cluster on the Mercury Highway around Mercury Pass, a heavily traveled corridor. There are also extensive records of kills in Area 5 on the Mercury Highway farther north of the pass. No hatchling roadkill snakes were detected in 2013–2014.

There were 11 species of snakes recorded as roadkill overall (Table 4-4). The most abundant snake in the southern region, the red racer, was the most numerically impacted species, with 48% of the detections (Table 4-4). The western patch-nosed snake (*Salvadora hexalepis*) (16.7%) was the second-most impacted species. Nine additional species were detected, including the widespread gopher snake (*Pituophis catenifer*) (13%) and the sidewinder rattlesnake (*Crotalus cerastes*) (9.5%).

There were eight species of lizards detected as roadkill (Table 4-4). The most abundant species, the long-nosed leopard lizard (*Gambelia wislizenii*) (31%) was the most impacted, followed by the zebra-tailed lizard (*Callisaurus draconoides*) (22 %) and the desert horned lizard (20%). One noteworthy record was a desert iguana.

Most road kills occurred during May and June with a peak in snake road kills during May, and a peak in lizard road kills during May and June. This corresponds to the time when reptiles are most active due to the optimal temperatures for activity. Cool nighttime temperatures are also a factor because reptiles are drawn to paved roads to warm up when their body temperatures decline to a certain level.

4.3.3 Opportunistic Observations

A dead western shovel-nosed snake was found in Mercury. A red racer (*Masticophis flagellum*) and a desert banded gecko were found on glue traps around buildings in Mercury and released. A long-nosed snake (*Rhinocheilus lecontei*) was found on a glue trap in Area 5 and released.

Table 4-4. Roadkill reptiles by month in 2013–2014 on the NNSS

Number of Road Kills by Month								
	April	May	June	July	August	Sept	**Totals**	%
Snakes								
Glossy snake *(Arizona elegans)*			2	1			3	3.6
Western shovel-nosed snake (*Chionactis occipitalis*)		2					2	2.4
Sidewinder (*Crotalus cerastes*)	4	1	1	1	1		8	9.5
Ring-necked snake (*Diadophis punctatus*)		1					1	1.2
Common kingsnake (*Lampropeltis getula*)		1					1	1.2
Red racer (*Masticophis flagellum*)	7	11	5	1	12	4	**40**	47.6
Striped whipsnake (*Masticophis taeniatus*)			1				**1**	1.2
Gopher snake (*Pituophis catenifer*)	1	5	2		1	2	11	13.1
Long-nosed snake (*Rhinocheilus lecontei*)		2					2	2.4
Western patch-nosed snake (*Salvadora hexalepis*)	4	5	1	2		2	**14**	16.7
Western ground snake (*Sonora semiannulata*)		1					1	1.2
Total	**16**	**29**	**12**	**5**	**13**	**8**	**84**	**100**
Lizards								
Zebra-tailed lizard (*Callisaurus draconoides*)	3	6	4	7	1	1	**22**	22.2
Western whiptail lizard (*Cnemidophorus tigris*)		1	7	2	1		11	11.1
Great Basin Collared lizard (*Crotaphytus bicinctores*)		2	3				5	5.1
Desert iguana (*Dipsosaurus dorsalis*)			1				1	1.0
Long-nosed leopard lizard (*Gambelia wislizenii*)	5	9	11	1	1	4	**31**	31.3
Desert horned lizard (*Phrynosoma platyrhinos*)	2	9	5	2	2		20	20.2
Western fence lizard (*Sceloporus occidentalis*)		1			1		2	2.0
Desert spiny lizard (*Sceloporus magister*)		3		3		1	7	7.1
Total	**10**	**31**	**31**	**15**	**6**	**6**	**99**	**100**
Grand Total	**26**	**58**	**43**	**20**	**19**	**14**	**183**	

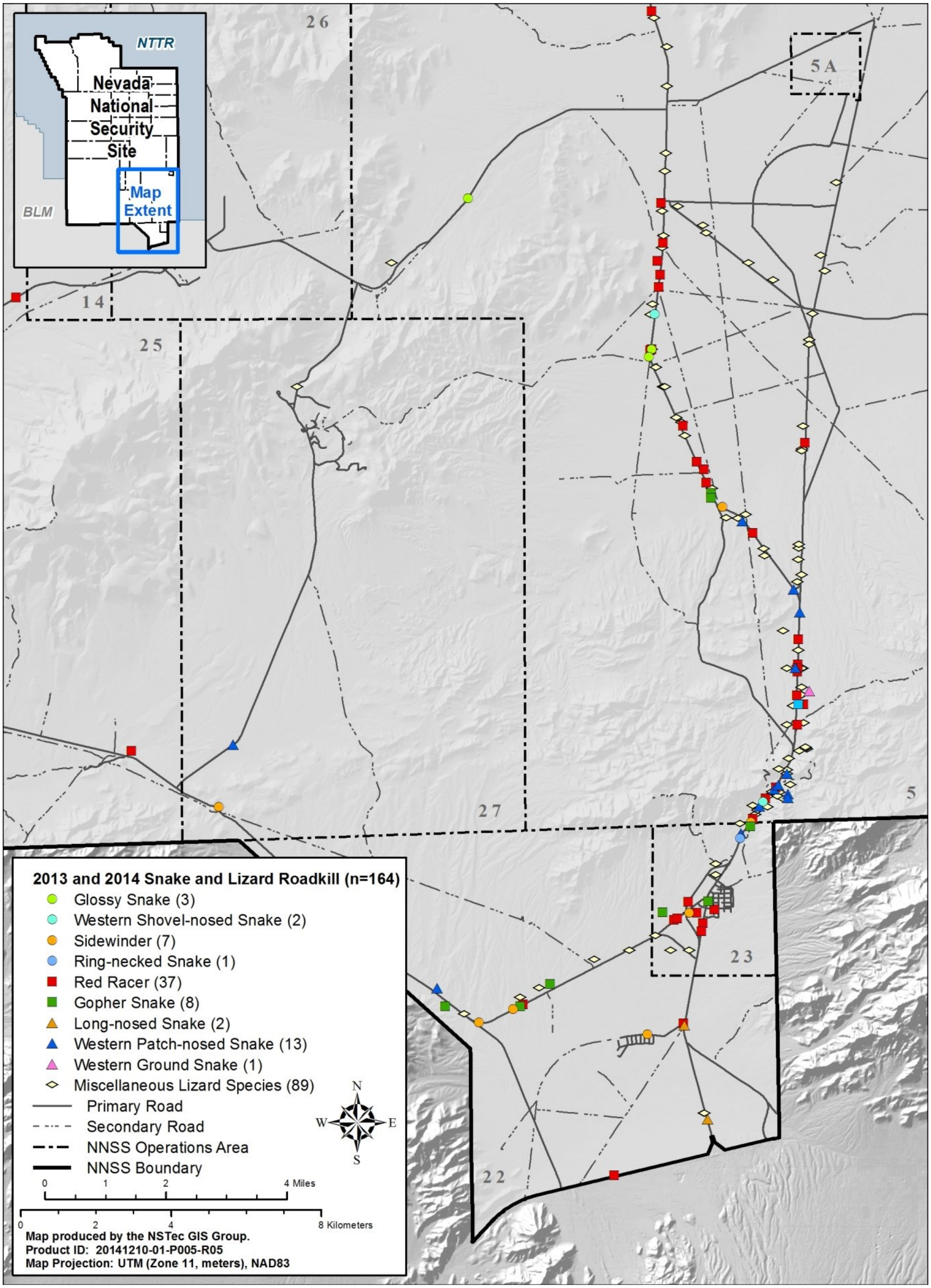

Figure 4-7. Reptile roadkill locations on the southern third of the NNSS during 2013–2014

4.4 Natural Water Source Monitoring

4.4.1 Existing Water Sources Monitored

Water sources were monitored this year to characterize physical and biological parameters. The Frenchman Flat Playa Ponds were removed from the natural water source list and are now included in the man-made water source list because they are not natural depressions. Eleven water sources were visited at least once during 2014 to record wildlife use, the presence/absence of land disturbance, water flow rates when applicable, and surface area of standing water (Table 4-5).

Monitoring of natural water sources is qualitative, and is designed to measure large changes, for example when a spring dries up, which is a significant observation. Surface area of the monitored water sources varied greatly from very small areas (<1 square meter [m^2]) to moderately sized springs (180–600 m^2) to large temporary playa pools (28,000 m^2). Surface flow rates were typically low (<5 liters per minute [lpm]) at most water sources where flow was measurable. Disturbance from horses was noted at two sites and by mule deer at one site, and some form of natural change (e.g., dense spread of wetlands plants) occurred at another site (Table 4-5). Locations of natural water sources on the NNSS are shown in Figure 4-8. Topopah Spring was reduced to a wet spot during the summer.

Wildlife use data recorded during site visits are summarized in Table 4-6. Mule deer (*Odocoileus hemionus*), burro (*Equus asinus*), and horses (*Equus caballus*) benefit significantly from the water sources. Burros seem to have expanded their range from Area 5 onto southern Yucca Flat this year at Yucca Playa Pond (Table 4-6). Overall in 2014, few birds including chukar (*Alectoris chukar*) and mourning doves (*Zenaida macroura*) were observed throughout the NNSS (Table 4-6), indicative of a dry year. One exception was at Topopah Spring where at least 100 chukar were observed. Monitoring for the presence of the Southeast Nevada Pyrg snail (*Pyrgulopis turbatrix*) at Cane Spring continued in 2014. It was found in the outflow about 10 m from the cave pool below the cattails. It is considered a sensitive species in Nevada (Table 2-1) and occurs at only eight springs in southern Nevada.

Table 4-5. Hydrology and disturbance data recorded at natural water sources on the NNSS during 2014

Spring	Date	Surface Area of water (m^2)	Flow rate (L/min)	Impacts at Spring
Cane Spring	6/26/14	15	NM	Heavy growth of cattails
Cottonwood Spring	12/17/14	<1	NA	None
Gold Meadows Spring	10/15/14	0	NA	Heavy horse use
Little Wildhorse Seep	12/3/14	0	NA	Horse grazing and trampling of vegetation
Pahute Pond	2/13/14	900	NA	None
Tippipah Spring	12/18/14	80	NA	None
Topopah Spring	6/4/14	0	NA	Wet spot at cave pool
Twin Spring	12/17/14	1	NA	Mule deer trampling
Whiterock Spring	12/18/14	6	NM	None
Wildhorse Seep	12/3/14	8	NA	Horse grazing and trampling of vegetation
Yucca Playa Pond	9/8/14	28,000	NA	Burro use but no impacts
NM=not measured; NA=not applicable				

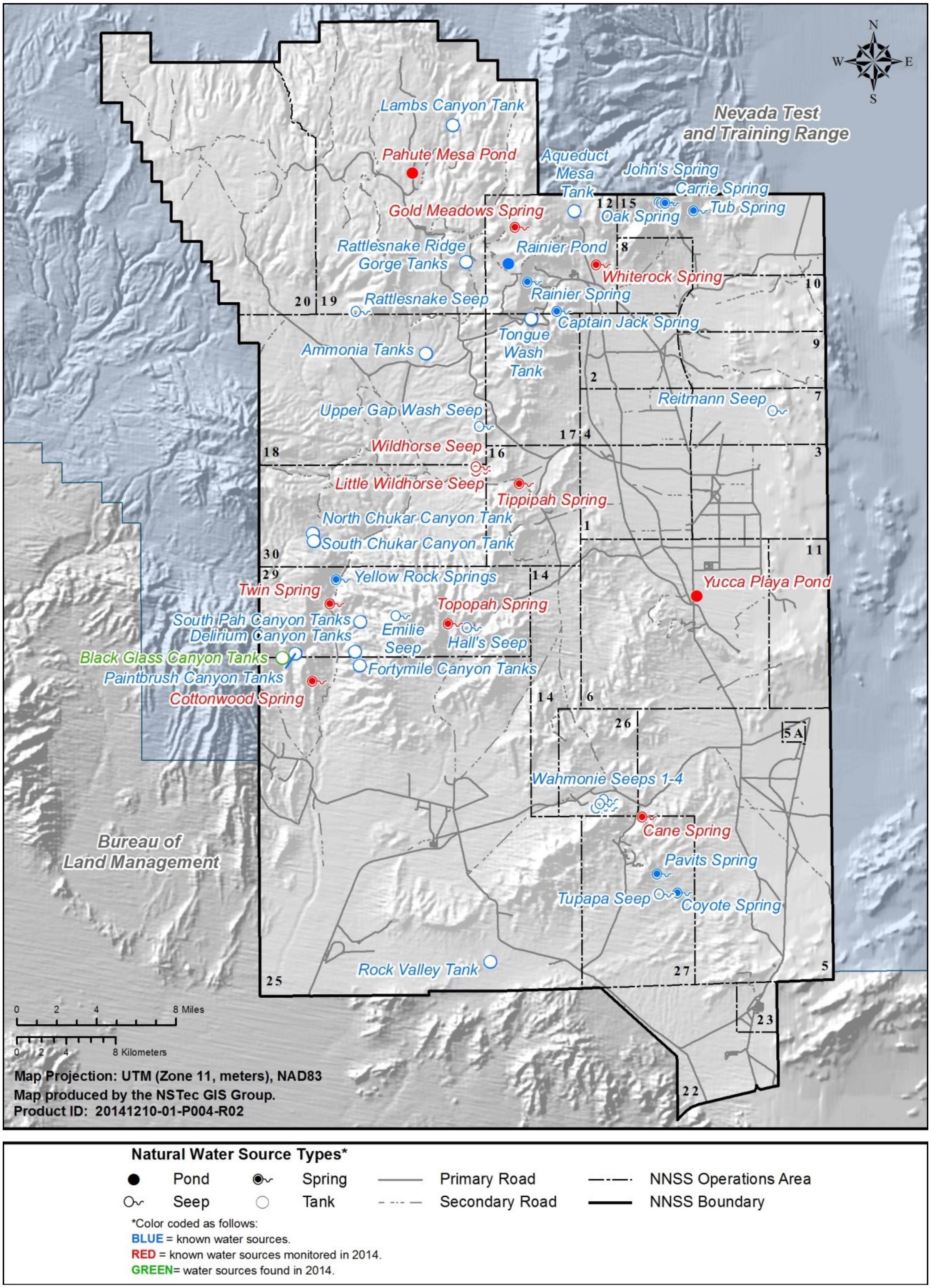

Figure 4-8. Natural water sources on the NNSS including those monitored and found in 2014

Table 4-6. Number of wildlife species observed or inferred (P=Present) from site visits at NNSS natural water sources in 2014

Wildlife Species Observed	**Cane Spring**	**Cottonwood Spring**	**Gold Meadows Spring**	**Little Wildhorse Seep**	**Pahute Pond**	**Tippipah Spring**	**Topopah Spring**	**Twin Spring**	**Whiterock Spring**	**Wildhorse Seep**	**Yucca Playa Pond**
Date Observed (month/day)	**5/26**	**12/17**	**10/19**	**12/10**	**2/22**	**12/03**	**6/4**	**12/17**	**9/26**	**12/10**	**7/26**
Mammals											
Coyote (*Canis latrans*)	P		P	P	P	P			P	P	P
Feral horse (*Equus caballus*)			5	P						P	
Mule deer (*Odocoileus hemionus*)	P	P	P	P	P	P		P	P	P	P
Burro (*Equus asinus*)											P
Birds											
American avocet (*Recurvirostra americana)*											1
Common Raven (*Corvus corax)*	2			1		2					
Chukar (*Alectoris chukar*)	10						100			P	
Coopers Hawk (*Accipiter cooperi)*					1						
Green-winged Teal (*Anas crecca*)											2
Horned Larks (*Eremophila alpestris)*									5		
Long-eared owl (*Asio otus*)									2		
Mourning dove *(Zenaida macroura)*	3										2
Red-tailed hawk (*Buteo jamaicensis)*	1										
Number of bird species detected:	**4**	**0**	**0**	**1**	**1**	**1**	**1**	**0**	**2**	**1**	**3**

4.4.2 New Water Sources

One new water source was discovered during 2014 on the NNSS: Black Glass Canyon Tanks (Figure 4-9). Tanks collect water from overland flow after precipitation events (e.g., runoff from rain or melting snow). Depending on the depth and size of the tank, rock type, surrounding topography, and timing of precipitation, these tanks may hold water for a few weeks to several months. These are important, albeit ephemeral, sources of water for several species of wildlife.

Black Glass Canyon Tanks (Figure 4-9) are a series of rock catchments in exposed, welded volcanic tuff. They were found during mountain lion monitoring on December 9. Surface area of the biggest tank was about 20 m^2. Elevation at the site is 1,375 m above sea level, and dominant vegetation in the area is blackbrush, Mormon tea (*Ephedra viridis*), and desert bitterbrush (*Purshia glandulosa*). Abundant chuckwalla (*Sauromalus ater*) and desert bighorn sheep (*Ovis canadensis nelsoni*) scat and mountain lion sign suggest this is an important site for wildlife.

Figure 4-9. Black Glass Canyon Tanks
(Photo by D. B. Hall, December 9, 2014)

4.5 Constructed Water Source Monitoring

Monitoring of plastic sumps was discontinued in 2014 because no new sumps were constructed this year, and it was decided that monitoring of old sumps was not needed as no animals have been found dead in these sumps since 2008. Therefore, it was regarded as cost effective to discontinue this work in 2014. When new sumps are constructed, they will still be a risk to wildlife, and they will be monitored on a case-by-case basis for animal entrapment. It is highly recommended that sediment ramps be built in at least one corner of each new plastic-lined sump to allow animals to escape.

4.5.1 Mitigating Water Loss for Wildlife

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

Drying these ponds up resulted in the loss of valuable wildlife habitat, so water troughs were installed to help mitigate the loss of the well ponds. The water troughs were not meant to replace the well ponds as wildlife habitat, but were meant to provide at a minimum some supplemental water in areas with very limited perennial water sources and at sites where animals had become accustomed to finding water. Water troughs were installed adjacent to the Area 6 LANL Pond and Well C1 Pond to mitigate the loss of these ponds, at Well 5A (Well 5C) to mitigate the loss of the Well 5B Pond, and at Cane Spring and Topopah Spring to mitigate the loss of the J11 Pond (Figure 4-10). Motion-activated cameras were set up at each trough during the fall of 2012 and monitored during 2013 to document wildlife use. These cameras were also added to the network of cameras used for monitoring mountain lions (see Section 6.6.1, Motion-Activated Cameras). Monitoring continued during 2014.

At the Area 6 LANL Pond, wildlife use of the trough was heavy and peaked during the dry, summer months. Use was dominated by turkey vultures (*Cathartes aura*) (382 images) and pronghorn antelope (*Antilocapra americana*) (350 images) (Figure 4-11). At least 10 species (5 mammals and 5 birds) were documented through the year (Table 6-4 in Section 6.6.1, Motion-Activated Cameras). Common ravens (*Corvus corax*) and coyotes (*Canis latrans*) were regular visitors with as many as four individual coyotes seen in some images.

Wildlife use at Well C1 trough during 2014 was heavy with at least 14 species (7 mammals and 7 birds) documented at the trough (Table 6-4). Use peaked during the dry, summer months. Use was dominated by common ravens (392 images). Coyotes, bobcats (*Lynx rufus*) (Figure 4-12), and wild burros (Figure 4-13) consistently used the trough, with an occasional visit by pronghorn antelope and mule deer.

Wildlife use at Well 5C was heavy with at least 14 species (9 mammals and 5 birds) photographed at the trough (Table 6-4). Coyotes, burros, and black-tailed jackrabbits had the highest use. A badger was photographed on May 27, 2014.

Wildlife use at the trough at Cane Spring was light with 6 species detected (2 mammals and 4 birds) (Table 6-4). Mourning doves (*Zenaida macroura*) (40 images) and mule deer (20 images) had the highest use. Wildlife use at Cane Spring was also light with 6 species detected (4 mammals and 2 birds) (Table 6-4). Mule deer had the highest use (23 images) with coyotes (14 images) and bobcats (9 images) occurring next most frequently. The camera at the spring was not working from June 11 to September 4.

Wildlife use at the Topopah Spring trough was moderate with 10 species (7 mammals and 3 birds) documented (Table 6-4). Most of the activity was from mule deer (129 images) (Figure 4-14). No images of mountain lions (*Puma concolor*) were taken near the trough. Wildlife use at Topopah Spring was heavy with 12 species (9 mammals, 3 birds) recorded (Table 6-4). Noteworthy differences include the following: 16 images of mountain lions were taken at the spring, and none were taken at the trough; 16 images of desert bighorn sheep were taken at the spring while 1 was taken at the trough; 80 images of coyotes were

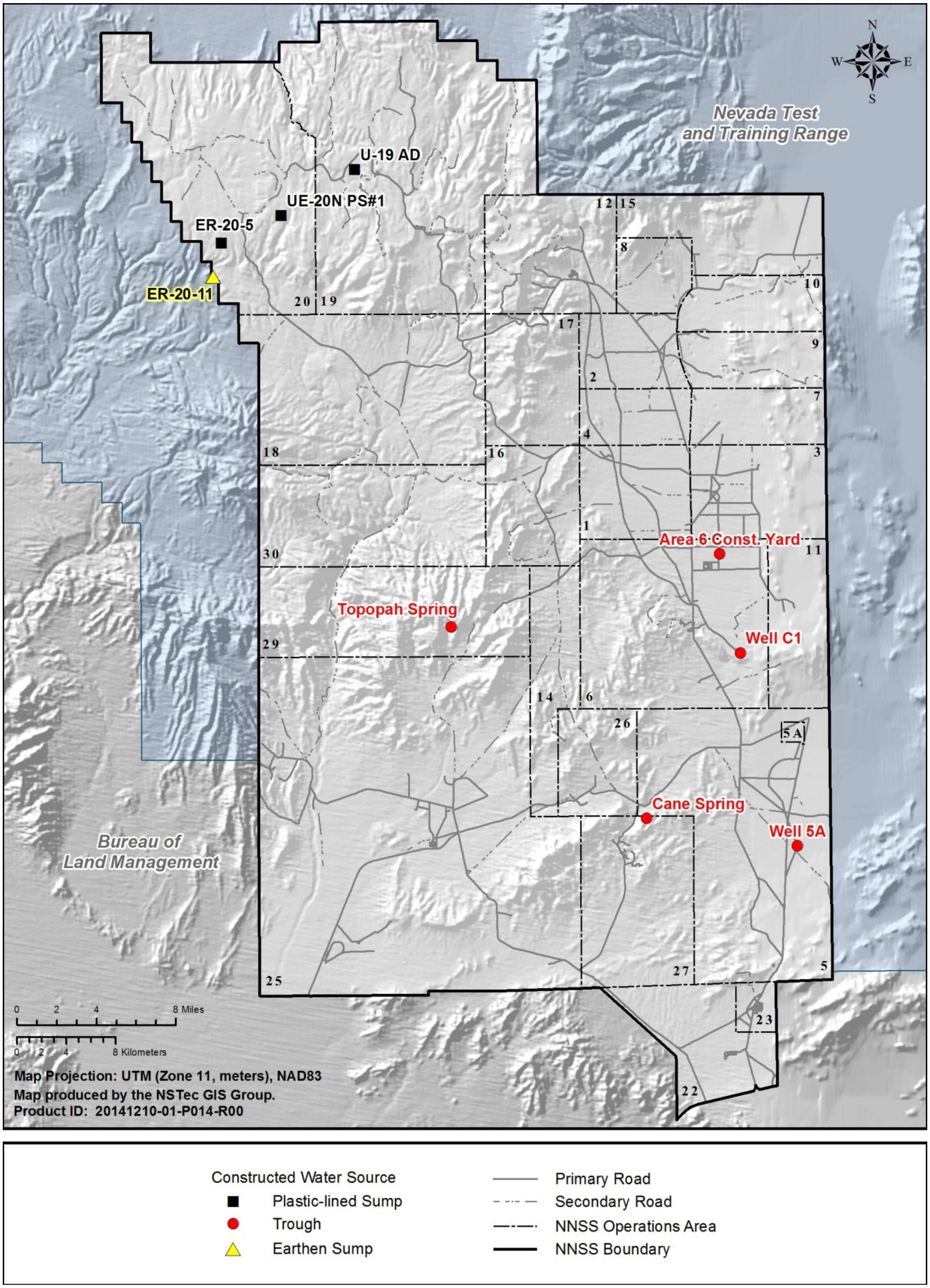

Figure 4-10. Water trough and contaminated sump locations monitored for wildlife use with cameras during 2014

Figure 4-11. Pronghorn antelope drinking at the Area 6 LANL Pond trough
(Photo #799 taken July 23, 2014, by motion-activated camera)

Figure 4-12. Coyote and bobcat at the water trough at Well C1 Pond
(Photo #33 taken August 29, 2014, by motion-activated camera)

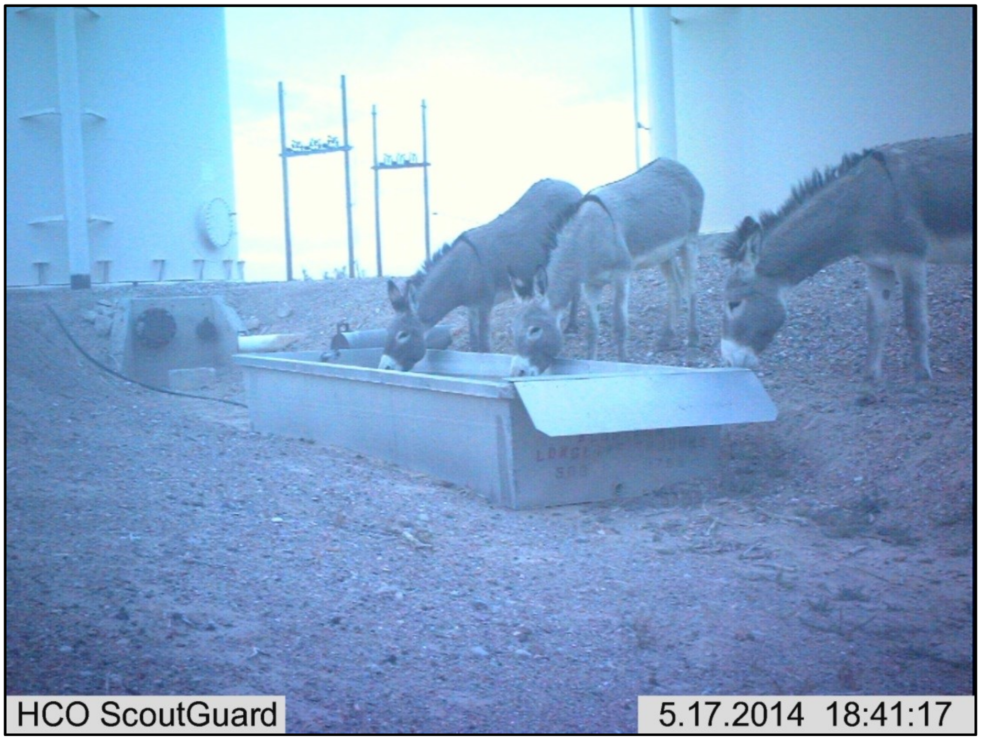

Figure 4-13. Three burros drinking from the water trough at Well C1, Area 6
(Photo #29 taken May 17, 2014, by motion-activated camera)

Figure 4-14. Mule deer standing in trough at Topopah Spring presumably to get a drink and another one standing in front of camera (foreground)
(Photo #170 taken May 29, 2014, by motion-activated camera)

taken at the spring, and 8 were taken at the trough; 487 images of chukar were taken at the spring, and 68 were taken at the trough; and more mourning dove images were taken at the trough than at the spring (41 versus 15). Differences in use may be a preference for the natural setting at the spring versus using the artificial trough or water availability or a combination of both. The trough was dry for most of June and July, whereas the spring was always wet.

