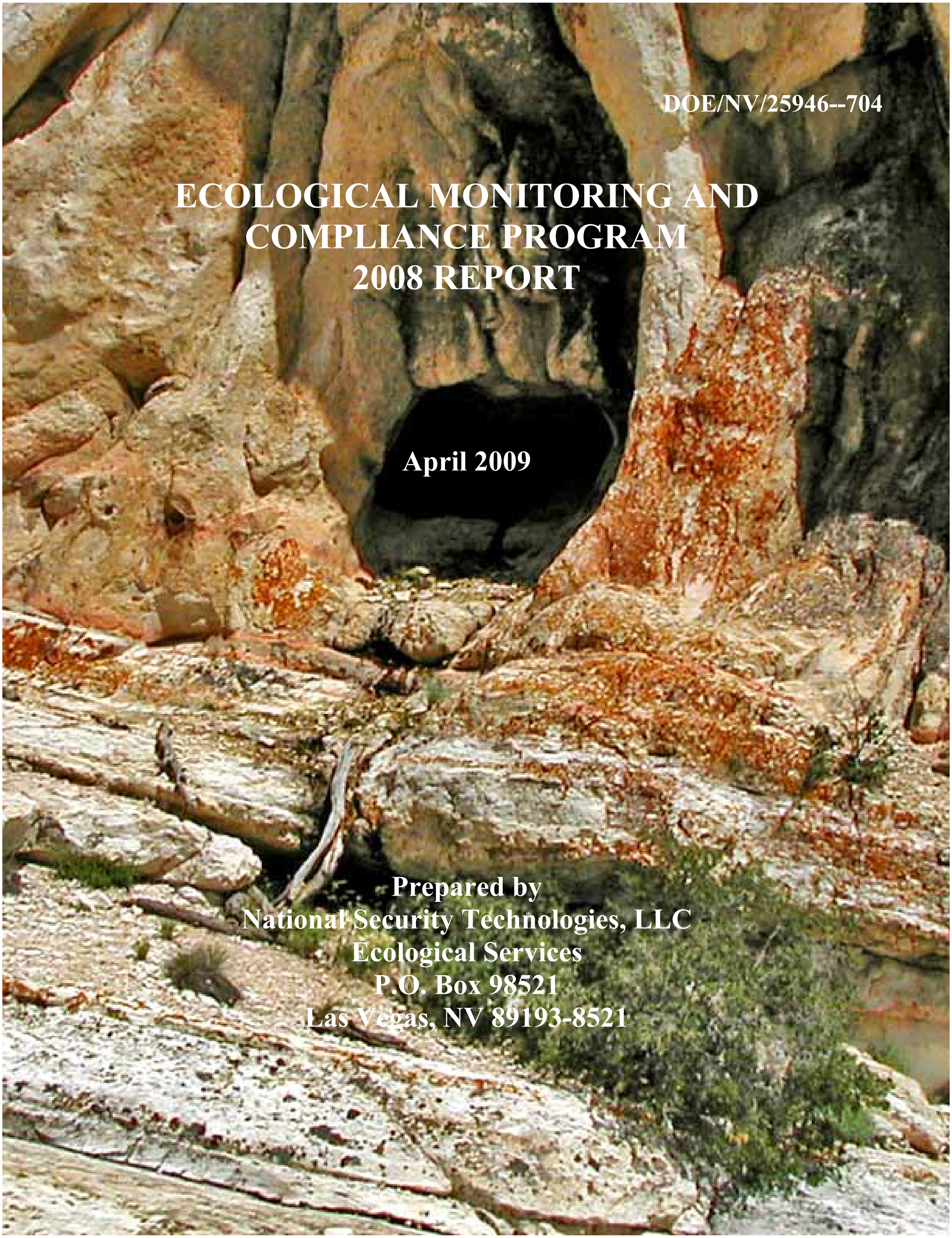

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ECOLOGICAL MONITORING AND COMPLIANCE PROGRAM 2008 REPORT

April 2009

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Front Cover Picture: Tongue Wash Tank in Area 12 (Photo by Paul D. Greger, May 26, 2005). This natural water source provides water to wildlife on the Nevada Test Site. Note the resemblance of rocks to a tongue protruding from the mouth of a cave in the center of the photo.

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ECOLOGICAL MONITORING AND COMPLIANCE PROGRAM 2008 REPORT

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EXECUTIVE SUMMARY

The Ecological Monitoring and Compliance Program, funded through the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO), monitors the ecosystem of the Nevada Test Site (NTS) and ensures compliance with laws and regulations pertaining to NTS biota. This report summarizes the program's activities conducted by National Security Technologies, LLC (NSTec), during calendar year 2008. Program activities included (a) biological surveys at proposed construction sites, (b) desert tortoise compliance, (c) ecosystem mapping and data management, (d) sensitive plant species monitoring, (e) sensitive and protected/regulated animal monitoring, (f) habitat monitoring, (g) habitat restoration monitoring, and (h) monitoring of the Nonproliferation Test and Evaluation Complex (NPTEC).

Sensitive and protected/regulated species of the NTS include 43 plants, 1 mollusk, 2 reptiles, 238 birds, and 26 mammals. These species are protected, regulated, or considered sensitive as per state or federal regulations and natural resource agencies and organizations. The threatened desert tortoise *(Gopherus agassizii)* is the only species on the NTS protected under the *Endangered Species Act*. Biological surveys for the presence of sensitive and protected/regulated species and important biological resources on which they depend were conducted for 28 projects. A total of 224.06 hectares (ha) (553.66 acres [ac]) was surveyed for these projects. Sensitive and protected/regulated species and important biological resources found during these surveys included inactive and potential tortoise burrows, active predator burrows, mature Joshua trees *(Yucca brevifolia)*, yuccas, cacti, and Darin buckwheat *(Eriogonum concinnum)*. NSTec provided a written summary report of all survey findings and mitigation recommendations, where applicable. All flagged burrows were avoided during project activities.

Eighteen of the 28 projects occurred within the distribution range of the threatened desert tortoise. NNSA/NSO must comply with the terms and conditions of a permit (called a Biological Opinion) from the U.S. Fish and Wildlife Service (FWS) when conducting work in tortoise habitat. No tortoises were found in project areas, nor were any accidentally injured, killed, captured, or displaced during project activities. No desert tortoises were killed along paved roads. In 2008, 1.69 ha (4.18 ac) of tortoise habitat were disturbed. No revegetation of habitat was conducted in 2008 because of the severe drought. There were several activities that paid mitigation fees in 2008 for sites that were disturbed in 2006–2008.

On July 2, 2008, NNSA/NSO sent a Biological Assessment to the FWS and entered into formal consultation for a new programmatic opinion for the NTS. A draft Biological Opinion (Opinion) was received from FWS in December, and NNSA/NSO provided comments on that draft Opinion in late December. The final Opinion was received in February 2009.

There has been an average of 11.6 wildland fires per year on the NTS since 1978 with an average of about 85.6 ha (211.4 ac) burned per fire. In 2008, there were 20 wildland fires and a total of less than 0.8 ha (2 ac) burned. All fires in 2008 were small fires consisting of single shrubs or trees or small areas and were extinguished before they could spread. Precipitation in 2008 was about 50 percent of the average for the winter months, which resulted in little or no germination from annual herbaceous plants and almost no production of fine fuels. A road survey to evaluate wildland fire fuel hazards was conducted, and maps showing indices for fine fuels, woody fuels, and combined fuels are presented in this report.

The list of sensitive plant species for the NTS was reviewed, and Bullfrog Hills peavine *(Lathyrus hitchcockianus)* was removed. It is found about 3.2 kilometers (2 miles) west of the NTS boundary; however, it has not been found on the NTS. Field surveys were conducted in 2008 for Clokey buckwheat *(Eriogonum heermannii* var. *clokeyi)* and Pahute green gentian *(Frasera pahutensis)*. Over 5,000 plants of *E. heermannii* var. *clokeyi* were located on the north slopes of Red Mountain and Mercury Ridge covering approximately 178 ha (439 ac). Approximately 1,000 individuals of Pahute green gentian were located in the Gold Meadows area on 9 ha (21 ac). A map of the sensitive plants on the NTS was prepared, replacing a similar map prepared in 1994.

Surveys for sensitive and protected/regulated animals on the NTS included western red-tailed skinks *(Eumeces gilberti rubricaudatus)*, western burrowing owls *(Athene cunicularia hypugaea)*, and kangaroo mice *(Microdipodops spp).* Additional studies were conducted to investigate trends in populations of mule deer *(Odocoileus hemionus)*, feral horses *(Equus caballus),* and mountain lions *(Puma concolor).*

During 2008, NSTec biologists responded to 31 calls regarding nuisance or potentially dangerous wildlife in or around buildings and work areas. Problem animals included coyotes *(Canis latrans)*, bats, snakes (including one sidewinder rattlesnake [*Crotalus cerastes*]), a scorpion, tarantulas, and birds. Mitigation measures taken usually entailed moving the animal away from people or disposing of dead animals. Notices were also communicated via radio, e-mail, and various company publications to alert people to potentially dangerous situations involving wildlife and to remind employees not to feed any wild animal on the NTS. West Nile virus surveillance was also conducted at 10 sites with no mosquitoes testing positive for the virus.

An objective of the habitat restoration monitoring is to evaluate the success of previous revegetation efforts on the NTS. Eight previously revegetated sites were monitored in 2008; seven are located on the Tonopah Test Range (TTR) and one on the NTS. Plant cover was 10 percent higher than it was last year on the TTR sites. The increase was primarily due to the abundance of annual plants. Perennial plant density has not changed significantly over the last few years. Total plant cover was the highest it has ever been on the U-3ax/bl cover cap, which is located on the NTS. Plant density was higher in 2008 than in previous years, primarily due to the increase in annuals. Perennial plant cover and density remain about the same as has been experienced in the past. There were no significant declines in perennial plant cover or density at any of the sites monitored in 2008.

NSTec scientists reviewed two chemical spill test plans in 2008. Chemicals were released at such low volumes or low toxicity that there was no need to monitor downwind transects for biological impacts. Baseline monitoring was not conducted at established control-treatment transects near the NPTEC in 2008.

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ACRONYMS AND ABBREVIATIONS

ac	acre
AIC	Aikake's Information Criterion
BN	Bechtel Nevada
BYU	Brigham Young University
CAU	Corrective Action Unit
cm	centimeter
CV	coefficient of variation
CP	Control Point
DoD	U.S. Department of Defense
DOE	U.S. Department of Energy
DOE/NV	U.S. Department of Energy, Nevada Operations Office
EGIS	Ecological Geographic Information System
ELU	Ecological Landform Unit
EM	Environmental Monitor
EMAC	Ecological Monitoring and Compliance
ESA	*Endangered Species Act*
ft	feet
ft^2	square feet
FWS	U.S. Fish and Wildlife Service
FY	fiscal year
GIS	Geographic Information System
GPS	Global Positioning System
ha	hectare
in.	inch
km	kilometer
LANL	Los Alamos National Laboratory
m	meter
mm	millimeter
m^2	square meter
mi	mile
NAC	Nevada Administrative Code

ACRONYMS AND ABBREVIATIONS (Continued)

NNHP	Nevada Natural Heritage Program
NNPS	Nevada Native Plant Society
NNSA/NSO	U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office
NOAA	National Oceanic and Atmospheric Administration
NPTEC	Nonproliferation Test and Evaluation Complex
NSTec	National Security Technologies, LLC
NTS	Nevada Test Site
s.e.	standard error
SNHD	Southern Nevada Health District
SOC	Special Operations Center
ssp	subspecies
spp	species
TTR	Tonopah Test Range
UNLV	University of Nevada, Las Vegas
USGS	U.S. Geological Survey
WNV	West Nile Virus
yd	yard

1.0 INTRODUCTION

In accordance with U.S. Department of Energy Order DOE O 450.1A, "Environmental Protection Program," the Office of the Assistant Manager for Environmental Management of the U.S. Department of Energy, National Nuclear Security Administration Nevada Site Office (NNSA/NSO) requires ecological monitoring and biological compliance support for activities and programs conducted at the Nevada Test Site (NTS). National Security Technologies, LLC (NSTec), Ecological Services has implemented the Ecological Monitoring and Compliance (EMAC) Program to provide this support. EMAC is designed to ensure compliance with applicable laws and regulations, delineate and define NTS ecosystems, and provide ecological information that can be used to predict and evaluate the potential impacts of proposed projects and programs on those ecosystems.

This report summarizes the EMAC activities conducted by NSTec during calendar year 2008. Monitoring tasks during 2008 included eight program areas: (a) biological surveys, (b) desert tortoise compliance, (c) ecosystem mapping and data management, (d) sensitive plant monitoring, (e) sensitive and protected/regulated animal monitoring, (f) habitat monitoring, (g) habitat restoration monitoring, and (h) biological monitoring at the Nonproliferation Test and Evaluation Complex (NPTEC). The following sections of this report describe work performed under these eight areas.

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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 and bat species ranked as moderate or high in the Nevada Bat Conservation Plan Bat Species Risk Assessment. 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 such things as cover sites, nest or burrow sites, roost sites, or water sources important to sensitive species. Survey reports are written to document species and resources found, and to provide mitigation recommendations.

2.1 Sites Surveyed and Sensitive and Protected/Regulated Species Observed

During 2008, biological surveys for 28 projects were conducted on or near the NTS (Figure 2-1, Table 2-2). For some of the projects, multiple sites were surveyed (Figure 2-1). A total of 224.06 hectares (ha) (553.66 acres [ac]) was surveyed for the projects (Table 2-2). Eighteen of the projects were within the range of the threatened desert tortoise *(Gopherus agassizii)*. Sensitive and protected/regulated species and important biological resources found included 22 potential tortoise burrows, *Eriogonum concinnum* (Darin buckwheat), yuccas, and cacti (Table 2-2). NSTec provided to each project manager a written summary report of all survey findings and mitigation recommendations, where applicable (Table 2-2). All burrows, except rodent burrows, were flagged and avoided during project activities.

2.2 Potential Habitat Disturbance

Surveys are conducted at old industrial or nuclear weapons testing sites whenever vegetation has recolonized the site or it is suspected that a sensitive or protected/regulated species may be found. For example, tortoises may move through revegetated earthen sumps and may be concealed under vegetation during activities where heavy equipment is used. Preactivity surveys are conducted at such revegetated sites to ensure that desert tortoises are not in harm's way. Additionally, burrowing owls frequently inhabit burrows and culverts at disturbed sites, so preactivity surveys are conducted to ensure that adults, eggs, and nestlings in burrows are not harmed.

Of the projects for which surveys were conducted, 22 were entirely on sites previously disturbed (e.g., building sites, industrial waste sites, existing well pads, or road shoulders) (Table 2-2). Six projects were located either partially or entirely in areas that had not been previously disturbed. These projects have the potential to disturb 22.68 ha (56.01 ac). Two projects occured in areas designated as important habitats (Table 2-3, Figure 2-2). During vegetation mapping of the NTS, Ecological Landform Units (ELUs) were evaluated and some were identified as *Pristine Habitat* (having few man-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), 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.

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

Plant Species	Common Names	Status[a]
Moss Species		
Entosthodon planoconvexus	Planoconvex cordmoss	S, T, 5 years
Flowering Plant Species		
Arctomecon merriamii	White bearpoppy	S, W, 10 years
Astragalus beatleyae	Beatley milkvetch	S, W, 5 years
Astragalus funereus	Black woollypod	S, W, 5 years
Astragalus oophorus var. *clokeyanus*	Clokey eggvetch	S, W, 5 years
Camissonia megalantha	Cane Spring suncup	S, W, 10 years
Cymopterus ripleyi var. *saniculoides*	Sanicle biscuitroot	S, W, 10 years
Eriogonum concinnum	Darin buckwheat	S, W, 5 years
Eriogonum heermannii var. *clokeyi*	Clokey buckwheat	S, W, 5 years
Frasera pahutensis	Pahute green gentian	S, W, 10 years
Galium hilendiae ssp. *kingstonense*	Kingston Mountains bedstraw	S, T, 10 years
Hulsea vestita ssp. *inyoensis*	Inyo Hulsea	S, W, 10 years
Ivesia arizonica var. *saxosa*	Rock purpusia	S, W, 5 years
Penstemon fruticiformis ssp. *amargosae*	Death Valley beardtongue	S, T, 5 years
Penstemon pahutensis	Pahute Mesa beardtongue	S, W, 10 years
Phacelia beatleyae	Beatley Scorpionflower	S, W, 10 years
Phacelia filiae	Clarke Phacelia	S, W, 10 years
Phacelia mustelina	Weasel Phacelia	S, W, 10 years
Phacelia parishii	Parish Phacelia	S, W, 10 years
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 NTS (Continued)

Animal Species	Common Name	Status[a]
Mollusk Species		
Pyrgulopsis turbatrix	Southeast Nevada pyrg	S, A
Reptile Species		
Eumeces gilberti rubricaudatus	Western red-tailed skink	S, E
Gopherus agassizii	Desert tortoise	LT, S, NPT, IA
Bird Species		
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	C, S, NPS, 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
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
Corynorhinus townsendii	Townsend's big-eared bat	H, NPS, A
Equus asinus	Burro	H&B, IA
Equus caballus	Horse	H&B, A
Euderma maculatum	Spotted bat	M, NPT, A
Lasionycteris noctivagans	Silver-haired bat	M, A

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

Animal Species	Common Name	Status[a]
Lasiurus blossevillii	Western red bat	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	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 velox 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
- NP - Nevada Protected, species protected under NAC 503
- G - Regulated as game species
- F - Regulated as fur-bearer species

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

State of Nevada-Plants
S - Nevada Natural Heritage Program –Animal and Plant At Risk Tracking List
CY - Protected as a cactus, yucca, or Christmas tree

Nevada Native Plant Society
T - Threatened Species
W - Watch Species

Long-term Animal Monitoring Status for the Nevada Test Site (NTS)
A - Active
IA - Inactive
E - Evaluate

Long-term Plant Monitoring Status for the NTS
5 years - Monitor a minimum of once every 5 years
10 years - Monitor a minimum of once every 10 years

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

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

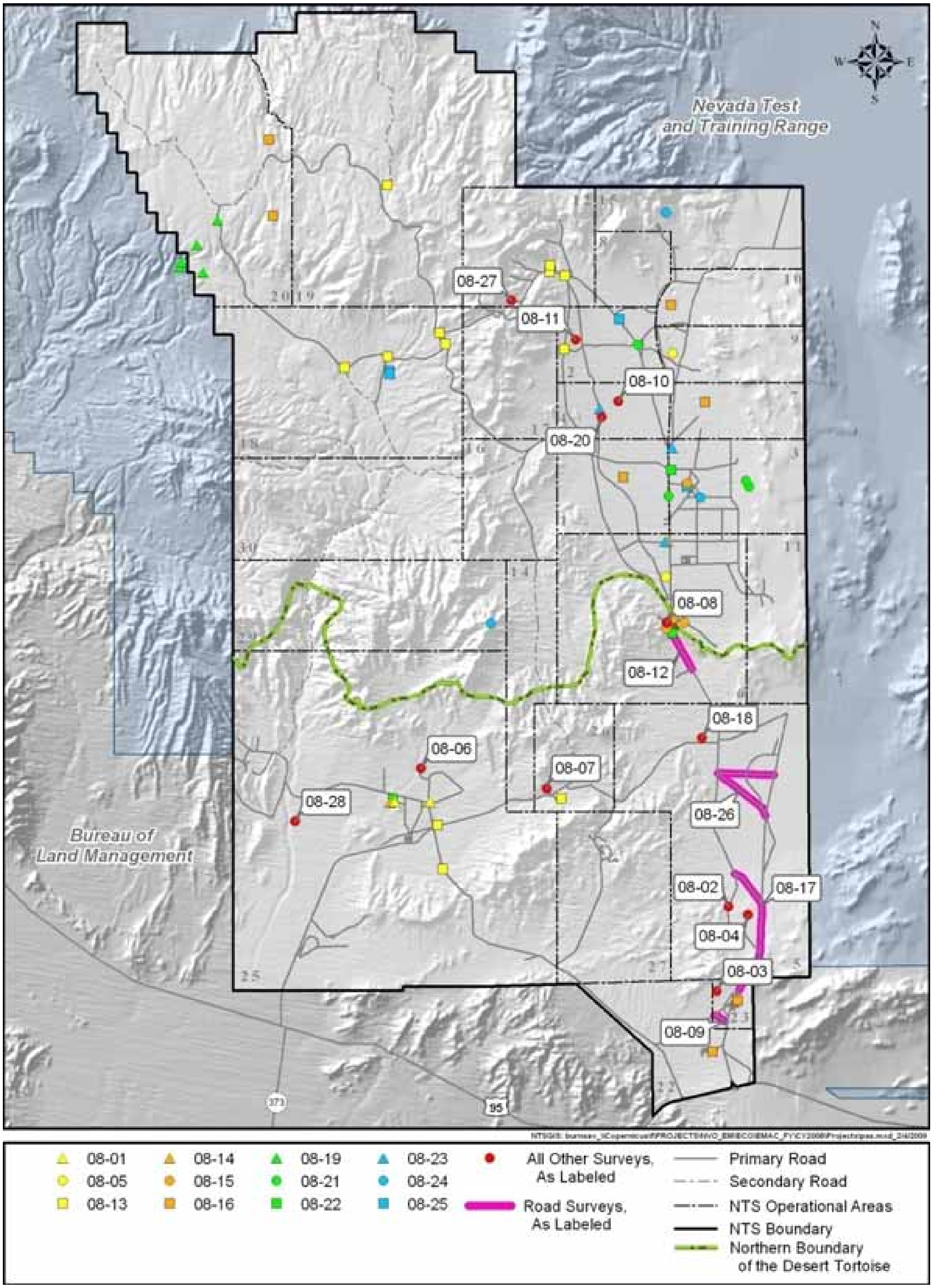

Figure 2-1. Biological surveys conducted on the NTS during 2008

Table 2-2. Summary of biological surveys conducted on the NTS during 2008

Project No.	Project	Important Species/ Resources Found	Area Surveyed in ha (ac)	Proposed Project Area in Undisturbed Habitat in ha (ac)	Mitigation Recommendations
08-01	Corrective Action Unit (CAU) 556	None	1.61 (3.98)	0	None
08-02	WSI training exercise	18 burrows	33.80 (83.52)	0.01 (0.02)	Avoid flagged burrows, Environmental Monitor (EM) needed
08-03	WSI Firing Range extension	2 burrows	8.38 (20.71)	1.69 (4.18)	Avoid flagged burrows, mitigation required, EM needed
08-04	NPTEC releases	2 burrows	3.14 (7.76)	0	Avoid flagged burrows, EM needed
08-05	CAU 546	None	2.00 (4.94)	0	None
08-06	CAU 116 shed demolition	None	0.001 (0.002)	0	Remove shed prior to nesting season
08-07	CAU 117 building demolition	None	0.001 (0.002)	0	None
08-08	CP-40 new waterline	None	4.89 (12.08)	0	EM needed
08-09	Roadside grading	None	4.00 (9.88)	0	None
08-10	Full Toss	None	65.67 (162.27)	0	None
08-11	UE-2ce	None	1.68 (4.15)	0	None
08-12	Roadside mowing	None	7.20 (17.79)	0	None
08-13	OST	1 burrow	6.30 (15.57)	0	Avoid flagged burrow
08-14	CAU 556	None	1.21 (2.99)	0	None
08-15	CAU 560	None	1.78 (4.40)	0	None
08-16	CAU 130	None	0.72 (1.78)	0	None

Table 2-2. Summary of biological surveys conducted on the NTS during 2008 (Continued)

Project Number	Project	Important Species/ Resources Found	Area Surveyed in ha (ac)	Proposed Project Area in Undisturbed Habitat in ha (ac)	Mitigation Recommendations
08-17	Roadside mowing	None	39.72 (98.15)	0	None
08-18	ARMAG	None	0.82 (2.03)	0	None
08-19	UGTA EREC wells	Darin buckwheat	25.20 (62.27)	20.87 (51.57)	Avoid Darin buckwheat if possible
08-20	Stones Throw	None	0.66 (1.63)	0.02 (0.05)	None
08-21	Sandia	None	0.16 (0.40)	0.08 (0.20)	None
08-22	CAU 557	None	0.91 (2.25)	0	None
08-23	CAU 139	None	1.26 (3.11)	0	None
08-24	CAU 134	None	0.12 (0.30)	0.01 (0.02)	None
08-25	CAU 166	None	1.18 (2.92)	0	None
08-26	Roadside mowing 5-05, 5-07 roads	None	8.09 (19.99)	0	None
08-27	Area 12 PIDS West	None	1.63 (4.03)	0	None
08-28	J-13 Waterline repair	None	0.50 (1.24)	0	None
		Totals in ha	**222.63**	**22.68**	
		(ac)	**(550.13)**	**(56.08)**	

Table 2-3. Total area in hectares (acres in parentheses) that were disturbed within important habitats in 2008 and over the past 10 fiscal or calendar years

Project No.	Project Name	Pristine Habitat	Unique Habitat	Sensitive Habitat	Diverse Habitat
08-02	WSI Training Exercise	0	0	0.01 (0.02)	0
08-24	CAU 132	0.01 (0.02)	0	0	0
	Total ha 2008	**0.01**	**0**	**0.01**	**0**
	(ac)	**(0.02)**	**(0)**	**(0.02)**	**(0)**
	Grand Total ha 1999–2008	**9.21**	**11.85**	**184.62**	**82.17**
	(ac)	**(22.75)**	**(29.28)**	**(456.21)**	**(203.07)**

Figure 2-2 shows the distribution of these important habitats, ranked so that pristine habitat overlays unique habitat, which then overlays sensitive habitat, which then overlays diverse habitat. The expected area disturbed in important habitats due to 2008 projects is 0.02 ha (0.04 ac) (Table 2-3). Since fiscal year (FY) 1999, a tally of all acreage disturbed within important habitats has been kept (Table 2-3). This tally may be used in the future to estimate the area and rate of establishment of invasive species into these habitats. Land-disturbing activities are known to cause the spread of invasive species such as *Bromus rubens* (red brome) into areas of the NTS where they have not previously occurred. Such nonnative weeds can degrade important habitats by decreasing plant biodiversity and increasing the risk and spread of wildfires. The monitoring and control of invasive plants on federal lands is encouraged under Executive Order 13112, “Invasive Species.”

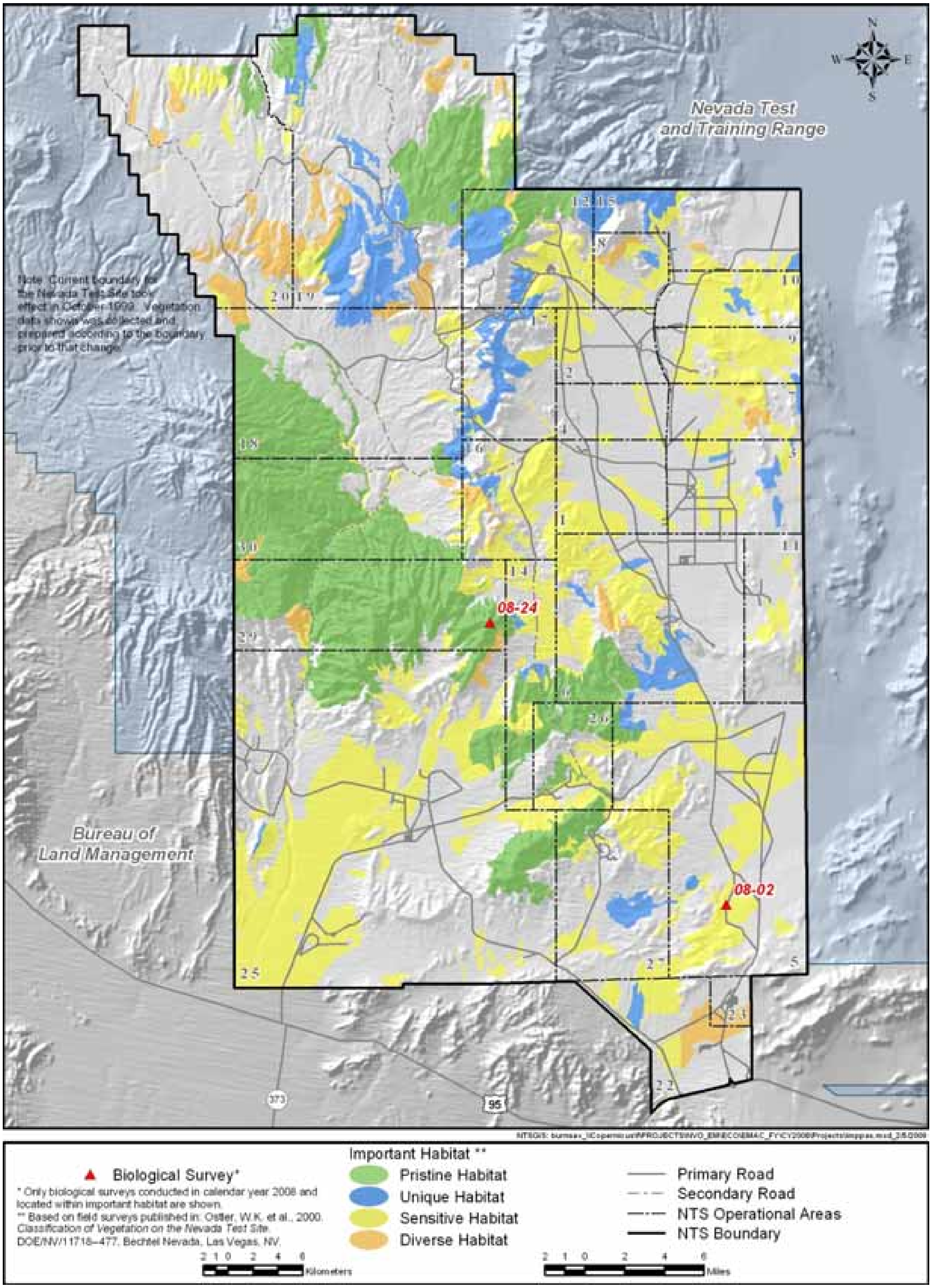

Figure 2-2. Biological surveys conducted in important habitats of the NTS during 2008

3.0 DESERT TORTOISE COMPLIANCE

Desert tortoises occur within the southern one-third of the NTS. This species is listed as threatened under the *Endangered Species Act* (ESA). In December 1995, NNSA/NSO completed consultation with the U.S. Fish and Wildlife Service (FWS) concerning the effects of NNSA/NSO 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. A final Biological Opinion (Opinion) (FWS, 1996) was received from FWS in August 1996. The Opinion concluded that the proposed activities on the NTS were not likely to jeopardize the continued existence of the Mojave population of the species and that no critical habitat would be destroyed or adversely modified. All terms and conditions listed in the Opinion must be followed when activities are conducted within the range of the desert tortoise on the NTS. On March 20, 2007, NNSA/NSO requested an extension of the August 1996 Opinion until the Supplement Analysis for the NTS Environmental Impact Statement was completed. That extension was granted by the FWS in a letter dated July 6, 2007. The extension of the Opinion was valid until December 31, 2008. All terms and conditions listed in the Opinion remained in effect until that date.

On July 2, 2008, NNSA/NSO provided FWS with a Biological Assessment of anticipated activities on the NTS for the next 10 years and entered into formal consultation with FWS to obtain a new Opinion for the NTS. On December 6, 2008, NNSA/NSO received a draft Opinion from the FWS and asked for comments prior to making the Opinion final. NSTec and NNSA/NSO biologists met with FWS personnel and provided changes to that draft Opinion. A final Opinion was received in February 2009.

The Desert Tortoise Compliance task of EMAC was developed to implement the terms and conditions of the Opinion, document compliance actions taken by NNSA/NSO, and assist NNSA/NSO in FWS consultations. The terms and conditions that were implemented by NSTec staff biologists in 2008 included (a) conducting clearance surveys at project sites within one to seven days from the start of project construction, (b) ensuring that environmental monitors are on site during heavy equipment operation, and (c) preparing and submitting an annual compliance report to the FWS.

3.1 Project Surveys and Compliance Documentation

During 2008, biologists conducted biological and desert tortoise clearance surveys prior to ground-disturbing activities for 18 proposed projects (23 sites) within the range of the desert tortoise on the NTS (Table 3-1, Figure 3-1). Most of these projects were in, or immediately adjacent to, existing facilities and disturbances. Several inactive tortoise burrows were found during tortoise clearance surveys (Table 2-2). These inactive tortoise burrows (Project No. 08-01, 08-02, 08-03, 08-13) were flagged and avoided during project activities.

Two projects were initiated that disturbed previously undisturbed desert tortoise habitat. Project 08-03 disturbed 1.69 ha (4.18 ac) of desert tortoise habitat (Table 3-1). This project is located west of Mercury, north of the Mercury landfill in Area 23. Project 08-08 disturbed approximately 4.89 ha (12.08 ac) of undisturbed habitat near Control Point (CP) and west of the Mercury Highway in Area 6. This project is not yet complete, so a final estimate of area disturbed will be included in the 2009 report. NSTec Ecological Services ensured that onsite construction monitoring was conducted by a designated environmental monitor at all sites where desert tortoise clearance surveys were performed.

Post-activity surveys to quantify the acreage of tortoise habitat actually disturbed were conducted for nine projects during this reporting period (Table 3-1). Post-activity surveys were not conducted if the projects were located within the tortoise exclusion zone, if viable tortoise habitat was not found within the project area boundaries (due to previous disturbance) during the clearance survey, or if the environmental monitor documented that the project stayed within its proposed boundaries. In 2008, a total of 1.69 ha (4.18 ac) of tortoise habitat was disturbed (Table 3-1).