In summary, several wildlife species are using the water troughs, indicating the troughs are benefiting many wildlife species on the NNSS, especially certain bird species, ungulates, and coyotes. Our data also imply that some species such as bighorn sheep and mountain lions may prefer natural springs over the troughs. Waterfowl and shorebirds do not appear to be using the troughs very much 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.

4.5.2 Monitoring Wildlife Use at Contaminated Water Sources

During 2014, cameras were set up at four contaminated water sources: ER 20-5, ER 20-11, U19ad, and Ue20n#1 (Figure 4-10) to determine which wildlife species were using these resources and how frequently they were using them. Monitoring was done to assess the potential of radionuclides being transported off site by wildlife and the potential impact to wildlife from these contaminated water sources. The cameras were also added to the network of cameras used for mountain lion monitoring (see Section 6.6.1, Motion-Activated Cameras).

There are seven, plastic-lined sumps at ER 20-5. The camera was set up at the sump in the northwest corner. Periodically, contaminated groundwater is pumped into this sump. Additionally, water from natural precipitation events and melting snow runs off the slope, carrying soil and other debris, and accumulates in this sump. This water may also become contaminated. Although water from precipitation may be diluted compared to the pumped contaminated groundwater, it is still a source of contaminants to wildlife. Results from the camera indicated light wildlife use at the site with only 22 photos of animals taken, including 1 mammal species and 5 bird species (Table 6-4). Chukar, mourning doves, and ducks were documented at the sump, which is important because these are hunted species that may move off site. Another important species documented at the sump was the golden eagle (Figure 4-15). This species is not hunted but is federally protected by the *Bald and Golden Eagle Protection Act*.

Contaminated groundwater from the well at ER 20-11 is periodically pumped into the sump. Because it is an earthen, unlined sump, the water does not remain in it for very long. A camera was set up at ER 20-11 in early September and checked on December 10, 2014. During this time, no water had been pumped into the sump. No images had been taken by the camera, and there was a live black-tailed jackrabbit (*Lepus californicus*) in the bottom of the sump (Table 6-4).

A camera was set up at the U19ad plastic-lined sump in Area 19 on January 15, 2014. Wildlife use at the sump was light, with 22 images of mule deer (Figure 4-16) and 1 image of mourning doves (Table 6-4). However, the camera only worked about a third of the time, so not all wildlife use of the sump was documented. A new camera was set up on December 10, 2014. Both mule deer and mourning doves are hunted species and have the potential of moving off site and being shot and eaten.

A camera was set up at the Ue20n#1 plastic-lined sump in Area 20 on January 15, 2014. Wildlife use at the sump was light, with 20 images of common ravens, 10 images of mule deer, 3 images of coyotes, and 1 image of mourning doves (Table 6-4). Both mule deer and mourning doves are hunted species and have the potential of moving off site and being shot and eaten.

Figure 4-15. Two golden eagles in ER 20-5 sump, Area 20
(Photo #117 taken October 31, 2014, by motion-activated camera)

Figure 4-16. Two mule deer in U19ad sump, Area 19
(Photo #2086 taken June 8, 2014, by motion-activated camera)

Sumps will continue to be monitored over the next couple of years to determine species, frequency, and level of use by wildlife. Sampling of the water and sediment is also being done to determine what radionuclides are present and at what concentrations. Biota dose assessments will be done to calculate potential dose to wildlife and to humans ingesting contaminated wildlife. Previous results have shown that dose to wildlife and humans is well below the allowable limits. This information is published in the annual site-wide environmental report (NSTec 2015).

4.6 Coordination with Scientists and Ecosystem Management Agencies

Site biologists interfaced with other scientists and ecosystem management agencies in 2014 for the following activities:

- Gave 17 reptile genetic samples and 6 voucher specimens to Nevada Department of Wildlife (NDOW) and Brigham Young University.
- Participated in a meeting of the Mojave Desert Initiative designed to address research needs in the areas of wildfires and reclamation of Mojave Desert lands.
- Assisted Dr. Krissa Skogen, of the Chicago Botanical Gardens, by providing information on three species of *Oenothera* and setting up a field study in 2015 on the NNSS.
- Reviewed a manuscript for the journal *Western North American Naturalist*.
- Participated in a meeting with Dr. Julie Miller and other researchers at the Desert Research Institute and the DOE and NNSA/NFO designed to address wildland fire mitigation and monitoring needs.
- Worked with Dr. Mary Barkworth, a botanist from Utah State University, to include the Mercury Herbarium database into the Southwest Environmental Information Network, a website that contains data from most of the herbaria in southwestern America.

5.0 SENSITIVE PLANT MONITORING

The list of sensitive plants on the NNSS is reviewed annually to ensure that the appropriate species are included in the NNSS Sensitive Plant Monitoring Program. The review takes into consideration information gathered on sensitive plants during the current year by NSTec botanists as well as input from regional botanists with expertise or knowledge with particular species. As part of the Adaptive Management Plan for Sensitive Plant Species (Bechtel Nevada 2001), the status of each plant is monitored periodically to ensure NNSS activities are not impacting the species. Field surveys are also routinely conducted to verify previously reported locations, to better define population boundaries, and to identify potential habitat for sensitive plant species known to occur on or adjacent to the NNSS. Information gathered during the year on sensitive plants is disseminated to state and federal agencies and other interested entities.

5.1 Program Awareness

The annual Rare Plant Workshop, sponsored by NNHP and the NNPS, was held in Reno, Nevada, this year. NNSS botanists participated in the workshop remotely this year. There were no actions or recommendations from the participants of the workshop that affected the sensitive plants that are listed for the NNSS.

As part of the statewide effort to disseminate information throughout the botanical community, NSTec prepared site-specific data for all 17 sensitive plants and provided it to the NNHP in 2012. As a follow-up to that effort, a shapefile was sent to the NNHP in 2014. The shapefile contains the location of all 17 species on the NNSS and on lands adjacent to or in the near vicinity of the NNSS. The information will be incorporated into the NNHP statewide database.

5.2 Monitoring

No field surveys were conducted this year on the NNSS. Growing conditions continue to be suboptimum, and plants of key species were not observed. Monitoring was scheduled for Cane Springs sunray (*Camissonia megalantha*) and Darin buckwheat (*E. concinnum*) as it has been for the last several years. Monitoring will be conducted when growing conditions are favorable.

6.0 SENSITIVE AND PROTECTED/REGULATED ANIMAL MONITORING

The NNHP Animal and Plant At-Risk Tracking List (NNHP 2015); NAC 503, "Hunting, Fishing and Trapping; Miscellaneous Protective Measures" (NAC 2015); the FWS Endangered Species home page (FWS 2015); 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. One major change was the designation of the western yellow-billed cuckoo (*Coccyzus americanus*) as a threatened species under the *Endangered Species Act* (Federal Register 2014). Previously, it was considered to be a candidate for listing. However, there has only been one documented sighting of this species on the NNSS, so the listing should not impact NNSS activities. In addition, the American crow (*Corvus brachyrhynchos*) was added as a game species. This was done to complete the list of species protected as game by the State of Nevada, even though this species has not been detected on the NNSS since 1993. The complete list with current designations is found in the Sensitive and Protected/Regulated Animal Species List (Table 2-1, shown previously).

Surveys of sensitive and protected/regulated animals during 2014 focused on (a) winter raptors, (b) bats, (c) wild horses, (d) mule deer, (e) desert bighorn sheep, and (f) mountain lions. Information about other noteworthy wildlife observations, bird mortalities, and a summary of nuisance animals and their control on the NNSS is also presented.

6.1 Raptors and Bird Mortality

6.1.1 Winter Raptor Surveys

Winter raptor surveys were initiated during 2014, in an effort to better understand wintering raptors on the NNSS and as a collaborative effort to provide data to the U.S. Army Corps of Engineers (USACE) for their nationwide mid-winter bald eagle survey and to NDOW for their statewide monitoring effort. Surveys were conducted by driving a standard route and identifying all raptors observed (i.e., eagles, hawks, owls, and vultures). Two official routes were established on the NNSS: Southern NNSS, Route #60, and Yucca Flat, Route #61 (Figure 6-1). Data including common name, UTM coordinates (NAD 83), time, activity, age, and perpendicular distance from the road were recorded, and climatic data (i.e., temperature, wind speed, and cloud cover) were taken at the beginning and end of each survey. Surveys were conducted January 8 (Southern NNSS) and January 9 (Yucca Flat) to coincide with the national bald and golden eagle survey and on February 10 (Southern NNSS) and February 11 (Yucca Flat). The intent is for these surveys to be conducted each year for numerous years to look at long-term trends in winter raptor use. Much is known about raptors on the NNSS in the summer, but winter data are lacking. This may be important if the climate continues to warm to be able to detect changes in the species composition. Data on common ravens and loggerhead shrikes (*Lanius ludovicianus*) were also recorded because ravens are known desert tortoise predators, and the loggerhead shrike is a sensitive species. The southern route is located primarily in the Mojave Desert portion of the NNSS while the Yucca Flat route is located in the transition zone between the Mojave Desert and Great Basin Desert. A detailed description of each route is given below:

- Southern NNSS—Begin route at the junction of Mercury Bypass and Jackass Flats Road (588818mE, 4057221mN). Drive west and north along Jackass Flats Road all the way to the intersection with Cane Spring Road. Turn right and drive east on Cane Spring Road all the way to Mercury Highway. Turn right and drive south on Mercury Highway all the way to the north end of the Mercury Bypass/Mercury Highway junction, which is where the route ends (590060mE, 4058668mN). Total length is 82.6 km.

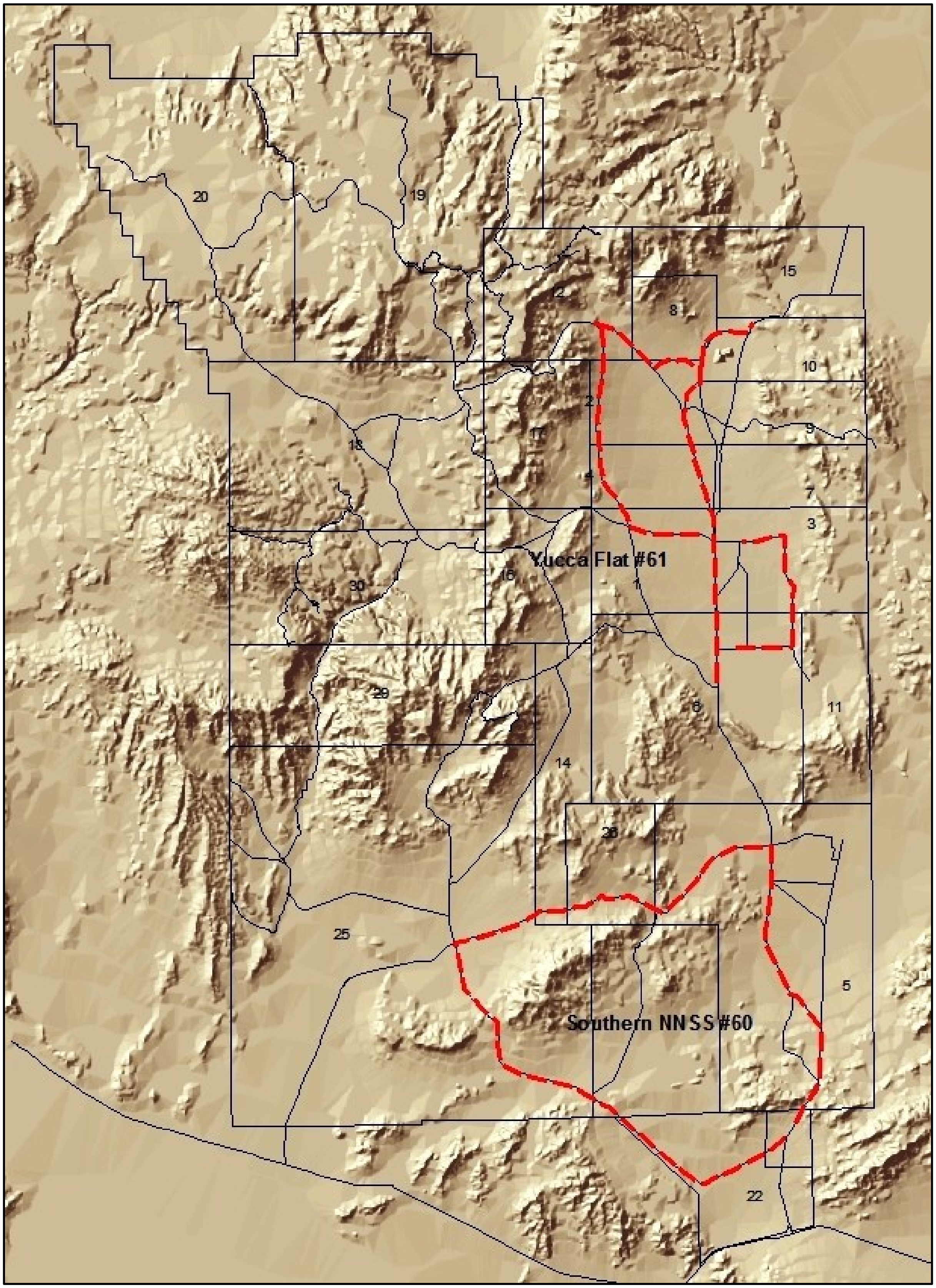

Figure 6-1. Winter raptor survey routes (red lines) on the NNSS

- Yucca Flat—Begin route just east of Wet and Wild Area 6, Building 6-900, on Tweezer Road (585801mE, 4092926mN). Drive east to junction with Orange Blossom Road. Turn left and drive north along Orange Blossom Road to the intersection with 3-03 Road. Turn left and drive west along 3-03 Road to Area 3 Mudplant (586224mE, 4100626mN). This ends this section. Drive to the start of the next section on Pahute Mesa Road, west of Mercury Highway at the A4 RADSAFE sign (583156mE, 4101146mN). Resume looking for raptors and proceed west on Pahute Mesa Road to the junction of Tippipah Highway. Turn right on Tippipah Highway and drive north to the intersection of Rainier Mesa Road. Turn right and drive southeast on Rainier Mesa Road to the intersection with 2-07 Road. Turn left on 2-07 Road and drive east to the junction of Circle Road. Turn left on Circle Road and drive past Sedan Crater, past the junction with Mercury Highway all the way to the guard shack near the gate (586977mE, 4116348mN). This ends this section. Turn around and drive back to the Circle Road/2-07 Road intersection where you start the final section of the route (583225mE, 4113195mN). Drive south and follow the paved road. Curve right at the 10C landfill road intersection and proceed south along Mercury Highway all the way to the junction with Tippipah Highway just north of the Area 6 Gas Station. The route ends at 584446mE, 4090143mN. Total length is 75.0 km.

Results are found in Table 6-1. No bald eagles (*Haliaeetus leucocephalus*) were observed during the surveys, and only one golden eagle was observed in Yucca Flat. Red-tailed hawks were the most common species detected on both routes. Abundance and species richness was greater on the Yucca Flat route than on the Southern NNSS route. Data were entered into the Ecological Geographic Information System (EGIS) faunal database, and given to NDOW for inclusion in their analysis and forwarded to the USACE.

Table 6-1. Results of winter raptor surveys

Species	Southern NNSS (1/8/14)	Southern NNSS (2/10/14)	Yucca Flat (1/9/14)	Yucca Flat (2/11/14)
Golden Eagle (*Aquila chrysaetos*)	0	0	0	1
Red-tailed Hawk (*Buteo jamaicensis*)	4	7	4	7
Prairie Falcon (*Falco mexicanus*)	0	0	1	1
American Kestrel (*Falco sparverius*)	1	0	0	1
Unknown Hawk	0	0	1	0
Total Raptors	**5**	**7**	**6**	**10**
Common Raven (*Corvus corax*)	1	5	3	5
Loggerhead Shrike (*Lanius ludovicianus*)	1	4	4	1

6.1.2 Bird Mortality and Compliance with the Migratory Bird Treaty Act

Bird mortality is a measure of impacts that NNSA/NFO activities may have on protected bird species. NNSA/NFO activities that have affected birds typically have been of three types: collisions with buildings, electrocution from power lines, and vehicle mortalities. Workers and biologists work together to observe and report mortalities. Historically, reported deaths of birds are sometimes numerous, with episodes of predation and disease outbreaks involving large numbers of dead birds, particularly during wet years (Figure 6-2). Overall, few impacts to birds were observed and few mortalities were reported from onsite project activities. There were only nine reported bird mortalities in 2014, which varied in nature (Figure 6-2), with only three reported electrocutions (two ravens and a red-tailed hawk). Thus, reported impacts to bird populations from NNSA/NFO activities at the NNSS appear to be low. The Avian Power Line Interaction Committee (2006) has recommended numerous voluntary suggestions for improving safety for raptors on electrified poles when such hazards are specifically identified. As such, reducing the number of exposed grounding and electrified elements on poles with "unfriendly raptor perching configurations" will be encouraged on a case-by-case basis on the NNSS to reduce electrocutions.

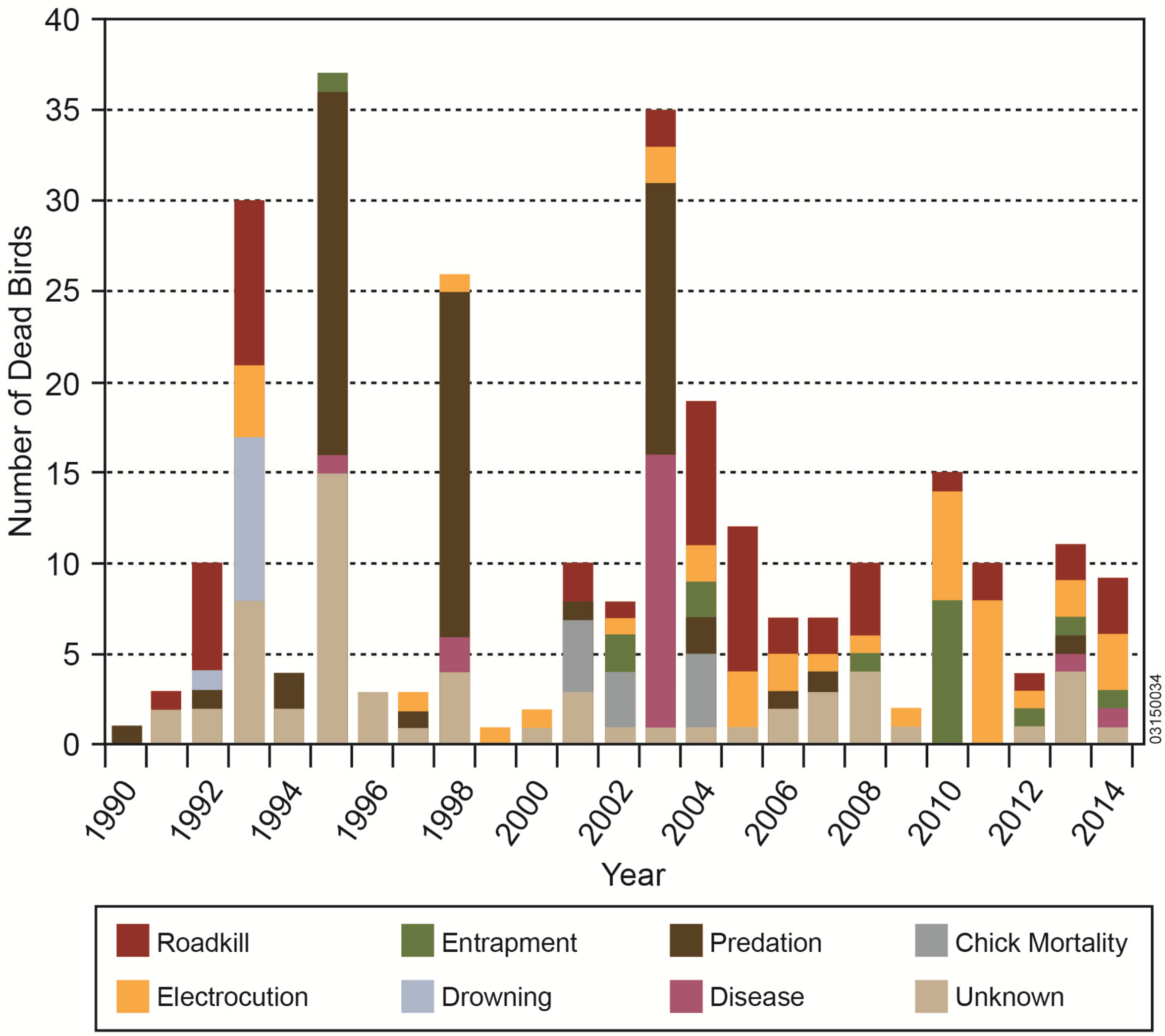

Figure 6-2. Historical records of reported bird deaths on the NNSS, 1990–2014

6.2 Bat Surveys

In 2014, bat monitoring focused on passive acoustic monitoring of bat activity at Camp 17 Pond and removing bats from buildings and documenting bat roosts.

6.2.1 Passive Acoustic Monitoring System at Camp 17 Pond

To learn more about long-term bat activity through different seasons and years, a passive acoustic monitoring system (Anabat II) was installed at Camp 17 Pond on September 22, 2003. Millions of electronic files containing bat calls have been recorded and are being analyzed by O'Farrell Biological Consulting as funding becomes available. Bat vocalizations and climatic data (e.g., temperature, humidity, wind, barometric pressure) were recorded again in 2014, but no analysis was performed due to a limited budget.

6.2.2 Bats at Buildings

During 2014, site biologists responded to five nuisance bat calls. One at the Mercury Cafeteria Warehouse was a juvenile, male canyon bat (*Parastrellus hesperus*). It was captured and released west of

California myotis (*Myotis californicus*) roosted outside Building 652 in Mercury for 5 weeks. Two dead bats (unknown species) were found in a trailer at the Area 5 Radioactive Waste Management Complex and were disposed of. Two canyon bats were found roosting in a boxcar in the heavy equipment yard in Area 6. Roost site locations were entered in the EGIS faunal database.

6.3 Wild Horse Surveys

Horse monitoring provides information on the abundance, recruitment (i.e., survival of horses to reproductive age), and distribution of the horse population on the NNSS. Annual monitoring of individual horses at the NNSS began in 1989 and has continued through 2014. In 2014, NSTec biologists determined horse abundance and recorded horse sign (e.g., droppings and hoof prints) along roads. Some of the natural and human-made water sources were visited in the summer of 2014 to assess their influence on horse distribution and movements and to document the impact horses are having on NNSS water sources. Important information on horse abundance and recruitment from 1990 to 1998 is found in Greger and Romney (1999).