Table 3-1. Summary of tortoise compliance activities conducted by NSTec biologists during 2008

Project Number	Project	Compliance Activities 100%-Coverage Clearance Survey	Tortoise Habitat Disturbed ha (ac)
08-01	CAU 556	Yes, post-activity survey completed	0 (0)
08-02	WSI training exercise	Yes, post-activity survey completed	0 (0)
08-03	WSI Range extension	Yes, post-activity survey completed	1.69 (4.18)
08-04	NPTEC Chemical release	Yes, post-activity survey completed	0 (0)
08-06	CAU 116 shed demolition	Yes*	0 (0)
08-07	CAU 117 Building demolition	Yes*	0 (0)
08-08	CP-40 New waterline	Yes, project still active	TBD
08-09	Roadside grading	Yes*	0 (0)
08-12	Roadside mowing	Yes*	0 (0)
08-13	OST	Yes, post-activity survey completed	0 (0)
08-14	CAU 556	Yes, post-activity survey completed	0 (0)
08-15	CAU 560	Yes, post-activity survey completed	0 (0)
08-16	CAU 130	Yes*	0 (0)
08-17	Roadside mowing	Yes*	0 (0)
08-18	ARMAG	No, post-activity survey was completed	0 (0)
08-22	CAU 557	Yes, post-activity survey completed	0 (0)
08-26	Roadside mowing	Yes*	0 (0)
08-28	J-13 Waterline repair	Yes*	0 (0)
		Total	**1.69 (4.18)**

*Post-activity survey was unnecessary because project was located within previously disturbed tortoise habitat.

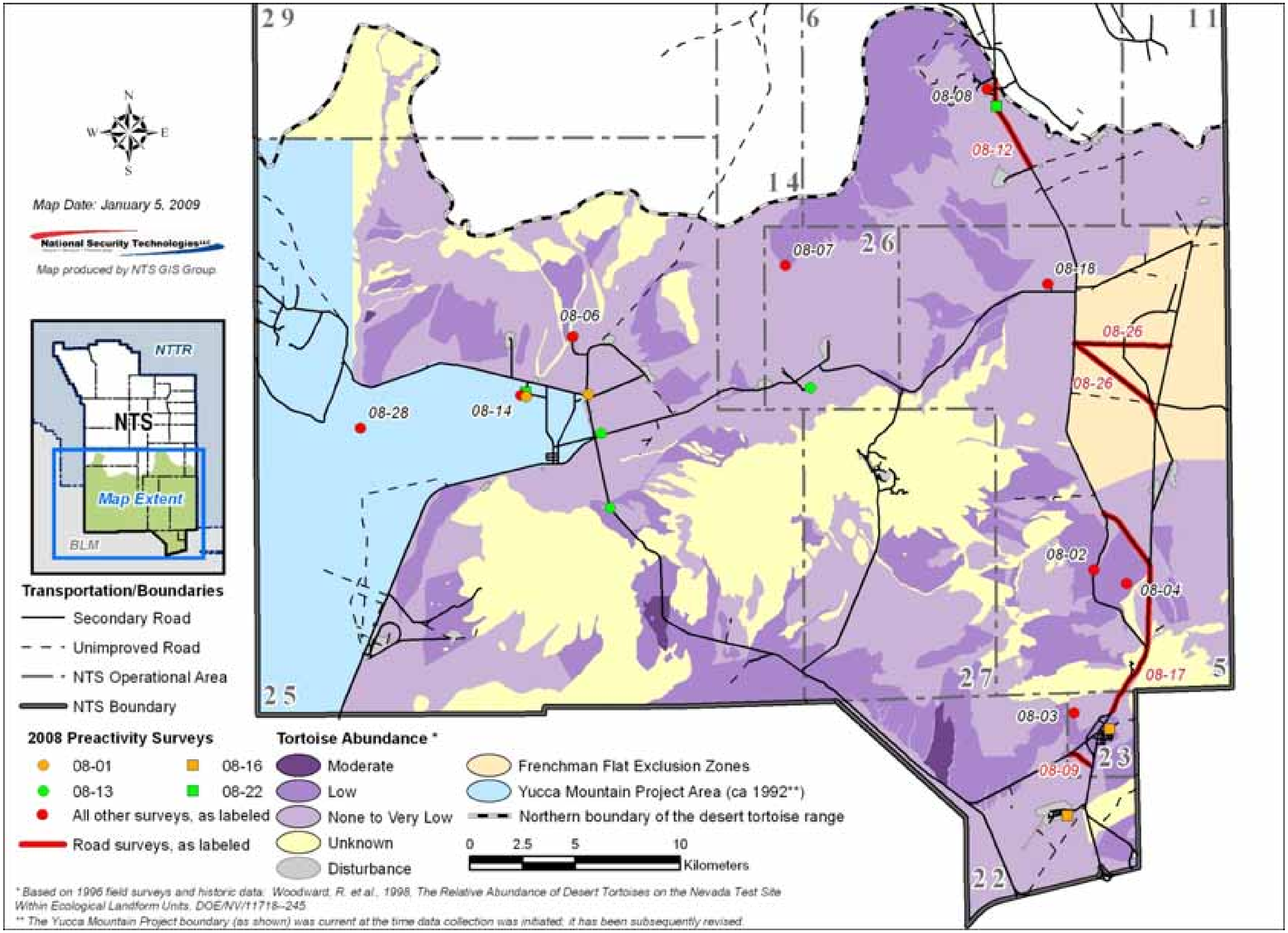

Figure 3-1. Biological surveys conducted in desert tortoise habitat on the NTS during 2008

In January 2008, NSTec submitted to NNSA/NSO the annual report that summarized tortoise compliance activities conducted on the NTS from January 1 through December 31, 2007. 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 NTS; and (d) a summary of construction mitigation and monitoring efforts.

Compliance with the Opinion will ensure that the two goals of the NNSA/NSO's Resource Management Plan (DOE/NV, 1998) are being met, namely, that the desert tortoise is protected on the NTS and that the cumulative impacts on this species are minimized. In the Opinion, the FWS has determined that the "incidental take"[1] of tortoises on the NTS and the cumulative acreage of tortoise habitat disturbed on the NTS are parameters to 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, nor were any captured or displaced from project sites. No desert tortoises were killed along roadways within the NTS in 2008.

Table 3-2. Parameters and threshold values for desert tortoise monitoring on the NTS

Monitored Parameter	Threshold Value	Adaptive Management Action	2008 Value of Monitored Parameter
Number of tortoises accidentally injured or killed as a result of NTS activities per year	3	Reinitiate consultation with FWS	0
Number of tortoises captured and displaced from NTS project sites per year	10	Reinitiate consultation with FWS	0
Number of tortoises taken in form of injury or mortality on paved roads on the NTS by vehicles other than those in use during a project	Unlimited	Supplemental employee education and bulletins	0
Number of total hectares (acres) of desert tortoise habitat disturbed during NTS project construction since 1992	**1,220 (3,015)**	Reinitiate consultation with FWS	**126.04 (311.46)**

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/NSO to perform either of two mitigation options: (a) pre-pay Clark County $1,860 per each ha ($753 for each ac) (current 2008 rate) of habitat disturbed, or (b) revegetate disturbed habitat following specified criteria. Since 1992, NNSA/NSO has been using the balance of $81,000 that NNSA/NSO deposited into a Clark County fund to pre-pay for the future disturbance of 101 ha (250 ac) of tortoise habitat on the NTS. As of December 31, 2005, this fund was depleted, and all new disturbances have to pay the required mitigation fee or revegetate the disturbances. NSTec biologists prepared two site-specific plans to revegetate tortoise habitat as mitigation for projects. These two plans were

[1] To "take" a threatened or endangered species, as defined by the ESA, is to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to engage in any such conduct.

implemented in 2005–2006. A total of 5.68 ha (14.04 ac) was revegetated. The remaining area (19.19 ha [47.42 ac]) that has been disturbed since 2005 was mitigated through payment into the Desert Tortoise Habitat Conservation Fund.

3.3 Coordination with Other Biologists and Wildlife Agencies

Three, 8.5-ha (21-ac) circular enclosures in Rock Valley were constructed during 1962–1963 to study the effects of chronic, low-level ionizing radiation on the desert flora and fauna. Over the past decades, at least 24 tortoises have been found, individually marked, and periodically measured within these enclosures. In 2002, there were approximately 18 adult tortoises remaining in the enclosures; however, in 2003, Phil Medica of the U.S. Geological Survey (USGS) Las Vegas Office, NSTec biologists, and a team of volunteer biologists found the remains of seven tortoises of known age. Two additional desert tortoises within the enclosures were lost in 2004 presumably to mountain lion *(Puma concolor)* predation. These plots were revisited once in the fall of 2008 with Phil Medica to observe desert tortoises in the fenced plots. No desert tortoises were found above ground this past year. One specimen was found dead and the bones/shell were salvaged. Areas around the enclosures were searched, but no additional carcasses were observed.

NSTec biologists attended the presentation of the final Desert Tortoise Recovery Plan on October 23, 2008. They also met with a scientist from the FWS involved with the Desert Tortoise Recovery Plan on November 21, 2008. The November meeting was a training forum to present and discuss the sampling techniques used to assess tortoise numbers and recovery rates. About 30 scientists from the local region were present.

During February 22–25, 2008, NSTec biologists attended the Desert Tortoise Council's 33rd annual meeting and symposium. This was held in Las Vegas, Nevada, and included numerous presentations on desert tortoise biology, ecology, and recovery efforts.

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4.0 ECOSYSTEM MAPPING/DATA MANAGEMENT

Ecological Services began comprehensive mapping of plant communities and wildlife habitat on the NTS in FY 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 types, slope, and hydrology. Boundaries of the ELUs were defined using aerial photographs, satellite imagery, and field confirmation. ELUs are considered by NTS 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 habitat types on the NTS were published and distributed (Ostler et al., 2000; Wills and Ostler, 2001). Ten vegetation alliances and 20 associations were recognized as occurring on the NTS.

In 2008, efforts continued to update and collect new habitat data when possible. Efforts focused on the following tasks in support of ecosystem mapping and data management of all NTS geospatial ecological data:

- Ecosystem mapping efforts were halted in 2008 due to drought conditions and the poor condition of vegetation, resulting in reductions in photography and sampling of ELUs
- A vegetation survey was conducted to determine wildland fire hazards
- Forty woody plant plots were established as long-term monitoring sites to supplement historic monitoring plots established previously on the NTS
- Coordination was made with ecosystem management agencies and scientists

4.1 No ELU Photography or Resampling of ELUs in 2008

Because of below average precipitation during the early part of 2008, much of the herbaceous vegetation failed to grow, and growth of perennial shrubs and trees was poor. Because of these conditions, no photographs of ELUs were taken in 2008 nor were any plots resampled.

4.2 Vegetation Survey for Determining Wildland Fire Hazards

Wildland fires on the NTS require considerable financial resources for fire suppression and mitigation. For example, costs for fire suppression on or near the NTS can cost as much as $198 per ha ($80 per ac). Additional costs are also incurred for replacement of burned structures. For example, the Egg Point Fire in August 2002 (121 ha [300 ac]) cost well over $1 million to replace burned power poles, while reclamation of the site cost more than $200,000 to stabilize and revegetate.

There has been an average of 11.6 wildland fires per year on the NTS since 1978 with an average of about 85.6 ha (211.4 ac) burned per fire (Table 4-1). These wildland fires do not occur randomly across the NTS, but occur more often in particular vegetation types that have sufficient fuels (woody and fine-textured fuels) that are conducive to ignition and spread of wildland fires. Once a site burns, it is much more likely to burn again because of the invasive annual plants that quickly colonize these areas.

Table 4-1. Number and acreage of wildland fires on the NTS

Year	Fires	Hectares	Acres
1978	10	3,197	7,901
1979	6	1	2
1980	26	5,465	13,504
1981	13	3	7
1982	6	1	2
1983	16	7,402	18,291
1984	17	458	1,132
1985	11	651	1,609
1986	12	96	236
1987	14	86	213
1988	23	332	821
1989	15	131	323
1990	7	3	7
1991	4	2	4
1992	12	97	239
1993	7	3	7
1994	8	6	15
1995	8	1,864	4,605
1996	2	688	1,700
1997	6	6	15
1998	9	1,044	2,580
1999	7	20	50
2000	11	61	151
2001	8	198	490
2002	7	146	360
2003	4	2	4
2004	8	3	8
2005	31	5,261	13,000
2006	16	3,486	8,615
2007	15	6	15
2008	20	1	2
31-Year Total	**359.0**	**30,718.9**	**75,908.0**
Average Per Year	**11.6**	**990.6**	**2,448.6**
Average Per Fire		**85.6**	**211.4**

Source: Hansen, 2008

Figures 4-1 and 4-2 show the number of wildland fires on the NTS since 1978 and their distribution by month of the year (for the period of available records). The increase in the number of wildland fires on the NTS in 2005 and 2006 is due in large measure to the increase in winter precipitation during these years and the residual amounts of fine fuels. The reduced number of large fires in 2008 is probably due to reduced amounts of fine fuels that resulted from the drought in 2008 and the low incidence of lightning during the summer months.

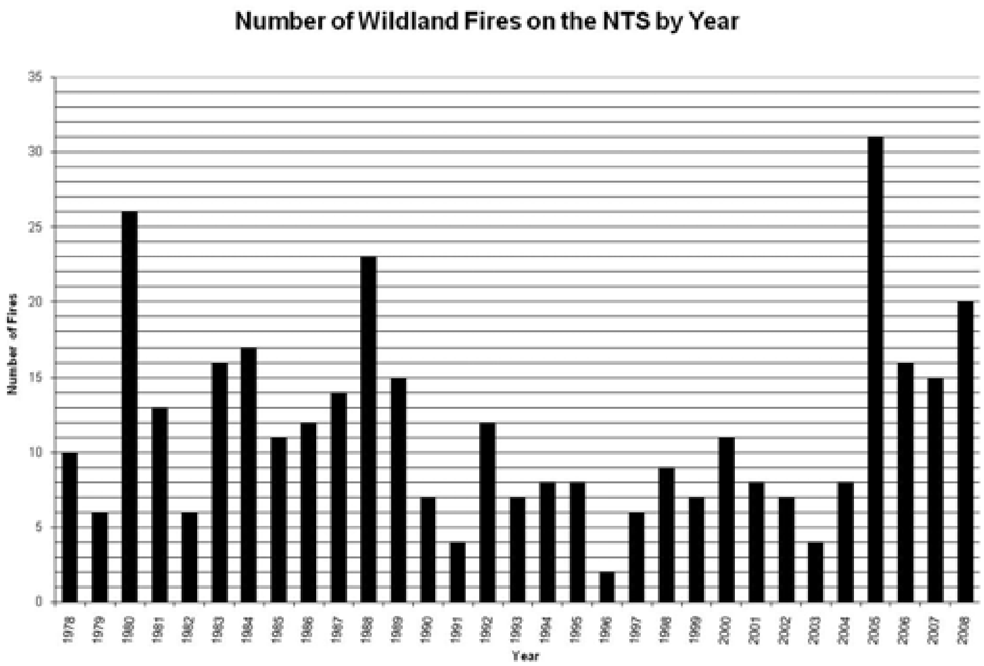


Figure 4-1. Number of wildland fires on the NTS by year

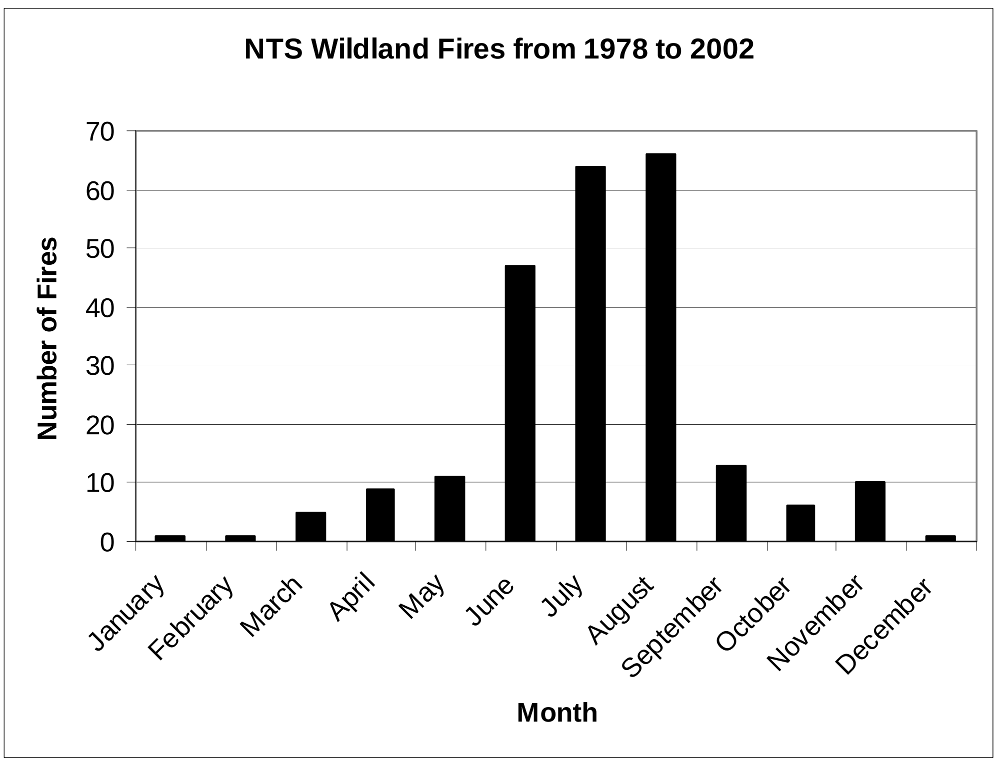


Figure 4-2. Distribution of wildland fires on the NTS by month based on available records from 1978 to 2002

The distribution of NTS wildland fires by month of occurrence indicates that most wildland fires occur during the months of June, July, and August, which defines the active wildland fire season on the NTS (Figure 4-2). Significantly fewer wildland fires occur during May and September, which represent the pre- and post-season months for the NTS wildland fire season.

During 2008 there were 20 wildland fires. Most of these fires covered very small areas, often consisting of few small shrubs or individual trees. As in most recent years, rapid response by NTS Fire and Rescue after fires are ignited was key to minimizing the wildland fire's spread and severity. No precise area measurements were made for these fires due to their small size, but it is estimated that less than 2 acres were burned. Approximately 70 percent of these fires were caused by ordnance, and most of these were confined to the shooting range located in Mercury in Area 23. Approximately 20 percent of the fires were caused by lightning. The remaining 10 percent were caused by arcing power poles or equipment. An evaluation of 120 wildland fires occurring on the NTS from 1998 through 2007 showed the following common causes: 52 percent caused by lightning, 30 percent undetermined, 12 percent caused by ordnance, 2 percent caused by electrical, 2 percent caused by vehicle exhaust systems, 1 percent caused by a discarded cigarette, and 1 percent caused by a generator malfunction (Hansen, 2008).

Beginning in 2004, and in response to DOE O 450.1A, surveys were initiated on the NTS to identify wildland fire hazards. A spring (April–May) road survey of vegetation at 211 sites located along and adjacent to major NTS corridors was conducted 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 were also identified and summarized as part of the wildland fire hazards assessment.

4.2.1 Survey Methods

The details of the spring survey to assess wildland fire hazards on the NTS are described in a report by Hansen and Ostler (2004). In short, the abundance of fine-textured (grasses and herbs) and coarse-textured (woody) fuels were visually estimated on numerical scales using the following 10-point potential scale: 0, 1, 1.5, 2, 2.5, 3, 3.5, 4, 4.5, and 5 (where 0 is barren and 5 is near maximum biomass encountered on the NTS).

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 [BN], 2006). Additionally, the numerical abundance rating for fine fuels at a site was added to the numerical abundance rating of woody fuels to derive a combined fuels rating for each site that ranged from 0 to 10 in one-half integer increments. The index ratings for fuels at these survey sites were then plotted on a Geographic Information System (GIS) map and color-coded for severity to indicate the hazards at various locations across the NTS.

4.2.2 Survey Results

Climate—There are 17 rain gauges (Table 4.2) on the NTS that are used to measure precipitation. Precipitation during the months of January, February, March, and April are most correlated with production of vegetation that produces fine fuels and contributes to woody fuels. The total accumulated precipitation appears to be highly correlated with biomass production during this winter/spring period as reported by Hansen and Ostler (2004). Precipitation measurements at the 17 rain gauges show that when precipitation was averaged for all stations on the NTS, the amount received during the spring of 2008 was 50 percent of the average

Table 4-2. Inches of precipitation for meteorological recording stations on the NTS for January through April 2008 compared to long-term averages

		Inches of Precipitation				Percent of AVG**
	YEAR	JAN	FEB	MAR	APR	January - April
RAINIER MESA (A12)	2008	1.690	1.620	0.420	0.000	
	LongTerm AVG*	1.610	1.690	1.920	0.880	
	Percent of AVG**	105.0	95.9	21.9	0.0	56
BUSTER JANGLE (BJY)	2008	1.010	0.970	0.170	0.000	
	LongTerm AVG*	0.820	0.950	0.720	0.370	
	Percent of AVG**	123.2	102.1	23.6	0.0	62
CANE SPRINGS (CS)	2008	1.400	0.210	0.000	0.000	
	LongTerm AVG*	1.140	1.340	0.930	0.480	
	Percent of AVG**	122.8	15.7	0.0	0.0	35
DESERT ROCK (DRA)	2008	0.760	0.140	0.000	0.000	
	LongTerm AVG*	0.660	0.880	0.650	0.350	
	Percent of AVG**	115.2	15.9	0.0	0.0	33
AREA 06 (SOUTH)	2008	0.890	0.260	0.000	0.000	
	LongTerm AVG*	0.500	1.260	0.380	0.550	
	Percent of AVG**	178.0	20.6	0.0	0.0	50
JACKASS FLATS (4JA)	2008	0.920	0.390	0.000	0.000	
	LongTerm AVG*	0.710	1.010	0.730	0.320	
	Percent of AVG**	129.6	38.6	0.0	0.0	42
E TUNNEL (ETU)	2008	1.920	1.720	0.540	0.000	
	LongTerm AVG*	1.170	2.480	1.030	0.930	
	Percent of AVG**	164.1	69.4	52.4	0.0	71
LITTLE FELLER 2 (LF2)	2008	1.120	0.770	0.300	0.000	
	LongTerm AVG*	1.010	1.150	1.170	0.520	
	Percent of AVG**	110.9	67.0	25.6	0.0	51
MERCURY (MER)	2008	0.910	0.230	0.000	0.000	
	LongTerm AVG*	0.700	0.850	0.630	0.320	
	Percent of AVG**	130.0	27.1	0.0	0.0	39
MID VALLEY (MV)	2008	2.180	0.830	0.420	0.030	
	LongTerm AVG*	1.380	1.620	1.070	0.500	
	Percent of AVG**	158.0	51.2	39.3	6.0	64
40 MILE CANYON NORTH (40M)	2008	1.570	1.070	0.250	0.000	
	LongTerm AVG*	0.840	1.120	1.050	0.520	
	Percent of AVG**	186.9	95.5	23.8	0.0	77
PAHUTE MESA 1 (PM1)	2008	0.260	1.130	0.320	0.000	
	LongTerm AVG*	0.620	0.840	0.860	0.620	
	Percent of AVG**	41.9	134.5	37.2	0.0	53
PHS FARM (PHS)	2008	0.910	1.330	0.410	0.000	
	LongTerm AVG*	0.930	1.200	0.940	0.500	
	Percent of AVG**	97.8	110.8	43.6	0.0	63
ROCK VALLEY (RV)	2008	1.210	0.260	0.000	0.000	
	LongTerm AVG*	0.840	1.120	0.820	0.340	
	Percent of AVG**	144.0	23.2	0.0	0.0	42
TIPPIPAH SPRINGS (TS2)	2008	1.530	0.880	0.320	0.000	
	LongTerm AVG*	1.090	1.420	1.050	0.520	
	Percent of AVG**	140.4	62.0	30.5	0.0	58
WELL 5 B (W5B)	2008	0.570	0.120	0.000	0.000	
	LongTerm AVG*	0.600	0.690	0.530	0.350	
	Percent of AVG**	95.0	17.4	0.0	0.0	28
YUCCA DRY LAKE (UCC)	2008	0.840	0.380	0.000	0.000	
	LongTerm AVG*	0.930	1.010	0.720	0.370	
	Percent of AVG**	90.3	37.6	0.0	0.0	32
		Percent of Average Precipitation for All Stations**				**50**

* Long-term average precipitation in inches for the month
** A value of 100 means precipitation equaled the mean of the long-term averages for all stations for January thru April
A value of 120 means precipitation exceed the mean by 20%
A value of 50 means that precipitation was less than the mean by 50%

Source: NOAAARL/SORD May 6, 2008: http://www.sord.nv.doe.gov/home_climate_rain.htm 2008MonthlyPecipData.xls precipitation for this period. This decreased precipitation was responsible for reducing production of fine fuels. This is substantially less precipitation than that reported by Hansen et al. (2008) for this same period of the year in 2004, 2005, and 2006 (104 percent, 167 percent, and 120 percent of average, respectively), but more than 2007 (42 percent of average). At the beginning of the fire season, the extended weather forecast for the United States for the summer of 2008 (June, July, and August) indicated hotter than average temperatures and about normal precipitation forecast through the fire season summer months (Figure 4-3).

Fuels—Because of the decreased precipitation in early 2008, there were low amounts of new fine fuels. Fine fuel values shown in Figure 4-4 represent little or no residual fine fuels from previous years. There was a slight increase in woody fuels (Figure 4-5) as shrubs and trees responded to the low precipitation that occurred during the winter and spring months. Figure 4-6 shows the location of combined index values for fine fuels and woody fuels. Figure 4-7 shows the mean combined fuels index, which correlates well with precipitation received during January through April (the growing season for most fine fuels). Highest index values were reported for Fortymile Canyon, Pahute Mesa, and mid-elevation slopes around Yucca Flat.

The average combined index values by NTS operational area are shown in Table 4-3. The NTS average combined index value for fine fuels and woody fuels for 2008 was 4.81 compared to 4.77 in 2007, 5.26 in 2006, 5.64 in 2005 (a very wet year), and 4.88 in 2004 (an average precipitation year). NTS areas having the highest combined fuels average index values were Areas 29 (7.7), 30 (6.75), 12, (5.83), 17 (5.81), and 14 (5.80).

Photographs were taken for all 211 sites during the past 5 years and are available upon request for comparing individual site conditions (see Figure 4-8 for examples of photos at Site 99). As in past years, sites with *C. ramosissima* and annual grasses appeared to respond most to the precipitation in producing fine fuels and increases in woody fuels. Areas in the Mojave Desert (southern 1/3 of the NTS) and the Great Basin Desert (northern 1/3 of the NTS) did not have large increases in fine or woody fuels in 2008 compared to more recent years.

Fine fuels were well cured in most areas of the NTS. Shrubs and trees were still relatively green in 2008 and not as dry as they were in 2007. The hazards of fuels contributing to wildland fires appeared to be lower than average and dependent on incidence of lightning. Figure 4-9 shows the location of large wildland fires on the NTS.

Invasives—The three most commonly observed invasive annual plants to colonize burned areas on the NTS are *Schismus arabicus* (Arabian schismus), found at low elevations; *B. rubens*, found at lower to moderate elevations; and *Bromus tectorum* (cheat grass), found at middle to high elevations (Table 4-4). 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. *Coleogyne ramosissima* (Blackbrush) vegetation types appear to be the most vulnerable plant communities to fire, followed by pinyon-juniper/sagebrush vegetation types. Wildland fires are costly to control and to mitigate once they occur. Revegetation of severely burned areas is very slow without reseeding or transplanting with native species and other rehabilitation efforts. Untreated areas become much more vulnerable to future fires once invasive species, rather than native species, colonize a burned area. Because of the low amount of winter precipitation during 2007, invasive introduced annual species and native species failed to germinate and establish. This resulted in no observable annual and few perennial herbaceous plants at the sampling sites.

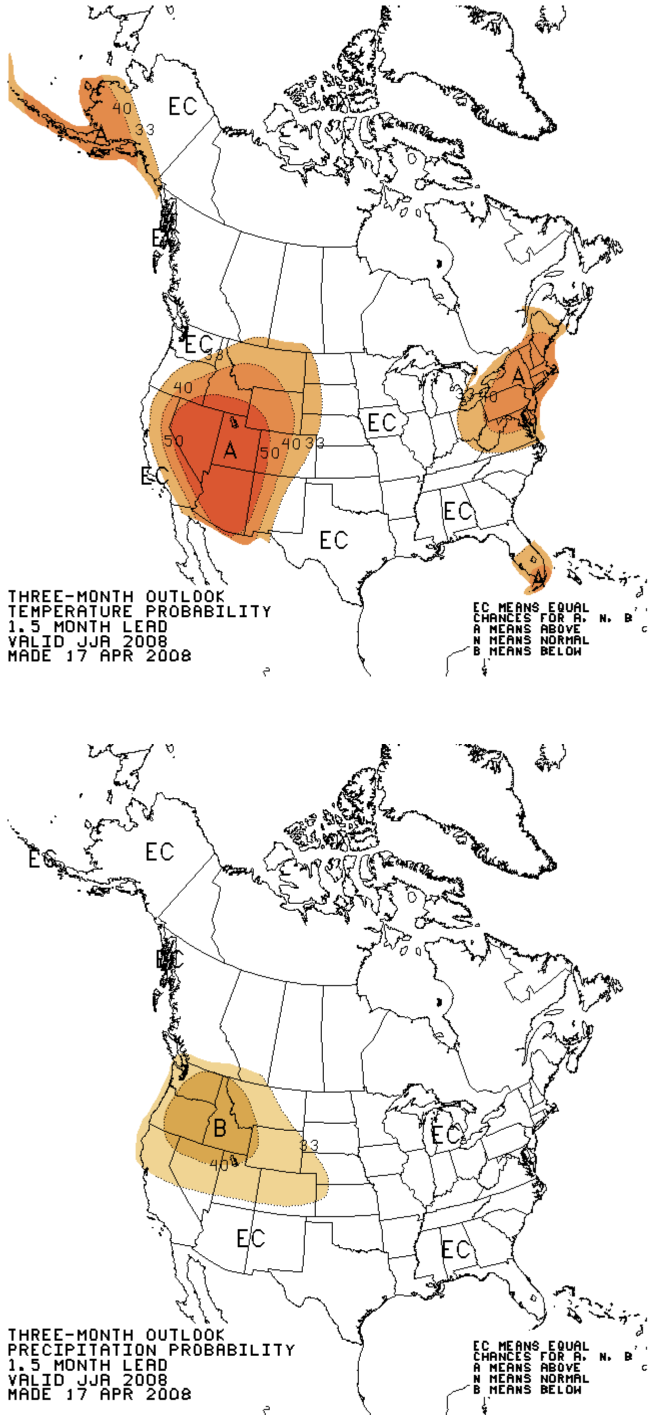


Figure 4-3. Extended weather forecast for June, July, and August of 2008 for temperature and precipitation (National Oceanic and Atmospheric Administration [NOAA], 2008a)

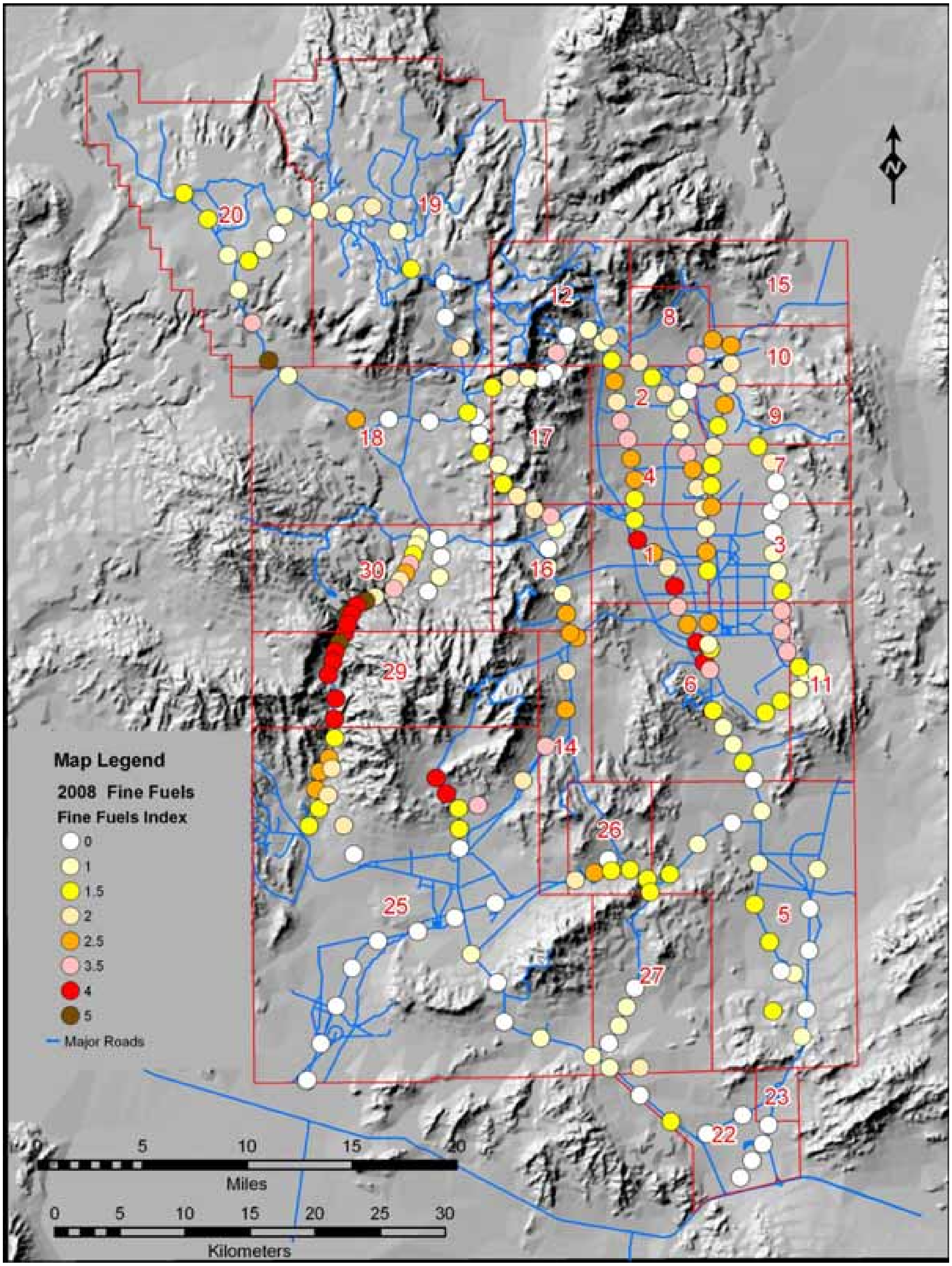


Figure 4-4. Index of fine fuels for 211 survey stations on the NTS by operational area during 2008

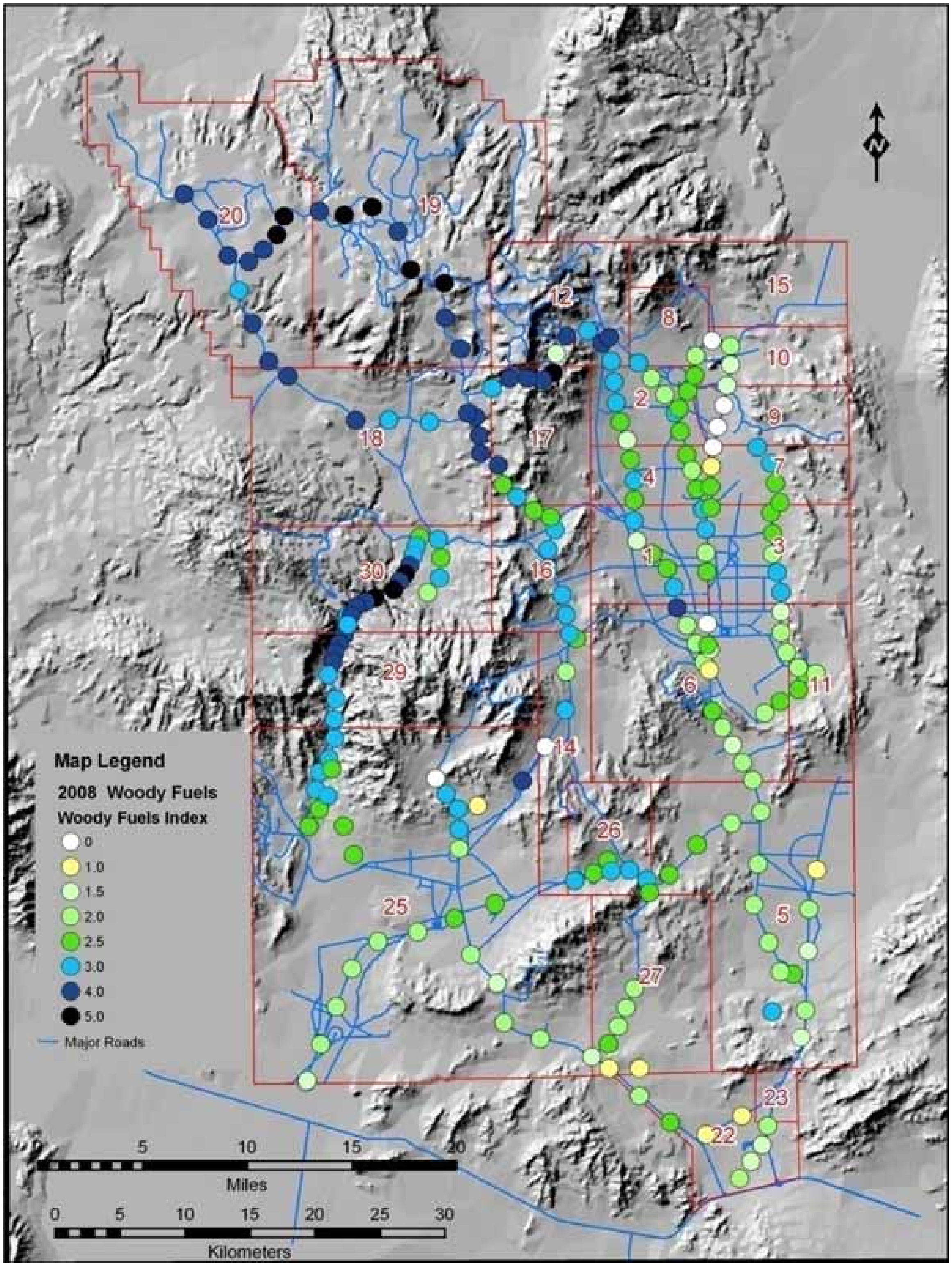


Figure 4-5. Index of woody fuels for 211 survey stations on the NTS by operational area during 2008

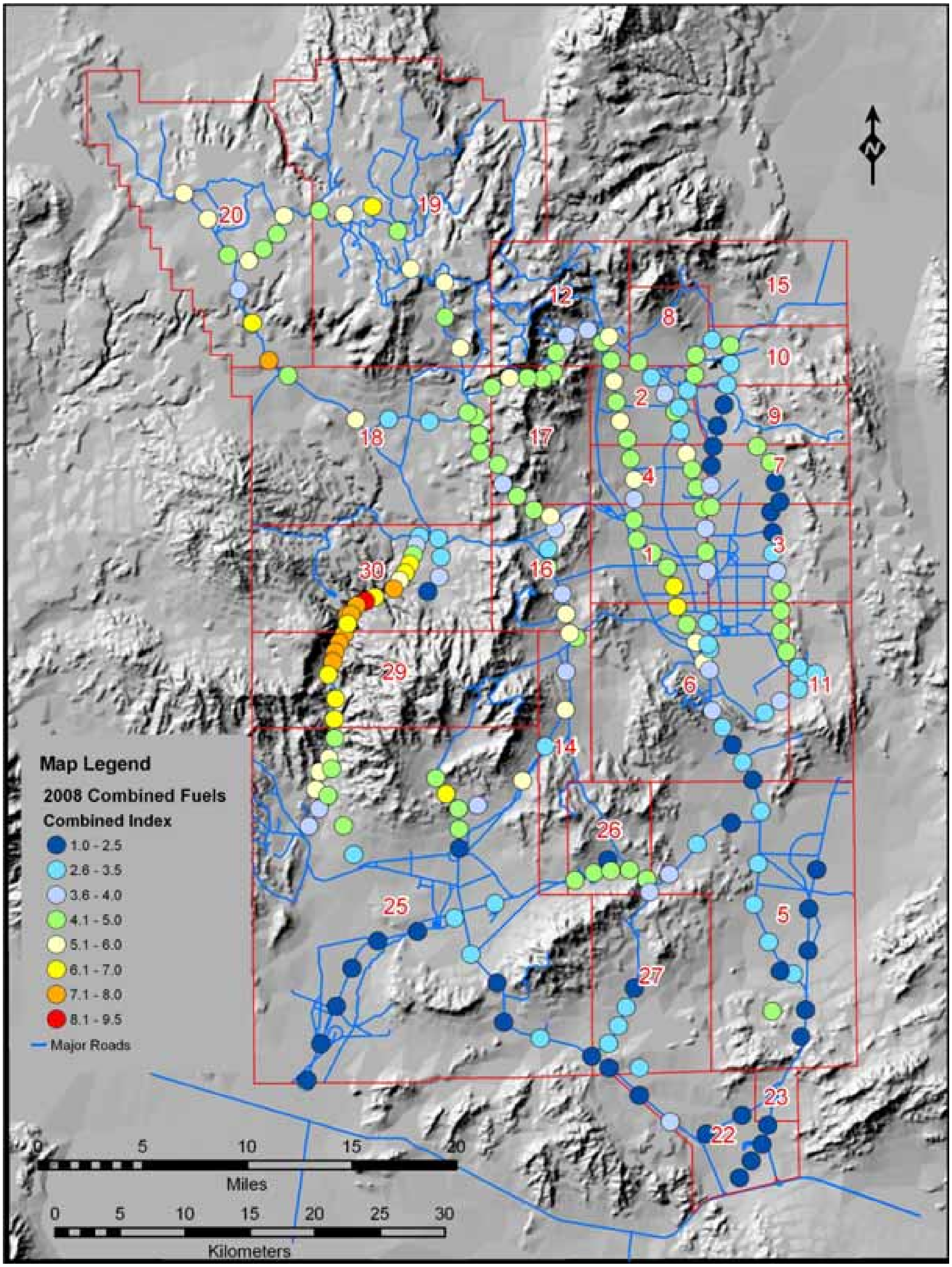
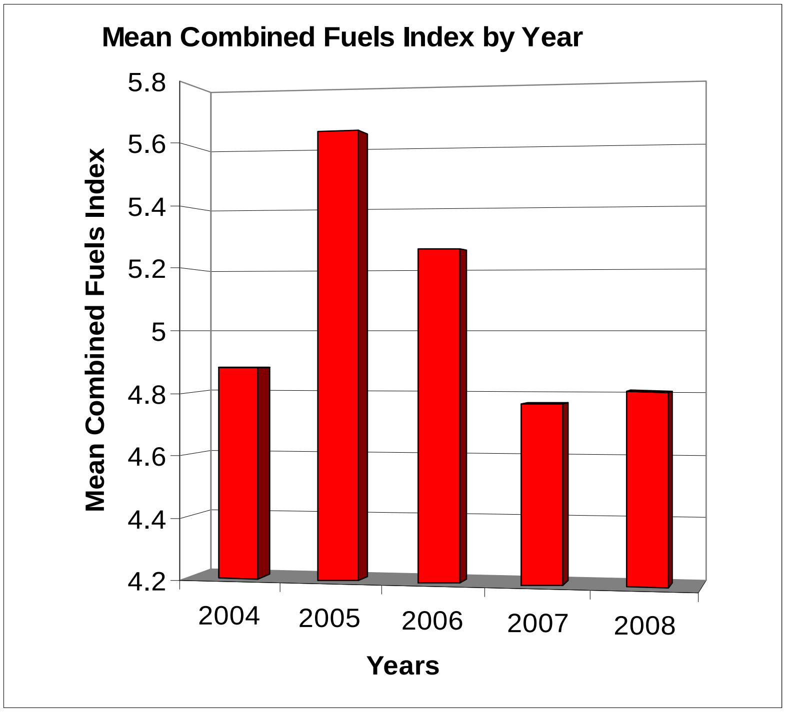


Figure 4-6. Index of combined fine fuels and woody fuels for 211 survey stations on the NTS by operational area during 2008



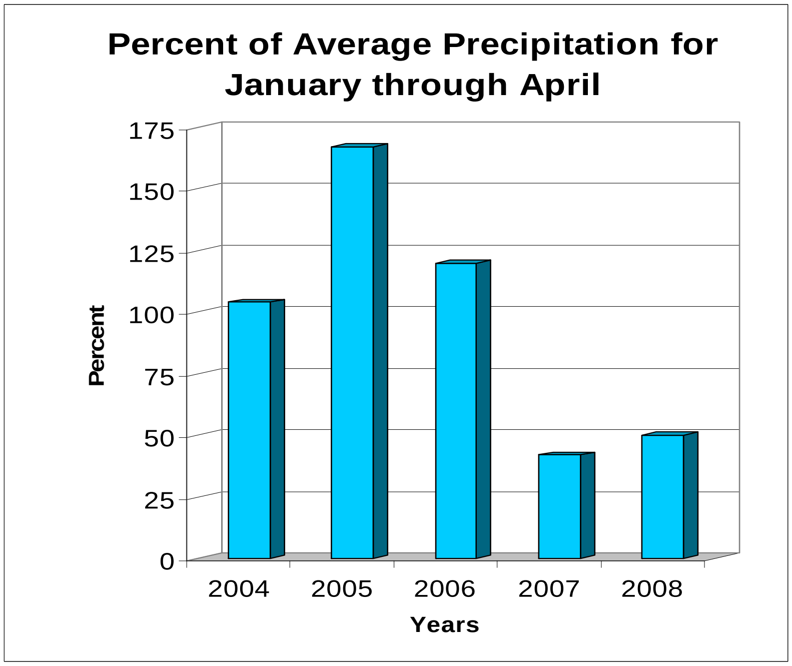


Figure 4-7. Mean combined fuels index (top) and percent of average precipitation for January through April (bottom) for the years 2004 to 2008

Table 4-3. Comparison of combined fuel ratings on the NTS for 2004–2008

Combined Fuels Average Index Value by NTS Area

NTS Area	2004 Data Average	2005 Data Average	2006 Data Average	2007 Data Average	2008 Data Average
1	4.28	5.72	5.56	5.06	5.28
2	4.19	5.69	5.19	4.34	5.13
3	4.58	5.25	4.67	4.13	4.33
4	4.58	6.00	5.83	5.00	5.17
5	3.41	4.56	3.97	2.97	2.88
6	4.59	5.88	5.71	4.73	4.62
7	4.00	5.36	4.64	3.82	4.57
8	5.50	7.00	6.50	5.75	5.50
9	2.75	4.88	4.88	3.75	4.00
10	5.75	6.17	6.17	5.08	5.25
11	3.63	5.25	4.75	4.06	4.00
12	5.00	5.67	6.67	5.63	5.83
14	5.90	6.50	6.00	5.35	5.80
16	5.93	6.43	6.43	5.50	5.64
17	5.25	5.69	5.50	5.13	5.81
18	5.22	5.94	5.39	4.94	4.89
19	6.44	6.56	5.63	5.53	5.63
20	5.25	5.20	4.65	4.43	5.40
22	3.19	3.88	3.38	2.25	2.19
25	4.85	5.19	4.65	4.16	4.23
26	4.71	5.50	5.07	4.29	4.43
27	2.80	3.60	3.40	2.70	3.20
29	8.30	7.86	8.30	8.10	7.70
30	6.78	6.94	6.72	6.14	6.75
NTS Average	**4.88**	**5.64**	**5.26**	**4.77**	**4.81**

Table 4-4. Precipitation history and percent presence in surveyed sites (top species contributing to fine fuels)

Precipitation History	**2004**	**2005**	**2006**	**2007**	**2008**
	percent of average				
Precipitation (January–April)	104	167	120	42	50
Invasive Introduced Species	**2004**	**2005**	**2006**	**2007**	**2008**
	percent presence				
Bromus rubens (red brome)	51.7	64.4	67.8	0	63.0
Bromus tectorum (cheatgrass)	40.3	54.0	60.7	0	59.2
Erodium cicutarium (redstem stork's bill)	5.2	6.2	24.6	0	21.3
Schismus arabicus (Arabian schismus)	4.7	2.8	5.2	0	11.4
Native Species	**2004**	**2005**	**2006**	**2007**	**2008**
	percent presence				
Amsinkia tessellata (bristly fiddleneck)	34.0	62.0	16.1	0	63.0
Mentzelia albicaulis (whitestem blazingstar)	49.8	8.1	0	0	2.4
Chaenactis fremontii (pincushion flower)	27.0	8.0	0	0	1.4

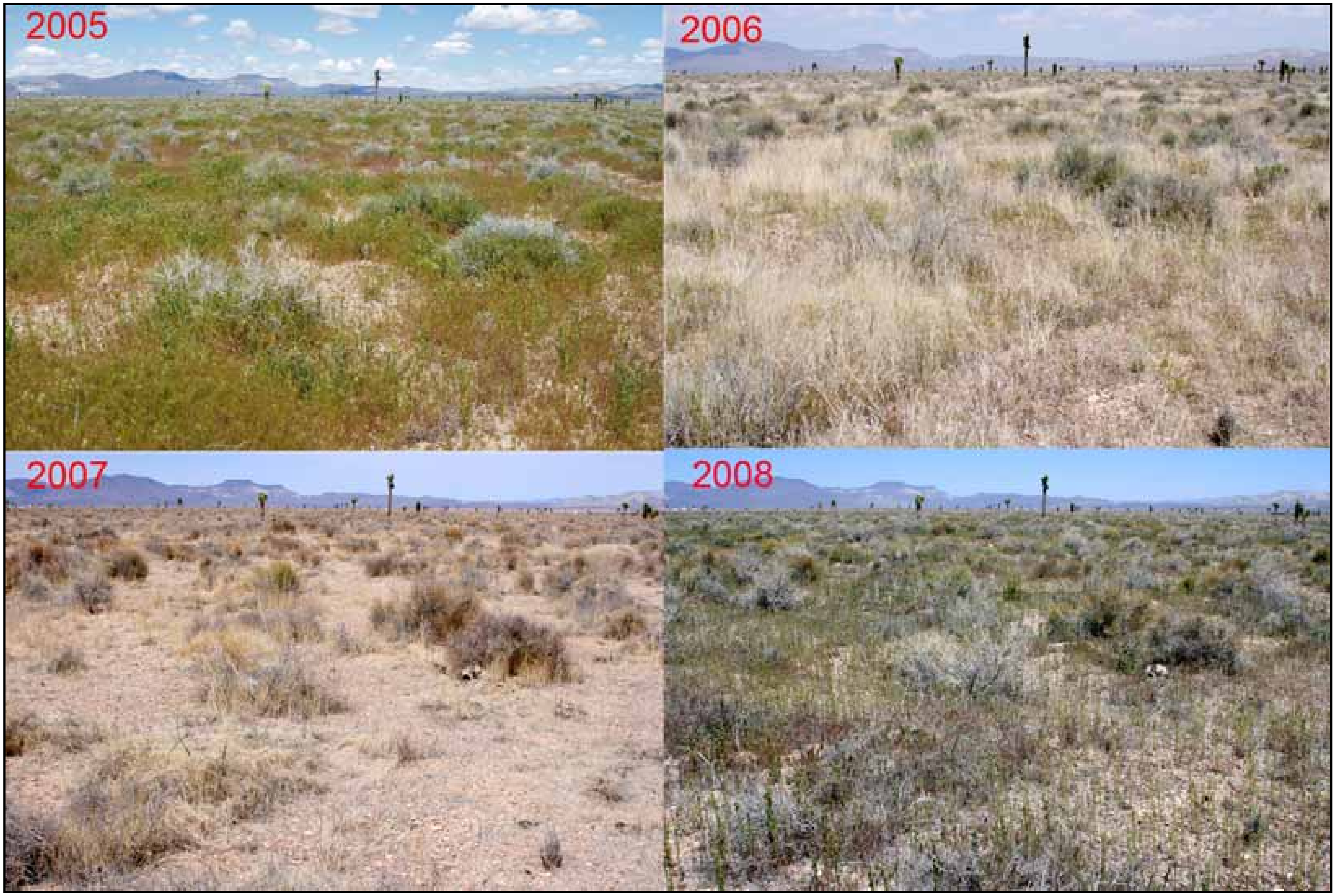


Figure 4-8. Site 99 on the west side of Yucca Flat in 2005–2008
(Photos by W. K. Ostler, April 20, 2005 [top left]; May 4, 2006 [top right]; April 19, 2007 [bottom left]; and April 10, 2008 [bottom right])

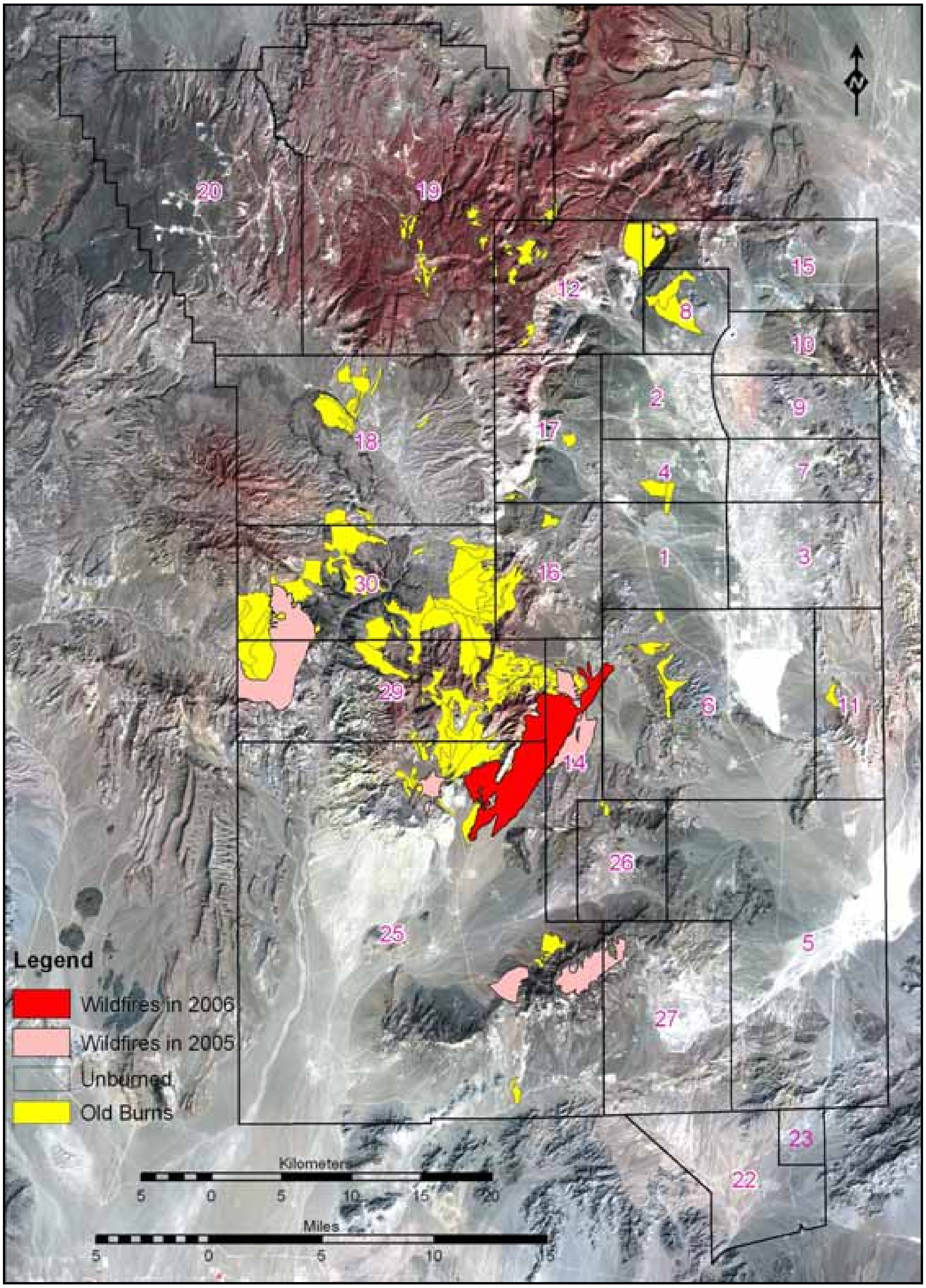


Figure 4-9. Location of large wildland fires on the NTS
(Note: All fires in 2007 and 2008 were very small and are not shown on this map.)

4.3 Woody Plant Plots

In 1963 Janice Beatley established 68 long-term ecological monitoring plots on the NTS. These plots were located throughout much of the southern and eastern portions of the NTS and represented the vegetation alliances in those areas. However, very few plots were established in the northwestern portions of the NTS. Beatley originally classified the northwestern portions of the NTS as mountains in her vegetation map of the NTS that was included in her "Vascular Plants of the NTS" (Beatley, 1976). The major vegetation associations in this area include *Artemisia nova* (black sagebrush), *Artemisia tridentata* (big sagebrush), *Pinus monophylla/Artemisia nova* (pinyon/black sagebrush), and *Pinus monophylla/Artemisia tridentata* (pinyon/big sagebrush) (Ostler et al., 2000). These vegetation associations collectively make up 27.5 percent of the total area of the NTS although they are nearly excluded in sites selected by Beatley for long-term monitoring.

In 2008, supplemental plots were established in the four vegetation associations listed above to better characterize the vegetation that occurs in the northwest portion of the NTS. These plots were selected randomly from ELUs identified in Ostler et al. (2000) that make up these four vegetation associations. Eight plots were selected in black sagebrush (Beatley had two plots in this vegetation association). Ten plots were selected in both big sagebrush and pinyon/black sagebrush, and 12 plots in pinyon/big sagebrush.

4.3.1 Field Surveys

Locations of the 8 black sagebrush sites (ARNO), 10 big sagebrush sites (ARTR), 10 pinyon/black sagebrush sites (PIMO-ARNO), and 12 pinyon/big sagebrush sites (PIMO-ARTR) on the NTS are shown in Figure 4-10. Examples of the four types of woody plant plots are shown in Figures 4-11 to 4-14.

Randomly selected ELUs were visited in November and December 2007, and a suitable plot within each ELU was marked with a center lath. Global Positioning System (GPS) coordinates and initial photographs of the plots were taken. The corners of each plot were marked with metal fence posts in the spring of 2008. Universal Transverse Mercator coordinates (NAD 83 datum) were recorded at each plot to document the location of corners for subsequent use. Accuracy of the coordinates was estimated to be ± 4.5 meters (m) [15 feet (ft)]. Plot size was approximately 50 m x 50 m (164 ft x 164 ft) and was established by GPS measurements due to the tall, woody vegetation that obscured line-of-sight and precluded use of a tape measure.

Plots were visited during the months of June, July, and August of 2008 as time became available from other field activities. Because vegetation was beginning to dry out and was not considered at its peak, only qualitative data were taken for cover, abundance, and phenology. Many of the annuals were in a late stage of phenological development. Qualitative data was taken for cover, abundance, and phenology. A species list for each plot was also recorded.

Vegetation was sampled by two botanists within the plot by traversing back and forth across the plot. New species were added to the list of plants as they were detected, and their percent cover and abundance were also recorded by seven classes (Table 4-5) and adjusted up or down as the plot was traversed to reflect their estimated values across the entire plot; phenology of the vegetation was recorded using four classes. After traversing the entire plot, phenology values were discussed for each species based on observations of the botanists, and mutual agreement as to the assigned value was made to minimize observer bias.

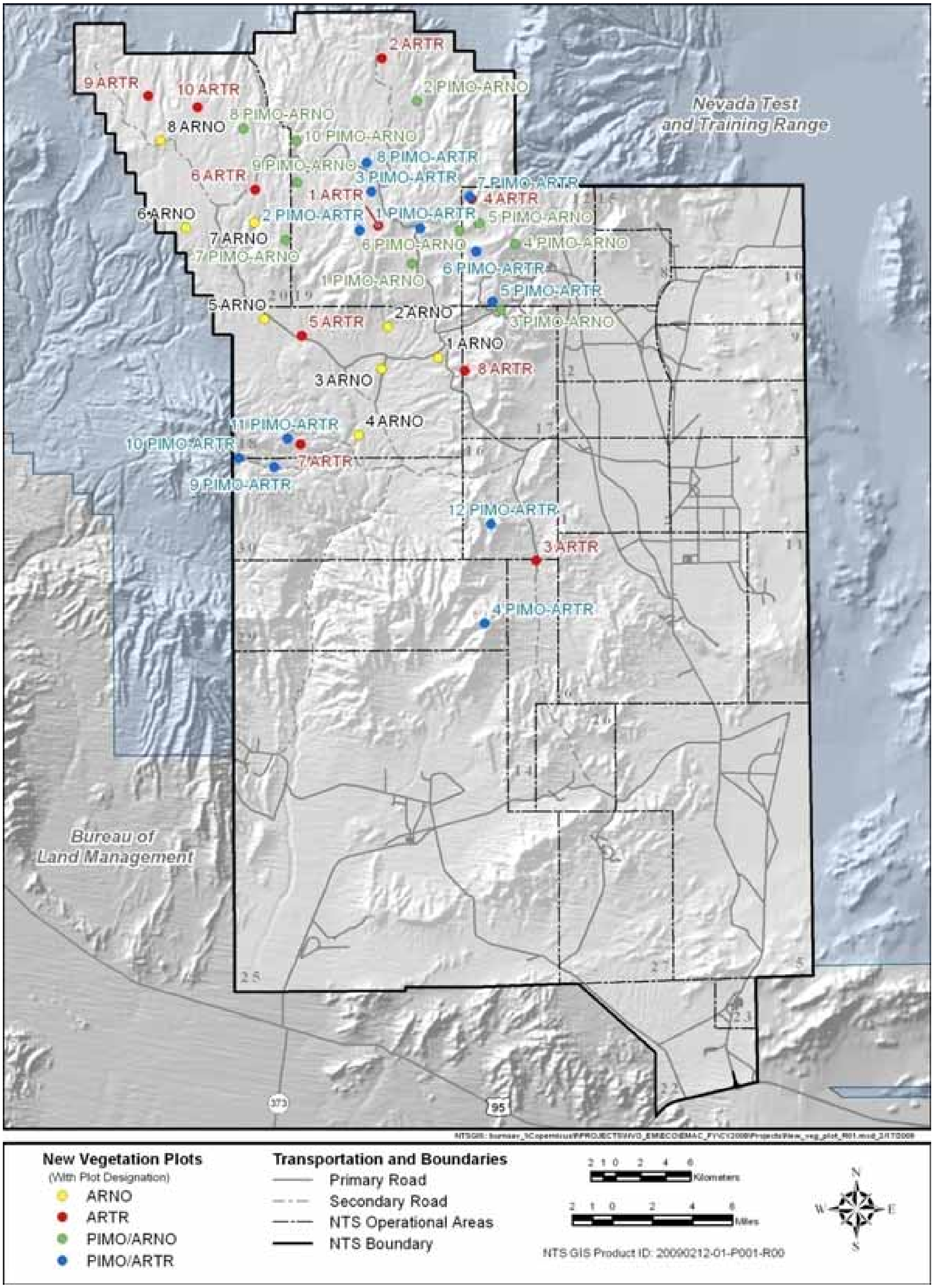


Figure 4-10. Location of new woody plant plots established on the NTS in 2008

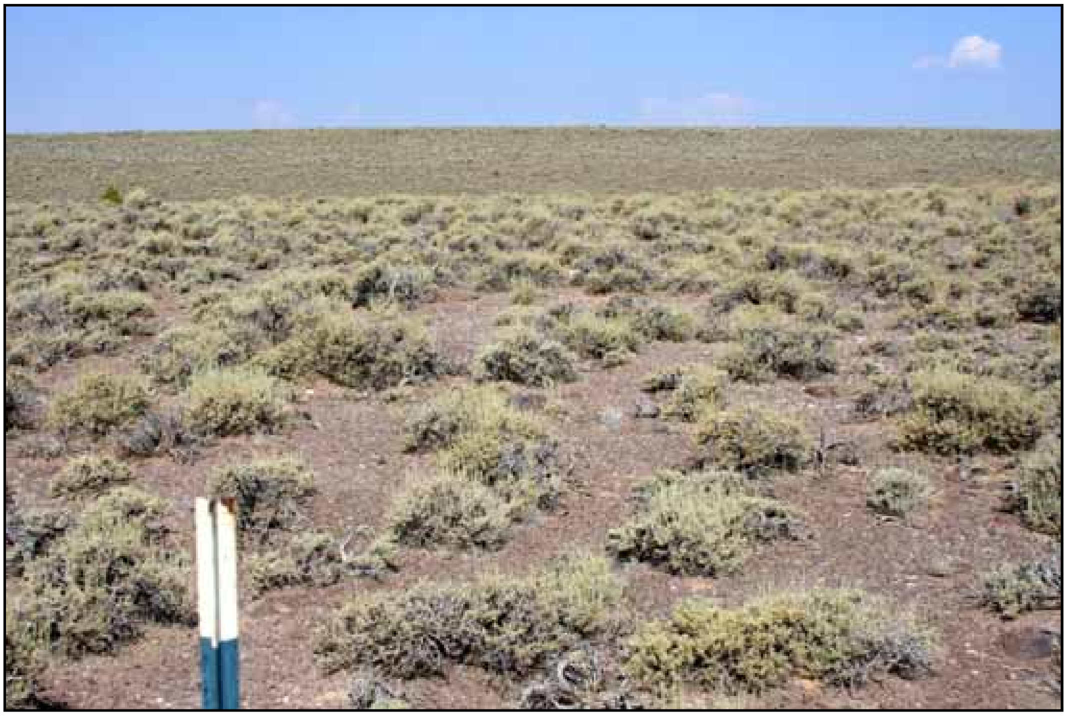


Figure 4-11. Example of black sagebrush vegetation type (Site: ARNO-06)
(Photograph by W. Kent Ostler in Area 20, July 15, 2008)

Figure 4-12. Example of big sagebrush vegetation type (Site: ARTR-01)
(Photograph by W. Kent Ostler in Area 19, July 15, 2008)

Figure 4-13. Example of pinyon/black sagebrush vegetation type (Site: PIMO-ARNO-05)
(Photograph by W. Kent Ostler in Area 12, July 29, 2008)

Figure 4-14. Example of pinyon/big sagebrush vegetation type (Site: PIMO-ARTR-03)
(Photograph by W. Kent Ostler in Area 19, July 30, 2008)

Data for the 40 sites were added to the PLANTS Microsoft Access database maintained by Ecological Services. Species nomenclature followed that of Ostler et al. (2000). Appendix A contains the names of plant species observed in the woody plots by type and the number of stands within the type in which the species occurred. Counts of species by longevity, life-form, and vegetation type are shown in Tables 4-6 and 4-7 respectively.