6.3.1 Abundance

In 2014, counts of horses were made during 28 non-consecutive days between May and November. A standard road course was driven to locate and identify horses. Motion-activated cameras at Camp 17 Pond, Gold Meadows Spring, and Captain Jack Spring were also used to photograph horses (see Section 6.6.1, Motion-Activated Cameras). Individuals were identified by their unique physical markings (facial blazes) and classified as foal, yearling, or older when possible. Excluding foals, 42 horses were counted in 2014. This is a close approximation to the actual number of horses present. One adult was found dead in November, apparently of natural causes. About seven horse bands were detected, which were composed of stallions, subordinate males, females, and their offspring. The NNSS horse population in 2014 is about 41 individuals and is growing. Survival of yearlings and foals was moderately high in 2013–2014, different from previous years (Figure 6-3). Historically, Greger and Romney (1999) found that over 60 healthy foals were lost over a 5-year period at the NNSS, and hypothesized that mountain lion predation was the primary cause. Since then monitoring of mountain lions has revealed that this is in fact true. Foal losses are a significant factor in controlling the size of the herd of horses on the NNSS, and it now appears that this horse population may have always been controlled by lions, as far as records of horses on the site are known.

Interestingly, the horse population has increased in 2014 with the survival of an additional 10 to 12 yearlings from the apparent relaxed level of horse predation by mountain lions over the last 2 years. The recent death (February 2013) of one lion (NNSS4) that killed five horse foals over an 8-month period (Hall et al. 2013) is coincident with this increased survival. It is important to note that horse mortality may have numerous causes, including disease, malnutrition, drought, predation by coyotes, and genetic bottlenecks. Not all of these things have been investigated on the NNSS, and so far, other than coyote mortality, no other specific causes have been identified. It is possible that more than one lion may be feeding on the horses at one time, and therefore losses attributed only to one individual may be incorrect. Mountain lion predation is likely a learned skill, and such predation pressure when reduced is likely to return in the near future.

6.3.2 Annual Range Survey

During 2014, selected roads were driven within the NNSS, and all band sightings and fresh sign (estimated to be <1 year old) were recorded (Figure 6-4). Horse sign data collected during the road and walking surveys indicate that the horse range on the NNSS during 2014 included Gold Meadows, Eleana Range, the southwest foothills of the Eleana Range, Pahute Mesa, and Wildhorse Seeps in Area 30 (Figure 6-4). Horse results for 2014 were very similar to the previous 3–4 years, so in 2014 we plotted a

5-year summary of the data (2010–2014). This summary (Figure 6-4) presents an Adaptive Local Convex Hull GIS Home Range Analysis using three core area use analyses estimates of 50%, 90%, and 95% (Arcmet 10.2.2 version 3). These indices illustrate the high use areas of horses around roads because that is where the data were collected. This map does not reflect known movements of horses regularly through the Eleana Range to Yucca Flat or south to watering areas in Area 30 (e.g., areas lacking coloration) because these areas are not regularly sampled (Figure 6-4). However, the horse movement corridor between Camp 17 Pond and Gold Meadows Spring is clearly delimited by this analysis. The overall horse range boundary line was also added to this figure as in previous years approximating total annual range area using the locations of horses and fresh horse sign from 2010 to 2014.

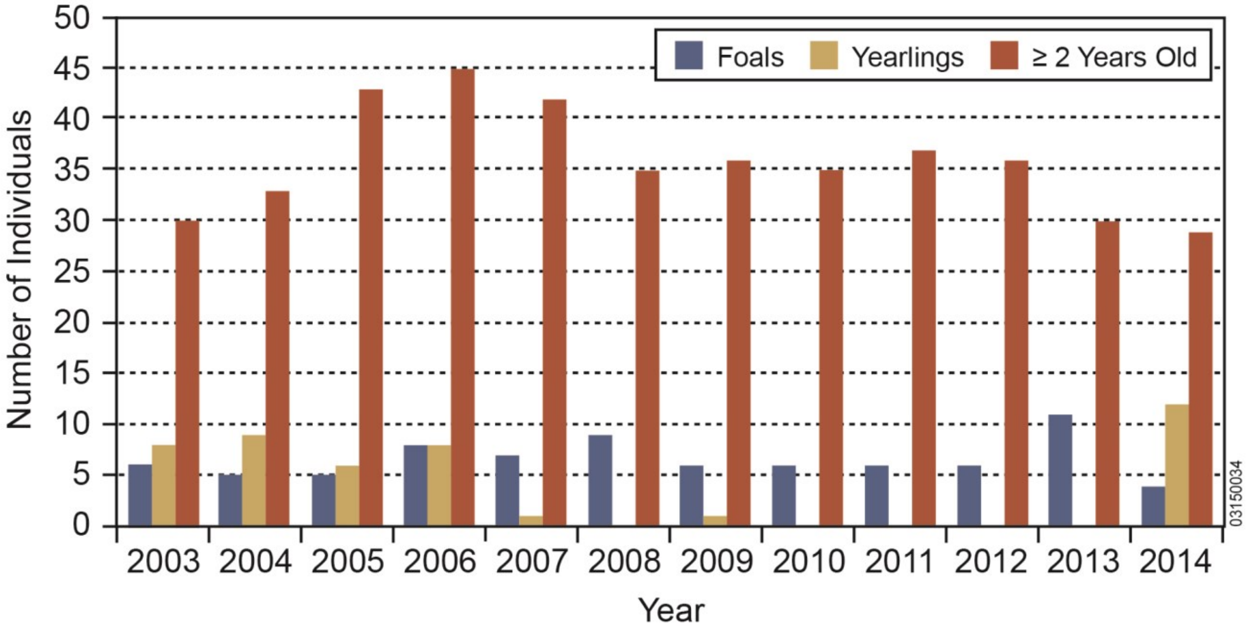

Figure 6-3. Trends in the age structure of the NNSS horse population from 2003 to 2014

Overall, no horse use has occurred around the vicinity of Captain Jack Spring area for the last 4 years. In January 2010, there was horse use at the spring, so the horse range boundary includes Captain Jack Spring to reflect that use. Horses occupied areas south of the Eleana Range in Area 30 and near Red Rock Valley as in previous years (Figure 6-4). Horse activity was heaviest along roads from Camp 17 Pond in all directions as shown by the concentration of points in Figure 6-4. The preferred horse range seems to be above 1,524 m elevation, especially during the summer months. The northern edge of the horse range extends onto Pahute Mesa near Echo Peak; however, use in this area was low in 2014 (Figure 6-4).

6.3.3 Horse Use of Water Sources

Camp 17 Pond and Gold Meadows Spring were two primary water sources used in 2014 by horses, as in previous years. Camp 17 Pond is permanent, and horse use generally begins in March and extends through November. Gold Meadows Spring use is temporary, and the spring was dry in September 2014 during ungulate surveys. Wildhorse seeps in Area 30 are also temporary water sources in slick rock areas (Figure 6-4) containing several water tanks on the southern edge of the horse range. They are used mostly in fall and winter. Captain Jack Spring was not used by horses during 2011 through 2014. No plastic-lined sumps within or near the horse range were used by horses this year.

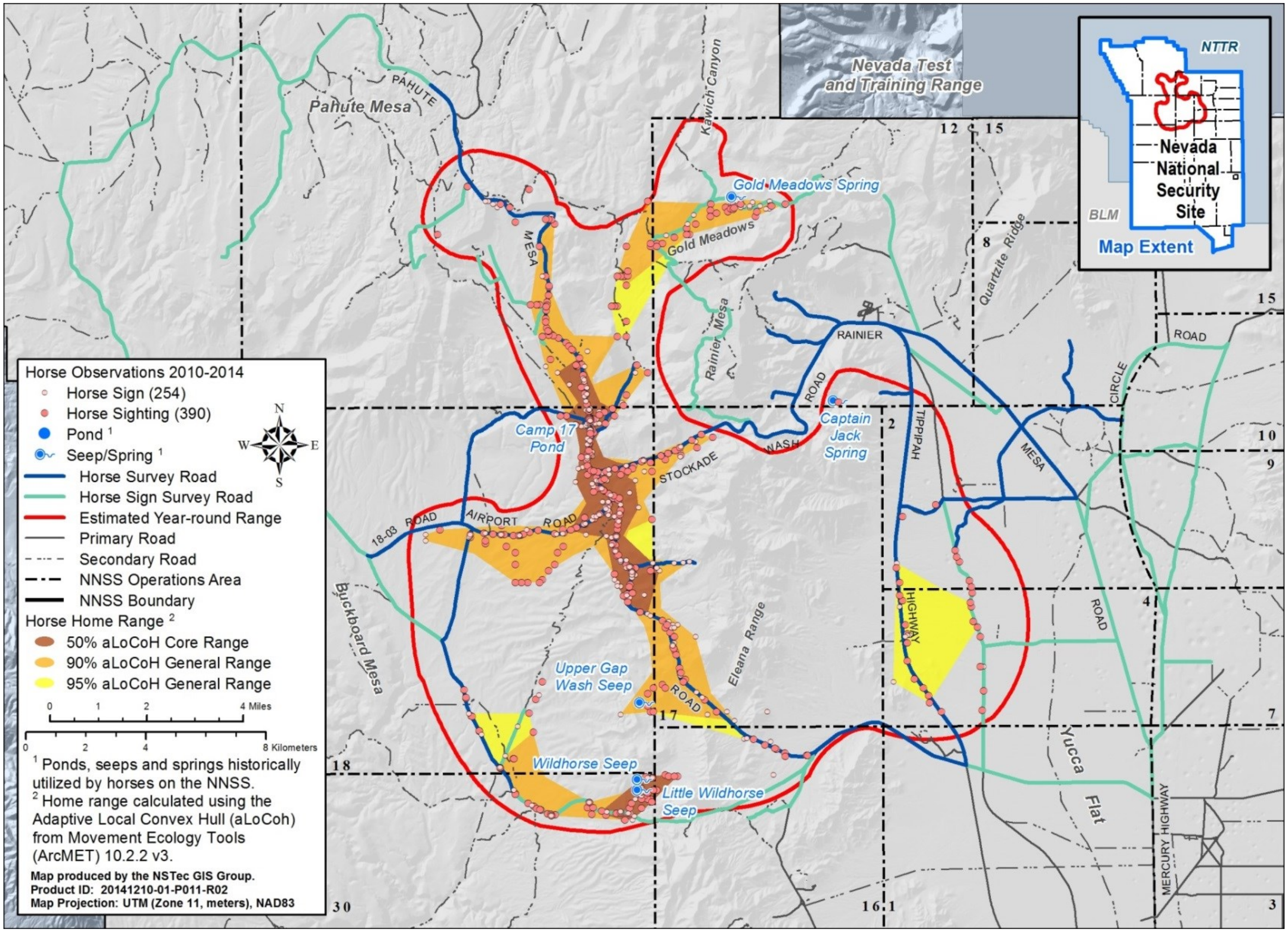

Figure 6-4. Feral horse sightings, horse sign, and core horse use areas on the NNSS during 2010–2014

6.4 Mule Deer

Initial studies of mule deer at the NNSS were conducted by Giles and Cooper (1985) from 1977 to 1982 when they performed mark and recapture studies on about 100 marked deer. They estimated the population to be about 1,500–2,000 deer. Spotlighting surveys for deer on the NNSS were conducted in 1989–1994, 1999–2000, and 2006 to 2014. The monitoring effort has emphasized estimating relative abundance and density.

6.4.1 Trends in Mule Deer Abundance

Mule deer abundance on the NNSS was measured by driving two standardized (59 km total length) road courses (Figure 6-5) to count and identify mule deer. One route was centered around Rainier Mesa and the second was centered around Pahute Mesa, following advice that there are two main deer herd components in these regions on the NNSS (Giles and Cooper 1985).

Locations of mule deer and selected predators were recorded with a GPS from the road centerline. Perpendicular distance from the road to each deer group was measured with a laser range finder. Locations of deer groups were displayed using GIS methodology and were superimposed on vegetation types previously delineated (Ostler et al. 2000, Hansen et al. 2010 [see Figure 6-12]).

During nine surveys conducted in 2014, total observations were made of 249 deer, which equates to an average of 28 deer per night. The deer counts in 2014 were similar to 2013 and near the long-term average of 32 deer per night. There appears to be no distinctive long-term trend; however, numbers appear stable on the NNSS (Figure 6-6). Counts per distance on the Pahute Mesa route increased somewhat in 2014 (Figure 6-7), and the lines cross for the first time in 8 years. This is due largely to restructuring the deer route on the western region of Pahute Mesa. Fifteen km of route were removed from sampling due to closure of Pahute Mesa Road west of the Dead Horse Flats intersection (Figure 6-5). This section has had few detections of deer in recent years.

6.4.2 Mule Deer Density

Densities of deer were calculated using the software program DISTANCE (Thomas et al. 2006) on two routes and several sub-routes (Figure 6-5). Stratification of the data was based mostly on differences in topography and elevation. A statistic called Akaike's Information Criterion (AIC) is used to assess model fit. The procedure involves running several models simultaneously on the data set and choosing the model with the lowest AIC to calculate density. A series of tests such as likelihood ratios and goodness of fit tests are also used along with visual inspection to evaluate the overall fit. In DISTANCE, the model fit closest to the centerline is the most important area to be concerned about, and agreement here allows the best fit (i.e., lowest AIC value) and most reliable density estimate.

The effective strip width (ESW) or (half width) is an important parameter in DISTANCE that is used to calculate density (D), with n = the number of animals counted (mean cluster size × cluster density) in area (A) sampled, $A = 2 \times ESW \times L$, with L as the transect length.

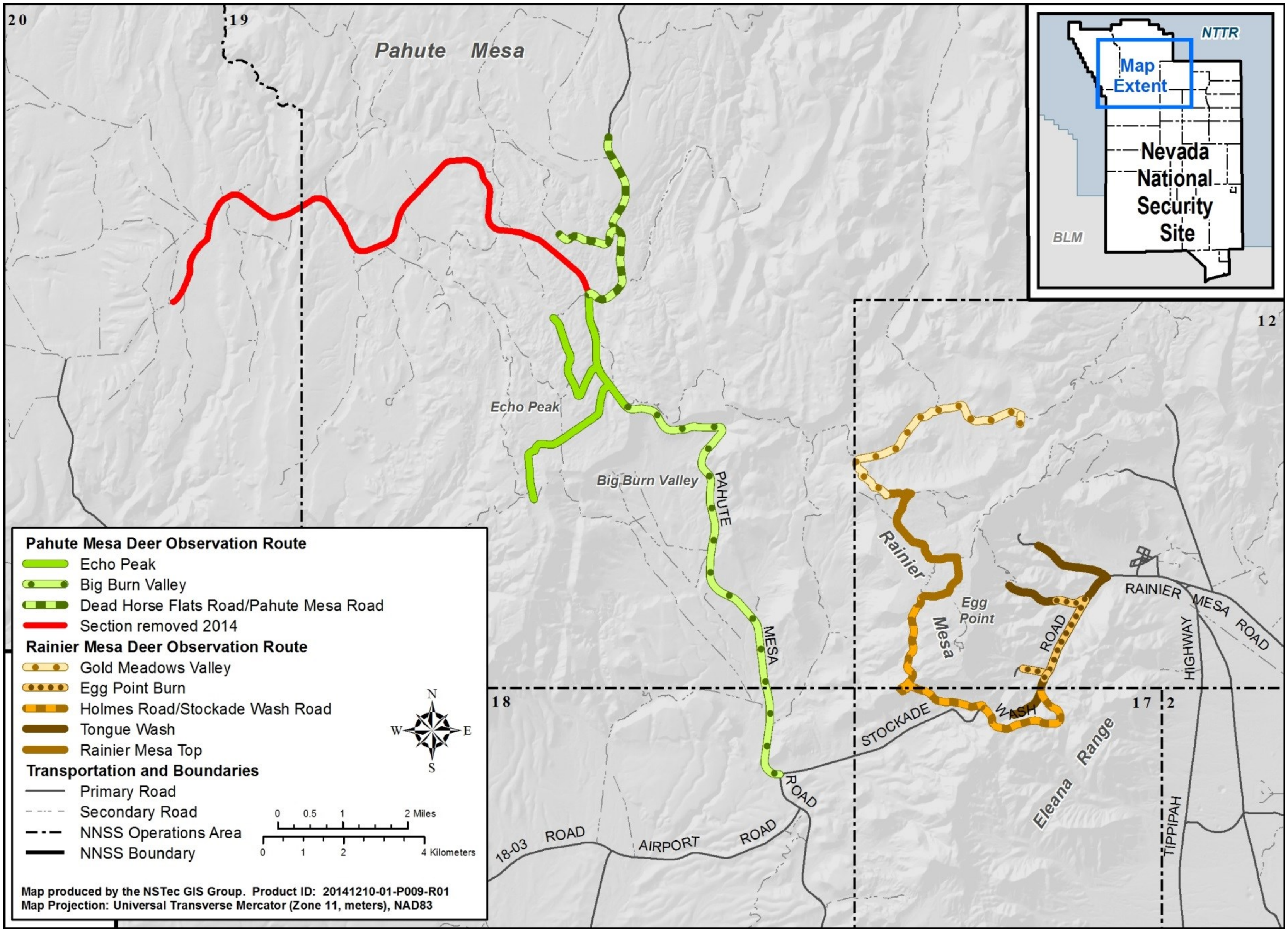

Figure 6-5. Road routes and sub-routes of two NNSS regions driven to count deer and section removed due to roadblock

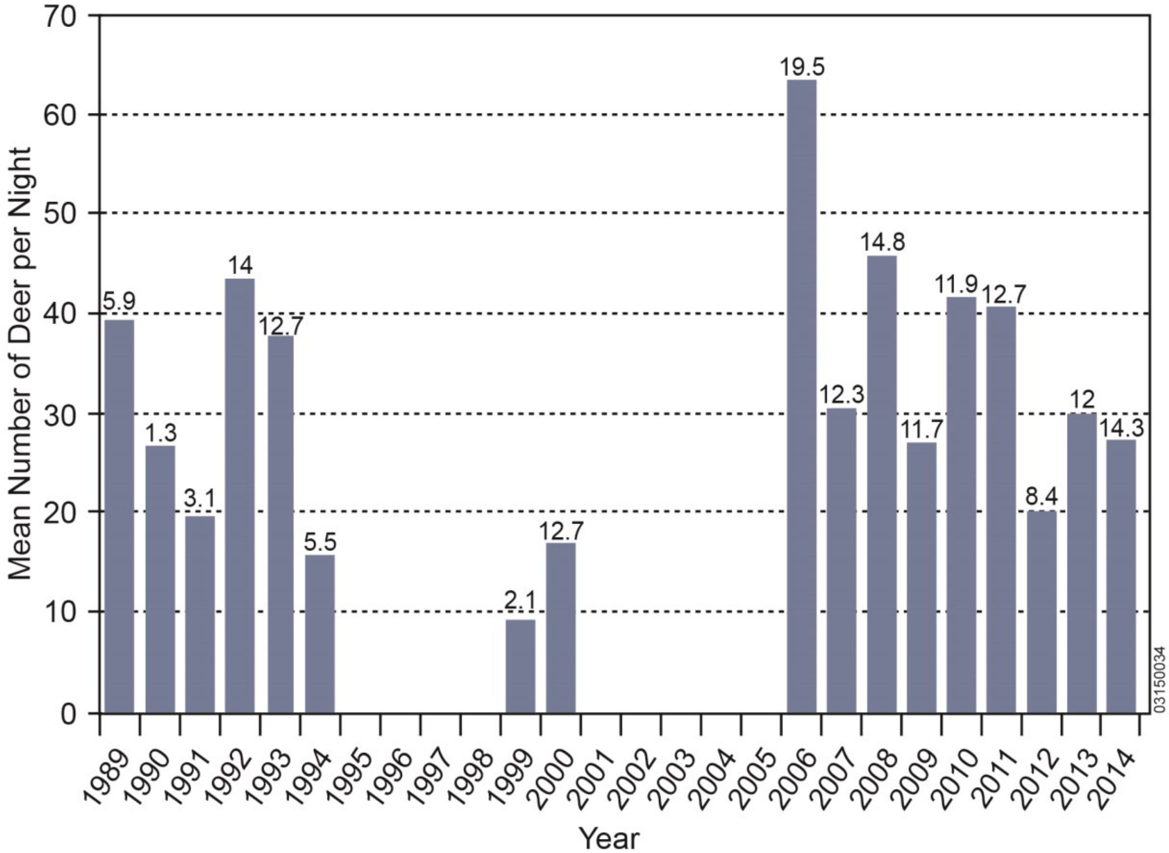

Figure 6-6. Trends in total deer count per night from 1989 to 2014 on the NNSS (surveys were not conducted during 1995–1998 or 2001–2005). Standard deviation values above bars.

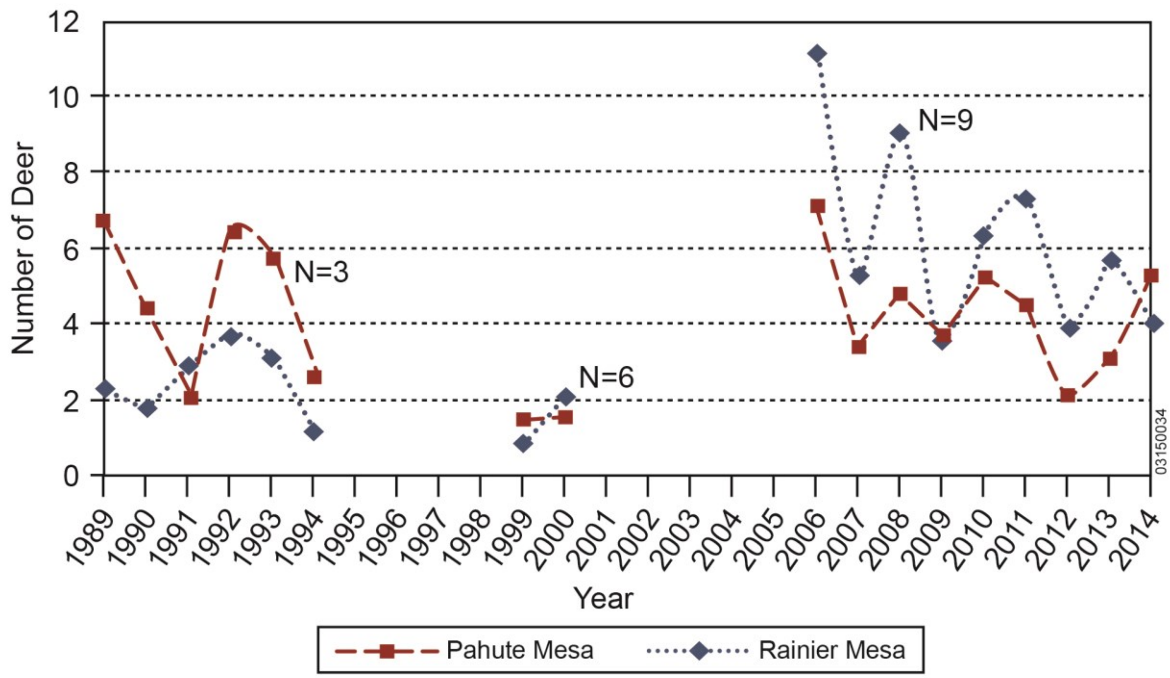

Figure 6-7. Mean number of mule deer per 10 km per night, counted on two routes (n = number of survey nights; n = 12 for 2012, n = 8 for 2013, n = 9 for 2014)

During the nine surveys conducted in September and October 2014, 100 observations (deer groups) were detected. Group size varied from one to eight animals. Overall, Pahute Mesa had an average deer group size of 2.2 deer, and Rainier Mesa was 3.1. Total density estimates for the Pahute Mesa route and Rainier Mesa route averaged about 2 and 1.5 deer per square kilometer (km^2), respectively (Table 6-2). As in previous years, the two areas with the highest deer density were Gold Meadows and Echo Peak (7.5 and 3.2 deer per km^2, respectively).

On the Rainier Mesa region, the deer density of Gold Meadows was significantly higher than that of the Tongue Wash section. However, Gold Meadows was not significantly higher in density than the Rainier Mesa top section (confidence intervals overlapped, Table 6-2). Rainier Mesa Top area had low sample size with a very high coefficient of variation, and the density estimate provided may not be reliable. As in previous years some sub-routes in 2014 had counts that were too low to calculate density (Table 6-2), namely Holmes Road/Stockade Wash and the Tongue Wash area.

Table 6-2. Deer density estimates, confidence intervals, and other parameters for two routes and sub-routes of the NNSS for 2014 using Program DISTANCE software

Survey Routes and Subroutes[a]	Route length (km)	Total Obs.	Deer density D^b, n/Km^2	95% lower confidence interval of D	95% upper confidence interval of D	Coefficent of variation of D
Pahute Mesa Total	30.0	66	2.0	1.3	2.9	0.20
Big Burn Valley	13.0	18	2.3	1.0	5.0	0.39
Echo Peak Area	10.0	40	3.2	1.9	5.3	0.26
Dead Horse Flats	7.0	8	0.8	0.4	1.8	0.39
Rainier Mesa Total	28.5	34	1.5	0.9	2.5	0.25
Tongue Wash Area	4.9	1	NE			
Egg Point Burn	3.7	6	1.0	0.5	2.9	0.46
SW Road to Holmes Road	7.5	1	NE			
Rainier Mesa Top	5.8	3	1.1	0.3	4.5	0.70
Gold Meadows	6.6	23	7.5	3.9	15.5	0.34

[a]Conventional distance sampling with major key, with cosine adjustments, 1 observer, and 1 parameter; 10% right data truncation

[b]Number of surveys is 9 for all estimates

NE=No estimate due to low counts

6.4.2.1 Trends in Mule Deer Density Estimates 2008–2014

Trends in average mule deer density on the NNSS from 2008 to 2014 over the total survey route lengths are shown in Figure 6-8. There were only 2 years (2008 and 2013) when significant differences in deer density estimates were detected between the two routes. Further, few significant differences were detected for specific habitat types on Pahute Mesa (Figure 6-9) and Rainier Mesa (Figure 6-10). For example, Echo Peak density was significantly higher than Big Burn Valley only in 3 out of 8 years (Figure 6-9). Also, Gold Meadows density was only found to be significantly higher than Rainier Mesa Top once in 8 years (Figure 6-10). Few significant differences shown across years is partly explainable from the general low counts of deer and high variances measured here. Another possible reason for the lack of significant differences may simply be that deer are able to move freely between habitats. The fact that we generally find higher estimates of density from more open habitats such as Gold Meadows (although not significant) and lower densities in thick wooded habitats like Rainier Mesa may be due to the increased probability of detecting deer in the more open habitat with fewer trees. The same also seems plausible between Echo Peak (more open) and Big Burn Valley (more wooded) habitats.

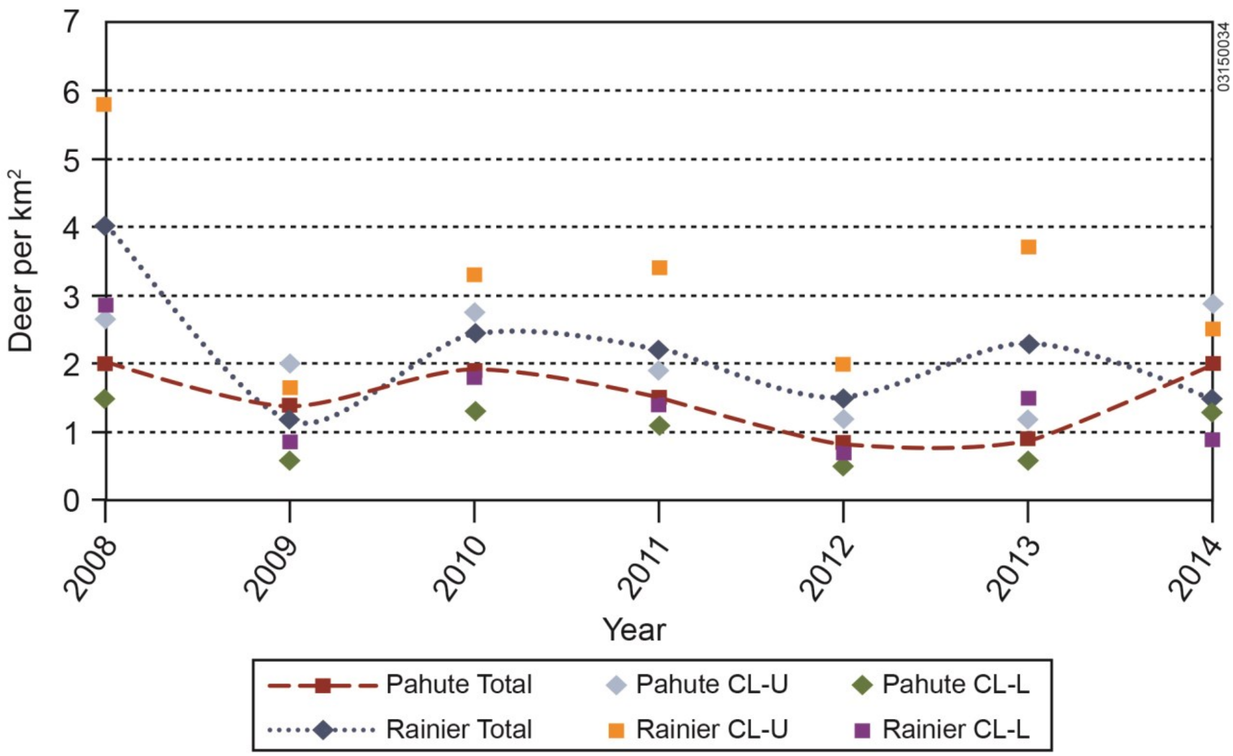

Figure 6-8. Deer density estimates (dashed lines) from Program Distance with 95% confidence limits for Pahute Mesa and Rainier Mesa routes (CL-L = lower confidence limit, CL-U = upper confidence limit)

To the contrary, deer densities at the Dead Horse flat subsection of the deer route have been significantly lower than deer densities measured at Echo Peak 8 years in a row (no overlap in confidence limits [CLs]: CLs not shown in Figure 6-9). Holmes road densities are also shown on Figure 6-9 (without CLs) to illustrate very low densities measured consistently around Rainier Mesa when compared to higher density areas in the region. This line is significantly down-trending in slope across years ($y = -0.4146x + 2.5557$, $r^2 = 0.829$). Echo Peak and Rainier Mesa density shows no definite trends over the past 7 years, but Gold Meadows' density shows a slightly positive trend.

The Egg Point Burn density rarely was significantly lower than other habitats except in 2013. However, deer densities in this region have decreased 4 years in a row after 2 high years in 2008 and 2010. The large decrease in 2009 seems out of place and may be an outlier. The slope of the trend line is distinctly negative ($y = -0.5496x + 4.3114$) with n = 7 and r^2 of 0.52. This decline may indicate that deer use peaked 3–6 years after the 2002 fire when desert bitterbrush resprouts were more palatable and nutritious and now with time the forage has become less palatable and nutritious. Demarchi and Lofts (1985) found that nitrogen content of antelope bitterbrush (*Purshia tridentata*) was elevated 3 years post-burn.

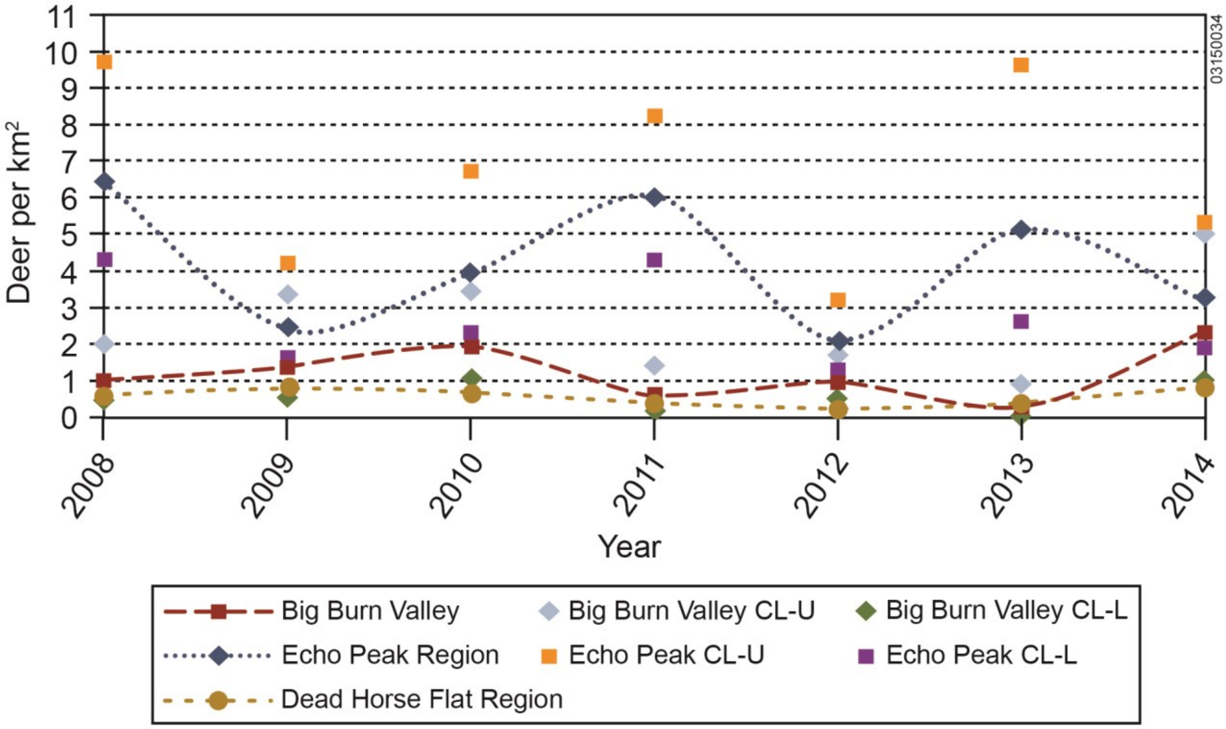

Figure 6-9. Deer density estimates (dashed lines) from Program Distance with 95% Confidence Endpoints in the Pahute Mesa region (CL-L=lower confidence limit, CL-U=upper confidence limit)

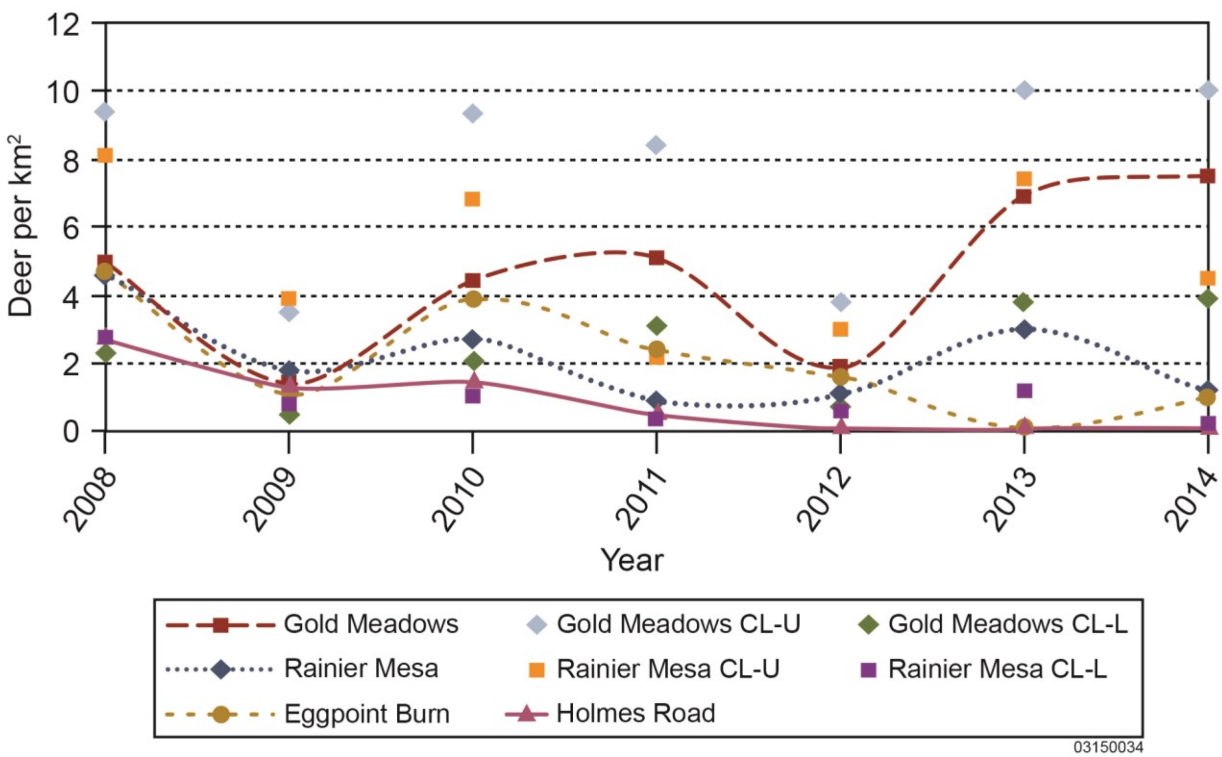

Figure 6-10. Deer density estimates (dashed lines) from Program Distance with 95% Confidence Endpoints in the Rainier Mesa region (CL-L = lower confidence limit, CL-U = upper confidence limit)

6.4.3 Sex and Fawn/Doe Ratios

Sex ratio (number of males/female) of deer was the lowest ratio ever measured on site (81 bucks/100 does) in 2014 (Table 6-3, Figure 6-11). These sex ratios have varied greatly on the NNSS across years. 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 many fewer males compared to females in the population than measured on the NNSS.

During the last 9 years, it is interesting to note that numbers of males and females track each other very well in 7 of 9 years (Figure 6-11). However, two peaks in buck/doe ratios were noted in 2007 and 2013, suggesting fewer does survived in those years (Figure 6-11). The largest disparity appears valid as 2007 was an exceptionally dry year on the NNSS, consistent with low numbers of females and fawns detected that year. Buck numbers also dropped in 2007 but not to the same degree fawns did. The second largest disparity of males to females was detected in 2013. However, in 2012, there was an almost identical substantial decline in both males and females, and males subsequently increased abundantly during 2013, while females remained at about the same level (Table 6-3). The fawn/doe ratio was the highest ever measured on the NNSS during 2013, which suggests that on average about half of the does had a fawn. We have continued to measure fawn/doe ratios that are much lower than Giles and Cooper's (1985) measurements (34–73 fawns/100 does). They conducted fawn/doe surveys from July to October (1977–1981) and we conducted our surveys in September and October. Some of the discrepancy may be due to fawn mortality occurring during July and August before we start our surveys. Body condition of does in the fall is also an important factor in determining how many fawns survive the following year. Additionally, 35% (60 of 170) of deer were unclassified in 2014 as to sex, mostly because many deer were recorded far away from the observers during surveys. This may also have contributed error to our fawn count providing very low estimates of fawns to does in 2014. More information is required to determine the reason(s) for our lower fawn/doe ratios.

Table 6-3. Mule deer classified by sex and age, with sex ratios, and fawn to doe ratios from 2006 to 2014 on the NNSS

Year	Bucks	Does	Unclassified Sex	Bucks/100 does	Fawns	Fawns/100 does
2006	224	222	96	101	31	14
2007	148	68	59	218	0	0
2008	164	147	50	112	47	32
2009	98	102	35	96	7	7
2010	133	150	50	89	32	21
2011	189	184	67	103	37	19
2012	65	67	28	97	19	30
2013	106	68	38	156	31	45
2014	76	94	60	81	19	20

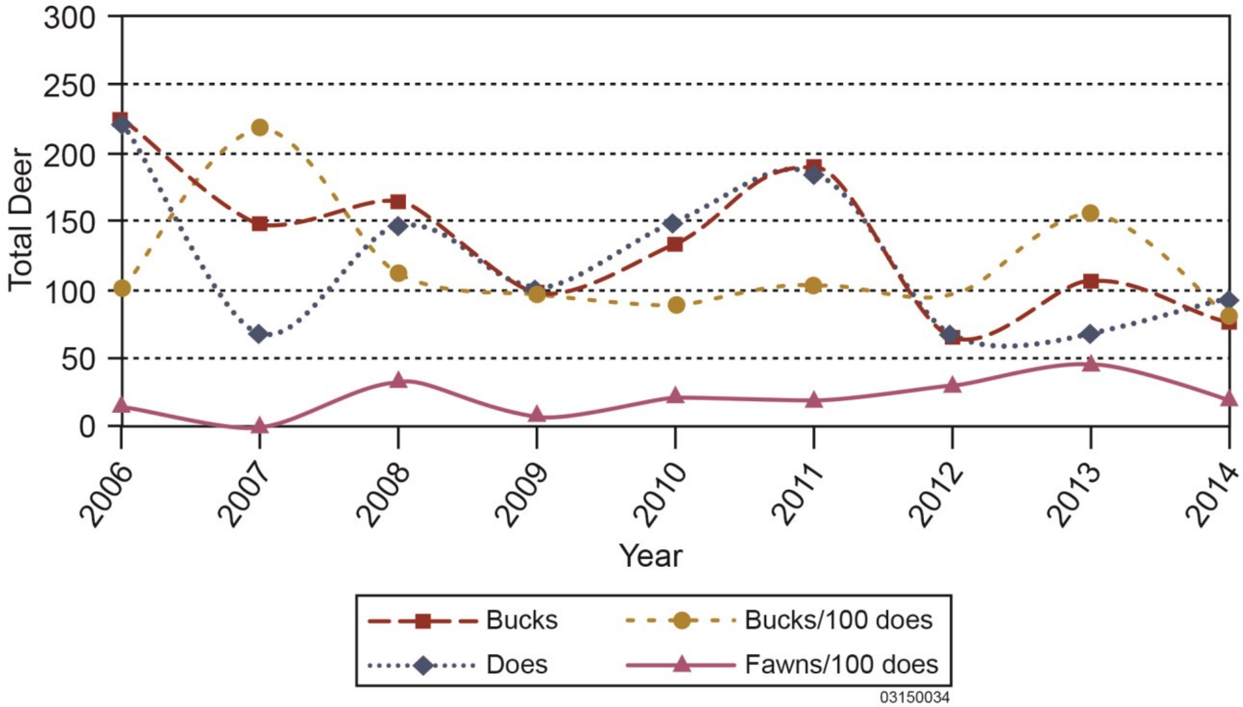

Figure 6-11. Total mule deer counted by year (solid lines), with associated bucks/100 doe ratios and fawns/100 doe ratios (dashed lines) from 2006 to 2014

6.4.4 Preferred Fall Mule Deer Habitat Use

From 2008 to 2014, the most heavily used habitat for deer was the sagebrush spp. alliance, often with the highest positive selectivity value, followed by the pinyon pine/big sagebrush woodland, which was normally second highest in use of the six classified habitats each year (Hall et al. 2013; 2014). These two habitats form an important habitat ecotone for mule deer because they often occur together and form an "edge" habitat (i.e., wooded areas interspersed with open sagebrush meadows). Movements of deer between these two habitats are probably dynamic and related to several factors of which weather or wind may be significant.

6.5 Desert Bighorn Sheep

Up until a few years ago, desert bighorn sheep (sheep) appeared to be rare on the NNSS with only eight recorded observations of their presence on or near the NNSS between 1963 and 2009. These observations were recorded in the southern part of the NNSS (Areas 5, 23, and 25) (EGIS faunal database) and were most likely reintroduced sheep from the Spotted Range, east of Mercury, and the Specter Range, southwest of Mercury. Since then numerous observations of sheep and sheep sign (i.e., scat, beds, remains) have been detected with motion-activated cameras and during the mountain lion study, including the discovery of ewes and lambs in the Yucca Mountain/Forty-mile Canyon area and southern flank of Pahute Mesa. These new data have expanded the known distribution of sheep on and near the NNSS (Figure 6-12). It is unknown if they have always occurred and were undetected or if they are colonizing new areas on the NNSS. Given the amount of human activity that occurred in the Yucca Mountain and Pahute Mesa areas, it is difficult to believe the sheep went undetected. It is currently thought that sheep have recolonized the NNSS from other sheep populations surrounding the NNSS (e.g., Stonewall Mountain, Thirsty Canyon, Specter Range, Spotted Range).

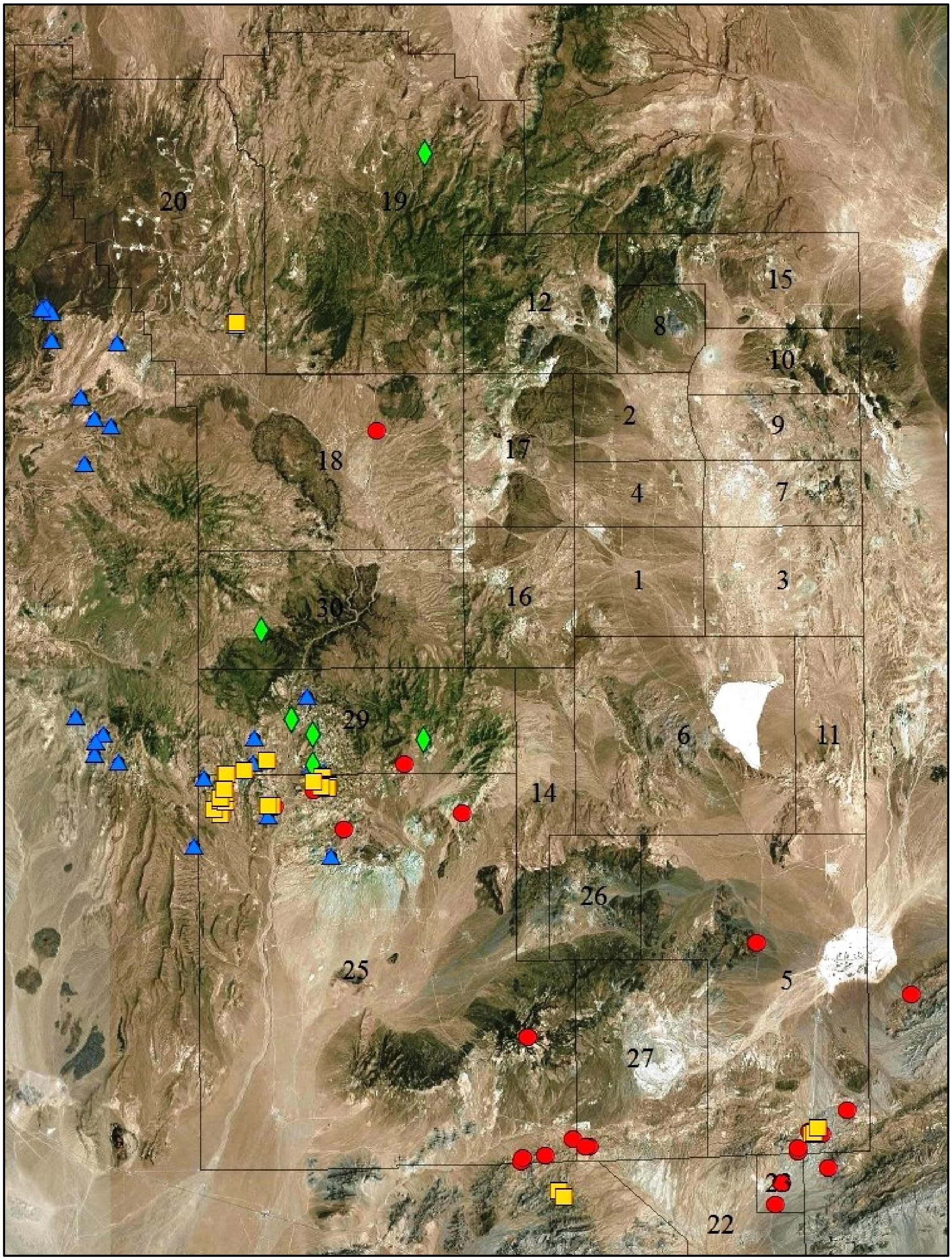

Figure 6-12. Desert bighorn sheep distribution on the NNSS and surrounding areas (1963–2014) (red circle = sighting [n = 26], blue triangle = mountain lion kill [n = 25], green diamond = camera [n = 6], orange square = scat [n = 62])

During 2014, motion-activated cameras detected sheep at Topopah Spring (16 images), Delirium Canyon Tanks (186 images) (Figure 6-13), South Pah Canyon Tanks (75 images), and Twin Spring (1 image).

Sheep use at Delirium Canyon Tanks and South Pah Canyon Tanks was fairly regular, with use documented during June, July, September, October, and November at both sites. Sheep were also photographed at Delirium Canyon Tanks during April and May. Photos included ewes and rams at both sites and lambs at Delirium Canyon Tanks. The photo at Twin Spring was the first time sheep have been detected at this water source since it was set up in May 2011.

There are plans to conduct helicopter surveys to census the population during fall 2015. Periodic population counts after defining the baseline population may be used to determine trends in sheep. Sheep are a major game species in Nevada, and hunting units are in close proximity to the NNSS. Characterizing radionuclide burdens of sheep found on site and determining their movement patterns off site into huntable areas is important to assess as a potential dose pathway to humans.

Figure 6-13. Five desert bighorn sheep at Delirium Canyon Tanks
(Photo by motion-activated camera, April 22, 2014)

Sheep scat is also being collected for genetic analysis to try to determine how sheep on the NNSS are related to surrounding sheep populations. This may help determine if NNSS sheep are recolonizing from surrounding populations and if so, which populations, or if they are native to the NNSS. This is a collaborative effort with USGS biologists.

6.6 Mountain Lion Monitoring

6.6.1 Motion-Activated Cameras

Little data exist for mountain lion numbers and their distribution in southern Nevada, including the NNSS. Since 2006, site biologists have collaborated with Dr. Erin Boydston, a USGS research scientist, to use remote, motion-activated cameras to determine the distribution and abundance of mountain lions on the NNSS. Cameras used this way are referred to as camera traps. Camera traps have also been used the last few years to assist with the capture effort for the telemetry study by identifying where mountain lions occur as well as the frequency of occurrence at those sites. Remote, motion-activated cameras were used at 32 sites, including seven new sites (Figure 6-14 and Table 6-4). Sites were selected at locations with previous or new mountain lion sightings or sign, on roads or landform features that are potential movement corridors from one area to another, and in areas of good mule deer habitat (mule deer are a primary prey species for mountain lions). The number of images reported is based on a 1-minute interval between images taken during a single episode. Some images were taken during late 2013 due to the accessibility and scheduling of camera trap visits.