Table 4-5. Percent cover, abundance, and phenology classes of woody plant plot vegetation

Class	% Cover	Class	Abundance	Class	Phenology
1	0	**0**	Inferred present from dead parts, but rare	**V**	Vegetative
2	1	**1**	Rare with evidence of living presence	**FL**	Flowering
3	2–4	**2**	Uncommon, widely scattered	**FR**	Fruiting
4	5–9	**3**	Common, or scattered clusters	**PFR**	Past Fruiting
5	10–25	**4**	Abundant or ubiquitous in plot		
6	26–59	**5**	Very abundant, but not dominant		
7	>60	**6**	Very abundant and subdominant or dominant		

Table 4-6. Counts of plant species by longevity type and woody plant plot type

		Plant Longevity Type				Mean Number
Vegetation Type	#Plots	Annuals	Biennials	Perennials	Total	Species/Plot
Black sagebrush	8	75		102	**177**	22.1
Big sagebrush	10	76	1	113	**190**	19.0
Pinyon/black sagebrush	10	36		207	**243**	24.3
Pinyon/big sagebrush	12	35		218	**253**	24.1
Total	**40**	**222**	**1**	**640**	**863**	**21.5**

Table 4-7. Counts of plant species by lifeform type and woody plant plot type

Vegetation Type	#Plots	Trees	Tall Shrubs	Short Shrubs	Subshrubs	Graminoids	Forbs	Epiphites	Succulents	Total
Black sagebrush	8	3		50		34	83		7	**177**
Big sagebrush	10	3	10	28	1	43	102		3	**190**
Pinyon/black sagebrush	10	22	1	59	4	51	91	1	14	**243**
Pinyon/big sagebrush	12	28	12	54	1	52	91	4	11	**253**
Total:	**40**	**56**	**23**	**191**	**6**	**180**	**367**	**5**	**35**	**863**

4.4 Coordination with Scientists and Ecosystem Management Agencies

NSTec biologists interfaced with other scientists and ecosystem management agencies in 2008 for the following activities:

- Attended a workshop in Reno, Nevada, entitled *Wildfires and Invasive Plants in American Deserts.*
- Invited to participate in the Mojave Desert Initiative designed to address research needs in the areas of wildfires and reclamation of lands that have been burned.

5.0 SENSITIVE PLANT MONITORING

The original list of rare, sensitive, threatened, or endangered plant species on the NTS has evolved over the last 30 years. The lists prepared in the late 1970s (Beatley, 1977a; 1977b; Rhoads and Williams, 1977; Rhoads et al., 1978; Cochrane, 1979) were created at a time when little was known about the distribution of rare plants on the NTS and included species that have since been found to be more abundant than originally proposed. Conversely, many of the plants identified as sensitive in the 1970s carry that same status some 30 years later. In more recent years surveys and research have focused on the status of individual species (Blomquist et al., 1992; 1995; Anderson, 1998), which has added to the overall understanding of the habitat requirements of rare plants found on the NTS. The current list of sensitive plants represents a monumental effort by botanists over the last three decades.

A goal of the sensitive plant monitoring program is to evaluate, on a regular basis, the status of those plants listed as sensitive plants on the NTS and to document if their habitat has been impacted by NNSA/NSO activities. This is used to evaluate whether protection or management under state or federal law is necessary, or if the species should still be included on the list of sensitive plant species.

There were several major accomplishments during 2008 regarding sensitive plants on the NTS. An NSTec scientist attended the annual rare plant workshop sponsored by the NNHP and the Nevada Native Plant Society (NNPS) in Reno, Nevada. A brief status report on the work at the NTS was presented to the group of botanists in attendance at the workshop. Field surveys were conducted in 2008 for several sensitive plants. The ranges of two species were expanded and new populations were found. A major accomplishment in 2008 was the completion of a map of the distribution of sensitive plants on the NTS. The map is the culmination of several years of work and replaces a similar map prepared in 1994. The map is available on the NNSA/NSO Web site at: http://www.nv.doe.gov/library/publications/Environmental/Figures/Fig11-3.pdf. The results of sensitive plant monitoring in 2008 are presented in the following sections.

5.1 List of Sensitive Plant Species for the NTS

The list of sensitive plant species for the NTS is reviewed annually, and modifications are made as necessary. Modifications are made based on the results of sensitive plant surveys conducted during the year or at the suggestion of regional botanists usually with expertise for a particular species. There were no species removed from the list as a result of field surveys in 2008. At the annual Rare Plant Workshop, sponsored by NNHP and the NNPS, no actions were taken by the group that affected the list of sensitive plant species for the NTS.

The only modification to the list of sensitive plant species for the NTS was with *Lathyrus hitchcockianus* (Bullfrog Hills peavine). It is found in the vicinity of Pinyon Pass on the northern end of Yucca Mountain about 3.2 kilometers (km) (2 miles [mi]) west of the NTS boundary. Field surveys have been conducted for this species in previous years, however, this species has not been found on the NTS. Until it is found on the NTS it will not be included on the list of sensitive plant species for the NTS (see Table 2-1).

5.2 Long-term Monitoring

In an ongoing effort to maintain an accurate assessment of the distribution of sensitive plant species on the NTS and to periodically evaluate their status, field surveys were conducted in 2008 for several sensitive plants. Formal surveys were conducted for some species while sightings of others were opportunistically recorded. During planned field monitoring the status of each population is assessed, which may include estimates of plant density, plant vigor, herbivory, disease, or documentation of direct or indirect impacts to the plant or its habitat.

Monitoring sensitive plant populations is on a priority basis. The more rare species are monitored more frequently, or if a certain species is known to occur in areas with increased activity, those populations will be targeted to ensure they are not being adversely impacted. There are several species found only on the NTS and its immediate vicinity. *Astragalus beatleyae* (Beatley milkvetch) is only known to occur on Pahute Mesa; *A. funereus* (black woollypod) occurs on French Peak and Shoshone mountain, extending westward into the hills west of Beatty, Nevada; *A. oophorus* var. *clokeyanus* (Clokey eggvetch) is found in the Spring Mountains. Populations on the NTS in Kawich Canyon and Lambs Canyon represent the northern-most distribution of *A. oophorus*. Three other species that occur on the NTS are equally rare. *Galium hilendiae* ssp. *kingstonense,* (Kingston Mountains bedstraw) is known from two sites on the NTS and in a single mountain range in California. *Ivesia arizonica* var. *saxosa* (rock purpusia) occurs on Pahute Mesa on the NTS and a location in Lincoln County, north and east of Alamo. The presence of *Penstemon fruticiformis* ssp. *Amargosae* (Death Valley beardtongue) on the NTS was confirmed a couple years ago. It had been reported near the southern border of NTS, but until field surveys were conducted in 2007 by NSTec botanists, it had not been confirmed to be on the NTS. This species, like the previous two, is only found off the NTS in a few mountain ranges in California, just south of the NTS. The number of individual plants of these rare species found on the NTS is relatively low compared to other sensitive plant species, which increases the need to monitor the status of these species more frequently.

The range of the other sensitive plant species on the NTS, for the most part, is broader than for those mentioned here. Many species are located at several other locations in Nevada, and a few are found across the border into California. As a result of the sensitive plant monitoring program on the NTS, the known distribution of several species has been better defined, as has the density of the individual species at each of the populations. Several of the sensitive species are annuals; during optimum growing conditions new locations are found, and plant densities are typically in the thousands. The distribution of most of these species is still restricted to southern Nevada and the Mojave Desert region of California.

The results of the sensitive plant monitoring program on the NTS during 2008 are presented in the following sections. Precipitation during the 2008 growing season (September 2007 to June 2008) was above average. However, the distribution of the rainfall did not promote above average plant growth. Of the 15.8 centimeters (cm) (6.2 inches [in.]) received during this growing season, half was received in September of 2007, followed by 2.5 cm (1 in.) in December 2007, January 2008, and February 2008. From February 2008 to June 2008 only 0.1 cm (0.2 in.) of rain was received (refer to Section 8, Table 8-15). This pattern of precipitation resulted in a mixed response from sensitive plants with no germination of any of the four annual phacelias.

5.2.1 *Astragalus oopherus* var. *clokeyi,* Clokey eggvetch

Populations of *A. oopherus* var. *clokeyi* were last monitored in1997. Monitoring has been scheduled for the past couple years for this species, but due to poor growing conditions there were no plants to monitor. *A. oopherus* var. *clokeyi* occurs in the northern portions of the NTS, specifically Kawich Canyon, Lambs Canyon, Captain Jack Spring in the Eleana Range, Echo Peak, Shoshone Mountain, and Timber Mountain.

A reconnaissance survey was conducted in mid-May 2008 at the Captain Jack Spring and Echo Peak populations. Only a few isolated plants were found at both locations. All the plants were relatively small compared to what has been encountered during previous surveys. Plants were flowering but had not set seed. No further surveys were conducted in 2008 because plant densities were so low. At both sites there were no signs of plant disease, insect damage, or habitat disturbance.

5.2.2 *Cymopteris ripleyi* var. *saniculoides,* Sanicle biscuitroot

C. ripleyi var. *saniculoides* is known from the lower elevations of the NTS, Yucca Flat, southern end of Frenchman Flat, and into Rock Valley. *C. ripleyi* var. *saniculoides* was identified as a variety of *C. ripleyi* by R. C. Barneby (1941) based on flower color and geographic location. Typically *C. ripleyi* var. *saniculoides* bears a black-purple colored flower, as opposed to the typical white flower of *C. ripleyi*.

The distinguishing characteristics between the two varieties have been in question for some time. J. C. Beatley (1976) thought the characteristics to be “ill-defined.” More recently it has been observed that populations of *C. ripleyi* var. *saniculoides* in Yucca Flat and other lower elevation populations contained plants with both the typical dark-purple flower as well as plants with white flowers.

In an attempt to resolve this taxonomic issue, populations of *C. ripleyi* var. *saniculoides* have been monitored for the past three years. Unfortunately, only a few plants have been found over the entire range of the species. Only one or two individual plants were found at some populations, and none were found at others. Until a more thorough review of the flower color issue can be assessed, it is not possible to resolve the taxonomy of this species.

5.2.3 *Eriogonum heermannii* var. *clokeyi,* Clokey buckwheat

E. heermannii var. *clokeyi* is known from the Spring Mountains in Clark County and Mercury Ridge and Red Mountain in the far southeastern corner of the NTS. Original surveys of this species identified one population on the north slope of Red Mountain and another population on the east side of Mercury Highway. The two populations covered approximately 26 ha (63 ac) (Figure 5-1 [bottom]). The number of plants observed during these early surveys was not recorded.

Plant surveys were conducted in 2008 along the north slope of Red Mountain and the slopes of Mercury Ridge to better define the range of this species on the NTS. The surveys were conducted using a handheld GPS device. A waypoint was recorded at the location of each plant encountered during the survey. Waypoints were transferred to a GIS geodatabase and used to delineate the boundaries of the two populations of *E. heermannii* var. *clokeyi*.

The results of the surveys were defining as is shown in Figure 5-1 (top). Over the four survey days in December of 2008, over 5,000 plants were observed. It is estimated that the two populations now cover approximately 157 ha (388 ac), more than six times the area reported previously. The most dramatic was the expansion of the range of the Mercury Ridge population, which was previously reported to cover about 8 ha (20 ac) and now covers about 136 ha (337 ac). The change in the range of the Red Mountain population was not as dramatic, increasing from the original estimate of 18 ha (44 ac) to about 21 ha (51 ac) now. Only the eastern sector of Red Mountain was surveyed in 2008. When the survey of the western sector is completed, the change

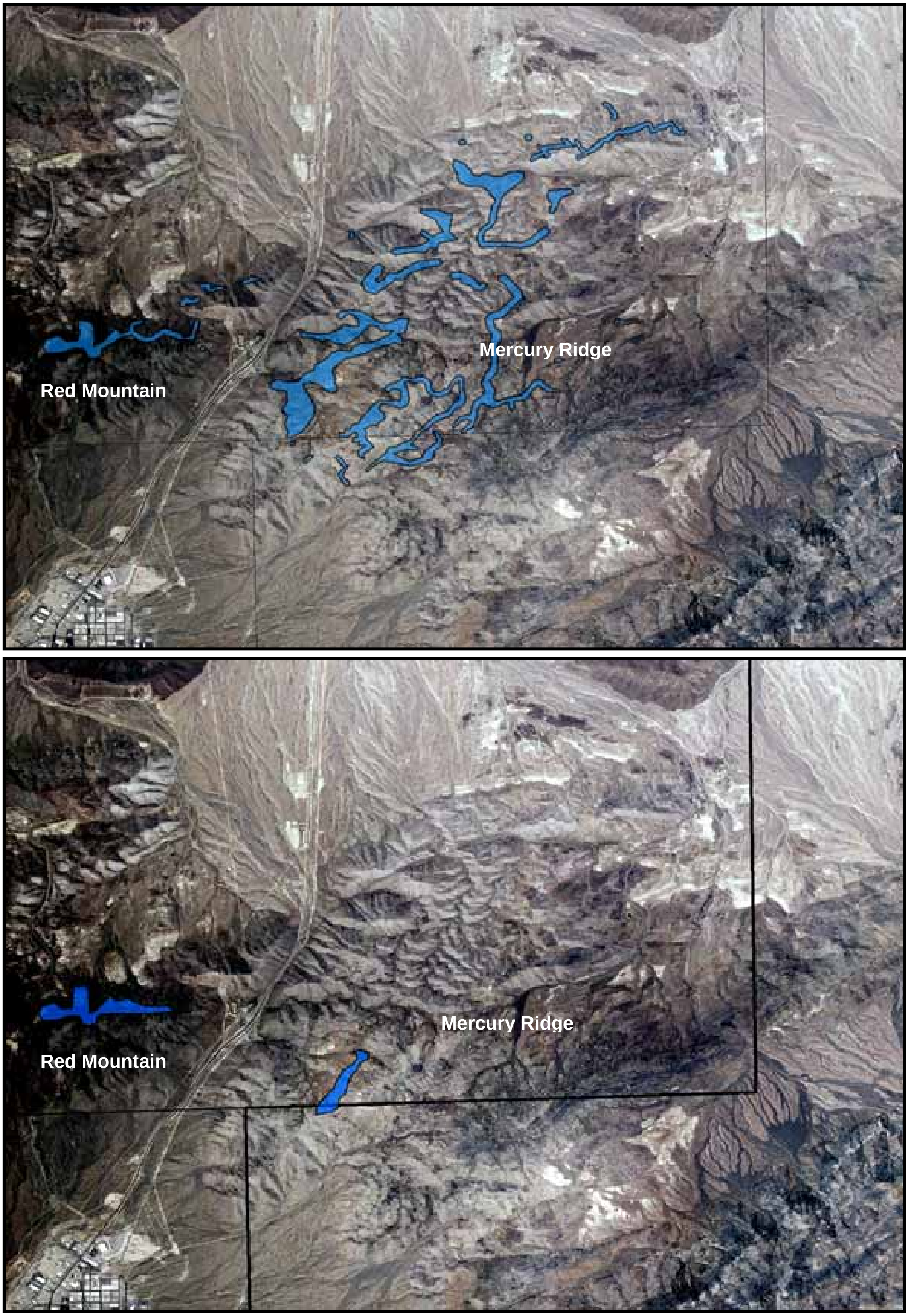


Figure 5-1. Distribution of *Eriogonum heermannii* var. *clokeyi* on the NTS prior to field surveys in 2008 (bottom) and after the 2008 surveys (top)

in the range of *E. heermannii* var. *clokeyi* on Red Mountain may be as significant as it was for Mercury Ridge. As was noted during previous surveys for E. heermannii var. clokeyi, this species prefers the north, northwest, and northeast facing slopes. In fact, no plants were found on south facing slopes.

5.2.4 *Eriogonum concinnum,* Darin buckwheat

Field surveys were conducted for *E. concinnum* in previous years, and several new populations were identified and the boundaries of known populations were better defined. Populations are found along Buckboard Mesa Road, around the Sugar Loaves, Pinyon Butte, Rattlesnake Ridge, and several isolated populations on Pahute Mesa.

During biological surveys conducted in 2008, prior to ground disturbing activities on Pahute Mesa, two new populations of *E. concinnum* were found: one towards the southern edge of Pahute Mesa and the other near the far northwestern border of the NTS. The first population is in an undisturbed area along the west facing slope of a small ridge on Pahute Mesa. The other population is on a recently constructed drill pad (Figure 5-2). The pad and associated cut and fill slopes were covered with *E. concinnum*. Both populations have been added to the sensitive plants GIS geodatabase maintained by Ecological Services.

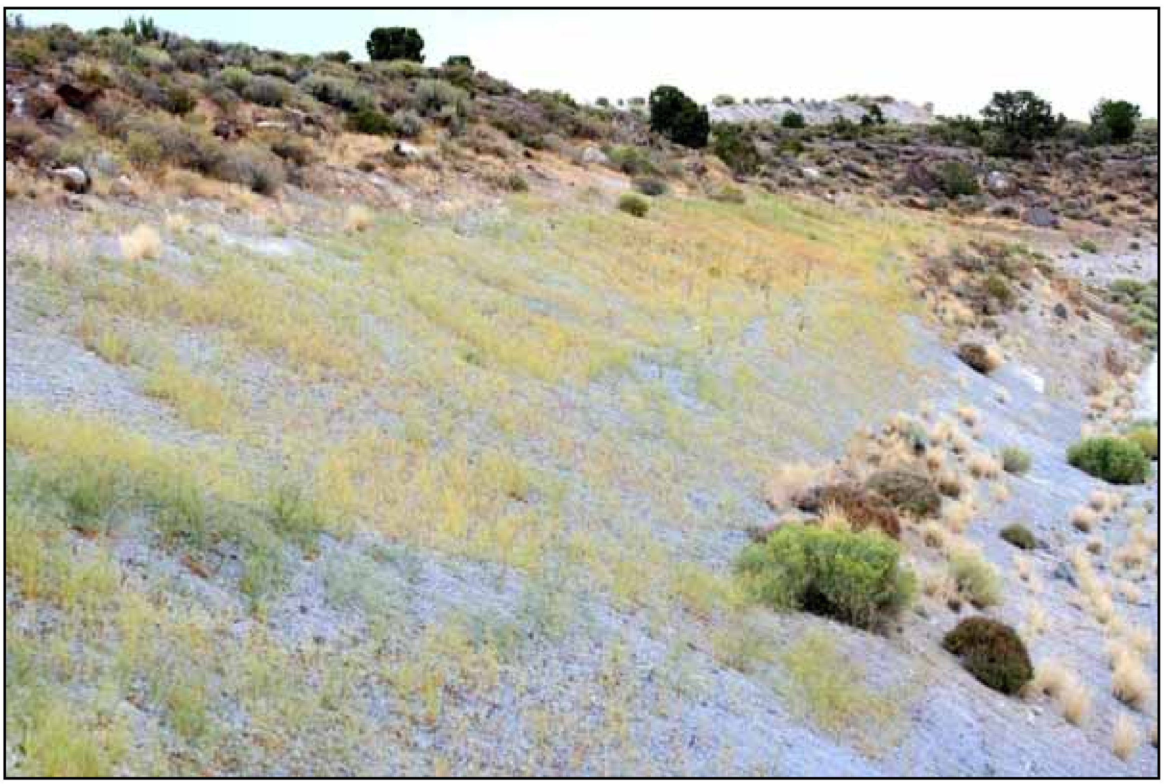


Figure 5-2. Drill pad with *E. concinnum* (light green color middle of slope) on cut slope
(Photograph by W. Kent Ostler, September 8, 2008)

5.2.5 *Frasera pahutensis,* Pahute green gentian

In 2006 field surveys focused on the delineation of two *F. pahutensis* populations along 19-01 road on the eastern sector of Pahute Mesa. The results of those surveys were reported previously (NSTec, 2007). One other population of *F. pahutensis* was discovered in 1997 in the Gold Meadows area of the NTS. Approximately 115 individuals were observed over about 1 ha (2 ac) (Figure 5-3, left).

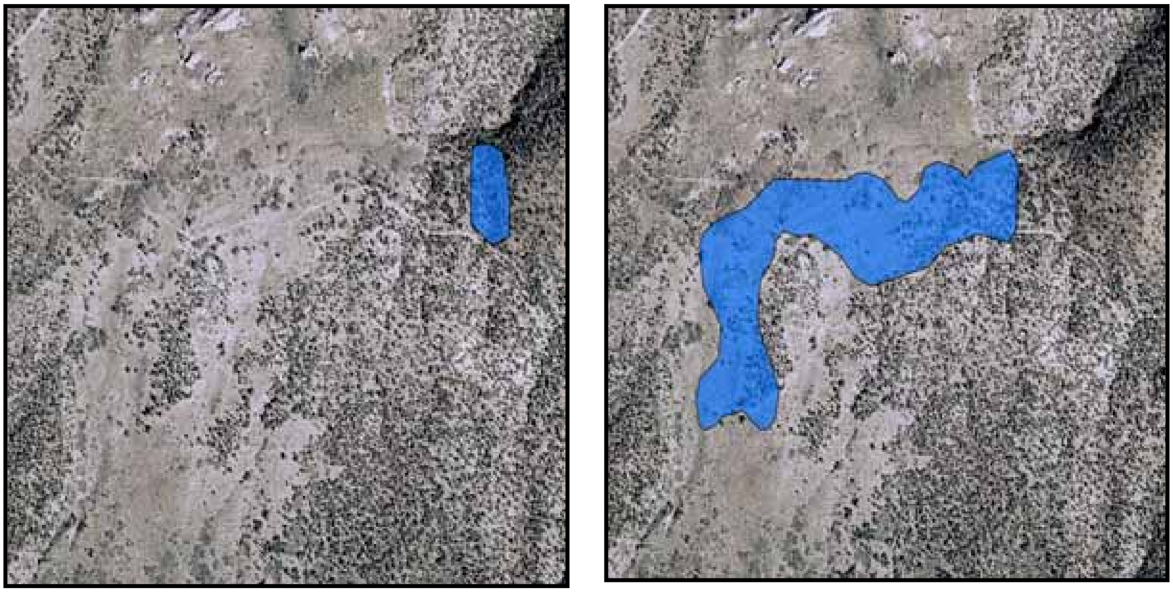


Figure 5-3. Delineation of boundaries of the population of *Frasera pahutensis* in Gold Meadows after surveys in 1997 (left) and after field surveys in 2008 (right)

In May 2008 a field survey was conducted with the objective of delineating the boundaries of the Gold Meadows population of *F. pahutensis*. Standard field survey methods were used, which included a hand-held GPS unit to record waypoints at each location of *F. pahutensis*. Waypoints were transferred to a GIS geodatabase and plotted on USGS topographic maps. During the field survey approximately 1,000 individual *F. pahutensis* plants were observed over 9 ha (21 ac) (Figure 5-3, right), ten times the size of the population originally identified in 1997. Surveys were conducted on May 14, 2008, and *F. pahutensis* was in early to full flower (Figure 5-4). There were no observed threats to the species. Plants appeared vigorous and showed no signs of disease or insect damage.

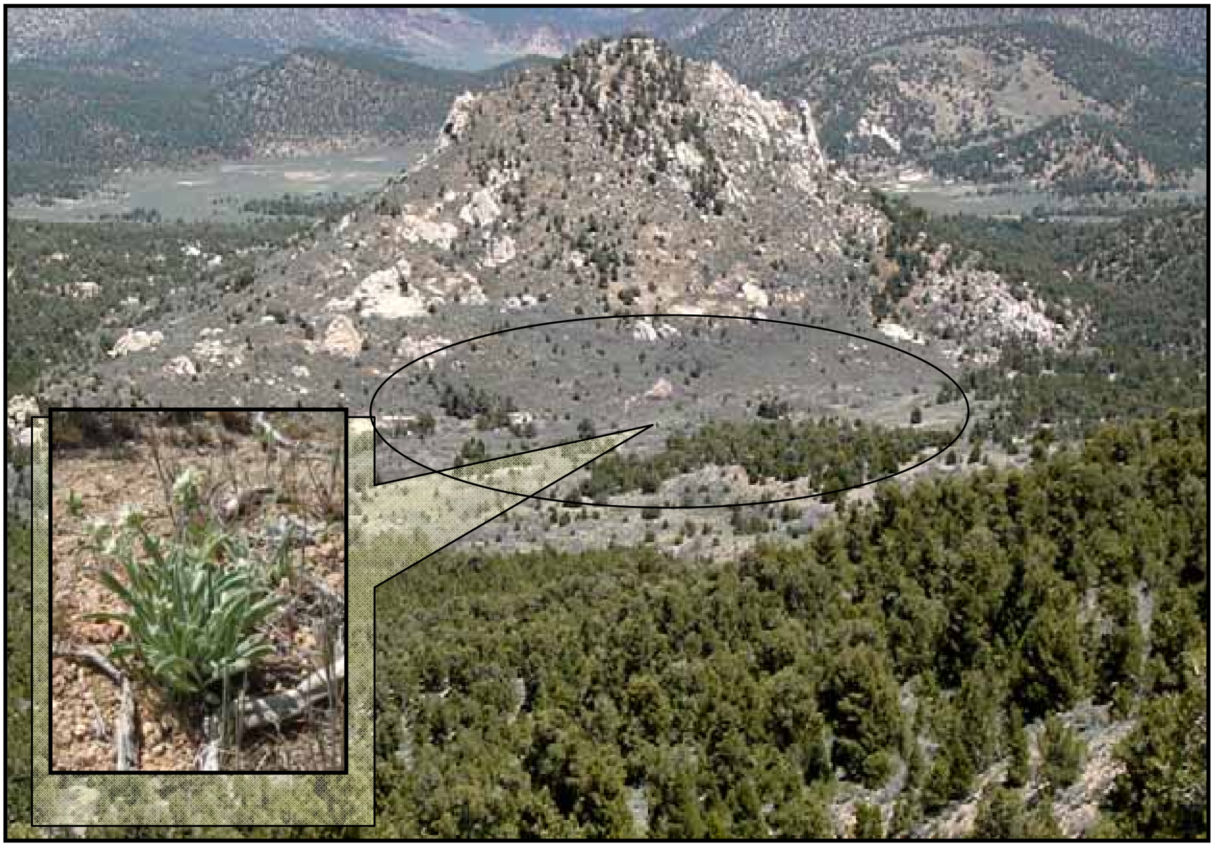


Figure 5-4. Location of field surveys (circle) conducted in 2008 for Frasera pahutensis in the Gold Meadows of the NTS. Photograph insert is one of hundreds of individual plants found in this area in 2008.
(Photograph by D. C. Anderson, 2008)

5.2.6 *Galium hilandiae* ssp. *kingstonense,* Kingston Mountain bedstraw

G. hilandiae ssp. *kingstonense* is known from the southern and eastern slopes of Oak Spring Butte and above Tongue Wash on the eastern slopes of Rainier Mesa. The only population outside the NTS is in Kingston Mountains, south of Pahrump, Nevada, in San Bernardino County, California.

G. hilandiae ssp. *kingstonense* is one of two sensitive plant species on the NTS that is listed as threatened by the NNPS (Table 2-1). The last field surveys conducted on the NTS to assess the status of *G. hilandiae* ssp. *kingstonense* were in 1991 and 1992. During those same years, surveys were conducted in the Kingston Peak area off the NTS, but no plants of *G. hilandiae* ssp. *kingstonense* were found. Surveys on the NTS did not identify any threats to the species. Since then there have been no activities in the general vicinity of these populations that would pose a threat. Both the Oak Spring Butte area and the Tongue Wash area are in remote areas of the NTS, characterized by steep rocky terrain and isolated from typical site activities.

A half-day reconnaissance survey was conducted above Tub Spring along the eastern slopes of Oak Spring Butte the first part of June 2008 to determine whether or not *G. hilandiae* ssp. *kingstonense* was present. This site is one of the two *G. hilandiae* ssp. *kingstonense* sites reported from the Oak Spring Butte area. Findings in 2008 were the same as in the previous three years; no plants were found. Based on these results formal surveys for *G. hilandiae* ssp. *kingstonense* were not conducted in 2008.

5.2.7 *Hulsea vestita* var. *inyoensis,* Inyo hulsea

H. vestita var. *inyoensis* is known from numerous locations on Rainier Mesa and in the Eleana Range. It is primarily found along road cuts and steep slopes. Its range extends from the NTS into the desert region of Inyo County, California.

Surveys were conducted for this species in 2006 at which time previously reported locations were verified. No surveys were specifically conducted for *H. vestita* var. *inyoensis* in 2008; however, a new population of *H. vestita* var. *inyoensis* was found along Pahute Mesa Road approximately 1.6 km (1 mi) south of the Sugar Loaves. The site is a south-facing road cut with approximately 200 plants present (Figure 5-5). Plants were in flower and showed no signs of stress. This species had been reported from the Sugar Loaves area but not from this area. Coordinates were taken for this site and information stored in the sensitive plant GIS geodatabase.

Figure 5-5. One of 200 plants of *H. vestita* var. *inyoensis* along Pahute Mesa Road approximately 1.6 km (1.0 mi) south of the Sugar Loaves

(Photograph by D. C. Anderson, May 15, 2008)

5.2.8 *Ivesia arizonica* var. *saxosa,* Rock purpusia

I. arizonica var. *saxosa* was historically known from Columbine Canyon on Pahute Mesa. Sensitive plant surveys conducted in recent years have added a couple of new locations of *I. arizonica* var. *saxosa* on the NTS. One was located about 2.0 km (1.3 mi) south of Columbine Canyon and another at the head of Pah Canyon on the western edges of Shoshone Mountain.

No formal surveys were conducted for *I. arizonica* var. *saxosa* in 2008; however, an opportunistic sighting of the species extended the boundaries for the Columbine Canyon population. *I. arizonica* var. *saxosa* was found about 0.3 km (0.2 mi) to the north and east of Columbine Canyon. In previous years surveys had focused on potential habitat to the south of Columbine Canyon.

5.3 Coordination with Scientists and Management Agencies

An NSTec scientist attended the 2008 Nevada Rare Plant Workshop sponsored by the NNPS and the NNHP. He gave a presentation on the sensitive plants that occur on the NTS. NNPS evaluates the status of sensitive and protected species in Nevada and makes recommendations on the level of protection needed.

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6.0 SENSITIVE AND PROTECTED/REGULATED ANIMAL MONITORING

The NNHP At-Risk Tracking List; Nevada Administrative Code (NAC) 503, "Hunting, Fishing and Trapping; Miscellaneous Protective Measures"; and other sources were reviewed to determine if any changes had been made to the status of animal species known to occur on the NTS. No changes to the status of any NTS species were noted. 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 2008 focused on (1) the western red-tailed skink *(Eumeces gilberti rubricaudatus)*, (2) western burrowing owl *(Athene cunicularia hypugaea)*, (3) raptor observations, (4) small mammals including kangaroo mice *(Microdipodops* spp*)*, (5) bats, (6) wild horses *(Equus caballus)*, (7) mule deer *(Odocoileus hemionus)*, (8) mountain lion *(Puma concolor)*, (9) opportunistic animal sightings including pronghorn antelope *(Antilocapra americana)* and southeast Nevada pyrg *(Pyrgulopsis turbatrix)*, and (10) nuisance animals and their control on the NTS. A discussion follows on the monitoring of these animals.

6.1 Western Red-Tailed Skink Surveys

The western red-tailed skink (Figure 6-1) is considered a sensitive species by the NNHP and has an "Evaluate" status for monitoring on the NTS. This means that there is insufficient information on its distribution and abundance to determine if it is threatened and, therefore, whether it warrants protection and monitoring or not. Surveys to determine the distribution and abundance of the western red-tailed skink on the NTS were begun in 2006 and conducted again in 2008.

Figure 6-1. Western red-tailed skink *(Eumeces gilberti rubricaudatus)*
(Photo by D. B. Hall, June 5, 2008)

In order to more systematically sample for western red-tailed skinks, a 5-km by 5-km (3.1-mi by 3.1-mi) grid was overlaid on the NTS beginning at a point approximately 8 km (5 mi) northwest of the northwest corner of the NTS to ensure that the grid encompassed the entire NTS (Figure 6-2). Each grid cell was assigned an alphanumeric label (A1 to M17), and 25 cells were randomly selected for sampling during 2008. Due to logistical considerations such as travel time into remote areas, road access to selected grid cells, and concurrent sampling for other species, 20 grids were sampled that were not randomly selected. Within each grid cell, one or two sampling sites were selected based on experience and habitat features (i.e., rocky areas, mesic areas) known to be associated with western red-tailed skinks (Morrison and Hall, 1999; Stebbins, 2003; NSTec, 2007; Hansen et al., 2008).

At each site, 30 funnel traps were set near rocks and vegetation that could potentially direct animals into the traps. At 11 sites, two types of traps were used. Both were rectangular traps with similar dimensions. They measured 61.0 cm long x 21.0 cm wide x 21.0 cm tall (24.0 x 8.3 x 8.3 in.). One was a box-type funnel trap with metal frame (Figure 6-3), and one was made from wire-mesh with no frame (Figure 6-4). Fifteen traps of each type were set for the same number of trap days for the comparative study. Percent trap success (number of reptiles captured/number of trap days x 100) was calculated and analyzed using a paired t-test to see which trap type was more effective.

A total of eight western red-tailed skinks were captured over 6,099 trap days (0.1 percent or 1 skink/762 trap days) at 4 of 31 sites (Table 6-1; Figure 6-2). Four western red-tailed skinks were captured at Site #87 on East Rainier Mesa, Area 12, making it the site where the most western red-tailed skinks have been captured on the NTS. The first hatchling (Figure 6-5) ever documented on the NTS was captured in 2008 at Site #32, Area 20 (Figure 6-2). This is significant because it indicates that western red-tailed skinks are reproducing, at least in some areas of the NTS. This site was sampled in July/August 2006 with no western red-tailed skink captures.