A total of 93 mountain lion images (i.e., photographs or video clips) were taken during 220,379 camera hours across all sites (Table 6-4 and Figure 6-15). This equates to about 0.4 mountain lion images per 1,000 camera hours. Mountain lions were detected at 16 of the 32 sites, including 6 water sources, 5 dirt roads, 3 canyons, 1 mountain pass, and 1 paved road (Figure 6-14). Table 6-5 contains the camera trap results by month, location, and radio-collared animal. A malfunctioning camera at Gold Meadows Spring made it impossible to determine the date and time of the mountain lion images, so it was not included in Table 6-5. NNSS7 was photographed 26 times at 10 sites in 2014 and 27 times at 10 sites in 2013. A female and young juvenile were recorded at four sites: North Chukar Canyon Tank (#22) (May 24), Delirium Canyon Tanks (#5) (June 5), Topopah Spring (#9) (June 11) (Figure 6-16), and Water Bottle Canyon (#17) (June 18). It is not known if these are the same animals at each site, but based on the size of the juvenile in the images, the timing, and locations, it is likely they are the same. It is difficult to tell individual mountain lions apart in the images and therefore determine the exact number of mountain lions on the NNSS. Including the subadult, a minimum of four individuals were known to occur on the NNSS during 2014, compared to a minimum of four individuals on the NNSS during 2013 and a minimum of six in 2012.

In order to investigate temporal activity of mountain lions, camera detection data from all 9 years (2006–2014) were combined. Mountain lions were detected every month with peak occurrences during June (n = 83) and November (n = 89). The number of images taken during summer and fall (June–November) (n = 355) accounted for nearly three-fourths of all images compared to the number of images taken during winter and spring (December–May) (n = 143) (Figure 6-17). Mountain lions were detected most frequently from 1700 to 0800 hours, during which time nearly 10 times as many images were recorded (n = 445) compared to the time period from 0800 to 1700 hours (n = 48) (Figure 6-18). From 2011 to 2014, almost twice as many images were taken when it was dark (n = 204) compared to when it was light (n = 104).

A secondary objective of the camera surveys is to detect other species using these areas to better define species distributions on the NNSS. A total of 11,946 images of at least 29 species other than mountain lions were taken during 220,379 camera hours across all sites (Table 6-4). This is about 54 images per 1,000 camera hours. The most prevalent species photographed (41% of all images) was mule deer (4,895 images at 22 of 32 sites). Captain Jack Spring (1,529 images), Camp 17 Pond (1,399 images), and Gold Meadows Spring (1,069 images) are very important water sources for mule deer. Some of the rarer, more elusive species documented during camera surveys were desert bighorn sheep (see Section 6.5), bobcat (found at 15 of 32 sites, 114 images at Well C1Pond Trough [#28]), gray fox (*Urocyon cinereoargenteus*), badger (*Taxidea taxus*), golden eagle (*Aquila chrysaetos*), great-horned owl (*Bubo virginianus*), great egret (*Ardea alba*) and great blue heron (*Ardea herodias*). Greatest use and highest species richness was documented at water sources especially during the summer and fall, which emphasizes the importance of these water sources for several wildlife species, especially during the drier months.

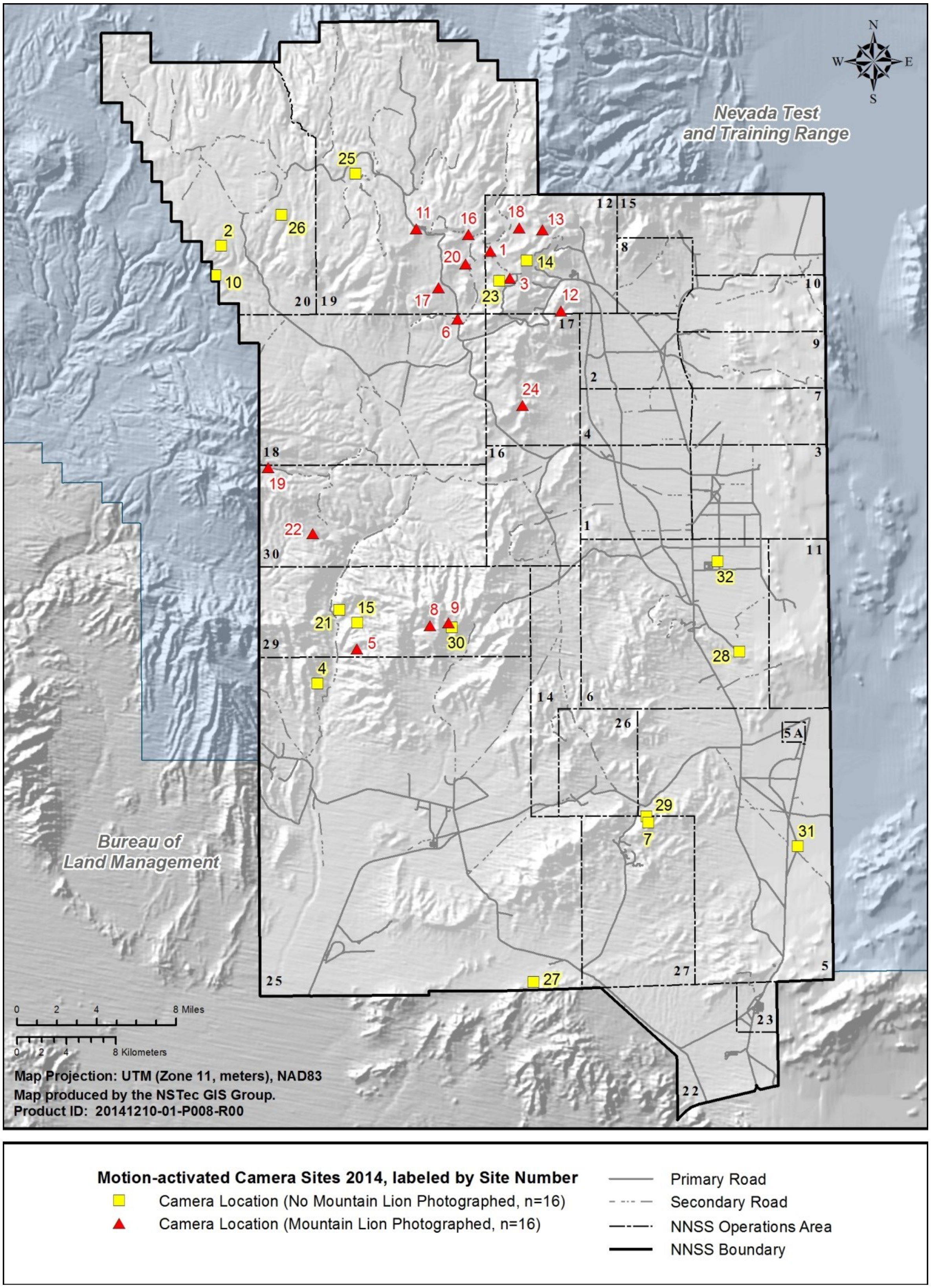

Figure 6-14. Locations of mountain lion photographic detections and motion-activated cameras on the NNSS during 2014

Table 6-4. Results of mountain lion camera surveys during 2014

Location (Site Number)	Dates Sampled	Camera Hours	Mountain Lion Images (Number of Images per 1,000 Camera Hours)	Other Observations (Number of Images)
Rattlesnake Ridge Gorge (#20)	12/16/13–12/11/14	8,639	20 (2.3)	Desert cottontail (2), rock squirrel (3)
Gold Meadows Spring[a] (#18)	3/6/14–12/11/14[b]	3,877	11 (2.1)	Coyote (75), pronghorn antelope (81), mule deer (1069), horse (610), black-tailed jackrabbit (12), golden eagle (12), turkey vulture (231), common raven (22)
Topopah Spring (#9)	1/7/14–12/16/14	8,228	16 (1.9)	Bobcat (2), gray fox (22), coyote (80), desert bighorn sheep (16), mule deer (139), desert cottontail (1), black-tailed jackrabbit (1), rock squirrel (2), chukar (487), mourning dove (15), common raven (3)
Redrock Valley Pass (#24)	3/5/14–12/10/14[b]	2,064	3 (1.5)	None
North Chukar Canyon Tank (#22)	12/17/13–12/15/14	8,715	9 (1.0)	Bobcat (10), coyote (30), desert cottontail (1), golden eagle (6), chukar (2), mourning dove (14), pinyon jay (10), common raven (2)
Water Bottle Canyon (#17)	12/16/13–12/10/14	8,622	7 (0.8)	Mule deer (7)
Delirium Canyon (#5)	3/27/14–12/17/14	6,363	5 (0.8)	Desert bighorn sheep (186), great-horned owl (2), red-tailed hawk (6), chukar (4), common raven (2), lizard (64)
West Topopah Spring (#8)	3/26/14–12/16/14[b]	5,207	4 (0.8)	Coyote (5)
Captain Jack Spring (#12)	12/16/13–12/11/14	8,639	6 (0.7)	Bobcat (16), gray fox (2), coyote (11), mule deer (1,529), rock squirrel (8), chukar (74), common raven (2), western fence lizard (1)
12T-26, Rainier Mesa (#1)	12/16/13–9/16/14	6,584	4 (0.6)	Bobcat (5), coyote (1), mule deer (10), black-tailed jackrabbit (13), cottontail rabbit (1), rock squirrel (1)
East 19-01 Road (#16)	10/7/14–12/11/14	1,557	1 (0.6)	Bobcat (1), coyote (3), mule deer (24)

Table 6-4. Results of mountain lion camera surveys during 2014 (cont.)

Location (Site Number)	Dates Sampled	Camera Hours	Mountain Lion Images (Number of Images per 1,000 Camera Hours)	Other Observations (Number of Images)
East Cat Canyon (#19)	12/17/13–12/15/14	8,715	3 (0.3)	Bobcat (1), coyote (2), mule deer (28), black-tailed jackrabbit (8)
Camp 17 Pond[a] (#6)	1/15/14–12/11/14[b]	4,921	1 (0.2)	Bobcat (10), badger (1), coyote (223), pronghorn antelope (1), mule deer (1399), horse (657), black-tailed jackrabbit (222), desert cottontail (13), bat (22), great blue heron (2), great egret (10), American coot (82), golden eagle (4), great-horned owl (2), red-tailed hawk (7), Cooper's hawk (5), turkey vulture (27), pinyon jay (1), chukar (1), common raven (387)
Pahute Mesa Summit, Road (#11)	12/16/13–12/10/14	8,838	1 (0.1)	Coyote (2), mule deer (33)
Dick Adams Cutoff Road, Rainier Mesa (#3)	12/17/13–12/11/14	8,618	1 (0.1)	Bobcat (3), coyote (1), mule deer (33), black-tailed jackrabbit (4), cottontail rabbit (5)
East Gold Meadows Pass (#13)	12/16/13–12/11/14	8,639	1 (0.1)	Bobcat (4), coyote (6), mule deer (126), black-tailed jackrabbit (3)
Topopah Spring Trough (#30)	1/7/14–12/16/14[b]	7,865	0	Bobcat (1), gray fox (24), coyote (8),desert bighorn sheep (1), mule deer (129), desert cottontail (6), rock squirrel (1), golden eagle (3), chukar (68), mourning dove (41)
Rainier Mesa Top, Above B Tunnel (#14)	12/17/13–12/11/14	8,685	0	Bobcat (1), coyote (1), mule deer (54), black-tailed jackrabbit (2), rock squirrel (4)
South Pah Canyon (#15)	3/12/14–12/17/14	4,989	0	Gray fox (1), desert bighorn sheep (75), red-tailed hawk (4), pinyon jay (12), chukar (26), mourning dove (10)
Rainier Mesa West Rim (#23)	3/6/14–12/11/14	6,715	0	None
Twin Spring (#21)	1/7/14–12/17/14[b]	7,544	0	Coyote (2), desert bighorn sheep (1), mule deer (85)
Cottonwood Spring (#4)	1/7/14–12/17/14	8,253	0	Bobcat (14), gray fox (1), mule deer (52), chukar (8)

Table 6-4. Results of mountain lion camera surveys during 2014 (cont.)

Location (Site Number)	Dates Sampled	Camera Hours	Mountain Lion Images (Number of Images per 1,000 Camera Hours)	Other Observations (Number of Images)
Rock Valley Road, south of plots (#27)	1/6/14–12/9/14	8,088	0	Burro (1)
Cane Spring (#7)	1/6/14–12/16/14[b]	6,210	0	Bobcat (9), coyote (14), mule deer (23), desert cottontail (3), chukar (3), mourning dove (2)
Cane Spring Trough (#29)	1/6/14–12/16/14	8,251	0	Coyote (6), mule deer (20), red-tailed hawk (1), turkey vulture (10), mourning dove (40), common raven (3)
Well 5C Trough (#31)	1/6/14–12/16/14	8,465	0	Bobcat (6), badger (1), kit fox (4), coyote (223), pronghorn antelope (80), mule deer (2), burro (135), black-tailed jackrabbit (154), desert cottontail (3), golden eagle (1), red-tailed hawk (1), turkey vulture (16), mourning dove (21), common raven (69)
Area 6 LANL Pond Trough (#32)	1/6/13–12/15/14	8,234	0	Coyote (75), pronghorn antelope (350), mule deer (23), burro (15), black-tailed jackrabbit (3), golden eagle (6), Cooper's hawk (2), red-tailed hawk (18), turkey vulture (382), common raven (133)
Well C1 Pond Trough (#28)	1/6/13–12/15/14	8,234	0	Bobcat (114), coyote (203), pronghorn antelope (19), mule deer (78), burro (167), black-tailed jackrabbit (3), bat (1), red-tailed hawk (21), great-horned owl (14), turkey vulture (23), chukar (24), mourning dove (41), brown-headed cowbird (1), common raven (392)
ER 20-5 Plastic-lined Sump (#2)	1/16/14–12/10/14	7,876	0	Coyote (1), golden eagle (1), chukar (1), mourning dove (3), common raven (9), ducks (7)
ER 20-11 (#10)	9/10/14–12/10/14	2,185	0	Black-tailed jackrabbit observation
U19ad Plastic-lined Sump (#25)	1/15/14–12/10/14[b]	2,663	0	Mule deer (22), mourning dove (1)
Ue20n#1 Plastic-lined Sump (#26)	1/15/14–12/10/14	7,896	0	Coyote (3), mule deer (10), mourning dove (1), common raven (20)

[a] Camera hours not known for some time periods. [b] Non-continuous operation due to camera problems, dead batteries, full memory cards, etc.

Figure 6-15. Mountain lion drinking at Gold Meadows Spring
(Photo #175 taken spring 2014, by motion-activated camera)

6.6.2 Mountain Lion Telemetry Study

A collaborative effort between Kathy Longshore, David Choate, Kirsten Ironside (USGS), and site biologists continued during 2014 to provide information to assess the risk of human encounters with mountain lions on the NNSS and determine what mountain lions eat and where they make their kills. This effort also provides information about their natural history and ecology as well. The NNSS and surrounding areas, encompassing the Nevada Test and Training Range (NTTR), Tonopah Test Range (TTR), and Desert National Wildlife Range, constitute one of the largest areas (over 15,540 km^2) in North America where human-caused mountain lion mortality is extremely low. The size of this area is large enough to allow population dynamics to emerge that likely typify an unexploited population of lions. This area is also located in some of the driest ecosystems in North America with relatively low prey densities. The goal for 2014 was to capture or recapture and radio-collar four mountain lions and track them for 1–1.5 years.

David Choate and McLain Mecham (trapper) were at the NNSS to capture mountain lions during two time periods during 2014. The first occurred between October 27 and November 26, 2014. During this 31-day period, capture work involved setting and monitoring snares over 25 days and hunting with hounds over two periods totaling 19 days' effort. Trapping occurred at three general locations: Rainier Mesa, Echo Peak/Big Burn Valley and East Cat Canyon/Timber Mountain. Eleven snares were set for a total of 122 trap nights. No mountain lions were captured. Trailing with hounds also occurred by searching roads daily for mountain lion sign, and riding mules to pursue any mountain lion trails found.

Table 6-5. Number of mountain lion images taken with camera traps by month, location, and animal number, if known

Camera Location (Site number)	Dec-13	Jan-14	Feb-14	Mar-14	Apr-14	May-14	Jun-14	Jul- 14	Aug-14	Sep-14	Oct-14	Nov-14	Dec-14
East Gold Meadows Pass (#13)							1						
12T-26, Rainier Mesa (#1)							1	1	2 (1-NNSS7)				
Dick Adams Cutoff Road (#3)							1-NNSS7						
East 19-01 Road (#16)											1-NNSS7		
Rattlesnake Ridge Gorge (#20)	2			2	4 (3-NNSS7)	2-NNSS7	3		5 (3-NNSS7)	2-NNSS7			
Water Bottle Canyon (#17)			1				1		1-NNSS7		4 (1-NNSS7)		
Camp 17 Pond (#6)								1					
Pahute Mesa Summit Road (#11)											1		
Captain Jack Spring (#12)							4	2					
East Cat Canyon (#19)													3
North Chukar Canyon Tank (#22)					2-NNSS7	6	1-NNSS7						
Delirium Canyon (#5)							4				1-NNSS7		
Canyon West of Topopah Spring (#8)				1-NNSS7	1-NNSS7		1-NNSS7			1-NNSS7			
Topopah Spring (#9)		1	1				13			1-NNSS7			
Redrock Valley Pass (#24)				2-NNSS7	1								

Number of mountain lion images by animal number (if known)

Camera operational, no mountain lions detected

Camera not operational

Figure 6-16. Female and subadult cub at Topopah Spring
(Photo #157 taken June 18, 2014, by motion-activated camera)

This trapping effort focused on recapturing NNSS7 to exchange his radio-collar with a new one. NNSS7 had been captured by snares on two previous occasions and had been pursued by hounds; consequently, he may have learned to evade capture techniques. On October 28, he stepped within 3 cm of a snare (Rattlesnake Ridge Gorge, Area 19), paused, turned completely around, and proceeded to leave two scrapes before completely leaving that area. Within 44 hours he had traveled >30 km first north, then southwest to a location beyond the westernmost NNSS boundary. Attempts to pursue him with hounds were further stymied by the great distances he traveled each night, the delay in receiving Argos data (at the earliest, always 12 hours behind his movements), his use of limited access areas, and complete failure of Argos data delivery on several occasions. On November 15, his collar released as programmed and was subsequently retrieved by NNSS biologists. The poor condition of the collar (i.e., split collar material, exposed wires) partially explained the failure of several data deliveries by Argos. The remaining 10 days of capture effort focused on new individuals, with no successful captures of adults.

On November 17, tracks from a female lion were encountered along Echo Peak Road and trailed by foot with the hounds to the edge of Pahute Mesa and off the cliff face to the south. During the pursuit, a den was discovered in the cliff face with three kittens present, each ~3–4 weeks of age (Figure 6-19). Due to concern for the safety of the kittens, the hounds were moved away from the site. Kittens at this age are barely mobile, extremely vulnerable to predation by other predators including adult male lions, and may be lost in transit if the female were to move them to a new den site. Therefore, time spent at the site was minimized and a few snares were set near the female's travel routes. The female did not subsequently travel near these snares and was not captured.

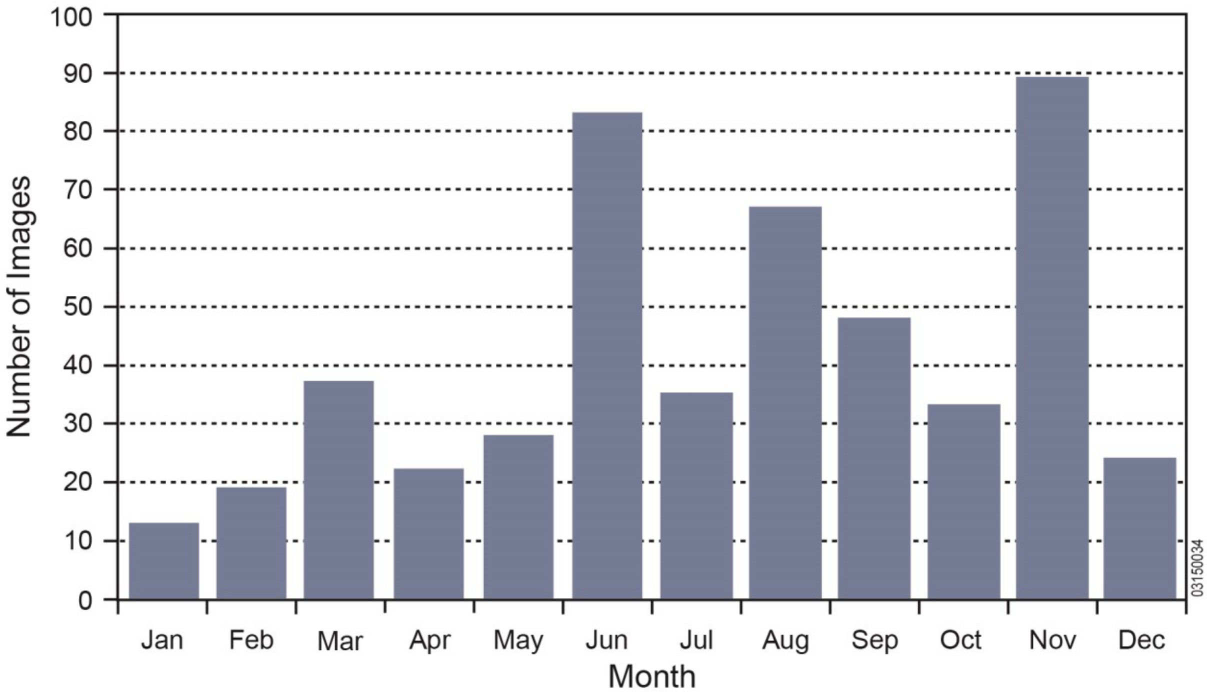

Figure 6-17. Number of mountain lion images by month for camera sites where mountain lions were detected from 2006 through 2014 (n = 498)

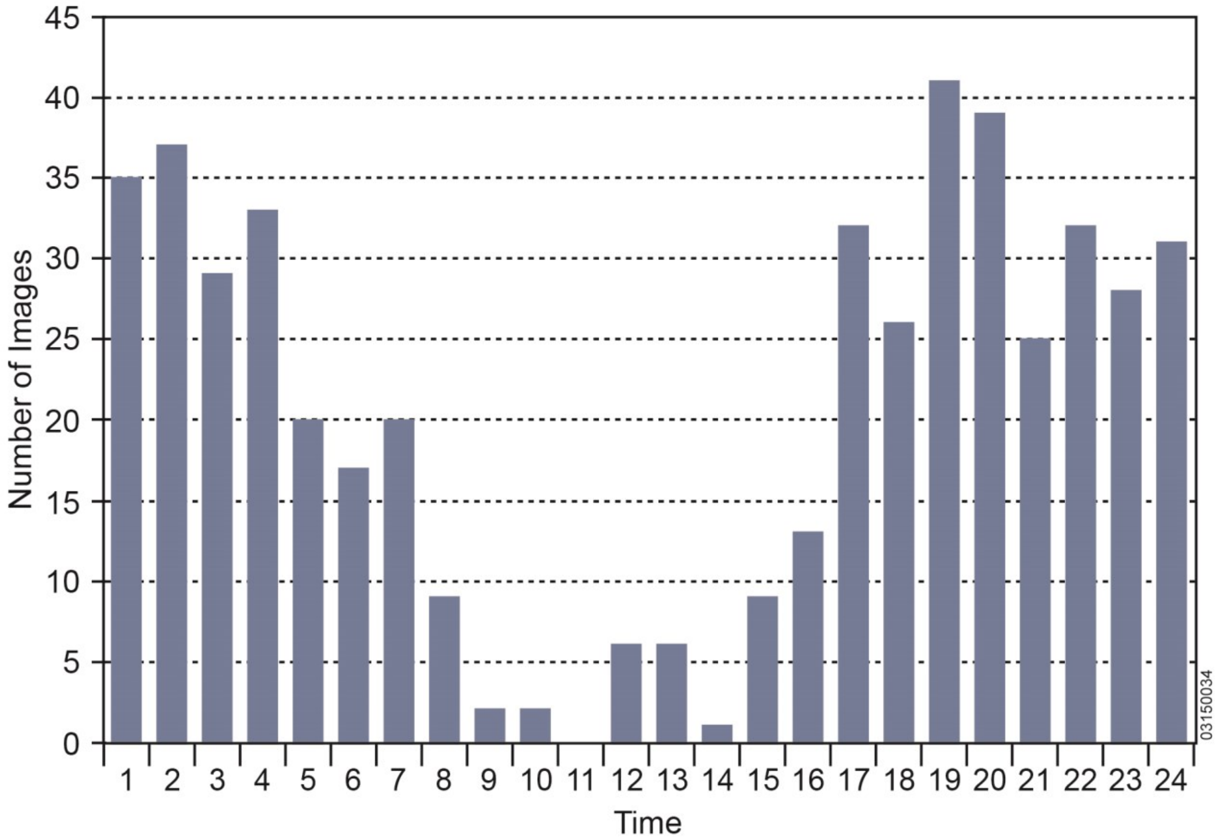

Figure 6-18. Number of mountain lion images by time of day (Pacific Standard Time) for camera sites where mountain lions were detected from 2006 through 2014 (n = 493)

Figure 6-19. One of three mountain lion kittens discovered at a den on Pahute Mesa, Area 19
(Photo taken by M. Mecham, November 17, 2014)

Tracking and pursuit efforts revealed and confirmed the presence of an additional three adults and one subadult that used the eastern Pahute Mesa and Rainier Mesa areas. These included one adult female traveling with a subadult and two adult males. Of these, an adult male, believed to be larger than NNSS7, was trailed from the east end of Echo Peak Road, across Pahute Mesa Road, and north/northeast across several ridges of Pahute Mesa towards Deadhorse Flat Road. Combined with camera trap data it is estimated there were a minimum of four adult mountain lions (two males including NNSS7, one female with subadult, and one female with three kittens) on the NNSS in 2014.