It is difficult to know if western red-tailed skinks really do not occur at sites where they were not detected or if they were just not detected for various reasons (not active above ground, trap shy, did not encounter traps, etc.). MacKenzie et al. (2002) have developed a model and computer software (Program PRESENCE version 2.0) to calculate the probability a site is occupied by a given species. They propose that by repeated surveying of the sites, the probability of detecting the species can be estimated without bias. Program PRESENCE was used to calculate an unbiased probability that a given site was occupied using western red-tailed skink capture data gathered in 2008. Of the 31 sites, 26 were used in the analysis where sampling effort was standardized (6 days of trapping=6 repeat surveys). Since western red-tailed skinks were not guaranteed to be detected even when present at a site, the naïve estimate of the proportion of sites occupied was 15.4 percent (4 sites occupied/26 sites sampled). Using program PRESENCE, an unbiased estimate of the proportion of sites occupied was calculated to be 22.8 percent (standard error [s.e.] 13.1). Thus, roughly 6 of 26 sites are estimated to be occupied rather than the observed 4 of 26. Further, the probability of detecting a western red-tailed skink, if present, at any given site is 18.4 percent (s.e. 10.7). More complex analyses can be performed using covariates to account for heterogeneity and may be applied to the complete dataset when the western red-tailed skink distribution study is finalized.

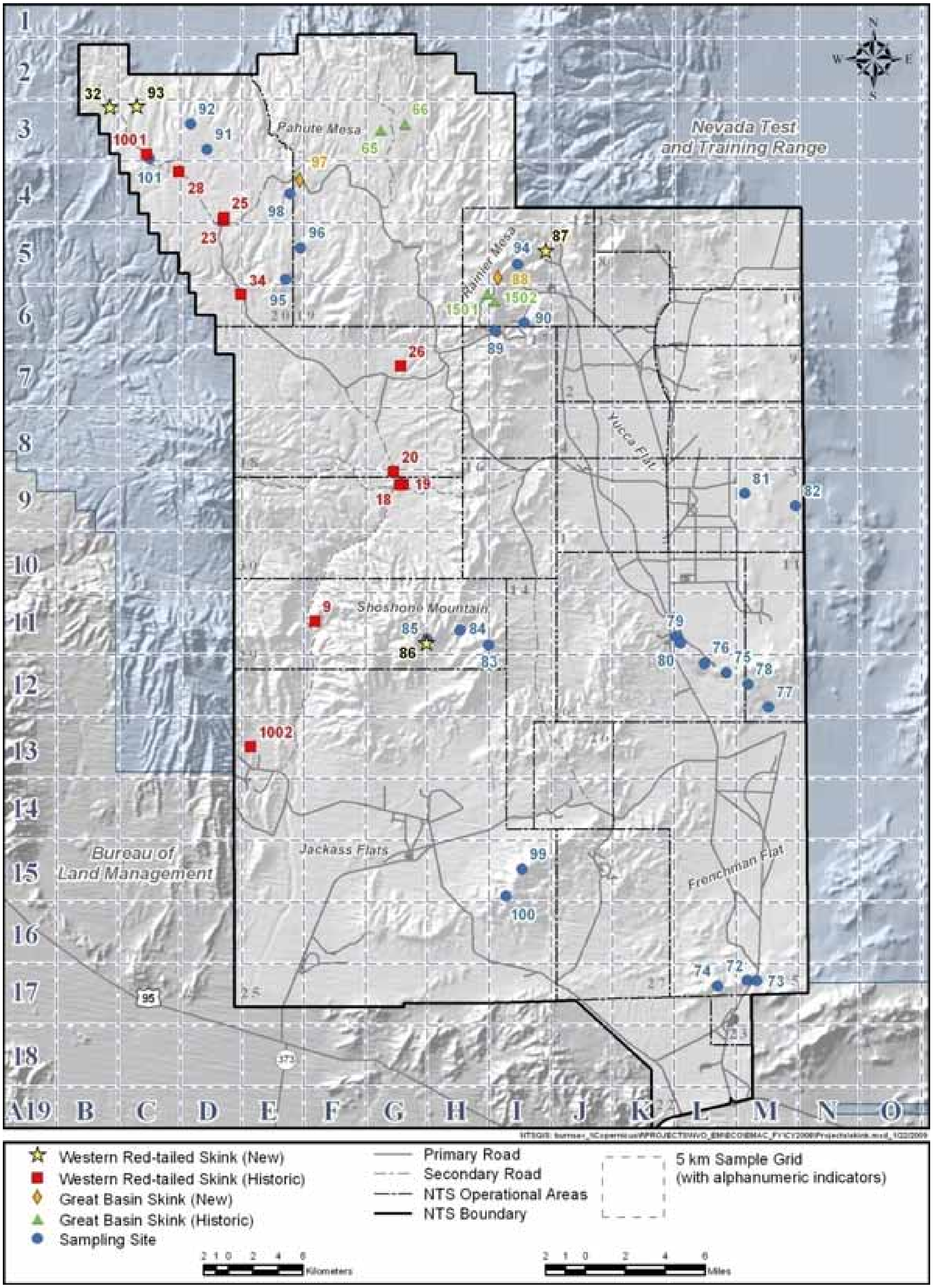

Figure 6-2. Western red-tailed and Great Basin skink distribution on the NTS including all known locations, sites sampled during 2008, and 5-km sample grid

Figure 6-3. Rectangular box-like funnel trap
(Photo by D. B. Hall, May 30, 2007)

Figure 6-4. Rectangular wire-mesh funnel trap
(Photo by P. D. Greger, August 4, 2008)

Table 6-1. Number of skinks and other reptiles captured by NTS area, site, and survey period
(P=species observed but not captured; [a]=Site where trap types were compared)

				Lizards										Snakes								
Site Number	NTS Area	Dates in 2008	Trap Days	*Cnemidophorus tigris*	*Coleonyx variegatus*	*Crotaphytus bicinctores*	*Eumeces gilberti*	*Eumeces skiltonianus*	*Sauromalus obesus*	*Sceloporus graciosus*	*Sceloporus magister*	*Sceloporus occidentalis*	*Uta stansburiana*	*Crotalus cerastes*	*Crotalus mitchellii*	*Diadophis punctatus*	*Masticophis flagellum*	*Masticophis taeniatus*	*Pituophis catenifer*	*Salvadora hexalepis*	Total	Percent Trap Success
72	5	4/21-5/1	300	2		1							2								5	1.7
73[a]	5	4/21-5/1	300	1									3								4	1.3
74	5	4/21-5/1	300			1							1	P							2	0.7
75	6	5/5-5/8; 5/12-5/15	180	4		P			P		8		6						1		19	10.6
76	6	5/5-5/8; 5/12-5/15	180	1	2						3		8		1						15	8.3
77[a]	11	5/5-5/8; 5/12-5/15	180	P							5		1							1	7	3.9
78[a]	6	5/5-5/8; 5/12-5/15	180	2	1						P		6				P				9	5.0
79	6	5/19-5/22; 5/27-5/30	180	2					P		3		2								7	3.9
80	6	5/19-5/22; 5/27-5/30	180	P							1		4								5	2.8
81[a]	3	5/19-5/22; 5/27-5/30	180	1	1						3		2								7	3.9
82[a]	3	5/19-5/22; 5/27-5/30	180	2		2					6		2								12	6.7
83	29	6/2-6/5; 6/9-6/12	184									5									5	2.7
84	29	6/2-6/5; 6/9-6/12	188									8						1			9	4.8
85	29	6/2-6/5; 6/9-6/12	180								1	2					1	2	4		10	5.6
86	29	6/2-6/5; 6/9-6/12	180	1			1				3	4							6		15	8.3
87[a]	12	6/23-6/26; 6/30-7/3	200	2			4				1	4	1					1			13	6.5
88	12	6/23-6/26; 6/30-7/3	184					2				10						1	1		14	7.6
89	17	6/23-6/26; 6/30-7/3	184									2	5						1		8	4.3
90[a]	12	6/23-6/26; 6/30-7/3	180							1		11	P		P			1			13	7.2
91	20	7/21-7/24; 7/28-7/31	180			1						7	4								12	6.7
92[a]	20	7/21-7/24; 7/28-7/31	180									2									2	1.1
93[a]	20	7/21-7/24; 7/28-7/31	180			P	1					4									5	2.8
32	20	7/21-7/24; 7/28-7/31	180			P	2					7	1					1			11	6.1
95[a]	20	8/18-8/21; 8/25-8/28	180	3								3	3								9	5.0
96[a]	19	8/18-8/21; 8/25-8/28	180									2	1								3	1.7
97	20	8/18-8/21; 8/25-8/28; 9/8-9/11	270					2			2	11	1			1		2			19	7.0
98	20	8/18-8/21; 8/25-8/28	180									4	1					1			6	3.3
99	25	9/15-9/18; 9/22-9/25	180										P								0	0.0
100	25	9/15-9/18; 9/22-9/25	180	1									4				1		1		7	3.9
94	12	7/23-9/17 Various	278									5	1					1			7	2.5
101	20	8/4-8/18	111	1		P						3									4	3.6
		Total:	**6,099**	**23**	**4**	**5**	**8**	**4**	**0**	**1**	**36**	**94**	**59**	**0**	**1**	**1**	**2**	**11**	**14**	**1**	**264**	**4.3**
Number of sites species was found:				**15**	**3**	**8**	**4**	**2**	**2**	**1**	**12**	**18**	**23**	**1**	**2**	**1**	**3**	**9**	**6**	**1**		

Figure 6-5. Hatchling western red-tailed skink, Site #32 (Schooner Wash), Area 20
(Photo by D. B. Hall, July 31, 2008)

Results from the genetic testing show how NTS skinks fit into the phylogeny of their conspecifics across their range (Figure 6-6). Results also showed that western red-tailed skinks from the NTS are part of the Inyo Clade and are most closely related to skinks from further northwest in Esmeralda County, Nevada, and west into the Panamint and Inyo/White Mountains in California. This is interesting because other western red-tailed skink samples collected by Dr. Richmond in 2008 in the Spring Mountains (Willow Creek area, about 30 km (19 mi) southeast of Mercury) belong to the Southwest Clade, which is a different evolutionary line age than the Inyo Clade (Figure 6-7). Great Basin skinks from the NTS are part of the Great Basin Clade, and their closest relatives are from southern Utah (Figure 6-7). Skink populations are known from sites between the NTS and southern Utah, but their genetic affinities are currently unknown. A little genetic difference was found among the 12 western red-tailed skinks collected from the NTS that spanned a distance of nearly 53 km (33 mi). In fact, identical haplotypes exist at multiple sites across the NTS. This likely reflects the young age of these populations and the fact that more suitable, continuous habitat in the recent past allowed greater opportunity for gene exchange. Genetic material from these specimens has been stored in hopes that future techniques will enable the determination of relatedness and patterns of dispersal at a much finer scale. Although molecular divergence among individuals of the same species was limited within the NTS, high levels of divergence were observed between species. This reflects the fact that the two skink species have been reproductively isolated (Figure 6-6) for an extended amount of time. Additionally, results suggest that the Great Basin skink has been present in the region longer than the western red-tailed skink.

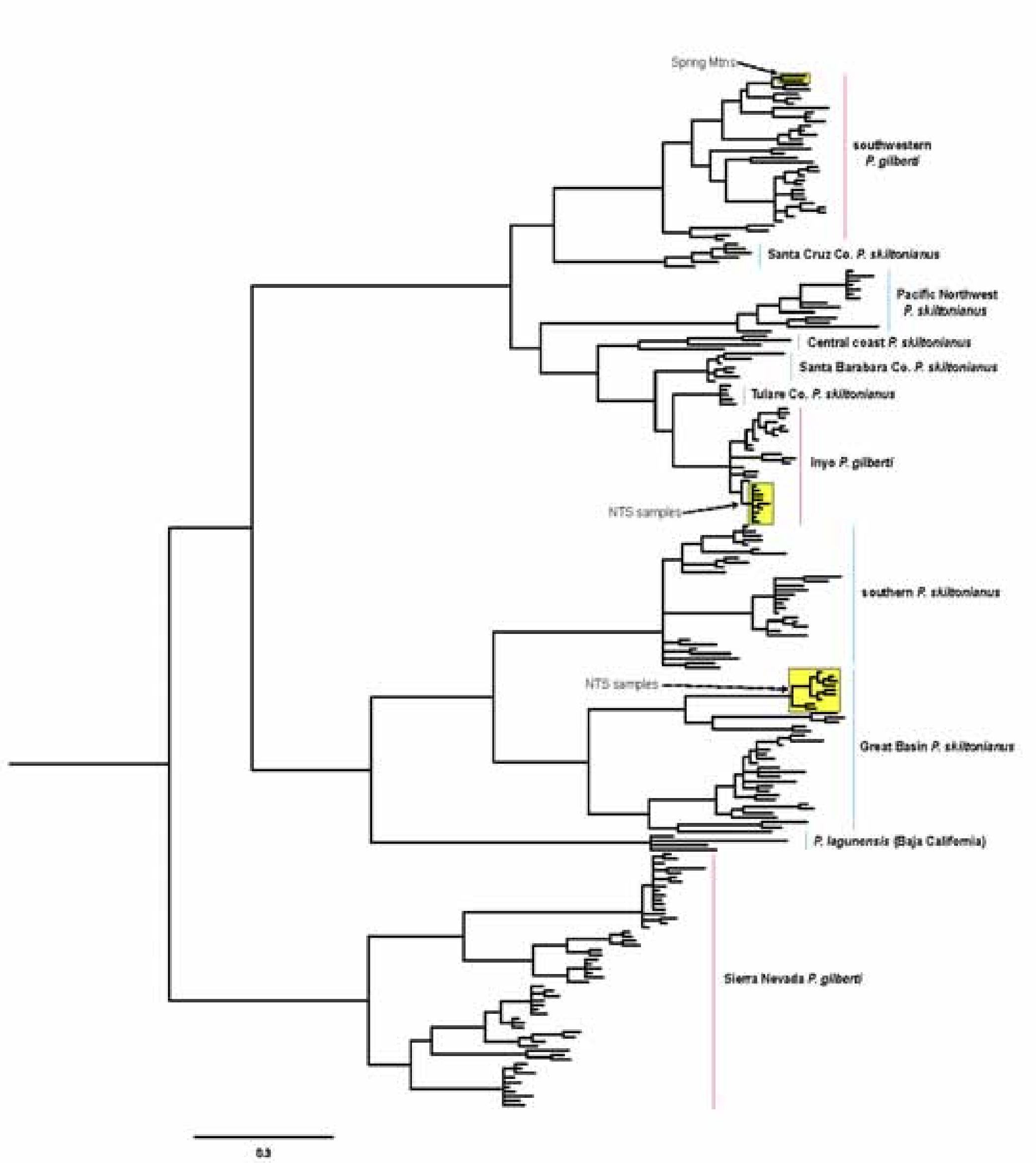

Figure 6-6. Phylogeny for the *Plestiodon* or *Eumeces skiltonianus* species complex (includes western red-tailed and Great Basin skinks) based on Bayesian analysis of mitochondrial DNA haplotypes. Red vertical bars=P. or *Eumeces gilberti* clades; blue vertical bars=P. or *Eumeces skiltonianus* clades. Yellow boxes highlight mtDNA lineages recovered from the NTS and Spring Mountains, NV

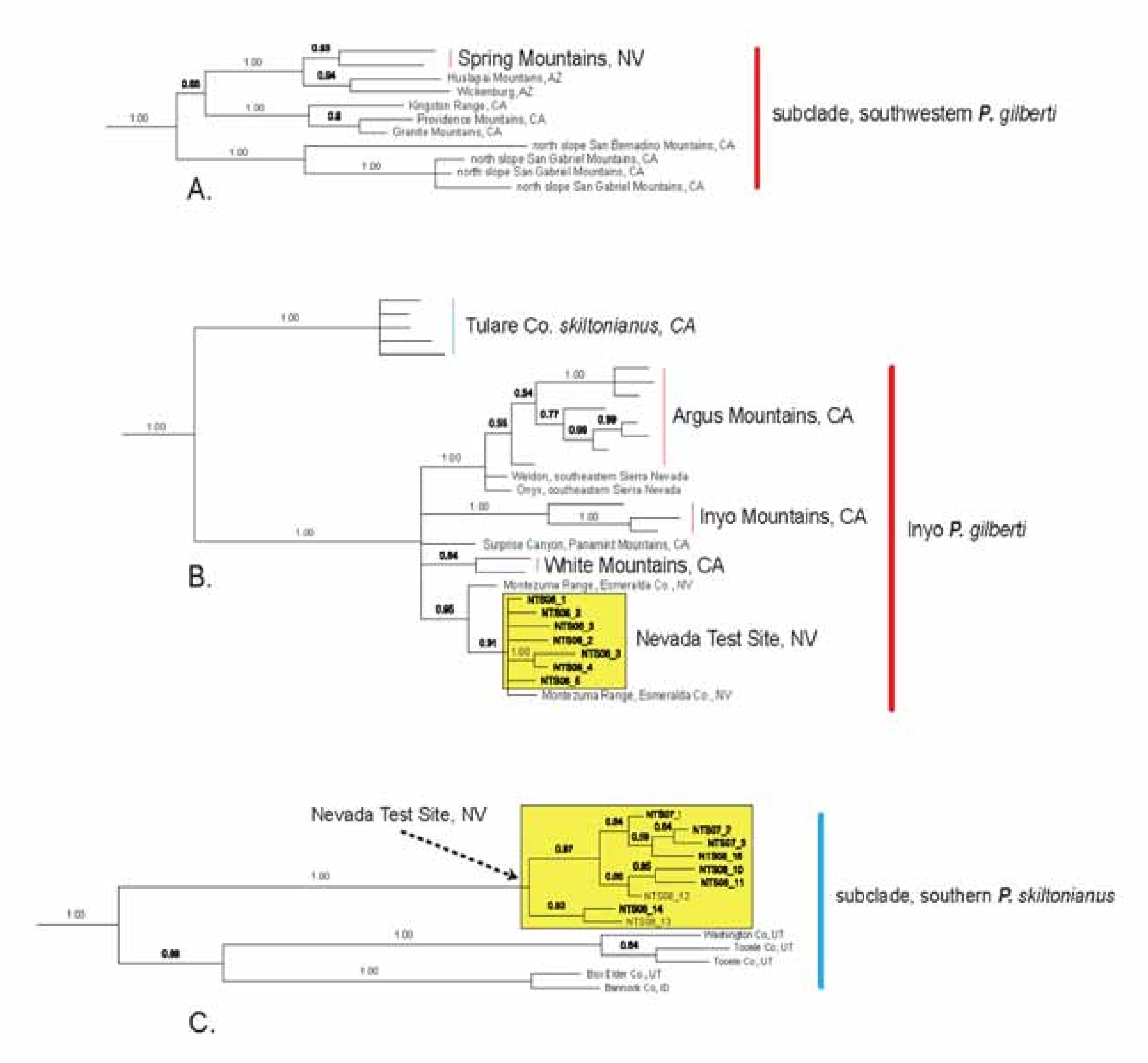

Figure 6-7. Detailed views of clades within the full phylogeny for the *P. skiltonianus* species complex. (A) Subset of lineages within the southwestern *P. gilberti* clade. (B) Inyo *P. gilberti* with its sister taxon, Tulare County, California *P. skiltonianus*. (C) Subset of lineages within the southern *P. skiltonianus* clade. Yellow boxes highlight mitochondrial DNA lineages recovered from the NTS and labels correspond to field identification numbers. Numbers in bold on the tree branches are Bayesian posterior probabilities and represent the probability that the corresponding clade is present in the "true" tree. A posterior probability of ≥95 percent is considered significantly supported. *(P. gilberti=Eumeces gilberti* and *P. skiltonianus=Eumeces skiltonianus)*

Overall trap success for reptiles was 4.3 percent in 2008 (264 captures/6,099 trap days) compared to 8.8 percent (538 captures/6,092 trap days) in 2006 and 3.6 percent (162 captures/4,517 trap days) in 2007. Trap success was significantly higher ($t=3.5$, $P=0.006$) in the box-type funnel traps with metal frame (6.1 percent, 64 captures/1,050 trap days) than in the wire-mesh traps (1.9 percent, 20 captures/1,050 trap days). The advantages of the wire-mesh traps are that they are cheaper to make and lighter than the box-type traps, so fewer trips are required to set them at sites long distances from roads. The disadvantage is that they are less effective than the box-type trap at capturing reptiles. Overall trap success increased from 4.3 percent to 5.1 percent (231 captures/4,506 trap days) when data from wire-mesh traps were excluded.

Based on captures and observations, 10 of the 16 known lizards and 7 of the 17 known snake species on the NTS were detected in 2008 (Table 6-1). Of particular interest was the capture of four Great Basin skinks *(Eumeces skiltonianus utahensis)* (Figure 6-8) at two locations (Figure 6-2), Site #88 (12T14, Rainier Mesa, Area 12) and Site #97 (Columbine Canyon, Pahute Mesa, Area 20). An additional two Great Basin skinks were captured by hand while turning over rocks during a field trip with Dr. Jonathan Richmond. He captured one at a historic location Site #1501 (Brigham Young University [BYU] Plot/RAM001 Plot) and one at Site #65 (Dead Horse Flat, south of Firing Range, Pahute Mesa, Area 20). Other noteworthy reptile observations and captures included three chuckwallas *(Sauromalus obesus)* seen at Site #75 (two under same rock, Figure 6-9) and one at Site #79; a sagebrush lizard *(Sceloporus graciosus)* captured at Site #90, east of G Tunnel, Area 12; numerous snake captures (primarily gopher snakes [*Pituophis catenifer*]) at Site #85 and Site #86, near Topopah Spring, Area 29 (Table 6-1); and a ring-necked snake *(Diadophis punctatus)* (Figure 6-10) and striped whipsnake *(Masticophis taeniatus)* in opposite corners of the same trap (even though the whipsnake was much larger than the ring-necked snake) at Site #97 (Columbine Canyon, Pahute Mesa, Area 20). Tissue samples from eight western red-tailed skinks and six Great Basin skinks caught in 2008 were sent to Dr. Jonathan Richmond at Cornell University for genetic testing. These are in addition to the four western red-tailed skink and three Great Basin skink tissue samples sent last year. Dr. Richmond is an expert on these two species and has been studying their evolutionary history using DNA for several years (Richmond and Reeder, 2002; Richmond and Jockusch, 2007). Genetic material from Nevada is sparse in his studies, and he was eager to analyze our samples to fill in data gaps from his sampling. Figures 6-9 and 6-10 and the information in the following paragraph were provided by Dr. Richmond.

During western red-tailed skink trapping, the presence of other species such as mammals and birds was also documented. A total of 103 captures or observations of 14 mammal species or their sign (e.g., tracks, scat, antlers) were recorded. In addition, 15 species of birds were detected audibly or by sight including 13 captures of rock wrens *(Salpinctes obsoletus)* and one black-throated sparrow *(Amphispiza bilineata)* capture. These data greatly expand the knowledge of the distribution of wildlife across the NTS, especially in areas that have never been sampled before.

Figure 6-8. Great Basin skink *(Eumeces skiltonianus utahensis)* captured at Site #88, 12T14, Rainier Mesa, Area 12

(Photo by D. B. Hall, July 3, 2008)

Figure 6-9. Two chuckwallas *(Sauromalus obesus)*, Site #75, Area 6

(Photo by D. B. Hall, May 5, 2008)

Figure 6-10. Ring-necked snake *(Diadophis punctatus)*, Site #97, Columbine Canyon, Pahute Mesa, Area 20

(Photo by D. B. Hall, September 11, 2008)

6.2 Western Burrowing Owl

Western burrowing owl monitoring entailed identifying their distribution on the NTS and trapping owls for a migratory study being conducted by the U.S. Department of Defense (DoD) Legacy project. Only one new burrow site was found in 2008. It is located in Area 25, along H Road near 40-Mile Wash. One sighting location was reclassified as an existing burrow site. An additional 26 records of western burrowing owls were found by examining the recently obtained original data collected by BYU from the late 1950s and early 1960s. Most data have no location information other than an NTS Area. Owls were documented in Areas 1 (N=11), 2 (N=3), 4 (N=5), 5 (N=4), and 17 (N=3). At three sites in Areas 1, 2, and 17, three or more owls were detected, which indicates a breeding pair at a burrow site. Another five records documented the presence of two individuals, presumably at burrow sites. Individual owls were documented at 18 locations and were considered sightings rather than burrow sites. This makes a total of 164 documented western burrowing owl locations (47 owl sightings [no burrow located] and 117 burrow sites) on the NTS (Figure 6-11). Of the 164 locations, 135 can be accurately plotted on a map, while there is insufficient information to plot the remaining 29.

Burrowing owl trapping was conducted for the fourth consecutive year. This is a collaborative effort with Dr. Courtney Conway from the University of Arizona. Dr. Conway is working on a DoD Legacy funded project evaluating migratory linkages of western burrowing owls in western North America. This involves trapping and banding burrowing owls and taking feather and blood samples. An NSTec biologist was trained by Vicki Garcia, an associate of Dr. Conway, to band owls and collect the required samples. Trapping and banding was conducted under authority of Federal Bird Banding Permit #22524 and Nevada Scientific Collection Permit #S29811.

Traps were set out at eight burrow sites (Figure 6-11) between April 16 and July 22 for a total of 32 "trap nights" (traps are usually set for three to six hours per night and checked regularly). Nineteen captures of 9 or 10 individual owls (7 adults and 2 or 3 juveniles) were documented (Table 6-2).

Table 6-2. Western burrowing owl trapping results on the NTS, April–July 2008

Site number/ Burrow	Date	Sex[a]	Weight (grams)	Juvenile Age (days)	Acraft band #	FWS band #	Feathers collected	Blood collected
32/A	4/16	M	153	Adult	Re-EC	934-26788	Yes	Yes
32/A	4/16	F	115	Adult[b]	Re-EB	934-26787	Yes	Yes
126/A	4/16	F	145	Adult[b]	Re-ED	934-26789	Yes	Yes
38/B	6/3	F	210	Adult[b]	Re-EE	934-26790	Yes	Yes
70/D	6/3	F	170	Adult	Re-EH	934-26791	Yes	No
64/A	7/8	F	147	Adult[b]	Re-HA	934-26792	Yes	Yes
78/A	7/8	F	135	Adult[b]	Re-HB	934-26793	Yes	Yes
78/A	7/9	J	DNT[c]	11	None	None	No	No
78/A	7/22	J	116	26	Br-M6	934-26794	Yes	Yes
70/D	7/22	J	157	32–45	Br-P6	934-26795	Yes	Yes

[a]J=juvenile, F=Female, M=Male; [b]Recapture same year; [c]Data not taken, owl was too young

It is unknown if the two juveniles captured at Site #78 are the same owl. Nine recaptures of five individuals were recorded. In addition, four 11–13 day old chicks were seen (not captured) on the burrow apron at Site #38 on July 9, 2008. Colored Acraft bands and FWS aluminum bands were placed on the left and right legs of adult females, respectively (Figure 6-12). For adult males, bands were reversed to facilitate identification of females and males in future years. Two juveniles were banded with brown colored Acraft bands on their left legs and FWS bands on their right legs. Feather and blood samples were taken from nine and eight owls, respectively. Feather and blood samples will be analyzed at a future date by Dr. Conway and his colleagues. Information learned from this cooperative effort will give NSTec biologists a greater understanding of western burrowing owl residency and migratory status on the NTS. It may also help determine where owls from the NTS are wintering and identify potential threats to them at their wintering areas, which may help explain changes in NTS burrowing owl numbers and future trends.

The number of owls captured in 2008 (9 or 10 [one juvenile was not marked and may have been captured twice]) was the second lowest recorded in the four years of trapping: 22 in 2005 [33 trap nights], 34 in 2006 [91 trap nights], and 7 in 2007 [70 trap nights]). Also, only three breeding pairs were documented in 2008 compared with two in 2007 and 5 to 11 breeding pairs in previous years (1999–2001, 2005–2006), even though numerous owl sightings were recorded during trapping activities. Breeding at Site #70, the northernmost and highest elevation (1,902 m) burrowing owl breeding site on the NTS, was documented for the second consecutive year. Reproduction appeared to be delayed again in 2008 with the first juveniles (very young, 11–13 days old) not being detected until July 9th. The effects of the drought (i.e., reduced insect and small mammal populations) are most likely the reason for the low and delayed reproduction. A conspicuous lack of breeding and overall reduction of burrowing owl activity was observed in 2008 in Yucca Flat, which is typically where most owl breeding and activity occurs. Perhaps owls are breeding at the higher elevation, moister sites because of the drier conditions at lower elevations.

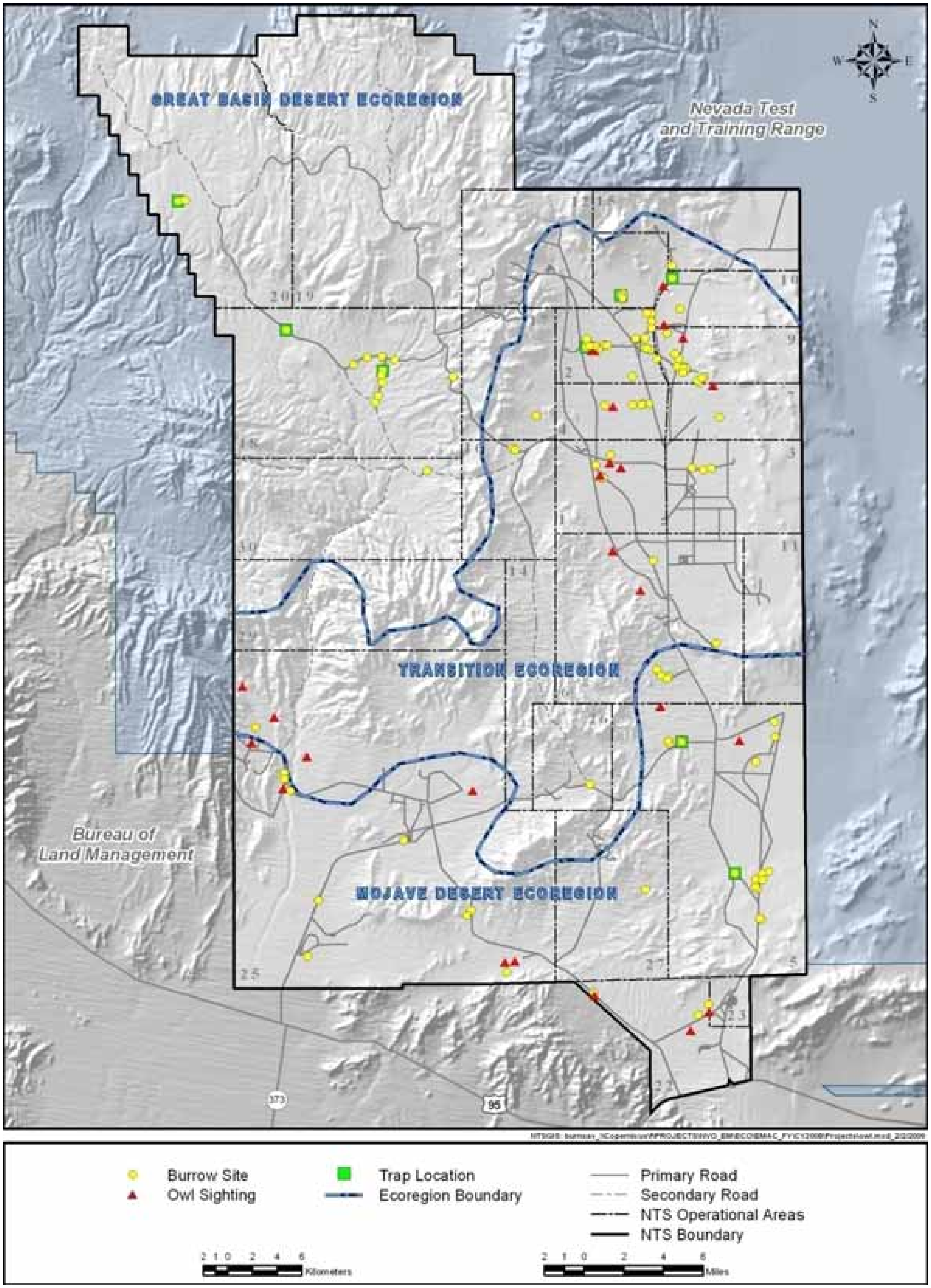

Figure 6-11. Known western burrowing owl distribution on the NTS and burrow sites where trapping occurred in 2008

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Figure 6-12. Captured female western burrowing owl with Acraft band on the left leg and aluminum FWS band on the right leg

(Photo by W. K. Ostler, June 20, 2007)

6.3 Raptor Observations

Sight records for 16 species of raptors on the NTS have been made historically, and nine species are known to breed on the NTS (Hunter, 1994). Raptors include all vultures, hawks, kites, eagles, ospreys, falcons, and owls. Some are rare visitors such as the Ferruginous hawk *(Buteo regalis)*. Hayward et al. (1963) reported only nine sight records in the fall–spring on NTS during 1959–62, mostly on Yucca Flat. Some raptors are common spring–fall migrants, adapted to foraging around trees (Sharp-shinned [*Accipiter striatus*] and Cooper's hawks [*A. cooperi*]), and others are fish eaters such as the Osprey *(Pandion haliaetus)*, occasionally seen perching on poles near ponds. Merlins *(Falco columbarius)* have not been observed at NTS in recent years; however, a recent literature search has revealed that Guillion et al. (1959) reported that a Merlin was sighted on Frenchman Flat on October 3, 1951. This is an example of a species that commonly migrates through Nevada and is rarely seen. All are protected/regulated under the *Migratory Bird Treaty Act* and/or Nevada State law. Because these raptors occupy the higher trophic levels of the food chain, they are regarded as indicators of ecosystem stability and health. During 2008 we recorded opportunistic records of raptors and mortalities of raptors (Sections 6.3.1 and 6.3.2).