The second trapping session occurred over a 3-day period in mid-December after the first snowfall. Roads were driven to detect fresh mountain lion tracks in the snow and then hounds were used to trail the lion. One male was tracked through the cliffs on top of Pahute Mesa, north of Pahute Mesa Road, with no success. The female with three kittens had moved from the den and tracks showed she was headed into the Back Mesa Road area.

6.6.2.1 NNSS7

NNSS7 (Figure 6-20) was radio-tracked from January 1 to November 15, 2014, when the collar dropped as programmed. The collar was programmed to record six locations per day (every 4 hours starting at noon) and then upload locations via satellite during a certain window of time each day. The data were processed and then sent to site biologists via email. Data were converted and plotted in ArcMap Version 10.2. Data were searched to identify clusters of locations that were within 100 m of each other typically over a minimum 12-hour period. Coordinates and maps were printed and taken to the field to search for kill sites. A kill site is defined as the area where a mountain lion killed and/or cached its prey. It was difficult to ascertain the exact spot where the prey was killed, but evidence of the kill such as burial sites, the carcass, bone fragments, rumen contents, and hair quite often remained. Once a kill site was found, prey species, sex, age, amount consumed, marrow color and consistency, number of burial sites, and dimensions of burial sites were recorded. Habitat data such as elevation, aspect, slope, landscape position, vegetative cover, and dominant plant species were also documented. Additionally, the number of latrines, scats, and beds was recorded. A field sketch was made detailing where key features were located, along with any other pertinent notes, and photos were taken. Beginning August 25, a new data sheet was used to include estimates of canopy and stalking cover that also included similar data from a paired random plot 200 m from the cluster site. Additionally, estimates of cover were recorded from a 30 m radius plot instead of a 10 m radius plot.

Detailed analyses of habitat use and home range have not been completed yet. However, a rough estimate of NNSS7's home range during 2014 is 1,689 km^2, which is about three times greater than the average home range for male mountain lions in eastern Nevada (Ashman et al. 1983).

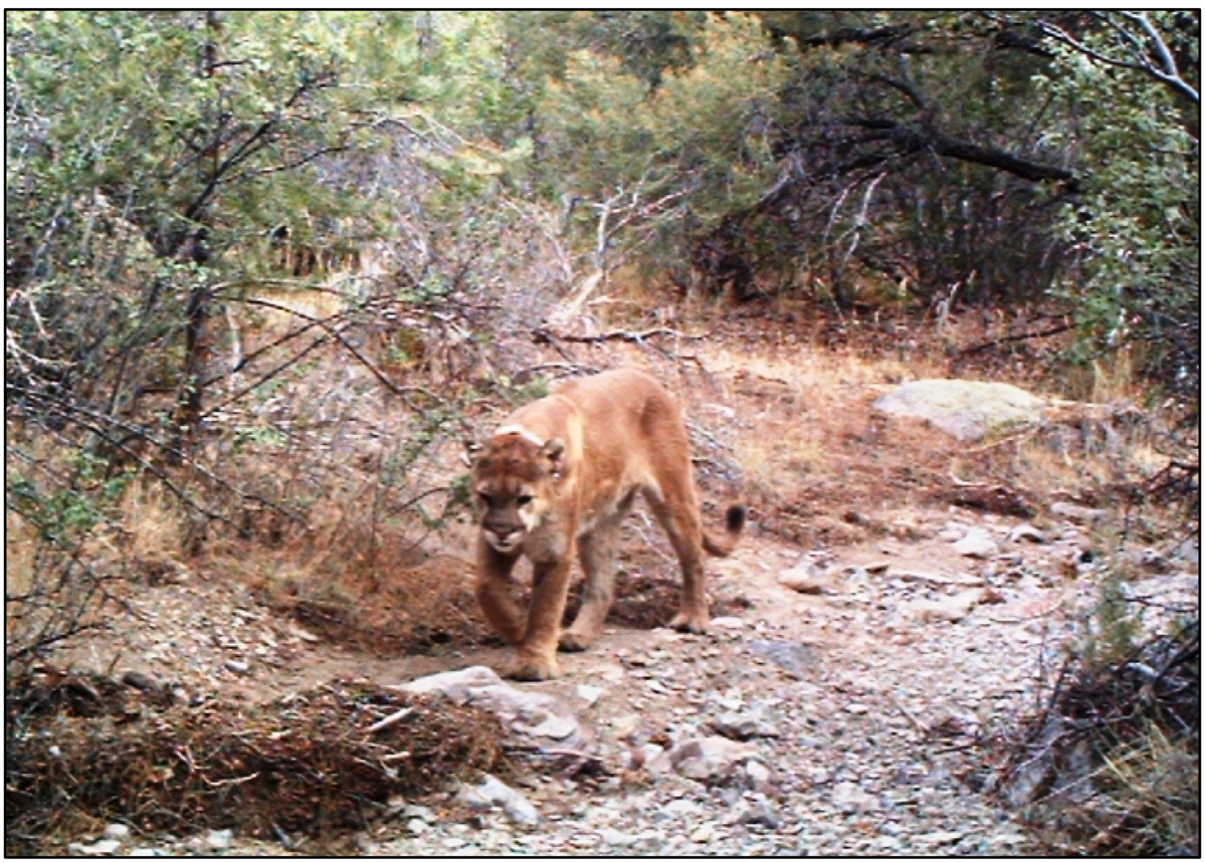

Figure 6-20. NNSS7 travelling along wash bottom in canyon west of Topopah Spring
(Photo #67 taken June 14, 2014, by motion-activated camera)

NNSS7's home range primarily covered the mountainous areas in the northern and western portions of the NNSS (i.e., Rainier Mesa, Pahute Mesa, Timber Mountain, Shoshone Mountain, and Eleana Range), and extended west and north off the NNSS into Yucca Mountain, Thirsty Canyon, Black Mountain, and Quartz Mountain on the NTTR (Figure 6-21). While NNSS7 covered his home range throughout the year, he used the higher elevations of Pahute Mesa and Rainier Mesa substantially more (76% of locations) between June 1 and October 31, 2014, than the lower elevation habitat on Shoshone Mountain, Forty-mile Canyon, Yucca Mountain, Timber Mountain, Thirsty Canyon, and Quartz Mountain. From November 1, 2013, through May 31, 2014, he used the lower elevation habitat substantially more (83% of locations) than the higher elevation habitat. The higher elevation areas are dominated by pinyon/juniper, big sagebrush, antelope bitterbrush, and Gambel oak. These areas are also prime mule deer summer habitat. The lower elevation areas contain pockets of high elevation habitat but are dominated by blackbrush, black sagebrush (*Artemisia nova*), rabbitbrush species (*Ericameria* and *Chrysothamnus* spp.), and desert bitterbrush. The shift to predominant use of higher elevation habitat in late May/early June and to lower elevation habitat in late October/early November roughly corresponds with the timing of migration of mule deer on and off their summer range, respectively (Giles and Cooper 1985). A similar shift to predominant use of lower elevation habitat by NNSS7 was noted during late October 2012 (Hall et al. 2013).

A total of 49 clusters made during 2014 were investigated, and prey remains were found at 37 sites (Figure 6-22). Multiple kills were documented at five sites: three desert bighorn sheep (yearling and two rams), ewe, and lamb; mule deer doe and fawn at two sites, and buck mule deer and juvenile bobcat (Figure 6-23). A total of 43 prey items were documented, including 22 mule deer (11 bucks, 4 does, and 7 fawns), 17 desert bighorn sheep (13 rams, 2 ewes, and 2 yearling/lambs), a juvenile bobcat, and 3 coyotes (2 mature and 1 juvenile).

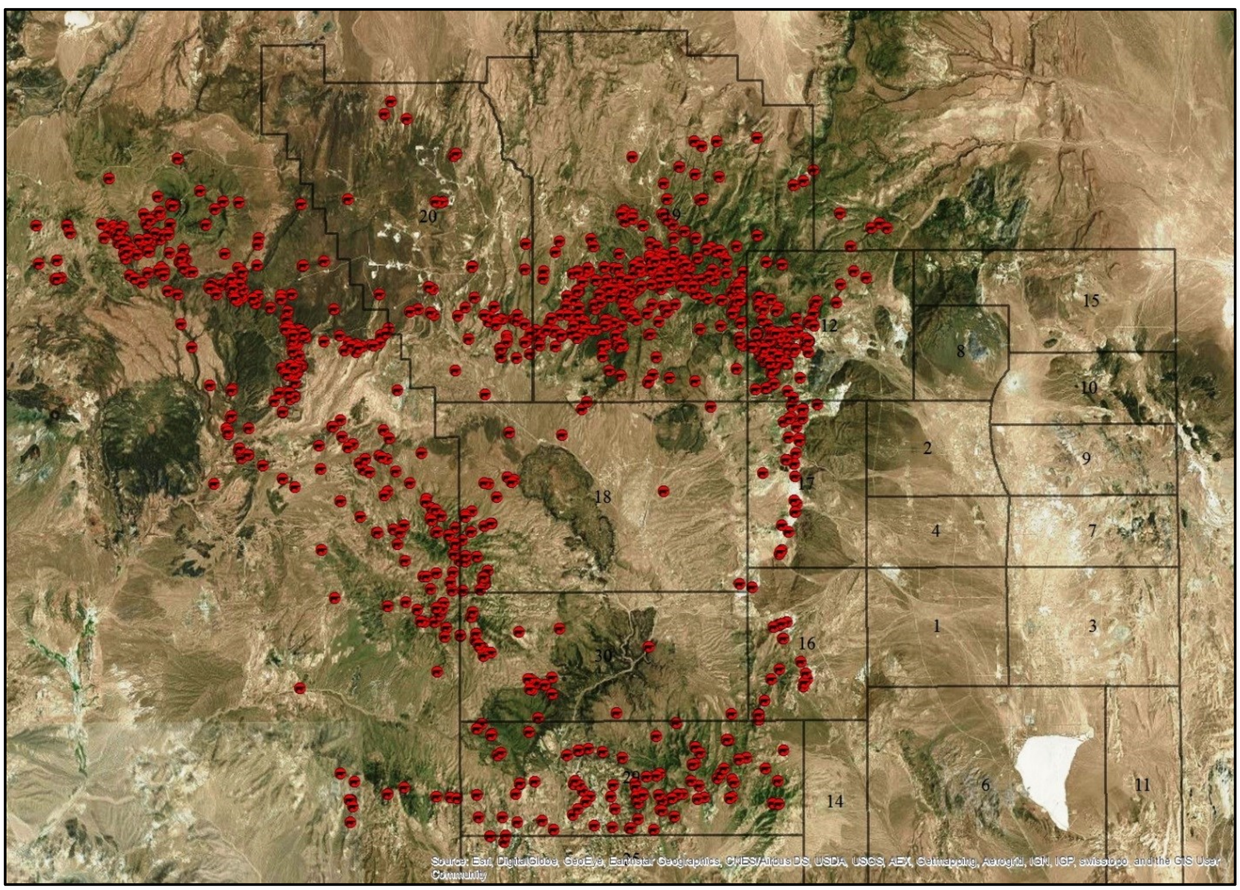

Figure 6-21. Documented locations of NNSS7 during 2014

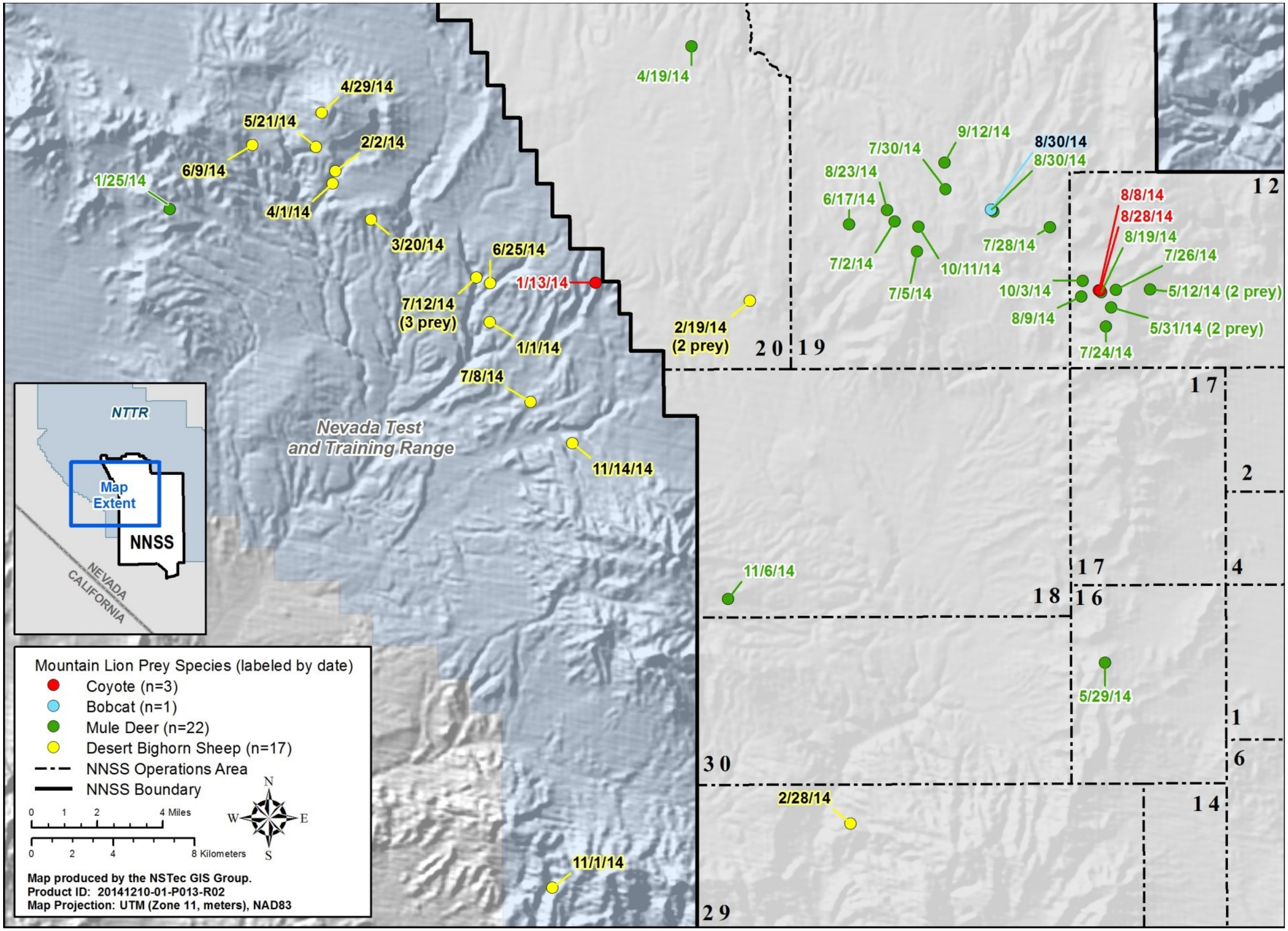

Figure 6-22. Kill site locations for NNSS7 by prey type during 2014

Combining mule deer and desert bighorn sheep kill data from 2013 and 2014 revealed a pattern of seasonal prey use. Mule deer kills were substantially higher during May through October (n = 45) than November through April (n = 7), and desert bighorn sheep kills were substantially higher during November to April (n = 20) than May through October (n = 9) (Figure 6-23). This can be explained by the movement of NNSS7 to lower elevations during winter and spring as he followed the mule deer migrating to their winter range. The mule deer winter range overlaps desert bighorn sheep habitat, making sheep available to mountain lions. The mule deer summer range is much smaller in comparison to their winter range and occurs primarily at the higher elevations of Pahute Mesa and Rainier Mesa on the NNSS, while the winter range is spread out over a large area at the lower elevations off the mesas (Giles and Cooper 1985). It is hypothesized that mule deer are dispersed over a large area during winter and spring and thus are more difficult to capture than desert bighorn sheep. Clearly, the preferred prey species for NNSS7 during the summer and fall was mule deer. NNSS1 (female) exhibited the same pattern with only desert bighorn sheep killed (n = 13) between December 2011 and mid-May 2012 and only mule deer killed (n = 18) between late May and mid-September when its collar failed. Likewise, NNSS4 (male) shifted its range to lower elevations during winter, presumably following the mule deer. These data suggest that mule deer migration dictates the movement of mountain lions on the NNSS and may attract multiple mountain lions to this abundant prey source on the summer range. This may help explain why at least six mountain lions were observed on the summer range in 2012 (Hall et al. 2013). Timing of migration by mountain lions corresponded with the migration of mule deer in a study done in eastern California as well (Pierce et al. 1999). However, in the California study, mule deer and mountain lions congregated on the winter range as opposed to the summer range. Sawyer et al. (2009) suggest this is typical across the Intermountain West, "where winter ranges are restricted to relatively small areas due to snow cover and limited forage availability, whereas summer ranges often consist of entire mountain ranges." In contrast, the NNSS and surrounding environs are just the opposite, with summer range restricted to relatively small areas of isolated high elevation habitat and expansive winter range at lower elevations. Other areas of southern Nevada or surrounding states that have limited summer range may exhibit similar patterns in mountain lion movements and predation patterns. If this high elevation habitat is lost or degraded due to climate change, it could significantly decrease the number of mule deer and change the predator-prey relationship with mountain lions, perhaps forcing them to kill more desert bighorn sheep or reducing the mountain lion population.

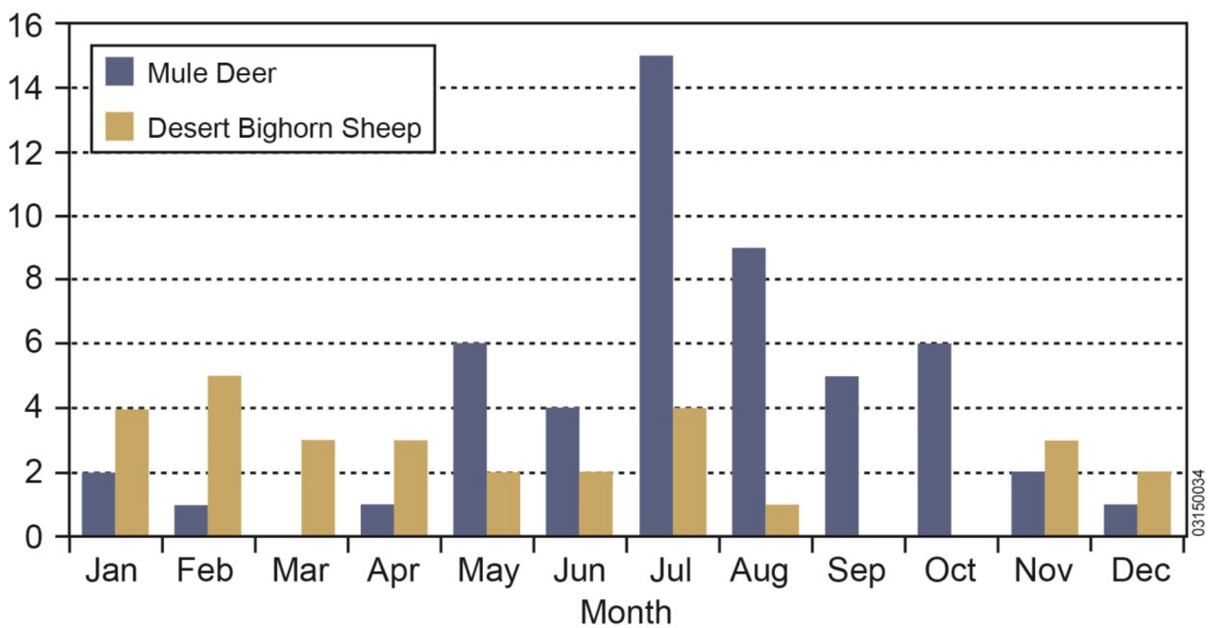

Figure 6-23. Number of ungulate prey items killed by NNSS7 by month (January 2013–November 2014)

6.6.2.2 Risk to Humans

No observations of mountain lions were reported to NNSS biologists by NNSS workers during 2014. Two mountain lion observations were made by biologists during deer surveys. One was seen near E Tunnel Ponds on September 16, and one was seen near the Pahute Mesa Substation (Area 19) on September 29. Based on recorded locations, it is evident that these animals prefer rugged, mountainous, typically forested habitat in the northern and western portions of the NNSS. Very few active projects occur in these areas, so the overall risk of human encounters with mountain lions on the NNSS appears to be quite low. Facilities in these areas include the Calico Hills firing range (Area 25), several tunnel complexes in Area 12 (e.g., G, U, V, and P Tunnels), and communication towers and power substations in Area 19 (Echo Peak and Pahute Mesa), Area 12 (DOE Point), and Area 29 (Shoshone Mountain). Personnel who work in these mountainous, remote areas (communication and power system maintenance workers, military personnel, etc.), especially at night, are most at risk and should be aware that mountain lions do occur around these facilities.

6.6.2.3 Radiological Testing

DOE facilities are required to estimate the radiological dose to the general public and biota caused by past and present facility operations. Animals on the NNSS can potentially uptake radiological contaminants from the environment through drinking and foraging. One potential pathway to the public then is through game animals (e.g., mule deer, bighorn sheep, mountain lions) that migrate off the NNSS into areas where hunting is allowed that are then killed and consumed. In order to supplement routine monitoring conducted to help assess the potential dose to the public and animals, mountain lion scat and mountain lion prey remains were collected and analyzed for radiological purposes.

A total of 27 samples (13 of mountain lion scat and 14 of lion-killed mule deer tissue) were collected. These were analyzed for tritium, a human-made radioactive hydrogen persisting in some portions of the NNSS as a result of nuclear weapons testing. This radioactive hydrogen acts like any hydrogen in the environment and is most commonly associated with water. Detectable levels of tritium were found in four mountain lion scat samples and four mule deer (Table 6-6). These levels are well below the drinking water standard (20,000 picocuries/liter) set for safe human consumption by the U.S. Environmental Protection Agency (Code of Federal Regulations 2010) and are not considered to be harmful to the animal (DOE 2002) or someone eating the animal. A noteworthy observation is the lactating doe and its fawn (NNSS7-103) that had nearly equal levels of tritium. The likely source for this tritium is the E Tunnel Ponds in Area 12.

Two muscle tissue samples from lion-killed mule deer (NNSS7-100 Buck, NNSS7-128 Buck) (Table 6-6) were large enough to allow for the analysis of gamma-emitting radionuclides, strontium, plutonium, and americium. Plutonium-239+240 and americium-241 were detected in the NNSS7-128 Buck at the following concentrations respectively: 0.603 ± 0.072 picocuries/gram-dry (pCi/g) (minimum detectable concentration [MDC] 0.007 pCi/g) and 0.041 ± 0.039 pCi/g-dry (MDC 0.003 pCi/g). Dose estimates to the deer and to a hypothetical person consuming this deer will be reported in the annual NNSS Environmental Report (NSTec 2015). These data show that mountain lions and mule deer do uptake tritium and other radionuclides on the NNSS and have potential to transport them off site.

6.7 Nuisance and Potentially Dangerous Wildlife

During 2014, site biologists responded to 32 calls regarding nuisance, injured, or potentially dangerous wildlife in or around buildings, power lines, and work areas on the NNSS. Problem or injured animals included birds (13 calls), bats (5 calls), coyotes (6 calls), reptiles (6 calls, including a rattlesnake), and badgers (2 calls). Another call involved the sighting of a medium-sized cat around the North Las Vegas Facility. It ended up being a feral cat that did not pose a threat to workers. Mitigation measures taken usually involved moving the animal away from people or disposing of dead animals. On one occasion, a coyote lying under a bus was chased out of Mercury with an air-soft rifle to try to instill fear of humans into it. It was not seen around the buses or bus stops after that.