6.3.1 2008 Notable Sightings

A prairie falcon *(Falco mexicanus)* adult was observed on top of a 21.3 m (70 ft) tower in Area 7 (Icecap) where it nested on a soil scrape seen on July 10, 2008, and a juvenile bird was found dead at this time at the nest. Cause of death was unknown. A fledgling falcon was later observed in the area. This is only the second known breeding record for prairie falcons on the NTS. Another Prairie falcon was found dead as a road kill on Frenchman Flat on June 12, 2008.

Opportunistic sightings of other raptors observed in 2008 included red-tailed hawks *(Buteo jamaicensis)*, turkey vultures *(Cathartes aura)*, golden eagles *(Aquila chrysaetos)*, and American kestrels *(Falco sparverius)*. Many of these raptors were seen perching on utility poles on Frenchman Flat and Yucca Flat. Great horned owls *(Bubo virginianus)* and Barn owls *(Tyto alba)* were also recorded regularly around buildings and facilities. Fewer Cooper's hawks and sharp-shinned hawks were observed around water sources or near Rainier Mesa than in previous years.

6.3.2 Bird Mortality

Bird mortality is recorded as a measure of potential impacts that NNSA/NSO activities may have on protected bird species. Only 10 bird mortalities were recorded in 2008. The most common cause of bird mortality detected in 2008 was road kill (Table 6-3). A Great-horned owl was found entangled in barbed wire at the Schooner solar panel site on July 22, 2008. Some raptors were found with broken wings or obvious head injuries of which the cause of death was indeterminate. A unique finding was a Sabine's gull *(Xema sabini)* found dead on the Tippipah Highway in Yucca Flat. This bird is an Alaska breeder and transient to Nevada that strayed significantly inland to the Mohave Desert on its migration. It is uncommon to find this species on the NTS, and was deposited at the Marjorie Barrick Museum of Natural History of the University of Nevada, Las Vegas (UNLV). Few impacts to birds were observed or reported from project activities. Therefore, impacts to bird populations from NNSA/NSO activities at the NTS appear to be very low.

Table 6-3. Records of bird mortality on the NTS during 2008

	Cause of Death			
Species	**Electrocution**	**Road kill**	**Tangled in barbed-wire**	**Unknown**
Barn owl *(Tyto alba)*				2
Common raven *(Corvus corax)*				1
Great-horned owl *(Bubo virginianus)*			1	
Horned lark *(Eremophila alpestris)*		1		
Prairie falcon *(Falco mexicanus)*		1		1
Red-tailed hawk *(Buteo jamaicensis)*	1	1		
Sabine's gull *(Xema sabini)*		1		
Totals:	**1**	**4**	**1**	**4**

6.4 Small Mammal Surveys

Surveys were conducted in 2008 to provide information on the distribution of small mammals on the NTS. The objectives were to (a) investigate potential new habitats for the dark kangaroo mouse *(Microdipodops megacephalus)* and the pale kangaroo mouse *(M. pallidus)*, (b) collect data on small mammals that can fill spatial data gaps needed for a better understanding of species distribution on the NTS, and (c) learn more about species occupancy at selected macro-habitats on the NTS. Macro-habitats are subjectively classified as wash, upland, valley, hill slope, etc.

Small mammal sampling was conducted by setting baited trap lines of 100 Sherman live traps for three consecutive nights. Trap-lines were opened and baited between 3:00 and 6:00 p.m. and checked the following morning between 6:00 and 10:00 a.m. Trapped animals were identified and marked with a unique indelible color on the first two days of trapping so total numbers of individuals could be tallied. Trapping design included two trap lines, one in each comparative macro-habitat, such as a wash and an upland habitat. Chi-square tests were performed across similar macro-habitat pairs to determine if species proportions varied significantly between macro-habitats. Cell totals (<8) were lumped into an “other species category” before conducting tests. Exclusive of paired comparisons, no statistical comparisons were made for species across sites. Statistical significance was set at $P = 0.05$ for all tests. It is recognized that the macro-habitat categories used are crude distinctions in relation to the overall complexity of habitats sampled and that these results, although preliminary, are instructive and should be viewed with caution. The intent by making these comparisons was to learn more about species occupancy of different habitats common on the NTS.

A total of 257 captures was recorded representing 12 species at nine sites on the NTS (Figure 6-13). A total of 187 small mammals were caught (Table 6-4). No kangaroo mice were captured during 2008. Trap success averaged 8.8 percent and ranged from 3.3 to 15.7 percent across sites, much lower than was recorded in 2007. The reduced success was attributed to drought conditions on the lower desert and lower densities of small mammals during the summer of 2008.

Four pair-wise comparisons were tested of rodent numbers at four locations in 2008 (Table 6-4). Two locations had significant differences in proportions of rodents in paired habitats (Shoshone Mountain Peak versus Valley Wash, and Skull Mountain Burn versus Unburned habitat). Two other locations did not have significant differences in proportions of species (Table 6-4).

Notable was that the Canyon Mouse *(Peromyscus. crinitis)* and desert packrats *(Neotoma lepida)* were abundant in a rocky area of the unburned habitat on top of Skull Mountain, but both were conspicuously absent from the previously burned habitat. Few species or individuals were present on the burned area (the fire occurred in 2005). Two species that began to show up on the burned area were Merriam’s *(Dipodomys merriami)* and chisel-toothed kangaroo rats *(D. microps)*, although in small numbers. It is noteworthy that after three trapping nights, there were four times the number of individual small mammals captured on the unburned area than on the burned area.

Comparing two additional habitats, a mountain slope to a valley wash at Shoshone Mountain, it was noted that pinyon mouse *(Peromyscus truei)* was a dominant species on the mountaintop slope, but was absent from lower-elevation wash habitats. The Great Basin pocket mouse *(Perognathus parvus)* and the deer mouse *(P. maniculatus)* also contributed significantly to the overall difference in species composition between habitats. The Great Basin pocket mouse was collected from two new regions (Scarp Canyon and Shoshone Mountain Valley Wash) (Table 6-4) on the NTS in 2008. Finally, the results from Red Mountain, the highest elevation site ever sampled on the southern end of the NTS, revealed moderate numbers of two co-dominant species, the chisel-toothed kangaroo rat and the long-tailed pocket mouse *(Chaetodipus formosus)* (Table 6-4).

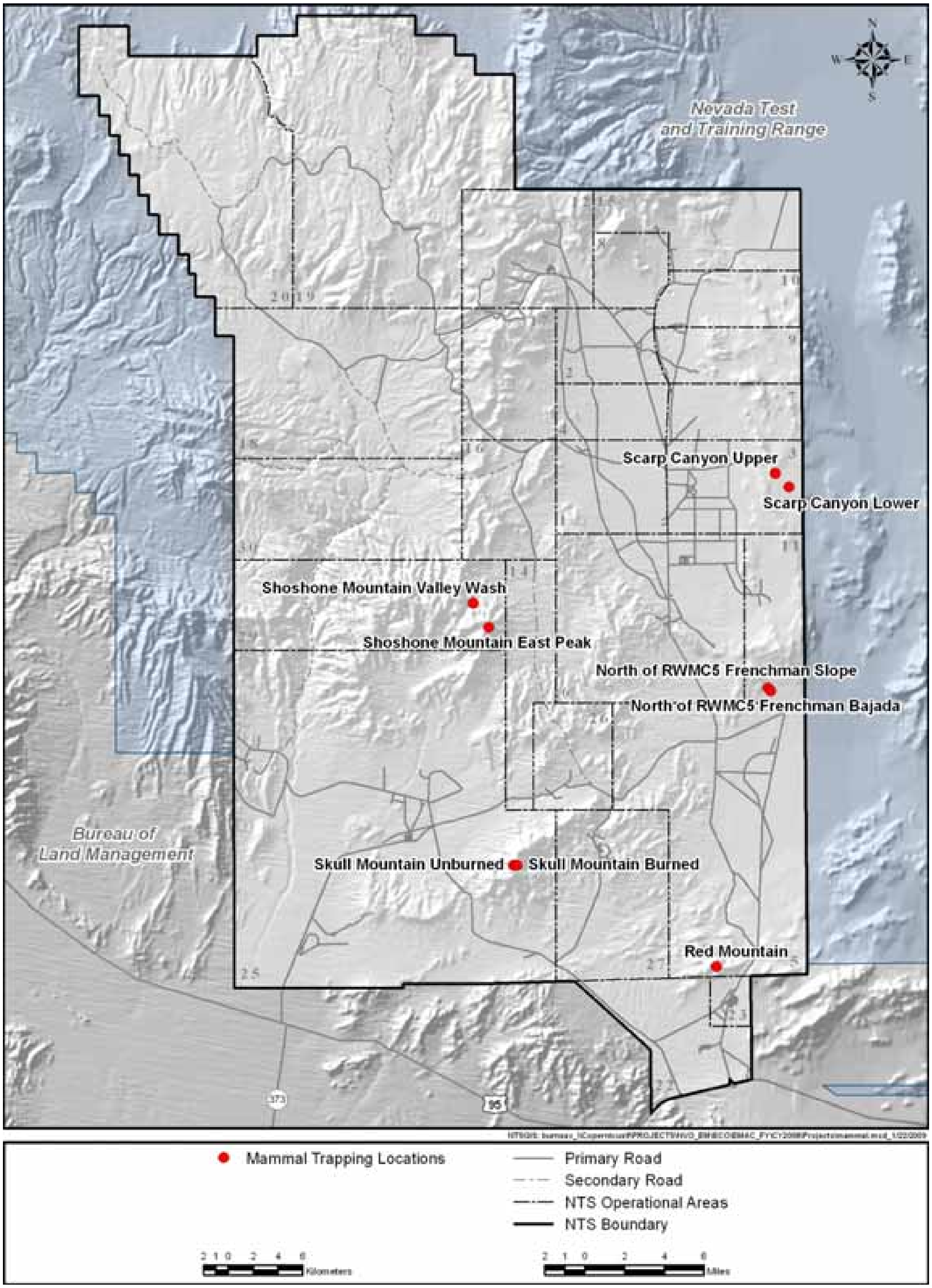

Figure 6-13. Trapping locations for small mammals on the NTS in 2008

Table 6-4. Numbers of individual small mammals captured on trap lines on the NTS in 2008[a]

Species			*Ammospermophilus leucurus*	*Dipodomys merriami*	*Dipodomys microps*	*Chaetodipus formosus*	*Neotoma lepida*	*Perognathus crinitus*	*Perognathus parvus*	*Peromyscus maniculatus*	*Peromyscus truei*	*Sylvilagus audubonii*	*Eutamias dorsalis*	*Thomomys bottae*	Total Individuals caught	% Capture Success	Chi square, P (df), for test of parallel patterns among species	Other species lumped into "other species" category	Total Mammal Captures
Trapping Sites	Area	Dates	**AMLE**	**DIME**	**DIMI**	**CHFO**	**NELE**	**PECR**	**PEPA**	**PEMA**	**PETR**	**SYAU**	**EUDO**	**THBO**					
Red Mountain	23	4-22 to 5-1	0	1	9	9	5	1	0	0	0	0	0	0	25	6.3			38
North of RWMC5 Frenchman Slope	5	5-6 to 5-8	0	0	0	37	6	3	0	0	0	0	0	0	46	21	0.003		63
North of RWMC5 Frenchman Bajada			1	3	2	25	0	0	0	0	0	0	0	1	32	15.7	0.999 (1)		47
Scarp Canyon Upper	7	5-20 to 5-22	1	6	3	0	0	0	5	0	0	0	0	0	15	5.7	3.31		17
Scarp Canyon Lower			0	8	0	0	0	0	2	0	0	0	0	0	10	6.7	0.069 (1)		20
Shoshone Mountain Vallley Wash	29	6-3 to 6-5	0	0	0	0	0	0	3	1	1	3	0	0	8	3.3	4.89	PEPA PEMA	10
Shoshone Mountain East Peak			0	0	0	0	0	0	0	2	8	0	2	0	12	4.7	0.03 (1)		14
Skull Mountain Unburned	23	9-16 to 9-18	3	0	1	0	8	20	0	0	0	0	0	0	32	12.7	30.32	DIME, DIMI, PEMA	38
Skull Mountain Burn			0	2	2	0	0	0	0	3	0	0	0	0	7	3.3	0.00001 (2)		10
Totals			5	20	17	71	19	24	10	6	9	4	2	1	187	8.8			257

[e] % Capture success =total caught/ total trap nights x 100

Excluded from statistical analyses

Minimal contribution to the Chi Square

Substantial contribution to the Chi Square

6.5 Bat Surveys

In 2008, bat monitoring focused on (a) passive acoustic monitoring of bat activity at Camp 17 Pond, (b) pre-closure monitoring at 16A Tunnel, and (c) removing bats from buildings and documenting bat roosts.

6.5.1 Camp 17 Pond Passive Acoustic Monitoring System

To learn more about long-term bat activity through different seasons and years, a passive acoustic monitoring system (Anabat II, Titley Electronics, Ballina, Australia) was installed at Camp 17 Pond (Figure 6-14) on September 22, 2003. Hundreds of thousands of electronic files containing bat calls have been recorded and are in the process of being analyzed by O'Farrell Biological Consulting. No comparable dataset exists. Bat vocalizations and climatic data (e.g., temperature, humidity, wind, barometric pressure) were recorded again in 2008. Progress was made to obtain and summarize the climatic data and put it into a format that can be correlated directly with bat vocalization data. This will help elucidate patterns of bat activity in relation to weather conditions. An NSTec biologist is collaborating with Dr. Mike O'Farrell (O'Farrell Biological Consulting) and Jason Williams (Nevada Department of Wildlife) to analyze these data, and it is anticipated that results will be submitted for publication.

Figure 6-14. Passive acoustic monitoring system at Camp 17 Pond
(Photo by D. B. Hall, September 23, 2003)

6.5.2 16A Tunnel Pre-Closure Survey

The 16A Tunnel was closed in 2008 as part of a plan to safely close certain facilities that are no longer being used. Prior to closure, project personnel contacted NSTec biologists to assess if the closure would impact important biological resources. Results from a previous survey in July 2003 indicated that the tunnel was used as a night roost and foraging site by three sensitive bat species (small-footed myotis [*Myotis ciliolabrum*], California myotis [*M. californicus*], and western pipistrelle [*Pipistrellus hesperus*]). Another survey was conducted on July 1, 2008, to determine if the tunnel was still being used by bats. The survey entailed recording bat vocalizations using an Anabat II™ system (about 2.5 hours) and video-taping the tunnel opening with a NightSight™ camera (about 1.5 hours). In all, 66 files containing vocalizations of five species were documented. In addition to the three species detected in 2003, two more sensitive bat species, fringed myotis *(M. thysanodes)* and Yuma myotis *(M. yumanensis)*, were also detected. Video footage showed 20 bat exits and 18 bat entries. Based on the timing of these exits and entries, 16A Tunnel was being used as a day roost as well as a night roost and foraging site. Thus, it was decided to install a bat-compatible closure.

An NSTec biologist met with responsible managers and construction personnel at the 16A Tunnel to design the closure. Construction personnel determined the best and cheapest method of closure was to "shotcrete" the tunnel opening using the existing gate as the framework (Figure 6-15). The existing gate had a 10–15 cm (4–6 in.) gap between the top of the gate and the tunnel ceiling. This is a large enough gap for bats to fly in and out of the tunnel and also allow air flow in and out of the tunnel, both important considerations in maintaining the tunnel as bat habitat. Everyone agreed this closure method was the most cost-effective way to satisfy the requirements to close the tunnel and still allow bats to utilize this important biological resource. Additional surveys will be conducted over the next few years to see if bats use the tunnel with the new closure.

Figure 6-15. Bat-compatible closure at 16A Tunnel
(Photo by D. B. Hall, December 10, 2008)

6.5.3 Bats at Buildings

A single bat was observed roosting in an alcove near the main entrance to Building 23-652 several times in January and February and again in August. It is not known if it was the same individual each time, but it appears that this alcove is used frequently as a temporary roost site. The bat in January was a female California myotis and the one in February and August was either a California or small-footed myotis. Eight other bats, including California or small-footed myotis and western pipistrelles, were found at six other buildings in Mercury. Two dead bats (one California or small-footed myotis and one unidentified species) were found inside a building at the Area 5 Radioactive Waste Management Complex, and two bats (one California or small-footed myotis and one unidentified species) were removed from the Device Assembly Facility in Area 6. Roost site locations will continue to be documented and stored in the Ecological Geographic Information System (EGIS) faunal database to enable NSTec biologists to increase their knowledge about bat roosting sites on the NTS.

6.6 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 NTS. Monitoring of individual horses at NTS began in 1989. In 2008, NSTec biologists determined horse abundance and recorded horse sign along roads and in some areas distant from roads. Also, selected natural and human-made water sources were visited in the summer to determine their influence on horse distribution and movements and document the impact horses are having on NTS wetlands and water sources. Information on abundance and recruitment during 1990–1998 is summarized in Greger and Romney (1999).

6.6.1 Abundance Survey

A count of individual horses is used to estimate abundance. In 2008, a count of horses was conducted during several non-consecutive days between May and November. A standard road course was driven to locate and identify horses. Motion/heat activated cameras at Camp 17 Pond and Captain Jack Spring were also used to photograph horses. Individuals were identified by their unique physical markings (facial blazes) and classified as foal, yearling, or older when possible. The direct population count in 2008 was 35 individuals not including foals (Table 6-5). Several horse bands (composed of stallions, subordinate males, females, and their offspring) were detected in 2008. This decrease in numbers since 2007 is regarded as small and likely not biologically significant.

Table 6-5. Number of horses observed on the NTS by age class, gender, and year

Age Class	Years													
	2002		2003		2004		2005		2006		2007		2008	
Foals	5		6		5		5		8		8		9	
Yearlings	0		9[a]		9		6		8		1		0	
Age Class	***Gender***[b]													
	M	F	M	F	M	F	M	F	M	F	M	F	M	F
2-Year Olds	0	2	0	0	4	4	5	4	3	3	2	3	0	0
3-Year Olds	2	2	0	2	0	0	4	4	4	4	1	3	1	1
Adults (>3-Year Olds)	8	19	8	20	6	21	5	21	7	24	8	25	6	27
Total: (excluding foals and dead horses)	**33**		**38**		**44**		**49**		**53**		**42**		**35**	

[a] = 1 of the 9 was found dead; [b] M=Male, F=Female.

6.6.2 Horse Population Trends

Observations of the NTS horse population indicate a small decline in numbers from about 42 in 2007 to 35 in 2008 (Table 6-5, Figure 6-16). Survival of yearlings was low in 2007 and 2008, although foals recently detected are not surviving to yearling age. Overall, horse numbers appear to be holding stable over the last 6 years with no net trend.

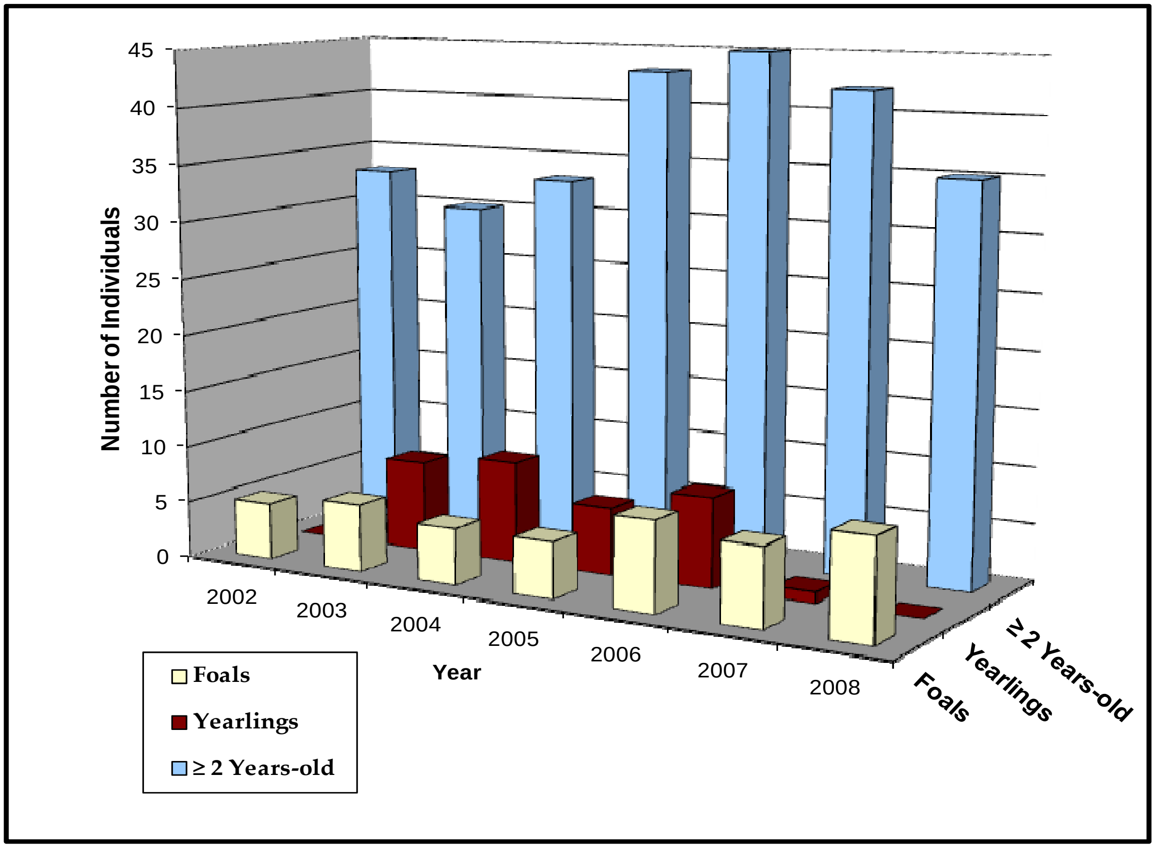

Figure 6-16. Trends in the age structure of the NTS horse population from 2002 to 2008

6.6.3 Annual Range Survey

During 2008, selected roads were driven within and along the boundaries of the suspected annual horse range, and all fresh sign (estimated to be < 1 year old) located on and adjacent to the roads were recorded. Eight days of effort were expended for the road surveys. Horse sign data collected during the road surveys and horse use at natural and human-made water sources indicate that the 2008 NTS horse range (Figure 6-17) includes Gold Meadows, Eleana Range, southwest foothills of the Eleana Range, and the Echo Peak region of southeast Pahute Mesa. Overall, the estimated annual horse range in 2008 appears to be similar to 2007 (213 km^2 [82 mi^2]).

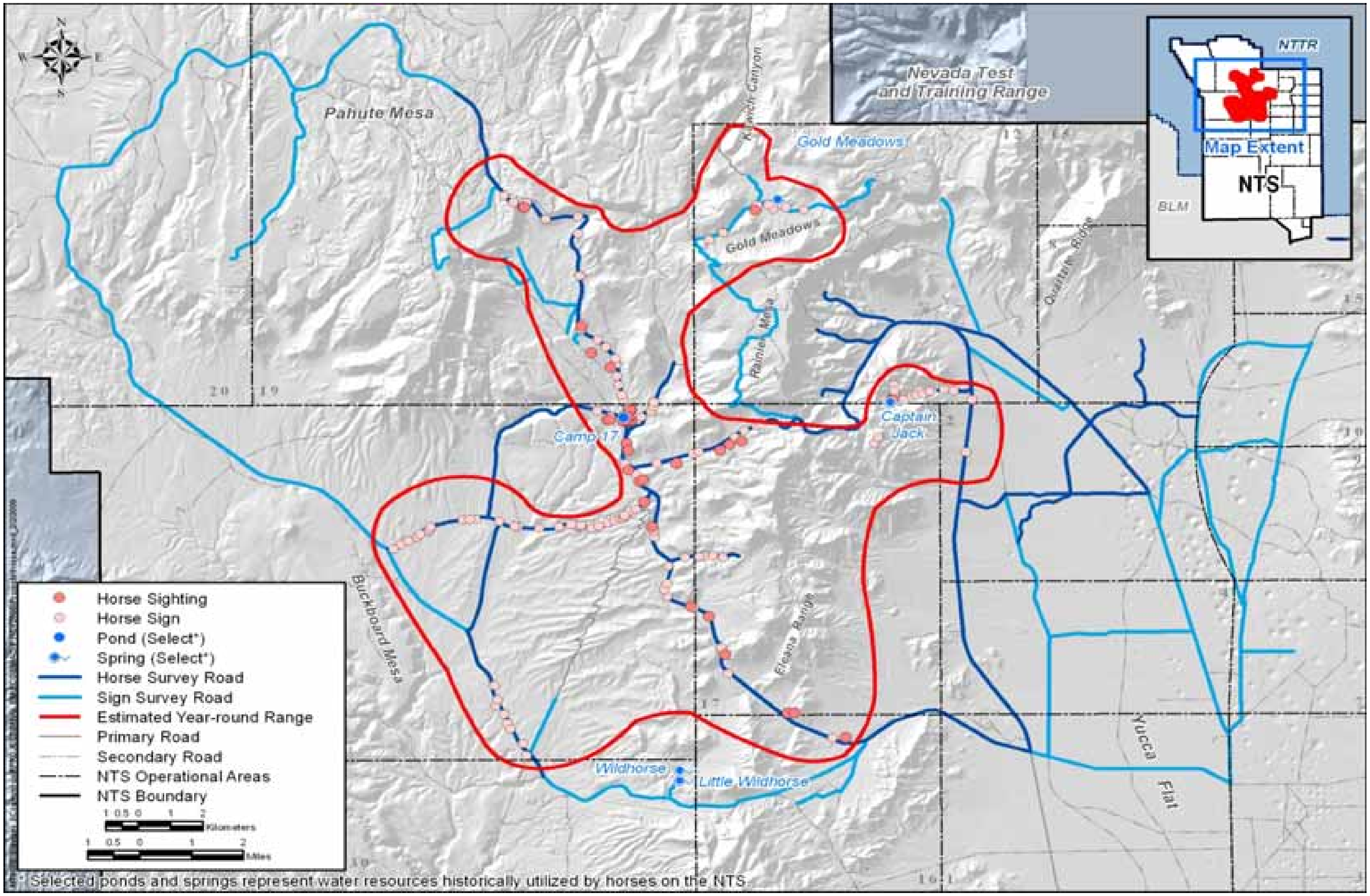

Figure 6-17. Feral horse sightings and horse sign observed on the NTS during 2008

6.6.4 Horse Use of NTS Water Sources

The NTS horse population is dependent on several natural and human-made water sources in Areas 18, 12, and 30 during different seasons (Figure 6-17). One natural water source (Gold Meadows Spring in Area 12) and one human-made pond (Camp 17 Pond in Area 18) were used heavily as in past years. Captain Jack Spring had low use in the fall of 2008 compared to 2007, when it showed no use by horses.

Horse and wildlife use at Camp 17 Pond was measured extensively from 2007 to 2008 by camera surveys (photos per day) with a photo delay set at one per minute, and a flash used at night. Camera monitoring was also conducted at Captain Jack Spring but on a limited basis in 2008. Digital cameras used were the Cam-Tracker™ at Camp 17 Pond and Scout Guard™ at Captain Jack Spring. These cameras are capable of recording 1,000 or more events per month before the data cards become full. In one case in July 2008, use was high enough to fill the card and stop the actual recording of photos.

Captain Jack Spring was used in 2008 by horses but only at a minimal level of activity shown by the lack of fresh tracks during visits. Also, placement of a video camera between October 22, 2008, and November 5, 2008 (14-day duration) showed only three separate days of use by horses and only two bands (six and two individuals each) visited the spring, mostly between 6:00 and 7:30 a.m. At Camp 17 Pond, horse use was much more extensive than at Captain Jack Spring. Monthly horse use for 2007 and 2008 for Camp 17 Pond is expressed as total number of photos per month (Table 6-6).

Table 6-6. Frequency of horse use from camera surveys (numbers of photos per month) at Camp 17 Pond

Month	2007	2008
February	0	0
March	211	9
April	170	30
May	255	48
June	187	39
July	78[a]	M[b]
August	130	M[b]
September	27	M[b]
October	0	168
November	8	93
March-June average	205.75	31.5

[a] 24 days of data are missing

[b] all data missing for month

T Test, P=0.0007, df=8

Camera surveys showed the importance of Camp 17 Pond as a major horse watering location. Horse usage varied significantly across years and was higher in early 2007 than 2008 as shown by the number of photos per month (Table 6-6). Horse use paralleled deer use at Camp 17 Pond in 2007 (see Section 6.7) with heavy use early (March–June). Horse use continued through July and

August when use was abruptly curtailed after a large rainfall on August 27 (Figure 6-18). Horses stopped using the pond for 13 consecutive days after the rain. Low use continued through the end of the year following the August–September rains. The following year, 2008, had a wetter spring than 2007, and as a result, horse use was significantly lower (t = 5.0, P = 0.0007) at Camp 17 Pond from March to June 2008 compared to 2007 (Table 6-6).

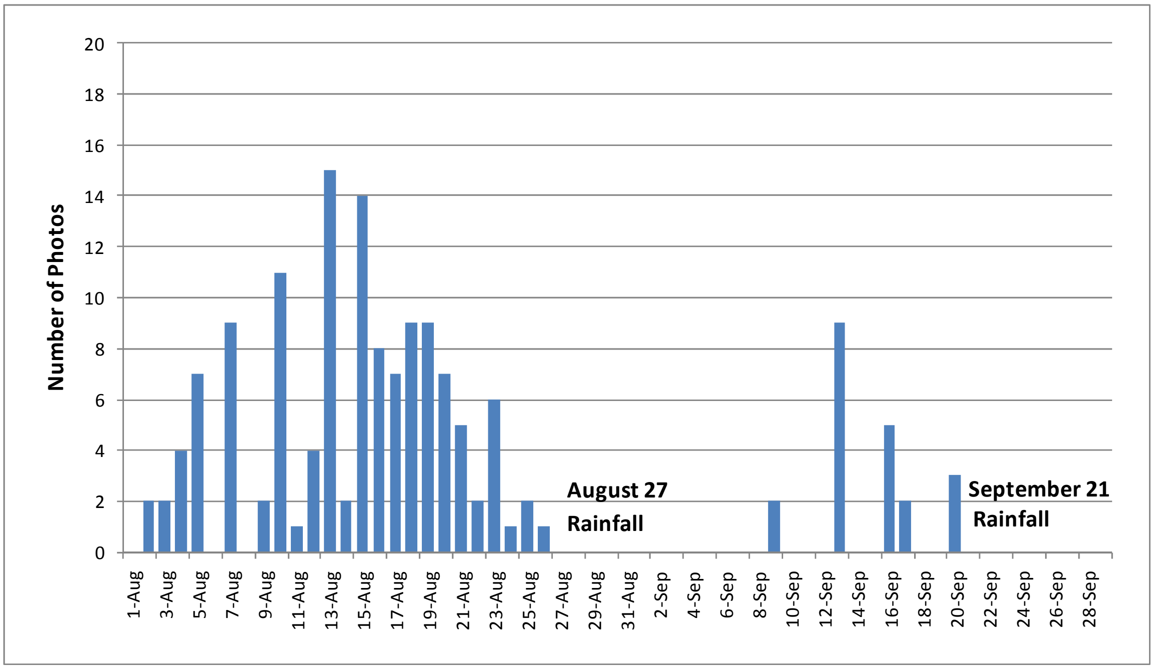

Figure 6-18. Horse use of Camp 17 Pond (number of photos/day) for August–September 2007 with affects of rainfall.

One major way that spring rains could lessen the importance of Camp 17 Pond is by making water available in small ephemeral catchments throughout the area. A second way is by improving or increasing the water content in vegetation, thereby reducing the water needs of wildlife and visits to the pond.

Some NTS springs used by horses are ephemeral in nature such as the Wild Horse Seeps, Pahute Pond, and Gold Meadows Spring. Gold Meadows Spring dried up in late May but refilled after a late September rainstorm and was reused by horses late in the year. As in past years, none of the plastic-lined sumps within or near the horse range was used by horses in 2008.

6.7 Mule Deer Abundance on the NTS

Previous studies of mule deer on the NTS show that the Pahute Mesa portion of the deer herd on NTS was much larger than the Rainier Mesa portion (Giles and Cooper, 1985). Estimates of deer abundance (deer/km) had been conducted from 1989 to 2007 to develop more information on trends in the NTS deer population. Recent work suggests that more deer are seen on the Rainier Mesa Transect than on the Pahute Mesa Transect, indicating possible shifts in distribution of deer over time. Work continued in 2008 with nighttime surveys conducted on deer transects at two-week intervals in September and October and with additional emphasis on calculating density, an improvement over relative abundance.

6.7.1 Methods

Mule deer abundance on the NTS was measured by driving two standardized road courses (77-km [48-mi] total length) (Figure 6-19) to count and identify mule deer. Counts are made by two observers with spotlights in a vehicle moving at a constant speed of about 10–15 km/hour (6.2–9.3 mi/hour). When deer or predators are spotted, the vehicle is stopped and observers use binoculars to count and classify animals according to age (adult, spike, fawn, etc.) and sex, if possible. A spotlighting session involves three consecutive nights of work from August to October. Counts were made during a single session each year from 1989 to 1994. Two sessions a year were completed during 1999 and 2000, and three sessions were completed in 2006, 2007, and 2008. Trends in total counts (Pahute and Rainier transects combined) and counts separate transect were examined as in previous years. Sex ratios of deer were tallied and reported for 2006–2008 in this section. In 2008, the perpendicular distance to each deer group was measured with a laser range finder, to employ the calculation of a density estimate of deer based on line-transect theory using program “DISTANCE 5.0, version 3” (hereafter referred to as DISTANCE) (Thomas et al., 2006). These data are reported in Section 6.7.2.

6.7.2 Deer Counts/Sex Ratios

Average total counts (45.5 deer per session) from surveys in 2008 on the NTS have increased nearly 50 percent over counts from 2007 (Figure 6-20) suggesting an increase in abundance. The increase in deer may be related indirectly to the increased winter–spring moisture that fell in the northern regions of the test site during winter/spring of 2008. For example, average rainfall from three weather stations (E Tunnel Pond, Rainier Mesa, and Little Feller) from January to June showed an increase in precipitation by a factor of about 3 in 2008 (94 millimeters [mm] [3.72 in.]), over the same time period in 2007 (33 mm, [1.31 in.]). The deer counts in the Rainier Mesa survey area continue to be higher (6.5–10 deer/10 km [6.2 mi]) than on Pahute Mesa survey area (4–6 deer/10 km [6.2 mi]) based on distance surveyed (Figure 6-21). For corresponding deer densities for each transect, see Section 6.7.3.

Male to female sex ratios calculated during spotlighting for 2006–2008 were 1.01, 2.18 and 1.11, respectively. The increase in sex ratio favoring bucks in 2007 could be related solely to poor doe survival caused by stress of reproduction. The spring/summer of 2007 was very dry, with no annuals germinated on the NTS. It is also plausible that bucks may have survived these conditions better (lacking the reproductive demands of does) than does or fawns. Furthermore, the number of fawn observations detected during these years was 31, 0, and 47, in 2006–2008, respectively. Thus, very low detections of fawns and does in 2007 (only 68 does and 0 fawns) contrasts greatly with 2008 when overall numbers rebounded, and a count of 147 does and 47 fawns were detected. The recovery in numbers in 2008 is likely related to the surviving does of 2007 and possibly immigrant does and fawns they later produced. Sex ratios determined by Giles and Cooper (1985) ranged from 1.55 to 1.95 in 1977–1981 for the NTS combined herd. Except for 2007, sex ratios from spotlighting surveys were lower than estimates from 1977 to 1981.

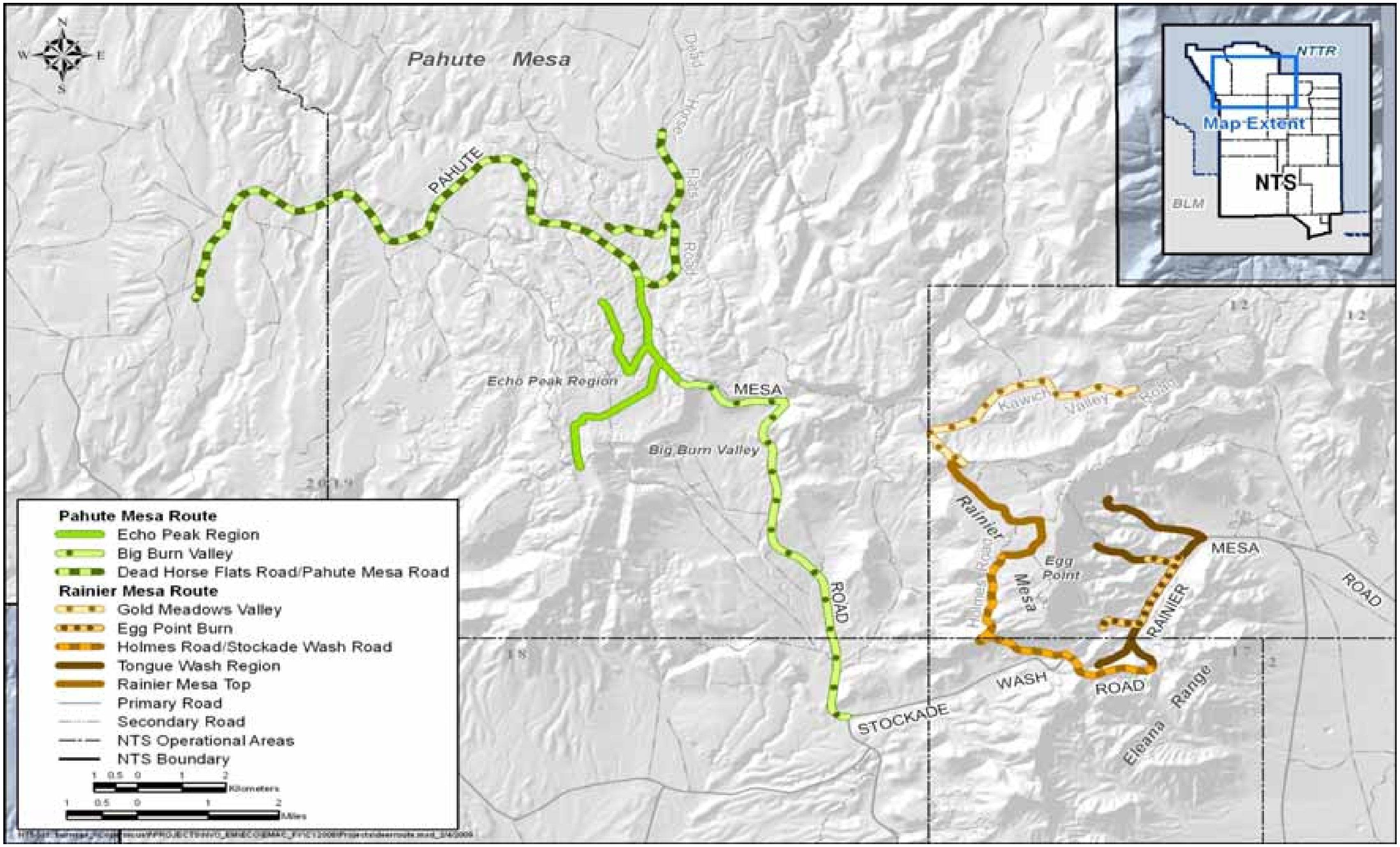

Figure 6-19. Two road routes and sections of each route driven on the NTS to count deer from 1989 to 2008

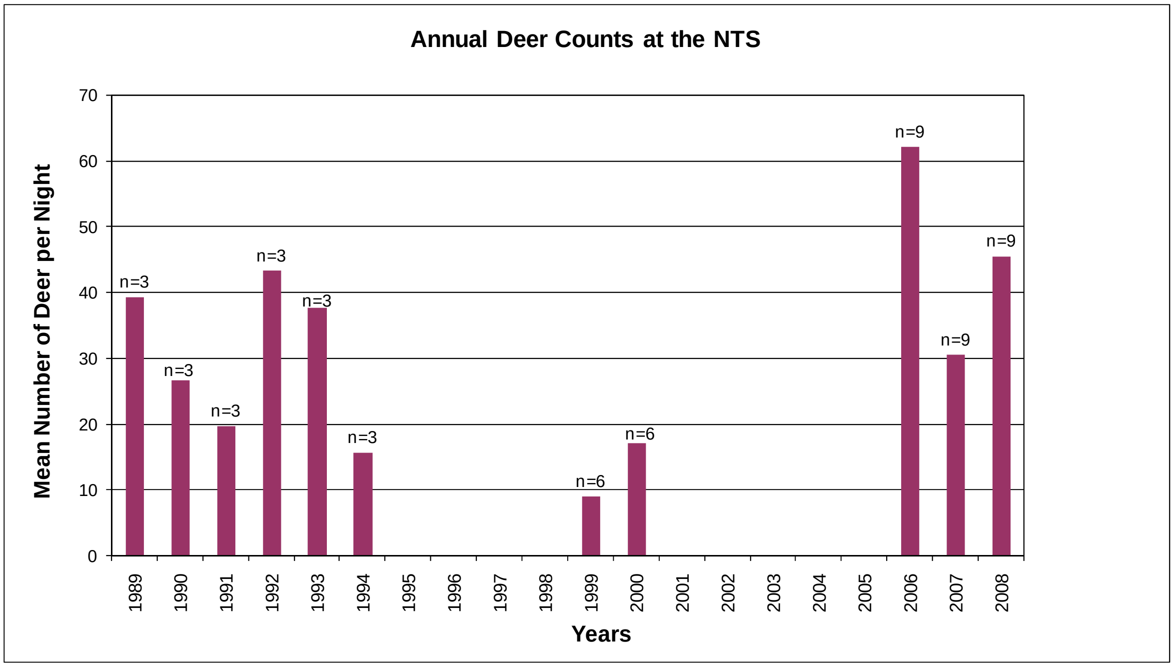

Figure 6-20. Trends in the total average deer counts per night from 1989 to 2008 on the NTS

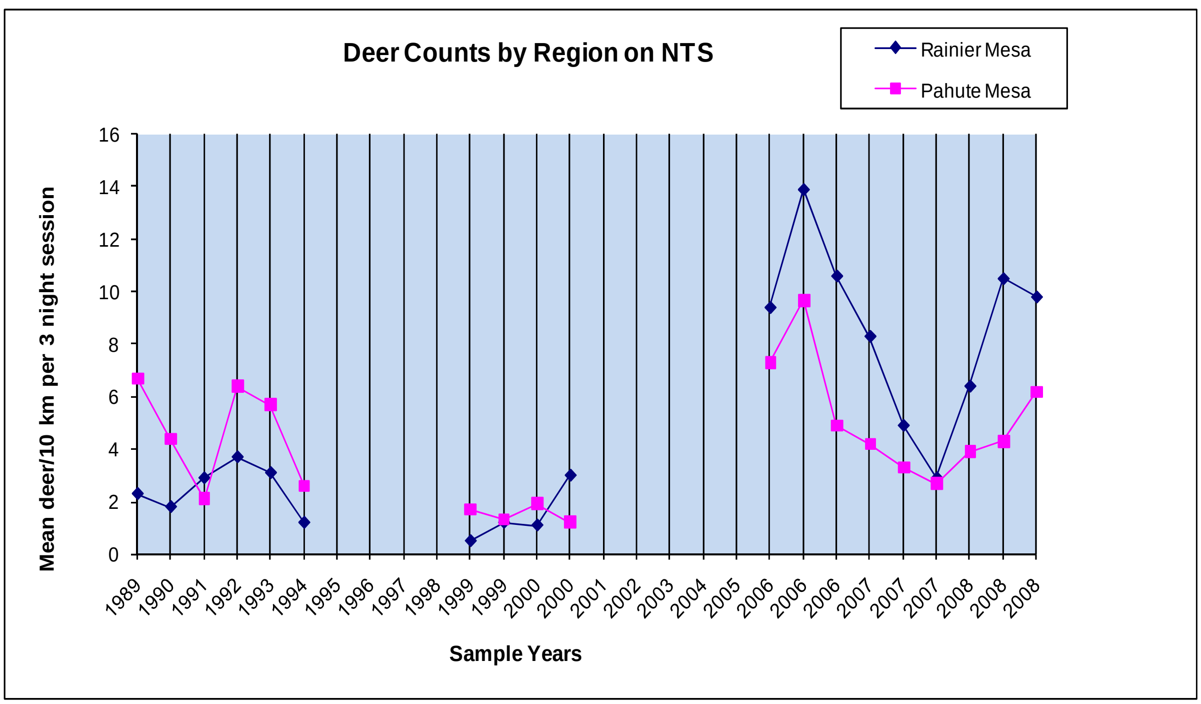

Figure 6-21. Deer counts from two regions of the NTS expressed as mean counts per three-night session per distance surveyed

6.7.3 Distance Sampling and Deer Density

Deer density was estimated on two routes (Figure 6-19) and several sub-routes using DISTANCE (Thomas et al., 2006). DISTANCE sampling is a plot-less method of assessment of densities when only a fraction of the animals along the transect are detected and when the exact area sampled is unknown (Buckland et al., 1993). Adequate population monitoring should focus on unbiased estimates of population density and trends of these parameters over time. Therefore, this new method has been used to estimate deer density as an improved measure, in addition to the abundance indices previously employed.

DISTANCE Methods – DISTANCE uses perpendicular sighting distances to calculate the probability of detecting animals as a function of distance from the transect. To employ the procedure, one fits several statistical models to the observed distributions of distances and uses goodness-of-fit tests and Akaike's Information Criterion (AIC value) to select the detection function model that best fits the data. The model with the lowest AIC value is chosen to model the data set. DISTANCE uses the selected model and observed average group size to estimate population density, the coefficient of variation, as well as log-based confidence intervals about the density estimate. DISTANCE has been previously used to estimate deer densities from spotlighting surveys on roads with good results (Stapp and Guttilla, 2006).

A Convention Distance Sampling Model was used with a half normal cosine procedure with one parameter (group size) for all of the density calculations. Two separate road surveys have been established as standard transects representative of deer herds in each region of NTS (Pahute and Rainier Mesa). They were driven at night a total of nine times, each two weeks apart from September to October. The response of the program DISTANCE was examined in calculating density from each deer route as a function of total number of accumulated sampling nights (range of 3–9 samples). Then smaller areas of each route were stratified into distinct habitats or topographic sections for analysis. The Rainier Mesa Transect was separated into five sections, and the Pahute Mesa Transect was divided into three sections (Figure 6-19, Table 6-8). Habitats in these sections varied with respect to openness of vegetation, topography, vegetation type, elevation, and level of disturbance, all factors that could possibly affect deer density. Deer density was calculated for all sections on the Rainier Mesa Transect except the Tongue Wash section. The Holmes Road/Stockade Wash Road section (Figure 6-19) was characterized as poor detectability typified by having high cliffs along the roadside and thick vegetation, thus limiting visibility. Deer density was calculated for all three sections of the Pahute Mesa Transect. For example, the Big Burn Area transect was stratified as separate from Pahute Mesa (Figure 6-19). In addition, density was calculated separately for the Echo Peak Region, a higher elevation area (2,120–2,295 m [6,955–7,530 ft]) on Pahute Mesa than the remainder of the route, Dead Horse Flats Road to the end of the route), which was a lower elevation region (1,970–2,120 m [6,463–6,955 ft]).

DISTANCE Results – A total of 412 deer were seen on routes combined in 2008 representing 206 deer groups during the fall season. Overall group size varied from 1 to 8, and average group size was 2 deer. Total number of deer spotted by NTS region varied from 190 at Pahute Mesa during 2008 to 222 at Rainier Mesa during nine surveys. Estimates of deer density after multiple sampling nights generally showed a leveling off in the estimate after eight days of sampling on Pahute Mesa, and after five to nine days of sampling on Rainier Mesa (Table 6-7). There is also a general increase in precision (shown by the gradual decline in the coefficient of variation [CV]) for each density estimate as additional sampling days are included (Table 6-7).

Table 6-7. The program DISTANCE deer density estimates (D) number/km^2, number of deer (N), and coefficient of variation (CV), for two transects on NTS by accumulated survey nights (n)

n	Rainier Mesa D	N deer	CV	Pahute Mesa D	N deer	CV
3	3.5	53 (26)	0.355	1.6	51 (26)	0.234
4	2.4	69 (35)	0.225	1.5	65 (36)	0.282
5	4	98 (45)	0.224	1.6	86 (49)	0.234
6	3.5	140 (65)	0.223	1.7	108 (63)	0.199
7	3.9	158 (77)	0.221	1.8	140 (76)	0.178
8	4.1	187 (91)	0.192	2	175 (89)	0.158
9	4	222(106)	0.174	2	190 (100)	0.151

n = number of accumulated survey nights

N deer = Total number of deer sighted (number of groups)

Overall, a significant difference in mean deer density (4 deer/km^2 [1.54 deer/mi^2] compared to 2 deer/km^2 [0.77 deer/mi^2]) was found between the Rainier Mesa Transect and the Pahute Mesa Transect (Table 6-8) based on the non-overlap of confidence intervals at the 0.05 level. This comparison had the lowest percent CVs (15.1 and 17.4, respectively) calculated for all densities.

Table 6-8. The program DISTANCE deer density estimates, confidence intervals, and other parameters for survey transects on the NTS.

Survey Transects	Transect Length (Km)	Deer Density D, n/Ha (n/Km^2)^b	Total Number Deer Counted	95% Lower Confidence Interval of D	95% Upper Confidence Interval of D	CVAR of D
Pahute Mesa Transect Total	**44.2**	**0.020 (2.0)**	**190**	**0.015**	**0.027**	**0.151**
Echo Peak	9	0.064 (6.4)	131	0.043	0.097	0.201
Dead Horse Flat Road/Pahute Mesa Road	22.4	0.006 (0.6)	29	0.003	0.011	0.321
Big Burn	12.8	0.01 (1.0)	30	0.005	0.02	0.323
Rainier Mesa Transect Total	**27**	**0.040 (4.0)**	**222**	**0.028**	**0.058**	**0.174**
Eggpoint Burn	4.5	0.047 (4.7)	51	0.024	0.09	0.328
Holmes Road/Stockade Wash Road	6.4	0.027 (2.7)	26	0.01	0.073	0.513
Rainier Mesa Top	5.8	0.047 (4.7)	40	0.027	0.081	0.274
Gold Meadows	6.2	0.049 (4.9)	80	0.026	0.094	0.327

[a]Model used is Conventional Distance Sampling, Half Cosine Model, with 1 observer, and 1 parameter (cluster size)

[b]Number of transects is 9 for all estimates

On Pahute Mesa, Echo Peak Transect had a mean density of 6.4 deer/ km^2 (95 Percent Confidence Interval: 4.3, 9.7) that was significantly higher than the density of the total Pahute Mesa Transect (2.0 deer/ km^2) as well as the Big Burn (1.0 deer/ km^2) and the Dead Horse Flat/Pahute Mesa Road transects (0.6 deer/km^2) (Table 6-8). The northern most transect of Pahute Mesa from Dead Horse Flats Road to the end of the route had the lowest calculated deer density of this study (Table 6-8). This area lacks a local permanent water source in summer (Figure 6-23).

The Holmes Road/Stockade Wash Road transect of the Rainier Mesa deer route had relatively lower deer density (2.7 deer/km^2) than other transects, suggesting poorer deer habitat and/or deer sighting problems, although density was not significantly lower, undoubtedly the result of a low sample size (26 deer). There were no significant differences among the habitats stratified for comparison on the Rainer Mesa Transect (Table 6-8).

The application of DISTANCE to deer data on the NTS appears to be a reasonable method for analyzing deer abundance across habitats. Limitations in the analysis were obvious at times. Density estimates that had lower sample size (i.e., the number of deer, or deer groups) tended towards higher CV values and wider confidence intervals (Table 6-8), thus limiting the ability to distinguish differences. In general, it was found that in several but not all cases, density estimates, based on data sets of about 50 deer or less (20–25 groups), were highly variable and less useful than larger sample sizes.

6.7.4 Long Term Changes in Deer Distribution on the NTS

Deer monitoring began on NTS in 1989. Since then the GPS locations have been recorded during surveys for continuous years (1989–1994) and non-continuous years (1999–2000, 2006–2008). Level of effort changed from three surveys per year in 1989–1994 to six surveys per year during 1999–2000 and finally to nine surveys per year in 2006–2008. A total of 241 deer groups were recorded from 1989 to 1994, and 675 deer groups from 1999 to 2008. No attempt was made to adjust for differences in survey effort across time. Individual group sightings were categorized into several size categories (1, 2–3, 4–7, etc.) and plotted to detect qualitative changes in patterns between the two routes (Figure 6-19) on the NTS during different time periods (1989–1994 and 1999–2008).

Groups of deer observed during spotlighting surveys from 1989 to 1994 are shown to be more evenly distributed along the route and, in general, appear more numerous around permanent water sources on Pahute Mesa, especially near Pahute Lake (Figure 6-22). Larger groups of deer also appear more numerous near Pahute Lake and other reservoirs during this time. Surveys from more recent years 1999–2008 on Pahute Mesa show deer locations to be less evenly distributed along the route, and fewer deer groups were sighted towards the western end of Pahute Mesa (near a dry Pahute lake) even though survey effort has increased by a factor of 2–3 in recent years (Figure 6-23). The lower occurrence or detection of deer on the western region of Pahute Mesa appears to be strongly related to the absence of permanent water sources. Most ponds on Pahute Mesa were decommissioned (drained) due to reduced work effort in the forward areas of NTS by 1995. These actions do appear to have had effects on deer. Deer surveys from both periods, however, show moderate to high concentrations of deer in the Echo Peak region more than other areas (Figures 6-22 and 6-23). This has been true despite the presence or absence of ponds (19C upper and lower) in this region, suggesting that this region may be high quality deer habitat. Echo Peak now has no known permanent summer water source; however, summer rains can fill Pahute Pond for short periods. Deer in this region may have to move a distance of 8–11 km (5–7 mi) from Echo Peak to Camp 17 Pond to drink in summer at the only known permanent water source in this region. The Echo Peak area, which has the highest elevation on Pahute Mesa, probably receives more annual rainfall than the western slope of Pahute Mesa and, therefore, may be more productive deer habitat than other areas. Larger trees and deeper soil profiles may also be important factors. It is evident that the presence of permanent water sources on the NTS had significantly influenced the distribution of deer over time on the NTS, and their removal infers impacts on distribution. In recent years, there have been concentrations of deer around Rainier Mesa, particularly near the Egg Point Burn. This may have been related to the presence of younger, more succulent vegetation on the burn site (Figure 6-23). Overall, the data suggest that man-mediated activities on the NTS (pond construction, water availability, burns) may affect the distribution and abundance of wildlife on the NTS.

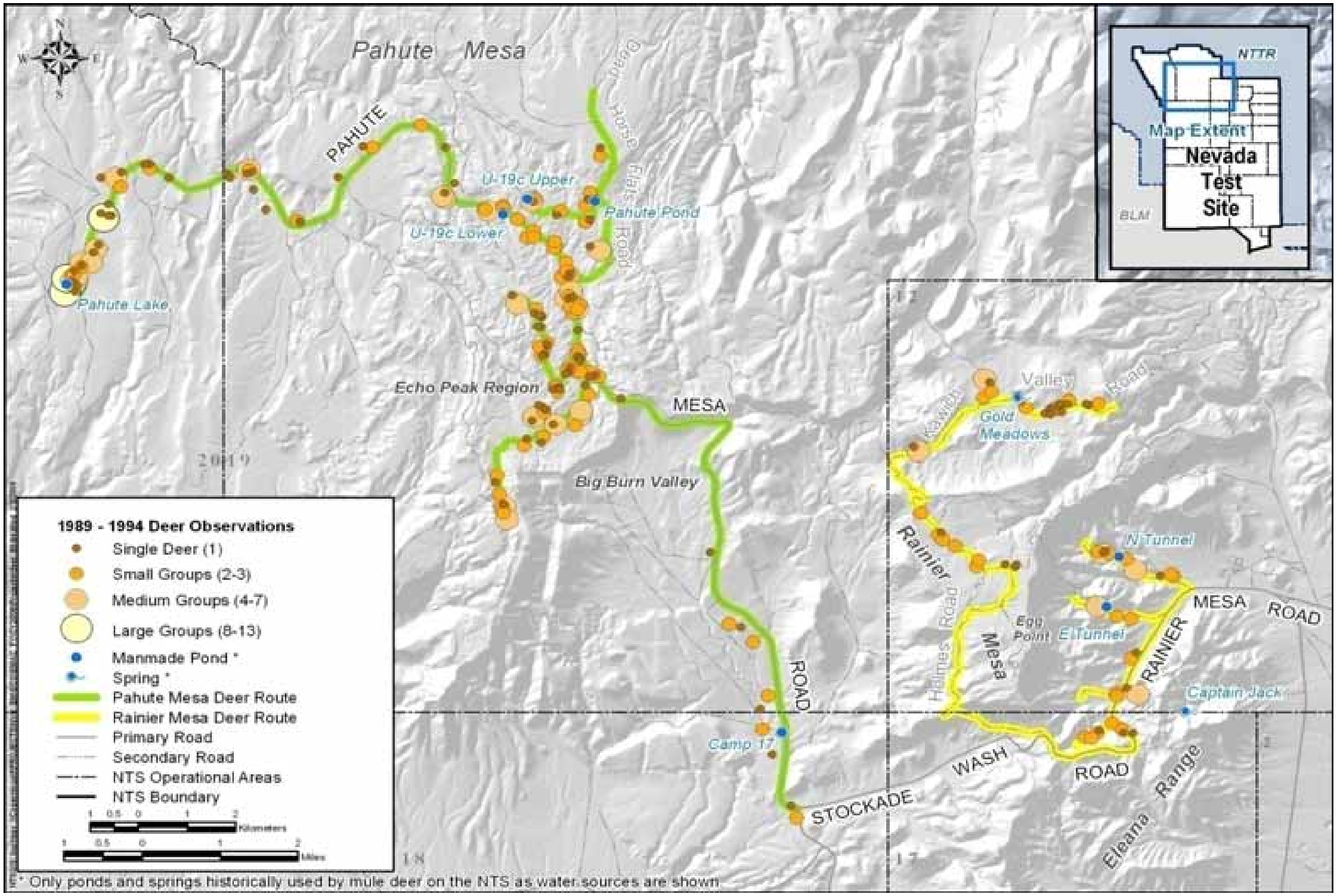

Figure 6-22. Deer locations (n=241 groups) from spotlighting surveys for two routes at the NTS from 1989 to 1994

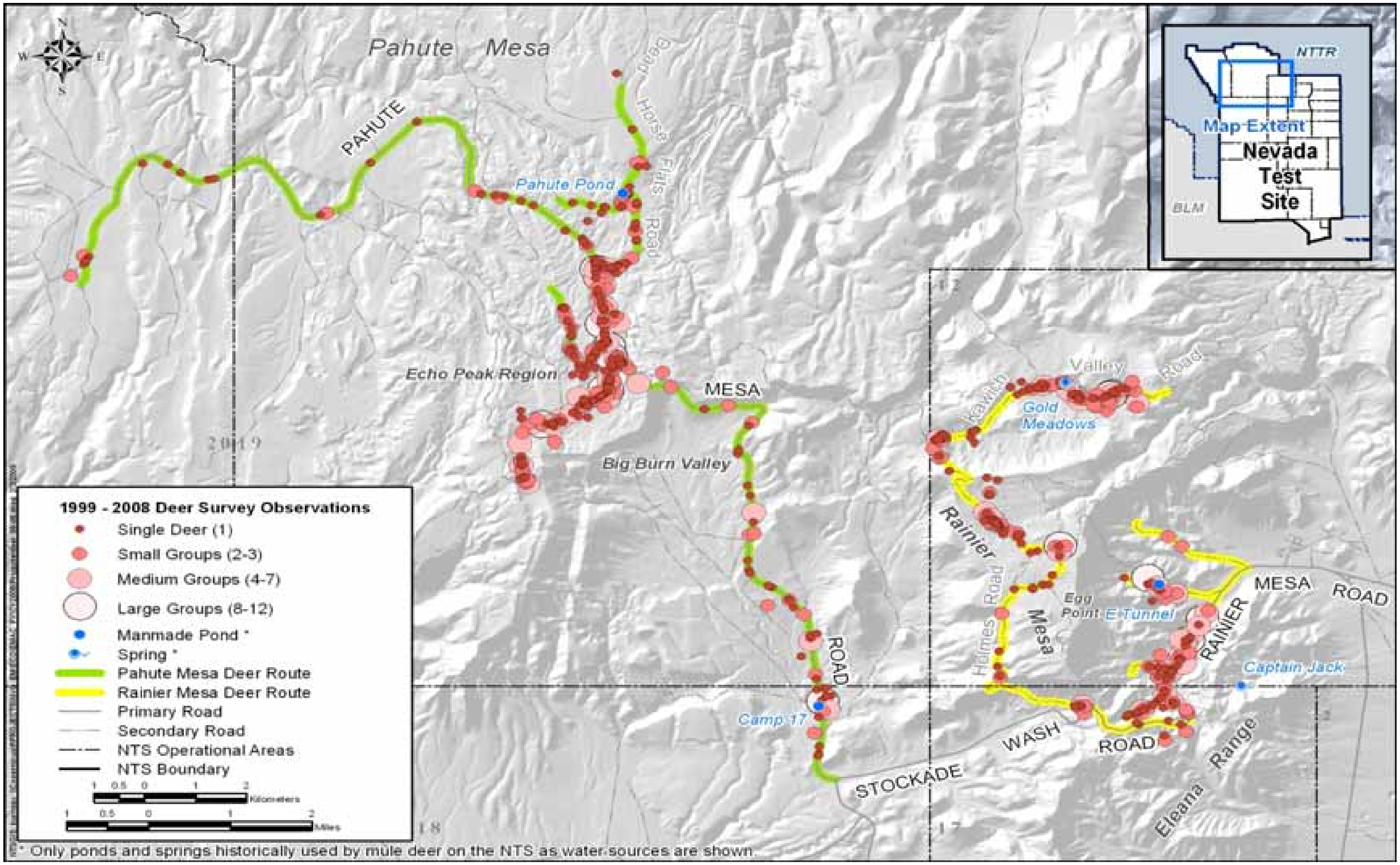

Figure 6-23. Deer locations (n=675 groups) from spotlighting surveys for two routes at the NTS from 1999 to 2008

6.7.5 Mule Deer Use of Water Sources

Deer visitation rates were measured at two important water sources with motion-activated cameras for one month or longer. Two types of motion/thermal detection cameras were used to photograph wildlife during 24-hour nonstop periods. At Captain Jack Spring a Scout Guard Model 550™ was used without a flash that captured infrared light at night with a one-minute delay between photos. At Camp 17 Pond a Camtrackker[M] was used with a flash with a one-minute delay between photos.

Captain Jack Spring – Data were limited to 14 days from October 22, 2008, to November 5, 2008, because of camera recording limitations. A total of 294 deer detections was recorded from 177 video clips (mean group size 1.6 individuals, range 1–5 deer per group). Deer used the spring daily during this period, and many individuals were counted repeatedly (i.e., could not be distinguished as individuals). Captain Jack Spring data is not directly comparable to Camp 17 Pond data because of the short collection period.

Camp 17 Pond – At Camp 17 Pond, a camera was used at the southwest corner of the pond for a two-year period (2007–2008) to record horse and wildlife use. Group size of the deer detections ranged from 1 to 10 deer per photo over two years (Figure 6-24). Deer use (number of photos) varied significantly ($t = 2.6$. $P = 0.037$) between years (Table 6-9). The spring of 2007 was much drier than the spring of 2008. The average winter–early summer rainfall (January–June) was about a factor of 3 lower in 2007 than 2008 as shown by three of the closest rain gauges in the area. This dry period probably affected the rate and timing of deer watering of Camp 17 Pond. Deer came to the pond to drink earlier in the year and at a much higher frequency in 2007 over 2008 (Table 6-9) as shown by a number of photos recorded. Furthermore, the large rainfall of August 26–27 appeared to reduce deer use immediately at Camp 17 Pond (Figure 6-25, Table 6-9) during the end of August to early September 2007. The quick response suggests that local catchments of water were created by rainfall, and this decoupled deer use of the pond. An additional late September rain also appeared to influence deer watering (low activity) in the fall of 2007 (Figure 6-25).

Figure 6-24. Nighttime deer use at Camp 17 Pond on August 23, 2007
(Photo by motion-sensing camera taken on August 23, 2007)

Additional camera data from June 26 to September 2008 was lost due to a stolen camera. Deer use in the fall (October–November) also appeared to be somewhat higher in 2008 than 2007 (exactly similar to the pattern by horses) due to drier fall conditions of that year (Table 6-9).

Table 6-9. Frequency of deer use (total number photos per month) from camera surveys at Camp 17 Pond

Month	2007	2008
February	8	2
March	45	1
April	80	5
May	141	7
June	356	106
July	72[a]	M[b]
August	165	M[b]
September	37	M[b]
October	9	129
November	14	84
Feb-June average	126	24.2

[a](24 missing days of data) due to a full data card
[b] all data lost
T Test, p= 0.037, 8 df

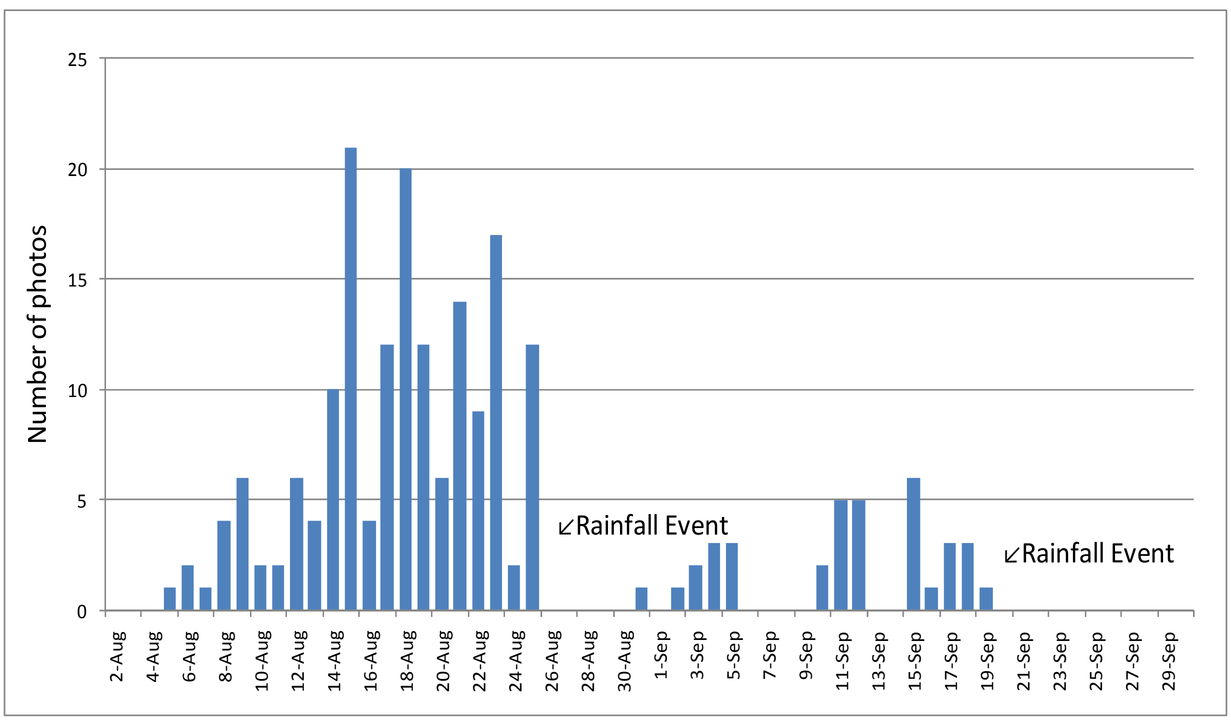

Figure 6-25. Deer use (number of photos/day) at Camp 17 Pond during August–September 2007 with affects of rainfall

6.8 Mountain Lion Camera Surveys

Little data exist for mountain lion numbers and distribution in southern Nevada, including the NTS. Dr. Erin Boydston, a research scientist with USGS, is investigating mountain lion distribution and abundance using remote, motion-activated cameras. NSTec biologists have collaborated with Dr. Boydston since 2006 in setting up cameras on the NTS to help determine how many mountain lions are found here and where they occur. Knowing the number of mountain lions and their distribution on the NTS will enable a better assessment of the potential risk of mountain lions to NTS workers. In 2008, Dr. Boydston purchased additional cameras (ScoutGuard Model 550™) and supplies (e.g., batteries, memory cards). This camera has the ability to take video or digital photographs using infrared at night and regular color during the day. This eliminates the bright flash. It also uses AA batteries and is very power-efficient, small, lightweight, and easy to mount to a variety of substrates.