Table 6-6. Tritium concentrations in mountain lion scat and lion-killed mule deer prey remain samples during 2014. Shaded results indicate results greater than MDC

Sample ID	Location	Result (pCi/L)	Tritium Uncertainty (2 SD)	MDC
NNSS 7-88 Scat	East Quartz Mountain, NTTR	757	538	623
NNSS 7-106 Scat	Dick Adams Cutoff, Area 12	1312	627	997
NNSS 7-118 Scat	East of Pahute Mesa Substation, Area 19	3061	669	999
NNSS 7-128 Scat	Echo Peak Area, Area 19	243	129	197
NNSS 7-100 Buck	North Pahute Mesa, Area 20	366	122	164
NNSS 7-103 Doe	N Tunnel, Area 12	5816	628	625
NNSS 7-103 Fawn	N Tunnel, Area 12	5331	617	621
NNSS 7-127 Buck	Rainier Mesa, near DOE point, Area 12	7447	657	839
NNSS 7-128 Buck	Echo Peak Area, Area 19	Non-detect		
NNSS 7-94 Scat	South Pahute Mesa, Area 20	Non-detect		
NNSS 7-100 Scat	North Pahute Mesa, Area 20	Non-detect		
NNSS 7-105 Fawn	West Tippipah Spring, Area 16	Non-detect		
NNSS 7-109 Doe	East 19-02 Road, Area 19	Non-detect		
NNSS 7-111 Doe	Echo Peak Road, Area 19	Non-detect		
NNSS 7-113 Scat	East Thirsty Canyon Tanks, NTTR	Non-detect		
NNSS 7-115 Scat	Upper Holmes Road, Area 12	Non-detect		
NNSS 7-118 Buck	East of Pahute Mesa Substation, Area 19	Non-detect		
NNSS 7-121 Buck	Rainier Mesa Top, west edge, Area 12	Non-detect		
NNSS 7-121 Scat	Rainier Mesa Top, west edge, Area 12	Non-detect		
NNSS 7-122 Buck	Echo Peak Road, Area 19	Non-detect		
NNSS 7-124 Buck	19-01 Road, Area 19	Non-detect		
NNSS 7-126 Buck	Dead Horse Flat/Pahute Mesa Road, Area 19	Non-detect		
NNSS 7-126 Scat	Dead Horse Flat/Pahute Mesa Road, Area 19	Non-detect		
NNSS 7-127 Scat	Rainier Mesa, near DOE point, Area 12	Non-detect		
NNSS 7-131 Fawn	East Cat Canyon, Area 18	Non-detect		
NNSS 7-131 Scat	East Cat Canyon, Area 18	Non-detect		
NNSS 7-132 Scat	South of EREC-14, NTTR	Non-detect		

(pCi/L = picocuries/liter; SD = Standard deviation; MDC = Minimum detectable concentration)

6.8 Coordination with Biologists and Wildlife Agencies

A site biologist gave a presentation about wildlife monitoring on the NNSS at the Devils Hole Workshop in Furnace Creek, California, and at the Annual Site Environmental Report (ASER) meeting in Los Alamos, New Mexico. Discussions were also held at the ASER meeting with biologists from other DOE sites about their wildlife monitoring programs to help improve wildlife monitoring on the NNSS. Site biologists published an article in *Western Birds* entitled "Documenting Western Burrowing Owl Reproduction and Activity Patterns with Motion-activated Cameras" (Hall and Greger 2014). A site biologist assisted NDOW in a small mammal trapping effort and gila monster radiotracking study for a day to learn more about gila monsters and their habitat to see if gila monster habitat occurs on the NNSS. A biologist from the Idaho National Laboratory (INL) made a visit to the NNSS and was given a field tour. Later in the year, a site biologist visited the INL site and assisted with a bat hibernacula survey.

7.0 HABITAT RESTORATION MONITORING

7.1 CAU 110, U-3ax/bl, Closure Cover

The installation of an evapotranspirative cover on the Corrective Action Unit (CAU) 110, U-3ax/bl, closure site, located in Area 3 of the NNSS, was completed in the fall of 2000. Once the evapotranspirative cover was in place, actions were taken to establish native vegetation on the cover. Revegetation activities were completed in December 2000. The plant community on the closure cover has been monitored annually from the spring of 2001 to the spring of 2013 to document the establishment of a native plant community and to identify any remedial actions that may be necessary to ensure the plant community persists. No quantitative vegetation monitoring was completed in 2014. Instead, a qualitative evaluation of the plant community on the closure cover was made. This included an evaluation of plant vigor, overall status of the plant community, notation of any signs of stress with individual plant species, an estimate of signs of burrowing activity by small mammals, and an assessment of the status of the transplants used during remedial revegetation activities in 2010. The surveys were conducted on May 14, 2014.

Precipitation for this year near CAU 110, U3-ax/bl, was below normal. Precipitation from January through May 2014 was 46 mm, which is 64% of the 53-year average. Precipitation for this year's growing season, October 2013 to May 2014, was 71 mm, or about 60% of the 53-year growing season average.

7.1.1 Status of Plant Community

The plant community that has established on the CAU 110, U3-ax/bl closure cover continues to show signs of stability and resilience to the adverse growing conditions that have persisted on the NNSS for the last several years. Shadscale (*Atriplex confertifolia*) is and has been the most abundant shrub species on the closure cover and showed signs of significant growth this year and was in flower and early fruit set during the site visit. The second most common species on the closure cover is Nevada jointfir (*Ephedra nevadensis*), which flowered profusely last year but was not in flower this year. The only other shrub encountered was winterfat (*Krascheninnikovia lanata*). Winterfat is not commonly encountered but has persisted over the years; in fact, this year it was flowering and setting seed. There were no signs of stress with any of the species encountered on the closure cover this year. As has been the situation over the last several years, there were no perennial grasses present on the site.

As would be common in a year with below normal precipitation, especially with little or no precipitation during the spring months, there were essentially no annual plants. A few individuals of blazingstar (*Mentzelia albicaulis*), flatcrown buckwheat (*Eriogonum deflexum*), pinnate tansymustard (*Descurania pinnata*) and redstem stork's bill (*Erodium cicutarium*) were encountered, but individual plants were small and sparse. Halogeton (*Halogeton glomeratus*) and Russian thistle (*Salsola tragus*), two invasive weeds, were found also, but like the other annual plants were small and uncommon to rare.

7.1.2 Wildlife Usage

During the vegetation surveys, small mammal activity on the CAU 110, U-3ax/bl, closure cover was evaluated. Surveys were made by making four equally spaced passes of the closure cover, traversing the site from east to west. During each pass, the number of small mammal burrow complexes as well as the number of individual burrows were counted and recorded. Those burrows showing signs of activity were noted. The area bordering the closure cover was also surveyed.

Nine burrow complexes and 18 individual burrows were located on the closure cover with about half of burrows in the complexes and half of the individual burrows showing signs of activity. Around the periphery of the closure cover, 4 burrow complexes and approximately 22 isolated burrows were found.

About half of the burrows within the complexes showed signs of activity, but only about a third of the individual burrows showed signs of activity.

The small mammal activity on the closure cover continues to be low. Plant growth and seed production, not only on the closure cover but also in the surrounding plant communities, have been below average the last several years. As a result, small mammal populations are low.

7.1.3 Summary

The vegetative cover on the CAU 110, U-3ax/bl, cover cap continues to show signs of a stable plant community capable of withstanding the paucity of good growing seasons. The annual forb component of the plant community fluctuates with the availability and timing of precipitation. This year, because of the below normal precipitation, annual forbs were essentially absent from the closure cover.

7.2 CAU 111, North-North Closure Cover, "92-Acre Site"

CAU 111 encompasses the southern portion of the Area 5 Radioactive Waste Management Complex and was recently designated for final closure operations. CAU 111 is referred to as the "92-Acre Site" and is composed of four semi-rectangular areas separated by drainage channels and access roads. The four areas are designated as the North-North Cover, the South-North Cover, the South Cover, and the West Cover. The total area of the four covers is approximately 18 ha.

The original attempt to establish a native perennial plant community on the closure covers incorporated reclamation techniques successfully employed at other sites on the NNSS and the TTR and included soil ripping, seeding with native species, straw mulching and supplemental irrigation (Ostler et al. 2002). Vegetation monitoring in the spring of 2013 revealed that seed germination and plant establishment were below expectations (Hall et al. 2014) and remedial revegetation would be required to establish a viable plant community, which is an integral component of the evapotranspirative cover designed for CAU 111.

The approach taken was to first evaluate different remedial revegetation scenarios on one of the covers. Once a successful revegetation methodology was identified, the remaining CAU 111 covers would be revegetated using that methodology. The North-North Cover was selected for the first series of research trials, which included the evaluation of hydroseeding and broadcast seeding, and mulching rates.

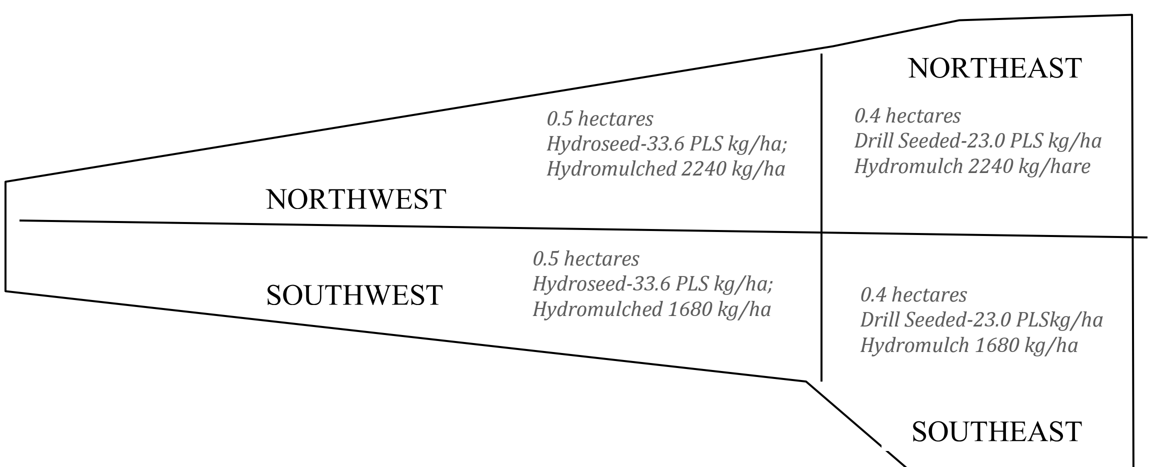

Figure 7-1. Design to test different revegetation methods on the North-North Cover

The North-North Cover was divided into four sections (Figure 7-1). The two eastern-most sections were selected to be broadcast seeded using a modified Tye rangeland drill. The two western-most sections were selected to be hydroseeded. Mulch rates of 2,240 kilograms (kg)/ha and 1,680 kg/ha were selected within each of the two seeding treatments. Revegetation implementation occurred in late October 2013.

7.2.1 Methods

7.2.1.1 Plant Pathology

During vegetation monitoring in 2013, it was noted that several plants were “infected” with what appeared to be a fungus. In an attempt to identify factors that may have contributed to the lack of plant establishment on the CAU 111 site, samples were taken from several plants showing these symptoms and sent to the Plant Pathology Laboratory of the Nevada Department of Agriculture for testing. Samples were examined, and it was concluded that the problem was a mite infection and not a fungus as suspected.

7.2.1.2 Site Preparation

On October 21, 2013, the entire North-North Cover was disked to a depth of approximately 15.2 cm to prepare the soil for seeding and to disk under any annual invasive plants that were present. Side slopes were not disked.

7.2.1.3 Seeding

The viability of the seed included in the seed mixes is verified by certification from the vendor based on seed testing within the past 12 months. To verify the viability of the seeds used at the time of seeding, samples of seed were taken for seven of the ten species used in the seed mix. Seeds were separated by species, sent to the Montana State Seed Testing Laboratory, and tested for germination and seed viability. Results of the seed testing indicated that for five of the seven species tested, viability had not changed significantly. Seed viability did decrease, however, for white bursage (*Ambrosia dumosa*) (81% to 48%) and shadscale saltbush (65% to 42%).

Table 7-1. Composition of seed mix used to seed the North-North Cover

Lifeform	Common Name (Scientific Name)	Drill Seeding Rate PLS kg/ha	Hydroseeding Rate PLS kg/ha
SHRUBS	White bursage (*Ambrosia dumosa*)	4.5	7.8
	Fourwing saltbush (*Atriplex canescens*)	3.4	4.5
	Shadscale saltbush (*Atriplex confertifolia*)	1.7	2.2
	Brittlebush (*Encelia farinosa*)	1.7	1.7
	Creosote bush (*Larrea tridentata*)	5.0	7.8
	Nevada jointfir (*Ephedra nevadensis*)	4.5	6.7
GRASSES	Indian ricegrass (*Achnatherum hymenoides*)	1.7	2.2
	Squirreltail (*Elymus elymoides*)	0.3	0.6
FORBS	Desert marigold (*Baileya multiradiata*)	0.1	0.2
	Desert globemallow (*Sphaeralcea ambigua*)	0.1	0.2
	Totals	**23.0**	**34.0**

The Tye rangeland seeder was calibrated on October 22 and the two eastern-most sections were broadcast seeded at a rate of 23.0 kg of Pure Live Seed (PLS)/ha. On October 23 the two western-most sections were hydroseeded at a rate of 33.6 PLS kg/ha and the side slopes were hydroseeded on October 30. The seed used was a mix of native shrubs, grasses, and forbs (Table 7-1).

7.2.1.4 Mulching

A renewable natural straw fiber mulch (Hydrostraw®) was applied to the North-North Cover using a 3785-liter (L) Finn hydromulcher on October 24. The mulch was applied at a rate of 2,240 kg/ha on the two northern-most sections (one hydroseeded and one broadcast seeded) and at a rate of 1,680 kg/ha on the two southern sections (also one hydroseeded and one broadcast seeded) (Figure 7-2). The side slopes were hydromulched at a rate of 2,240 kg/ha on October 30.

7.2.1.5 Supplemental Irrigation

An irrigation system was designed and constructed to provide a means of supplementing natural precipitation. The irrigation system is a solid-set design with 102 mm supply lines with 25 mm lateral lines with multiple attached "superstands" equipped with a Nelson R2000Wind Fighter sprinkler head (Figure 7-3). Sprinkler head performance included a throw radius of 11–12 m at a rate of 32 lpm. Berkeley pumps were used to move water from 37,850-liter storage tanks into the irrigation system. System pressures between 275 and 345 kilo-pascals were maintained to obtain the desired flow rate of 32 lpm.

Supplemental watering began in November 2013 and continued through June 2014. Minimal amounts of natural precipitation were received during that period. A total of 199 mm of supplemental irrigation was applied to the site. Combined with the 77 mm of natural precipitation, the 276 mm were more than the 175 mm typically received during a good growing season (Table 7-2). Average precipitation for the site is approximately 115 mm.

7.2.1.6 Vegetation Monitoring

The objective of vegetation monitoring the first years after revegetation is to determine if seeds have germinated and seedlings are establishing on the site. For CAU 111 there were added objectives, and vegetation monitoring was designed to evaluate the effect of the two seeding techniques and the two mulching rates on seed germination and plant establishment.

Figure 7-2. Hydromulch application on the North-North Cover, October 2013
(Photo by D. C. Anderson, October 23, 2013)

Figure 7-3. Supplemental irrigation system in operation on the North-North Cover
(Photo by D. C. Anderson, November 2013)

Table 7-2. Amount of natural precipitation and supplemental irrigation (mm) applied to the North-North Cover from November 2013 to June 2014

Month	Goal	Natural Precipitation	Supplemental Irrigation	Total
Oct 2013	-	18	0	18
Nov 2013	13	23	13	36
Dec 2013	13	0	13	13
Jan 2014	39	0	38	38
Feb 2014	59	18	59	77
Mar 2014	25	8	25	33
Apr 2014	25	3	25	28
May 2014	13	7	13	20
Jun 2014	13	0	13	13
Total	**200**	**77**	**199**	**276**

The sampling design for the North-North Cover included the placement of five 50 m transects within each of the four treatments (Figure 7-4). Transects were located at a minimum of 10 m apart. A 50 m tape was stretched along each transect and a meter-square quadrat was placed at 5 m intervals along each transect, alternating right to left, for a total of 10 quadrats per transect. The number of individual plants, by species and by life form, rooted within quadrat boundaries, was recorded for each quadrat and then averaged over all 50 quadrats within each of the four treatment areas. The presence of small mammals, rabbits, and other animals on the site were noted as well. Vegetation monitoring was performed June 9–11, 2014.

7.2.2 Vegetation Monitoring Results

7.2.2.1 Broadcast Seeding versus Hydroseeding

Plant density on the broadcast-seeded area was 4.3 plants/m^2, and 1.8 plants/m^2 on the hydroseeded area. Shrub density was about three times higher and grass density two times higher on the broadcast seeded area than on the hydroseeded area. There was not a meaningful difference of forb density or invasive species density between the broadcast seeded treatments and the hydroseeded treatments (Table 7-3).

Seeded species were more common on areas that were broadcast seeded than on the hydroseeded treatments. Invasive species were present within every quadrat sampled. The most commonly occurring species on both sites were Nevada jointfir, Indian ricegrass, squirreltail grass (*Elymus elymoides*), desert marigold (*Baileya multiradiata*), and fourwing saltbush. The density of Indian ricegrass and Nevada jointfir was the same, although Indian ricegrass was found within more quadrats than was Nevada jointfir. Seedlings of nine of the eleven species that were included in the seed mix were found on the broadcast area (Figure 7-5), but only five were encountered on the hydroseeded area. The density of Russian thistle and halogeton was lower on the hydroseeded treatment whereas Arabian schismus was ten times higher on the hydroseeded treatment than on the broadcast seeded treatment.

7.2.3 Heavy Mulch Rate versus Standard Mulch Rate

7.2.3.1 Broadcast Seeded Area

The effect of mulch amounts was nested within the two seeding treatments. On the broadcast seeded area, there was a slight mulch effect. The density of all seeded species where the standard mulch rate was used was 15% higher than on the heavier mulched area. Shrub density and grass density was 30% higher where the standard mulch rate was used (Table 7-3). Forb density was higher on the heavier mulched section.

Figure 7-4. Location of vegetation monitoring transects on the North-North Cover

Table 7-3. Summary of plant density (plants/m^2) for the broadcast seeded versus hydroseeded treatments, and standard mulch versus heavy mulch treatments

			Broadcast Seeded		Hydroseeded	
	Broadcast Seeded	Hydro-seeded	Standard Mulch Rate	Heavy Mulch Rate	Standard Mulch Rate	Heavy Mulch Rate
SHRUBS						
White bursage	0.1	0.0	0.1	0.1	0.0	0.0
Fourwing saltbush	0.1	0.02	0.2	0.04	0.04	0.0
Shadscale saltbush	0.1	0.0	0.1	0.1	0.0	0.0
Brittlebush	0.02	0.0	0.02	0.0	0.0	0.0
Nevada jointfir	1.6	0.6	1.6	1.6	0.5	0.7
Creosote bush	0.05	0.0	0.1	0.02	0.0	0.0
GRASSES						
Indian ricegrass	1.6	0.6	1.9	1.4	0.5	0.6
Squirreltail grass	0.4	0.1	0.5	0.3	0.1	0.2
FORBS						
Desert marigold	0.4	0.5	0.3	0.5	0.3	0.6
Desert globemallow	0.0	0.0	0.0	0.0	0.0	0.0
Flatcrown buckwheat*	0.02	0.0	0.04	0.0	0.0	0.0
ANNUAL GRASSES						
Arabian schismus*	0.04	0.7	0.02	0.1	0.4	0.9
Red brome*	0.1	0.1	0.2	0.1	0.1	0.06
ANNUAL FORBS						
Russian thistle*	9.2	3.4	10.5	7.8	4.4	2.4
Halogeton*	47.3	33.3	45.4	49.1	37.4	29.1
SUMMARY						
Shrubs-seeded	1.9	0.6	2.1	1.9	0.5	0.7
Grasses-seeded	2.0	0.7	2.4	1.7	0.6	0.8
Forbs-seeded	0.4	0.5	0.3	0.5	0.3	0.6
Seeded	4.3	1.8	4.8	4.1	1.4	2.1
Non-Seeded	56.7	38.2	56.1	57.0	42.3	33.0

(* = Not included in seed mix)

Figure 7-5. Seeded species encountered on the North-North Cover during vegetation monitoring in May 2014. Far left, a mature desert marigold; center, shadscale saltbush seedling; far right, fourwing saltbush seedling.

(Photos by D. C. Anderson, May 2014)

There was essentially no difference in the density of invasive species between the two mulch rates on the broadcast seeded area. Nevada jointfir (Figure 7-6) and Indian ricegrass were the two most frequently encountered species, followed by squirreltail grass and desert marigold (Figure 7-6) on both mulch treatments.

7.2.3.2 Hydroseeded Area

On the hydroseeded area, the mulch rate appeared to have an opposite effect than was observed on the broadcast seeded area (Table 7-3). Plant density for seeded species was 30% higher on the heavier mulched area than where the standard mulch rate was used. This relationship was similar for all three life forms. Where the higher mulch rate was used, the density of invasive species was lower.

Nevada jointfir was the most frequently occurring species followed by Indian ricegrass (Figure 7-7), desert marigold, and squirreltail grass. Overall, seeded species were more common where the higher mulch rate was used. Russian thistle, however, was less common where the heavier mulch rate was used.

7.2.4 Wildlife Observations

Small mammal burrows were observed on the site, but no burrows were encountered within the quadrats during vegetation sampling. A few burrows were observed on the cover but were widely scattered. Most of the small mammal activity was on the periphery of the cover.

Signs of herbivory were evident at many locations. Stems of halogeton had been cut and left without being eaten, but signs of herbivory was most notable on Nevada jointfir and Indian ricegrass (Figure 7- 7). Many young seedlings had been grazed to ground level and others showed signs of moderate to heavy grazing. The abundance of rabbits was documented by recording the presence of rabbit scat (pellets) within sample quadrats (Table 7-4). Rabbit usage was higher on the broadcast seeded area, possibly due to the higher density of seeded species.

Figure 7-6. Young seedlings of Nevada jointfir (foreground) and desert marigold (center)
(Photo by D. C. Anderson, May 2014)

Figure 7-7. Young seedlings of Indian ricegrass on the North-North Cover in the spring of 2014. Plant on right has experienced moderate grazing.
(Photos by D. C. Anderson, May 2014)

Table 7-4. Summary of animal observations on each of the four treatment areas on the North-North Cover

	Broadcast Seeded		Hydroseeded	
	Recommended Mulch Rate	Heavy Mulch Rate	Recommended Mulch Rate	Heavy Mulch Rate
Small Mammal Burrows	0	0	0	0
Rabbit sign (scat)	90%	50%	68%	58%
Rabbit sign by seeding treatment	70%		63%	

7.2.5 Discussion

The plan for remedial revegetation considered several different scenarios. One was to allow the site to naturally revegetate, which was not selected because research has shown that natural plant establishment can take several decades (Angerer 1995). Another scenario was to re-seed the four closure covers with no additional mulching or supplemental irrigation. Not knowing whether this approach would be successful and because it would still involve a substantial investment of labor and materials, it was concluded that a more cost-effective approach would be to first test several revegetation scenarios on the North-North Cover. Once a successful methodology was identified, then it would be applied to the rest of the 92-Acre Site. It was understood that if a successful methodology was not identified, other approaches would be identified and evaluated (Hall et al. 2014).

The following sections summarize the findings from research trials conducted this past year. Based on those findings and general observations, a remedial revegetation plan is proposed that addresses key factors for the successful establishment of a native plant community on the 92-Acre Site.

7.2.5.1 Plant Density

The density of seeded species on the North-North Cover this year (4.4 plants/m^2) (Table 7-3) is substantially higher than plant densities on the 92-Acre Site after the original seeding (0.1 plants/m^2) (Hall et al. 2014). However, plant density is still lower than observed on other sites that were successfully revegetated on the NNSS. At the U-3ax/bl closure cover, plant density was 65 plants/m^2 the first year after revegetation and 37 plants/m^2 a year later (Bechtel Nevada 2006). On the CP Water Line, which was revegetated 4 years ago, perennial plant density was 48 plants/m^2 the first year after revegetation and 37 plants/m^2 the following year (Hansen et al. 2012).

The composition of the plant density on the North-North Cover is concerning as is the low plant density. Half of the density is made up of perennial grasses. Although perennial grass density on both the U-3ax/bl and CP Water Line sites was relatively high the first few years after seeding, by the end of the fifth year, there were no perennial grasses present at the U-3ax/bl site. Perennial grasses do not appear to be tolerant of droughty conditions. Over the next few years, the density of perennial species, both shrubs and grasses, on the North-North Cover is expected to decline. The successful establishment of a viable plant community on the North-North Cover is unlikely based on the low plant densities reported this year.

7.2.5.2 Seeding

The original seeding method was broadcast seeding, which is a method that has been successfully used on the NNSS at several revegetation sites (Anderson and Ostler 2002). Hydroseeding had been used previously on the NNSS but with limited success. Hydroseeding was investigated this year on the North-North Cover, because it does provide a means of seeding that is more accommodating to the existing irrigation system as well as the controlled access to the cover. The research trials showed that areas broadcast seeded had three times the density of seeded species than areas that were hydroseeded.

The seeding rate was higher on the hydroseeded areas, but plant density was still lower. It is recommended that broadcast seeding be the method used for future remedial revegetation on the 92-Acre Site.

The seed mix used to revegetate the 92-Acre Site in the fall of 2011 included ten species of native shrubs, three grasses, and three forbs (Hall et al. 2013). There were several species in the mix that were marginally adapted to the 92-Acre Site, and it was unknown whether they would establish on the site. Vegetation monitoring in 2013 revealed that four shrub species, one grass, and one forb did not germinate and were, therefore, not included in the seed mix that was used to reseed the North-North Cover this past fall. Brittlebush was not encountered during vegetation monitoring in 2013, but it was considered to be a species that could still potentially establish on the 92-Acre Site. However, no seedlings of brittlebush were found this year on any of the treatments and will not be used in future seed mixes for revegetation efforts at the 92-Acre Site. It is recommended that the seeding rate used for future revegetation efforts at the 92-Acre Site be increased by 20%–30% to compensate for the reduction in seed viability and germination experienced this year with some species. Future seed procurements will also specify that seed certification be made within the last 6 months, rather than the last 12 months.

7.2.5.3 Mulching

Mulching in 2011 included the spreading of the native straw using a straw blower and then securing the straw using a crimper. Crimping is inherently not 100% effective, and a substantial amount of the straw blew off the covers and into areas where it posed a hazard and had to be removed. Hydromulching is an alternative to blowing and crimping. It was demonstrated this year that a heavier mulch rate did not result in higher plant densities. However, there remains a question as to whether additional mulch is necessary at all. The litter and residual mulch that is accumulating on the covers may be as effective in promoting seed germination and plant establishment as would be achieved with the application of more mulch. Future research trials should consider a "no-mulch" option.

7.2.5.4 Wildlife Use

It was originally assumed that the lack of vegetation within the Radioactive Waste Management Complex and the heavy vehicle traffic would deter the presence of grazing and browsing animals, such as rabbits, small mammals, antelope, and burros. It was known that the perimeter fences were not constructed to prohibit rabbit or small mammal movement onto the site, nor would they keep antelope and burros out.

Based on observations this year, it is evident that small mammals, especially rabbits, were present on the site. The presence of rabbits was noted at 90% of the quadrats within the broadcast seeded area, which was the area with the highest seedling density. Many young seedlings of Indian ricegrass and Nevada jointfir had been grazed to ground level or showed signs of moderate grazing. The heavily grazed plants were difficult to see, and many heavily grazed plants may have died, which suggests that the magnitude of this issue may be underestimated. Future reseeding efforts should definitely address protection from grazing animals, mainly rabbits. Fencing was used at the U-3ax/bl closure cover, the Central Nevada Test Area (CNTA) and five CAUs on the TTR, which may have contributed to the success of the revegetation effort at all of those sites. It is recommended that a rabbit-proof fence be installed around the perimeter of the cover to reduce the damaging effects of rabbit herbivory.

7.2.5.5 Invasive Weed Control

The first year after the original seeding, which included supplemental irrigation, halogeton and Russian thistle were abundant and covered the majority of all four covers within the 92-Acre Site. The second year, with no supplemental irrigation and during another year of below normal rainfall, halogeton and Russian thistle were essentially absent (Hall et al. 2014). This year both species were present on the other three covers within the 92-Acre Site, but at a fraction of the density and cover experienced on the

North-North Cover (Figure 7-8). There was some effort to deter the production of more seeds this year by disking the areas where high densities of halogeton were evident, but those efforts appear to be ineffective.

Controlling halogeton typically utilizes mechanical, chemical, and natural methodologies (U.S. Department of Agriculture, Natural Resources Conservation Service 2014; Monsen et al. 2004). The best method for the circumstances at the 92-Acre Site is to establish native vegetation. The effectiveness of this approach was demonstrated at the Bomblet Pit closure site on the TTR. Prior to revegetation the density of halogeton was similar to those found on the 92-Acre Site. The first year after revegetation, the density of halogeton was 5 plants/m^2, the following year 3 plants/m^2, and essentially none since then. A similar situation was observed at the U-3ax/bl site. Five years after revegetation, the density of Russian thistle was 77 plants/m^2 (Hansen et al. 2008). By 2013, the density of both Russian thistle and halogeton was 8 plants/m^2 (Hall et al. 2014), and the few plants that were present were less than a few millimeters in diameter and height, and contribute less than 1% cover. No chemical or additional mechanical methods to control invasive plants are recommended; rather, it is recommended that efforts focus on establishing a native plant community as the method to control invasive species.

7.2.5.6 Irrigation

Rainfall the last several years has been below normal. A couple of rainstorms in October and November this past fall were encouraging, but from December to February, when rainfall is critical for good seed germination and plant establishment, only 17 mm were received, compared to approximately 105 mm that are typically received during a good growing season. Successful revegetation was achieved at the U-3ax/bl site with 109 mm of natural precipitation and 125 mm of supplemental irrigation. About 200 mm of supplemental irrigation was applied this past growing season to the North-North Cover, augmenting the meager 72 mm of natural rainfall.

Irrigation has been used at sites where the immediate establishment of a vegetative cover is a high priority. The Double Tracks site on the TTR and the U-3ax/bl site are two examples. At other sites, such as the CNTA, the five CAUs on the TTR, and the CP Water line, no supplemental irrigation was used; yet, due to favorable natural rainfall events, a viable native plant community has established at all of these sites (Hall et al. 2013; NSTec 2007; Anderson and Ostler 2002). There are other factors associated with rainfall events that enhance seed germination and plant establishment, such as soil and air temperature. Future revegetation procedures may consider evaluating not using supplemental irrigation but to schedule revegetation at times when there is a higher probability of more favorable environmental conditions that would, in turn, promote better seed germination and plant establishment. This might be in years when the probability of an “El Niño” weather pattern is higher. Experience on the NNSS and the TTR has shown that successful revegetation can be achieved without supplemental irrigation.

In the event supplemental irrigation is used in the future, the timing and amounts of supplemental irrigation should be evaluated to ensure the greatest benefit for seeded plant species yet minimizing the benefit to invasive plant species. One such scenario would be to only provide supplemental irrigation in the fall and winter months (November to February). Observations at the NNSS suggest that rainfall during these months seems to favor native plant growth, whereas spring precipitation seems to favor growth of annuals, including invasive annual species such as halogeton and Russian thistle.

Figure 7- 8. Overview of North-North Cover showing abundance of halogeton and Russian thistle (Photo by D. C. Anderson, May 2014)

Supplemental irrigation in late spring may be required for the successful germination of creosote bush seed, which requires soil temperatures between 15° Celsius (C) and 37°C along with sufficient soil moisture (Ostler et al. 2002). Creosote bush is an important component of the native plant community, and efforts should be made to meet seed germination requirements.

7.3 CAU 407, Roller Coaster RADSAFE Survey Results

In 2004, actions were taken to repair erosion channels that had developed on the cover cap at the CAU 407 site on the TTR. Those actions left much of the cover without vegetation. In the fall of 2004, the cover cap was seeded with a mix of native plant species. The entire site was covered with a biodegradable erosion control blanket and supplemental irrigation applied as necessary through the following spring. Vegetation monitoring has been conducted annually since 2005 to document the success of revegetation efforts and to identify any issues that may need to be addressed to ensure that the plant community persists.

7.3.1 Objectives

The objectives of the revegetation efforts at CAU 407, Roller Coaster RADSAFE Area, were to accelerate the reestablishment of native plants and return the site to pre-disturbance conditions. Vegetation affords protection from wind and water erosion and maintains the integrity of the site. It also impedes the growth of noxious, weedy species and provides cover and food for wildlife.

7.3.2 Methods

Monitoring was performed on June 4, 2014. Plant cover and density were recorded, wildlife usage was noted, and erosion was evaluated. Plant cover was estimated using an optical point projection device. Samples were taken at intervals along each of the three 25 m long, permanent linear transects. Cover was recorded by species. Density was estimated using 1 m^2 quadrats placed at designated intervals along each transect. The total number of individual plants within each quadrat was recorded. The data were averaged over all quadrats. Species richness was calculated from density data. The number of different plant species within each quadrat was averaged over all quadrats and offers a gauge of the diversity or heterogeneity of the plant community.

Quantification of the success of the revegetation effort at this site is accomplished by comparing the percentage of plant cover and plant density on the reseeded closure cover with the percentage of plant cover and plant density on an adjacent undisturbed plant community or reference area. Typically, if cover and density on the reseeded area are close to 70% of the cover and density on the reference area over consecutive years, the site is considered to be "successfully revegetated."

Wildlife usage is a subjective determination and is measured by the presence of animals, burrows, scat or browsed shrubs and grasses. Indications of erosion include the movement of surface litter, pedestalling and rilling of soils or exposure of plant roots. Reclamation success standards were previously determined by averaging data collected at a reference site from 2000 to 2009. The reference site is located less than a mile north of CAU 407 cover cap.

7.3.3 Plant Cover

Plant cover at CAU 407 was 9.2% (Table 7-5) in 2014, all from shadscale saltbush and fourwing saltbush. Plant cover in 2014 was the lowest it has been at this site since it was revegetated in the fall of 2004. The average plant cover for the previous 7 years is 13.9%, almost 5% higher than was recorded this year. Plant cover on the site seems to have peaked at 21.7% in 2010 and has decreased since then. Perennial grasses have never contributed significantly to plant cover at this site and have not been part of total plant cover since 2009. Annual forbs have contributed to plant cover on occasion, but there have been no forbs the last 4 years.

7.3.4 Plant Density

Plant density at CAU 407 was 8.0 plants/m^2 this year and included four different shrubs (Table 7-6). The most abundant shrub was shadscale saltbush with a density of 5.8 plants/m^2, which was almost a 50% drop in density from last year when the density of shadscale saltbush was 11.0 plants/m^2. Fourwing saltbush is rarely encountered at the site but was up substantially from the last 4 years. Fourwing saltbush was relatively abundant between 2005 and 2009 but has become less common over the last few years. The increase in density this year is encouraging. The density of winterfat has never contributed to overall plant density at this site but was present this year at about half the density it was last year. Total plant density this year was lower than it was last year but similar to what it was 2 years ago. There were a few halogeton plants, but there have been no native forbs on the site for the last 4 years.

7.3.5 Species Richness

There was an average of one species encountered per quadrat on the CAU 407 cover (Table 7-7) this year, which is close to what it has been the last 4 years. The only species encountered on the site are shrubs. Perennial grasses and native forbs are occasionally observed but never in abundance.

Table 7-5. Plant cover (percent) on CAU 407

		Cover Cap	Reference	Standard
SHRUBS	Bud sagebrush		5.3	
	Fourwing saltbush	1.7	3.8	
	Shadscale saltbush	7.5		
	Yellow rabbitbrush		0.1	
	Winterfat		0.2	
	Total Shrub Cover	**9.2**	**9.4**	**6.6**
GRASSES	Indian ricegrass		0.7	
	Woolly tuftgrass		0.1	
	James' galleta grass		1.0	
	Total Grass Cover	**0.0**	**1.8**	**1.3**
FORBS	Esteve's pincushion		1.5	
	Redstem stork's bill		0.2	
	Milkvetch		0.2	
	Total Forb Cover	**0.0**	**1.9**	**1.3**
INVASIVE WEEDS	Halogeton	0.0	0.1	
	Total Invasive Weed Cover	**0.0**	**0.1**	
TOTAL PLANT COVER		**9.2**	**13.2**	**9.2***
Bare Ground		72.5	69.6	
Litter		18.3	17.2	

* Does not include invasive weeds

Table 7-6. Plant density (Plants per m²) on CAU 407

		Cover Cap	Reference	Standard
SHRUBS	Bud sagebrush	0.7	3.1	
	Fourwing saltbush	1.2	0.0	
	Shadscale saltbush	5.8	0.8	
	Sagebrush cholla		0.03	
	Winterfat	0.3	0.1	
	Total Shrub Density	**8.0**	**4.0**	**2.8**
GRASSES	Indian ricegrass	0	0.4	
	Woolly tuftgrass	0	0.4	
	Squirreltail grass	0	0.04	
	James' galleta grass	0	0.9	
	Total Grass Density	**0**	**1.7**	**1.2**
FORBS	Buckwheat species	0	0.1	
	Desert globemallow	0	0.3	
	Esteve's pincushion	0	8.7	
	Freckled milkvetch	0	0.1	
	Gooseberryleaf globemallow	0	0.1	
	Hoary tansyaster	0	0.04	
	Lambsquarter	0	0.1	
	Milkvetch	0	0.2	
	Pepperweed	0	0.2	
	Total Forb Density	**0**	**9.8**	**6.9**
INVASIVE WEEDS	Halogeton	0.7	0.3	
	Total Invasive Weed Cover	**0.7**	**0.3**	
TOTAL PLANT DENSITY		**8.7**	**15.9**	**10.9***

* Does not include invasive weeds

Table 7-7. Species richness (Species per m^2) on CAU 407

	Cover Cap	Reference	Standard
Shrubs	1.0	1.6	1.1
Grasses	0	0.5	0.4
Forbs	0	1.1	0.8
Total Species	**1.0**	**3.2**	**2.3**

7.3.6 Revegetation Success

Both plant cover and plant density were low this year. Plant cover was right at the standard for revegetation success, which is 9.2% (Table 7-5). The concern at the CAU 407 cover cap is the dearth of perennial grasses and forbs. It is anticipated that with increased amounts of rainfall, not only will shrub cover increase, but forbs will also eventually contribute more to overall plant cover, as they have in the past, and perennial grasses will reestablish on the site.

Total plant density dropped below the revegetation success standard of 10.9 plants/ m^2 for the second time since the site was revegetated. The only plants present were three species of shrubs. There have been no perennial grasses encountered since 2009 and no forbs since 2010.

The third parameter used to measure revegetation success is species richness, which for CAU 407 has been low for several years. Species richness this year is 1.0 species/quadrat and has not been above that value since 2010. The revegetation success standard is 2.3 species/quadrat, which has not been achieved since 2006, just a couple years after the site was reseeded.

7.3.7 Wildlife Use

As noted in prior years, there continue to be a few animal burrows on the side slopes of the cover. The burrows appeared to be shallow and, as in previous years, did not appear to be intensely used.

7.3.8 Soil Erosion

The soil on the cover and side slopes appears to be stable. No gullies were observed, and overall there were no indications that soil erosion is a concern.

7.3.9 Summary

Corrective measures taken previously at CAU 407, Roller Coaster RADSAFE Area, appear to be controlling severe erosion. The animal burrows, primarily along the southern slope, do not appear to be used frequently, and there are no signs of subsurface soils being carried to the surface.

The major concern at the CAU 407, Roller Coaster RADSAFE Area, continues to be the diversity of plants. Shrubs are the only life form found on the site, and both cover and density have declined over the past few years. The lack of natural rainfall continues in the region and is most likely the primary reason for the declines and the low diversity. As mentioned previously, plants that have established on the site appear smaller than would be expected, probably a result of the compacted subsurface soils, typical of most cover caps. As years of higher precipitation occur, the compacted soils may loosen and allow greater root penetration and more robust plant growth.

8.0 REFERENCES

Andersen, M. C., J. M. Watts, J. E. Freilich, S. R. Yool, G. I. Wakefield, J. F. McCauley, and P. B. Fahnestock, 2000. Regression-Tree Modeling of Desert Tortoise Habitat in the Central Mojave Desert. *Ecological Applications* 10:890–900.

Anderson, D. C., and W. K. Ostler, 2002. Revegetation of Degraded Lands at U.S. Department of Energy and U.S. Department of Defense Installations: Strategies and Successes. *J. Arid Land Research and Management.* 16(3):197–212.

Angerer, J. P, W. K. Ostler, W. D. Gabbert, and B. W. Schultz, 1995. *Secondary Plant Succession on Disturbed Sites at Yucca Mountain, Nevada.* EG&G/EM 11265-1118 UC-702. 72 pp.

Avian Power Line Interaction Committee, 2006. *Suggested Practices for Avian Protection on Power Lines. State of the Art in 2006*. Edison Electric Institute, Avian Power Line Interaction Committee, and the California Energy Commission. Washington, D.C., and Sacramento, CA.

Ashman, D. L., G. C. Christensen, M. L. Hess, G. K. Tsukamoto, and M. S. Wickersham, 1983. *The Mountain Lion in Nevada*. Nevada Department of Wildlife.

Bechtel Nevada, 2001. *Adaptive Management Plan for Sensitive Plant Species on the Nevada Test Site*. Environmental Monitoring, Ecological Services, Las Vegas, NV. March 2001.

Bechtel Nevada, 2006. *Ecological Monitoring and Compliance Program Calendar Year 2005 Report*. Environmental Monitoring, Ecological Services, Las Vegas, NV. March 2006.

Boarman, W. I., and M. Sazaki. 2006. A Highway's Road-Effect Zone for Desert Tortoises (*Gopherus agassizii*). *Journal of Arid Environments* 65:94–101.

Bradley, P. V., M. J. O'Farrell, J. A. Williams, and J. E. Newmark, 2006. *The Revised Nevada Bat Conservation Plan*. Nevada Bat Working Group. Reno, NV. 216 p.

Brookhart, J. O., and P. E. Cushing, 2008. The *Hemerotricha banksi* group (Arachnida, Solifugae), a diurnal group of solifuges from North America. *Journal of Arachnology* 36:49–64.

Code of Federal Regulations, 2010. Maximum Contaminant Levels for Radionuclides, Federal Drinking Water Standards, Title 40, Part 141.66, U.S. Environmental Protection Agency, Washington, D.C.

Demarchi, D. A., and S. Lofts, 1985. *The Effects of Spring Burning on the Productivity and Nutrient Concentration of Several Shrub Species in the Southern Rocky Mountain Trench.* MOE Technical Report 19. Victoria, BC: British Columbia Ministry of Environment, Wildlife Branch, Wildlife Habitat and Inventory Section. 89 p.

DOE, see U.S. Department of Energy.

DOE/NV, see U.S. Department of Energy, Nevada Operations Office.

Federal Register, 2014. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for the Western Distinct Population Segment of the Yellow-billed Cuckoo (*Coccyzus americanus*); Final Rule; Volume 79, No. 192, October 3, 2014.

FWS, see U.S. Fish and Wildlife Service.

Giles, K., and J. Cooper, 1985. *Characteristics and Migration Patterns of Mule Deer on the Nevada Test Site.* EPA 600/4-85-030.

Greger, P. D., and E. M. Romney, 1999. High Foal Mortality Limits Growth of a Desert Feral Horse Population in Nevada. *Great Basin Naturalist.* 59(4):374–79.

Hall, D. B., 2014. Personal communication with Melia Nafus, San Diego Zoo Institute for Conservation Research. December 4, 2014. Las Vegas, NV.

Hall, D. B., and P. D. Greger. 2014. Documenting Western Burrowing Owl Reproduction and Activity Patterns with Motion-activated Cameras. *Western Birds* 45:313–323.

Hall, D. B., D. C. Anderson, P. D. Greger, W. K. Ostler, and D. J. Hansen, 2013. *Ecological Monitoring and Compliance Program 2012 Report*. DOE/NV/25946--1776, National Security Technologies, LLC, Ecological Services, Las Vegas, NV. July 2013.

Hall, D. B., D. C. Anderson, P. D. Greger, and W. K. Ostler, 2014. *Ecological Monitoring and Compliance Program 2013 Report*. DOE/NV/25946--2045, National Security Technologies, LLC, Ecological Services, Las Vegas, NV. July 2014.

Hansen, D. J., 2012. Personal communication with Rick Lantrip, Air Resources Laboratory, Special Operations Division. May 4, 2012. Mercury, NV.

Hansen, D. J., and W. K. Ostler, 2004. *A Survey of Vegetation and Wildland Fire Hazards on the Nevada Test Site*. DOE/NV/11718--981. Bechtel Nevada, Ecological Services, Las Vegas, NV.

Hansen, D. J., D. C. Anderson, D. B. Hall, P. D. Greger, and W. K. Ostler, 2008. *Ecological Monitoring and Compliance Program 2007 Report*. DOE/NV/25946--402, National Security Technologies, LLC, Ecological Services, Las Vegas, NV. March 2008.

Hansen, D. J., D. C. Anderson, D. B. Hall, P. D. Greger, and W. K. Ostler, 2010. *Ecological Monitoring and Compliance Program 2009 Report*. DOE/NV/25946--946, National Security Technologies, LLC, Ecological Services, Las Vegas, NV. July 2010.

Hansen, D. J., D. C. Anderson, D. B. Hall, P. D. Greger, and W. K. Ostler, 2012. *Ecological Monitoring and Compliance Program 2011 Report*. DOE/NV/25946--1484, National Security Technologies, LLC, Ecological Services, Las Vegas, NV. July 2012.

Monsen, S. B., R. Stevens, N. L. Shaw, 2004. *Restoring Western Ranges and Wildlands*. Gen. Tech. Rep. RMRS-GTR-136-vol-1. Fort Collins, CO. Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Muma, M. H., 1963. Solpugida of the Nevada Test Site. Brigham Young University Science Bulletin Biological Series 3:1–15.

NAC, see Nevada Administrative Code.

National Oceanic and Atmospheric Administration, Air Resources Laboratory/Special Operations and Research Division, 2013. *Nevada Test Site (NTS) Climatological Rain Gauge Network.* Available at: http://www.sord.nv.doe.gov/home_climate_rain.htm. [Accessed May 15, 2013]. North Las Vegas, NV.

National Security Technologies, LLC, 2007. *Ecological Monitoring and Compliance Program 2006 Report*. DOE/NV/25946--174, Las Vegas, NV. March 2007.

National Security Technologies, LLC, 2015. *Nevada National Security Site Environmental Report 2014*. Report in preparation, prepared for U.S. Department of Energy, National Nuclear Security Administration, Nevada Field Office, Las Vegas, NV.

Nevada Administrative Code, 2015. *Chapter 503 - Hunting, Fishing and Trapping; Miscellaneous Protective Measures*. Available at: http://www.leg.state.nv.us/NAC/NAC-503.html [Accessed January 5, 2015]. Carson City, NV.

Nevada Native Plant Society, 2015. *Status Lists*. Maintained at Nevada Natural Heritage Program. Available at: http://heritage.nv.gov/lists/nnnpstat.htm. [Accessed January 5, 2015]. Carson City, NV.

Nevada Natural Heritage Program, 2015, *Animal and Plant At-Risk Tracking List*, November 2010. Maintained by the Nevada Natural Heritage Program. Available at: http://heritage.nv.gov/sites/default/files/library/track.pdf [Accessed on January 5, 2015]. Carson City, NV.

NNHP, see Nevada Natural Heritage Program.

NNPS, see Nevada Native Plant Society.

NOAA, see National Oceanic and Atmospheric Administration.

NSTec, see National Security Technologies, LLC.

Nussear, K. E., T. C. Esque, R. D. Inman, L. Gass, K. A. Thomas, C. S. A. Wallace, J. B. Blainey, D. M. Miller, and R. H. Webb, 2009. *Modeling Habitat of the Desert Tortoise (Gopherus Agassizii) in the Mojave and Parts of the Sonoran Deserts of California, Nevada, Utah, and Arizona*. U.S. Geological Survey Open File Report 2009-1102, 18 p.

Ostler, W. K., D. J. Hansen, D. C. Anderson, and D. B. Hall, 2000. *Classification of Vegetation on the Nevada Test Site.* DOE/NV/11718--477, Bechtel Nevada, Ecological Services, Las Vegas, NV, December 6, 2000.

Ostler, W. K., D. C. Anderson, D. B. Hall, and D. J. Hansen, 2002. *New Technologies to Reclaim Arid Lands User's Manual*. DOE/NV/11718--477. Bechtel Nevada Ecological Services, Las Vegas, NV.

Peterson, F. F., 1981. *Landforms of the Basin & Range Province Defined for Soil Survey.* Technical Bulletin 28, Nevada Agricultural Experiment Station, University of Nevada, Reno. January 1981.

Pierce, B. M., V. C. Bleich, J. D. Wehausen, and R. T. Bowyer, 1999. Migratory Patterns of Mountain Lions: Implications for Social Regulation and Conservation. *Journal of Mammalogy* 80:986–992.

Sawyer, H., M. J. Kauffman, R. M. Nielson, and J. S. Horne, 2009. Identifying and Prioritizing Ungulate Migration Routes for Landscape-Level Conservation. *Ecological Applications* 19:2016–2025.

Thomas, L., J. L. Laake, S. Strindburg, F. F. C. Marques, S. T. Buckland, D. L. Borchers, D. R. Anderson, K. P. Burnam, S. L. Hedly, J. R. D. Bishop, J. H. Pollard, and T. A. Marques, 2006. DISTANCE 5.0, Version 3, Research Unit for Wildlife, University of Saint Andrews, St. Andrews, Scotland. UK.

U.S. Department of Agriculture, Natural Resources Conservation Service. July 2014. Halogeton *Halogeton glomeratus* (M. Bieb.) C. Meyer, Plant Guide. http://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/idpmcpg7795.pdf

U.S. Department of Energy, 2002. *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*. DOE-STD-1153-2002. U.S. Department of Energy, Washington, D.C.

U.S. Department of Energy, Nevada Operations Office, 1996. *Final Environmental Impact Statement for the Nevada Test Site and Off-Site Locations in the State of Nevada,* Volume 1, Chapters 1–9, DOE/EIS--0243, Las Vegas, NV, August 1996.

U.S. Department of Energy, Nevada Operations Office, 1998. *Nevada Test Site Resource Management Plan,* DOE/NV--518, Las Vegas, NV, December 1998.

U.S. Fish and Wildlife Service, 1996. *Final Programmatic Biological Opinion for Nevada Test Site Activities*. File No. 1-5-96-F-33, Reno, NV, August 22, 1996.

U.S. Fish and Wildlife Service, 2009. *Final Programmatic Biological Opinion for Implementation of Actions on the Nevada Test Site, Nye County Nevada*. File No. 84320-2008-F-0416 and 84320-2008-B-0015, Las Vegas, NV, February 12, 2009.

U.S. Fish and Wildlife Service, 2015. *Endangered Species Program Home Page.* Maintained at: http://www.fws.gov/endangered [Accessed January 5, 2015].

Weinstein, M. N., 1989. *Modeling Desert Tortoise Habitat: Can a Useful Management Tool Be Developed from Existing Transect Data?* Los Angeles, University of California, unpublished Ph.D. dissertation, 121 p.

Wills, C. A., and W. K. Ostler, 2001. *Ecology of the Nevada Test Site: An Annotated Bibliography, with Narrative Summary, Keyword Index, and Species Lists*. DOE/NV/11718--594, Bechtel Nevada, Ecological Services, Las Vegas, NV. September 2001.

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