Historically, 87 records from opportunistic sightings of mountain lions or their sign have been recorded on the NTS (EGIS faunal database in 2007). In 2008, three opportunistic sightings of mountain lions or their sign were recorded (Figure 6-26). Tracks were seen in the snow around Captain Jack Spring (Area 12) on February 27th and in the mud at Topopah Spring (Area 29) on June 3rd. In November, a mountain lion was observed stalking two deer near the 12-3 Sump on Rainier Mesa.

During 2008, remote, motion-activated cameras were set up at 17 sites (9 new sites, 8 sites from 2007) (Figure 6-26, Table 6-11). Sites were selected based on previous mountain lion sightings, infrequently traveled dirt roads, and areas known to be frequented by mule deer (e.g., deer trails, water sources), a primary prey species of the mountain lion.

Fifteen mountain lion photographs/video clips were taken during 79,613 camera hours across all sites. This equates to 0.2 mountain lion photos/video clips per 1,000 camera hours (Table 6-10). Mountain lions were detected at 8 of the 17 sites including 5 sites established in 2007 and 3 new ones (Topopah Spring; behind CP, near 6-4C barricade; and Shoshone Mountain, Tippipah Point Road) (Table 6-26). Seven of the sites where mountain lions were detected were on dirt roads with little to no vehicle traffic. The other site was at a remote spring (Topopah Spring) in Area 29 where a video clip of a mature, male mountain lion was taken on December 22nd. The photograph taken behind CP6, near the 6-4C barricade (Figure 6-27) is evidence that mountain lions occur near active facilities (photo taken within 1.5 km (0.9 mi) of buildings at CP6). A photograph taken at Dick Adams Cutoff Road (Rainier Mesa) in August shows three mountain lions, apparently an adult female with two yearlings (Figure 6-28). This is most likely the same lactating female captured on film in October 2007 with her now nearly full-grown cubs.

Based on camera surveys, at least four individual mountain lions were documented, the three in the same photo (presumably no mature males present) and one mature male. It is difficult to distinguish between individuals based on the photographs. Mountain lions were detected in every month except January, April, May, and November with peak occurrence during August (Figure 6-29), and they were usually photographed between late afternoon and early morning. Only three photos were taken during daylight hours; one in June and two in August. One lion photograph at 12T-26B was determine to be the same individual photographed at 12T-26 and was not included in the monthly (Figure 6-29) graph to avoid duplication. Similarly, 10 photographs of the same mountain lion taken in 2007 were removed.

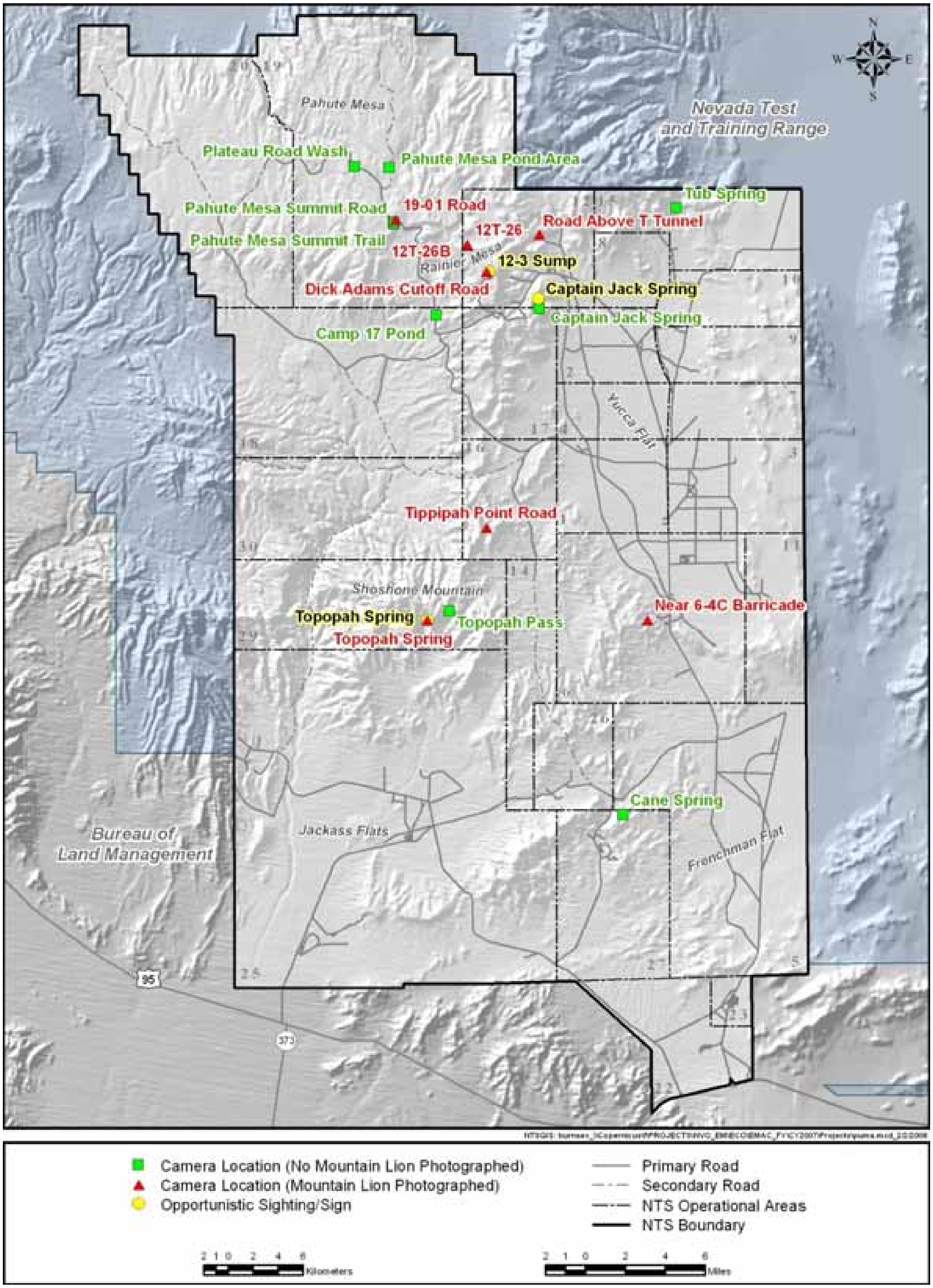

Figure 6-26. Locations of opportunistic mountain lion sightings, mountain lion photographic detections, and motion-activated cameras on the NTS during 2008

Table 6-10. Results of mountain lion camera surveys during 2008

Location	Dates Sampled	Camera Hours	Mountain Lion Photos/Video clips (No. photos/video clips per 1000 camera hours)	Other Animals (Number of photos/video clips)
Dick Adams Cutoff Road, Rainier Mesa	[d]1/2/08–1/15/09	6,743.75	6 (0.9)	Bobcat (1), coyote (2), gray fox (3), mule deer (74), black-tailed jackrabbit (53)
Road above T Tunnel	[d]1/2/08–1/20/09	8,221.00	3 (0.4)	Bobcat (7), gray fox (1), mule deer (68), black-tailed jackrabbit (4)
12T-26, Rainier Mesa	[d]1/2/08–1/15/09	6,606.75	1 (0.2)	Bobcat (2), coyote (6), gray fox (9), mule deer (9), black-tailed jackrabbit (85)
12T-26B, Rainier Mesa	1/2/08–1/15/09	9,098.00	1 (0.1)	Bobcat (1), coyote (4), gray fox (2), mule deer (33), black-tailed jackrabbit (15), rabbit (1)
19-01 Road, Pahute Mesa[a]	[d]12/5/07–1/20/09	6,033.75	1 (0.2)	Bobcat (2), mule deer (22)
Topopah Spring	12/1/08–1/8/09	912.50	1 (1.1)	Mule deer (2), desert cottontail (2)
Behind CP6, near 6-4C Barricade[a]	[d]3/10/08–1/7/09	5,907.75	1 (0.2)	Coyote (1), mule deer (7), pronghorn antelope (1)
Shoshone Mountain, Tippipah Point Road	3/10/08–1/7/09	7,249.50	1 (0.1)	Bobcat (1), mule deer (43), black-tailed jackrabbit (2)
Pahute Mesa Summit, Road	10/30/08–1/7/09	1,657.75	0	Horse (6), mule deer (63)
Plateau Road Wash, Pahute Mesa	10/30/08–1/7/09	1,656.00	0	Mule deer (2)
Pahute Mesa Summit, Trail	10/30/08–1/7/09	1,658.25	0	Mule deer (22)
Camp 17 Pond[a]	[d]1/2/08–1/7/09	6,373.00	0	Coyote (5), horse (402), mule deer (339), bat (1), raven (3), turkey vulture (7), unknown bird (7)

Table 6-10. Results of mountain lion camera surveys during 2008 (Continued)

Location	Dates Sampled	Camera Hours	Mountain Lion Photos/Video clips (No. photos/video clips per 1,000 camera hours)	Other Animals (Number of photos/video clips)
Shoshone Mountain, Topopah Pass	[d]3/10/08–1/8/09	7,065.00	0	Mule deer (7)
Pahute Mesa Pond Area	10/30/08–1/20/09	1,971.50	0	Coyote (3), mule deer (2)
Tub Spring[a]	[d]1/2/08–4/28/08	1,319.75	0	None
Captain Jack Spring	[d]10/21/08–12/10/08	355.00	0	Coyote (1), horse (29), mule deer (179)
Cane Spring[a, b, c] (2 locations)	[d]1/3/08–1/8/09	6,784.00	0	Bobcat (1), coyote (7), gray fox (1), mule deer (47), unknown mammal (1), Cooper's hawk (1), owl (1), chukar (2), mourning dove (21), unknown bird (1)

[a]Camera hours not known for some time periods
[b]Two cameras set up simultaneously for at least part of the year
[c]Cameras moved within a site
[d]Non-continuous operation due to camera problems, dead batteries, etc.

Figure 6-27. Mountain lion in a snowstorm behind CP6, near the 6-4C barricade
(Photo by motion-activated camera, December 15, 2008)

Figure 6-28. Three mountain lions, presumably an adult female with two yearlings, Dick Adams Cutoff Road, Rainier Mesa
(Photo by motion-activated camera, August 28, 2008)

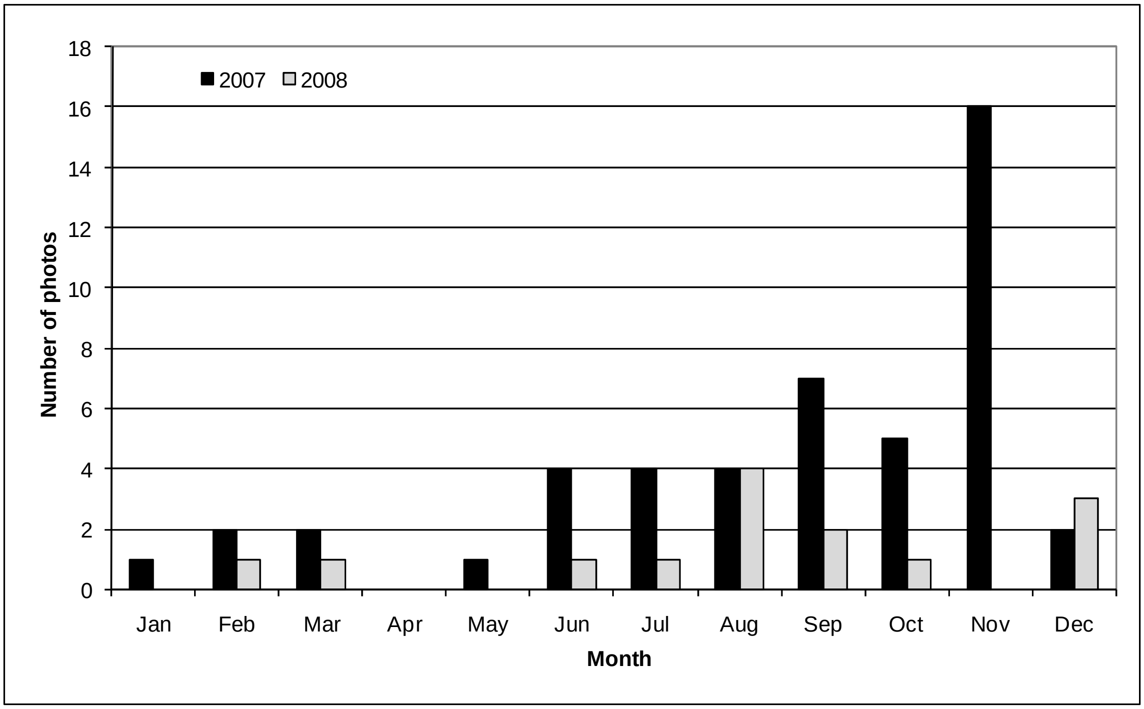

Figure 6-29. Numbers of mountain lion photographs by month for camera sites where mountain lions were detected during 2007 (N=48) and 2008 (N=14)

Even though several new locations were monitored during 2008, some general comparisons between 2007 and 2008 can be made. Only 0.2 mountain lion photos/video clips per 1,000 camera hours (15 photos-videos/79,613 camera hours) were documented at 8 of 17 sites in 2008 compared to 0.9 mountain lion photos per 1,000 camera hours (58 photos/62,681 camera hours) documented at 6 of 15 sites in 2007. This is a substantial decrease and is best explained by the drastic drop in mountain lion photos detected at three sites (i.e., Dick Adams Cutoff Road, 12T-26, and 12T-26B) on the western portion of Rainier Mesa. In 2007, there were 54 mountain lion photos taken at these sites, while in 2008 only eight were taken. Monthly photographic data reveal that mountain lions were detected on the western portion of Rainier Mesa through December 2007 but were not detected again until June 2008. Snowfall was much heavier during the winter of 2008 compared to the winter of 2007, which may have forced mule deer off Rainier Mesa, causing the mountain lions to also leave. However, it does not explain why few mountain lions were detected in the fall of 2008. Counts of mule deer around Rainier Mesa increased by about 50 percent between the fall of 2007 and fall of 2008, which may also suggest that mountain lion numbers decreased. Another possible explanation for the decrease in mountain lion photos is they were using other travel routes to avoid the flash from the camera. However, numerous photos of the same individual were repeatedly taken during fall 2007, suggesting the flash does not bother the mountain lions.

A secondary objective of the camera surveys is to detect other species using these areas to better define species distributions on the NTS. A total of 1,624 photographs of 14 species other than mountain lions were taken during 79,613 camera hours across all sites (Table 6-10). This is about 20 photos per 1,000 camera hours. A majority of these photographs (919 photographs at 16 sites) were of mule deer or about 12 mule deer photos per 1,000 camera hours (see Section 6.7 for trends in mule deer population). Nearly one-half (764 photos/1,624 total photos) of all photos recorded in 2008 were taken at Camp 17 Pond where photos of horses and mule deer made up 97 percent (741/764) of all photos taken at this site. This shows how important this water source is to these species, especially during the dry summer and fall months.

6.9 Nuisance and Potentially Dangerous Wildlife

During 2008, NSTec biologists responded to 31 calls regarding nuisance or potentially dangerous wildlife in or around buildings and work areas. Problem animals included coyotes *(Canis latrans)*, bats, snakes (including one sidewinder rattlesnake [*Crotalus cerastes*]), a scorpion, tarantulas, and birds. Mitigation measures taken usually entailed moving the animal away from people or disposing of dead animals. Notices were also communicated via radio, e-mail, and various company publications to alert people to potentially dangerous situations involving wildlife and to remind employees not to feed wild animals on the NTS.

6.10 Coordination with Biologists and Wildlife Agencies

In 2007, three manuscripts about burrowing owl ecology were submitted for publication. During 2008, one manuscript, “Regional and seasonal diet of the western burrowing owl in south-central Nevada,” was accepted for publication in the Western North American Naturalist and will be published in 2009. A second manuscript, “Burrow use by the western burrowing owl at the Nevada Test Site in south-central Nevada,” was also submitted to the Western North American Naturalist and accepted for publication in 2009. Another manuscript, “Documenting western burrowing owl reproduction and activity patterns using motion-activated cameras,” was not accepted by the Journal of Raptor Research but was submitted to Great Basin Birds for publication.

In support of a multi-year bird study with UNLV, NSTec recently received records of 270 bird specimens collected on the NTS from the UNLV Marjorie Barrick Museum of Natural History. NSTec biologists worked with Dr. Donald Baepler, an ornithologist from UNLV, for three years (2000–2002). Dr. John Klicka, the present ornithologist at UNLV, provided records of their study. These data added valuable information to NSTec’s bird database about breeding species from NTS areas (northern mesas) where little or no previous bird work has been conducted. For example, 25 species of spring–summer resident birds were identified in a mature pinion tree canopy at just one location near Echo Peak on Pahute Mesa. This is a high bird diversity area on the NTS that would be undescribed without the data from UNLV.

NTS records of five bird species of interest, blue grosbeak *(Guiraca caerulea)*, Phainopepla *(Phainopepla nitens)*, vermillion flycatcher *(Pyrocephalus rubinus)*, gray vireo *(Vireo vicinior)*, and LeConte’s thrasher *(Toxostoma lecontei)*, were shared with Dawn Fletcher upon request (Lake Mead National Recreation Area). She is working on an assessment of the historical distribution of these species in conjunction with the Great Basin Bird Observatory and Clark County, Nevada.

Derek Hall, an NSTec biologist, continued to serve as co-leader of the Nevada Bat Working Group; participated in the second Nevada Bat Working Group Bat Blitz, which entailed radiotracking several Brazilian free-tailed bats *(Tadarida brasiliensis)* at a migratory roost site around Ely, Nevada; and attended a working group meeting in December. He also served as a board member of the Western Bat Working Group and participated in several conference calls throughout the year with other group members throughout the western United States and Canada. Affiliation with these groups is important to keep abreast of the latest techniques in bat monitoring and facilitates data exchange within the bat community.

Dr. Ted Cohn, University of Michigan, is working on a group of invertebrates called camel crickets. Numerous specimens were collected from the NTS back in the 1960s by BYU researchers. Dr. Cohn is reviewing that collection and requested assistance from NSTec biologists to collect additional camel crickets, if possible, and to help identify GPS coordinates of some of the historic collection sites. More than 25 camel cricket specimens were collected during reptile trapping activities and sent to Dr. Cohn for identification. Preliminary analysis indicates that a new species of camel cricket occurs on the NTS. Additionally, much of the original BYU data were located in the L. Tom Perry Special Collections Library at BYU. These data are an invaluable source of information regarding hundreds of animal taxa and will help identify specific locations of animal captures and observations, something that has been lacking for many taxa, especially birds. A new Great Basin skink location and several new Great Basin skink records were found in these archived data as well as individual bat capture records and numerous western burrowing owl and other raptor records.

Derek Hall attended the 15th Annual Wildland Shrub Symposium in Bozeman, Montana, which focused on wildlife habitat in shrublands. He gave a presentation on wildlife monitoring on the NTS and prepared a manuscript for publication in the symposium proceedings. Derek Hall and Paul Greger, two NSTec biologists, attended the 15th Annual Wildlife Society Meeting in Miami, Florida, and presented a poster on western red-tailed skinks. They also attended a full-day workshop on detection probabilities and occupancy modeling taught by Darryl MacKenzie and others who are leading experts in this area. Contacts made at the workshop will be an important resource for NSTec biologists to consult with in applying the principles of occupancy modeling to wildlife monitoring projects on the NTS.

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7.0 HABITAT MONITORING

7.1 West Nile Virus Surveillance

West Nile Virus (WNV) is a potentially serious illness that is spread to humans and other animals through mosquito bites. It was first discovered in Uganda in 1937 and was not detected in North America until 1999. In southern Nevada, it was not detected until the spring of 2004. WNV surveillance continued in 2008 for the fifth consecutive year to determine if mosquitoes on the NTS carry WNV. WNV surveillance entails setting mosquito traps baited with dry ice overnight at sites where standing water provides a potential breeding site for mosquitoes (Figure 7-1). As the dry ice sublimates, it produces carbon dioxide, which serves as an attractant for mosquitoes. Ten sites were sampled during 12 surveys (Table 7-1). Mosquitoes collected during the surveys were taken to SNHD for species identification and WNV testing. A total of 89 individuals representing three species were captured and analyzed in 2008 (Table 7-1). All specimens were negative for WNV. Mosquito species identified will be entered into the EGIS faunal database to define mosquito distribution on the NTS. In 2008, no new species were detected.

Figure 7-1. Mosquito trap set at Well 3 Pond, Area 6 in Yucca Flat
(Photo by D. B. Hall, August 27, 2008)

Table 7-1. Results of West Nile Virus surveillance on the NTS in 2008

Location	Date	Number Captured	Species	WNV
Topopah Spring, Area 29	6/10/08	0	NA	NA
J-11 Pond, Area 25	6/10/08	0	NA	NA
Mercury SOC Park, Area 23	6/10/08	0	NA	NA
Well C1 Pond, Area 6	7/08/08	1	*Culex tarsalis*	Negative
Well 3 Pond, Area 6	7/08/08	9	*Culex tarsalis*	Negative
Mercury Sewage Lagoons, Area 23	7/08/08	0	NA	NA
Yucca Lake Sewage Lagoons, Area 6	8/27/08	0	NA	NA
Well 3 Pond, Area 6	8/27/08	41	*Culex tarsalis*	Negative
Cane Spring, Area 27	8/27/08	1	*Culex tarsalis*	Negative
Well 5B Pond, Area 5	9/08/08	10	*Culex tarsalis*	Negative
Well 3 Pond, Area 6	9/08/08	9	*Culiseta inornata*	Negative
LANL Pond, Area 6	9/08/08	14	*Culex tarsalis*	Negative
	9/08/08	3	*Culiseta inornata*	Negative
	9/08/08	1	*Culex erythrothorax*	Negative

LANL: Los Alamos National Laboratory
SOC: Special Operations Center
WNV: West Nile Virus

7.2 Constructed Wetlands Monitoring

No sampling was done in Frenchman Flat wetlands in 2008 due to a dry year and lack of collected water for most of the year. Yucca Playa was sampled at one natural site (see Section 7.4.1).

7.3 Natural Wetlands Monitoring

Monitoring wetlands continued in 2008 to characterize seasonal baselines and trends in physical and biological parameters. Eleven wetlands (Figure 7-2) were visited at least once during the year to record wildlife use, the presence/absence of land disturbance, water flow rates when applicable, and surface area of standing water (Table 7-2). Sizes of wetlands monitored varied greatly from very small areas (<1 square meter [m^2] [<10.8 square feet (ft^2)]) to moderately sized springs (180–600 m^2 [1,938–6,458 ft^2]). Surface flow rates were low (<5 liters per minute [1.3 gallons per minute]) at most wetlands where flow was measurable (Table 7-2).

Heavy cattail growth at Cane Spring comprises nearly 50 percent of the wet habitat and may block out sunlight and impact snails living there. Eradication of the cattails may be considered to open up the habitat to benefit the invertebrates.

Wildlife use data recorded at water sources during daytime sampling are summarized in Table 7-3. Two springs, Oak and John's, had high use by deer in the fall as subjectively estimated from frequency of tracks. Most all other springs had low usage by deer as inferred from sign. There were 10 species and about 108 individual birds observed in 2008 at the 10 wetlands visited compared to 5 species and about 50 individuals seen in 2007 at 9 wetlands. Overall, very low numbers of chukars *(Alectoris chukar)* or mourning doves *(Zenaida macroura)* were observed at springs throughout the NTS in 2008 (Table 7-3). Most notable in 2008 was the record of the probable tracks of a single elk *(Cervus elaphus)* in the mud at a dry Pahute Pond in midsummer, exact date not known. The dimensions of the track at a width of > 10 cm (4 in.) match the descriptions from *Peterson Field Guides: Animal Tracks* (Murie, 1974), and depth of tracks of 15–20 cm (> 6–8 in.), an indication of a heavy animal, appears to be quite convincing that the tracks belong to an elk. Plaster of Paris casts were also made to preserve a permanent record of the event and possibly confirm the identification of this species with an offsite ungulate expert.

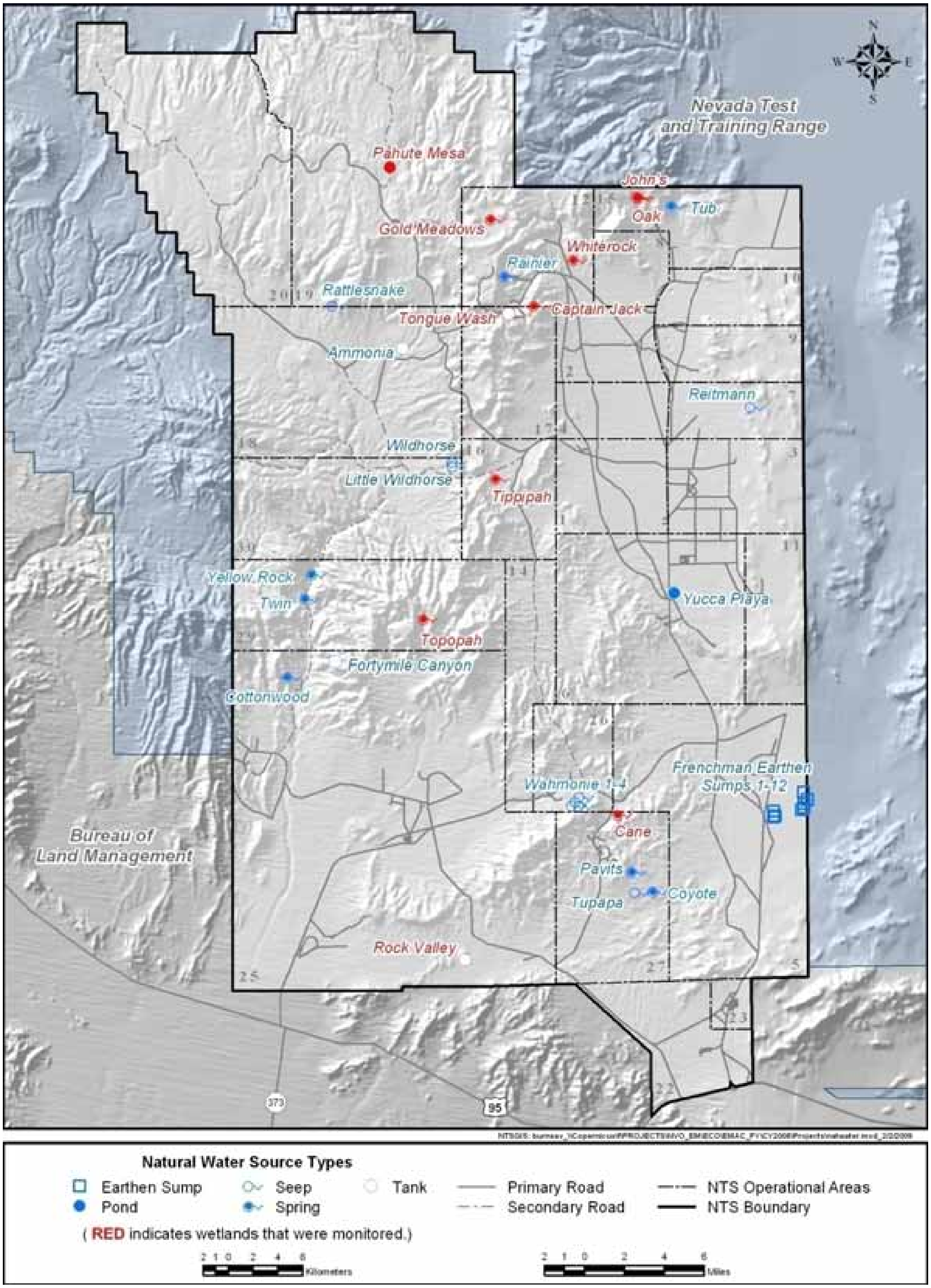

Figure 7-2. Natural water sources on the NTS, including those monitored in 2008

Table 7-2. Hydrology and disturbance data recorded at natural water sources on the NTS

Water Source	Date	Surface Area of Water (m^2)[a]	Surface Flow Rate (L/min)[b]	Disturbance at Spring
Cane Spring	10/31/08	15	1.5	heavy cattail growth in cave pool
Captain Jack Spring	10/21/08	30	1.2	horse trampling
Gold Meadows Spring	08/28/08	100	NM[c]	horse trampling
Gold Meadows Spring	09/24/08	0	NM[c]	spring dry
John's Spring	12/04/08	4	0.1	none
Pahute Pond	03/26/08	600	NM[c]	none
Pahute Pond	10/30/08	0	NM[c]	none
Oak Spring	12/04/08	5	0.6	none
Rock Valley Tank	03/27/08	<0.1	0	none
Tongue Wash Tank	12/11/08	0	0	none
Tippipah Spring	07/26/08	210	NM[c]	none, guzzler constructed
Topopah Spring	12/01/08	5	0.20	none
Whiterock Spring	11/18/08	6	1.0	none, guzzler constructed

[a] m^2 = square meters
[b] L/min = liters per minute
[c] NM = not measurable due to diffused flow

.

Table 7-3. Number of wildlife species observed or inferred at NTS natural water sources during 2008

Wildlife Species Observed at NTS Natural Water Sources	Cane Spring	Cane Spring	Captain Jack Spring	Gold Meadows Spring	Gold Meadows Spring	John's Spring	Oak Spring	Pahute Pond	Tippipah Spring	Tongue Wash Tank	Topopah Spring	Whiterock Spring
Date Observed (month/day) of 2008:	**4/15**	**10/30**	**10/21**	**8/28**	**9/27**	**11/25**	**11/25**	**10/30**	**10/22**	**12/11**	**6/10**	**11/18**
Mammals												
Bobcat (*Lynx rufus*)								P				
Coyote (*Canis latrans*)	P	P		P	P			P	P			P
Elk (*Cervus elaphus*)								P[a]				
Feral horse (*Equus caballus*)			P	P	P							
Mountain lion (*Puma concolor*)								P			P	
Mule deer (*Odocoileus hemionus*)	P	P	P	P	P	P	P	P	P	P	P	P
Birds												
Black-throated sparrow (*Amphispiza bilineata*)	>2	1										1
Chukar (*Alectoris chukar*)	P	P							>40	P	P	
Common raven (*Corvus corax*)		1	1								1	1
House finch (*Carpodacus mexicanus*)			1						>10			5
Mourning dove *(Zenaida macroura)*	>2										>15	
Oregon junco (*Junco hyemalis*)			>10			>4	>10		2			
Northern flicker (*Colaptes auratus*)			1									
Sage sparrow (*Amphispiza bellii*)												5
Scrub jay (*Aphelocoma caerulescens*)												1
White-crowned sparrow (*Zonotrichia leucophrys*)									5			6
Numbers of bird species detected:	**3**	**3**	**4**	**0**	**0**	**1**	**1**	**0**	**4**	**1**	**3**	**6**

P = species presence inferred from sign

[a] based on a track in mud preserved in plaster of paris for permanent record

7.4 Fairy Shrimp Inventory on the NTS

7.4.1 Yucca Flat Playa

Few wetland habitats were sampled during September–December on Yucca Playa due to lower fall–winter rainfall than the previous year. On Yucca Playa only one natural site was sampled. Sampling continued in 2008 to better describe species presence/abundance from habitat types in both Frenchman and Yucca Playas.

Shrimp were sampled using a hand-held fine mesh net (<1 mm [0.04 in]). Numerous grab samples were taken by pushing the net from the shoreline along the bottom out to about 1.8–3 m (6–10 ft) from shore, and all organisms collected in the net were put into a metal pan after washing away excess sediment. All grab samples from each habitat were combined into one sample for each site per day. Each sample was preserved in 80 percent ethyl alcohol and changed out at one hour, and again at one day, to prevent rotting of samples. All shrimp were identified following Pennak (1978). Shrimp from each sample were washed through a 1 mm (0.04 in.) mesh net, sorted by species, and counted.

Five individual giant fairy shrimp *(Branchinecta gigas)* were collected from Yucca Playa Pond on December 12, 2008 (not present in 2007 at this site) under a thin sheet of ice and in very shallow water (2.5–10 cm [1–4 in.] deep). The giant fairy shrimp is a predator (obtaining lengths of > 60 mm [2.4 in.]) and appeared to be sustained by foraging on the smaller sized (15–18 mm [0.6–0.7 in.] length) alkali fairy shrimp *(Branchinecta mackini)*, which were more numerous (25) at the time.

Numerous specimens of a small species of fairy shrimp *(Branchinecta* sp*)* were collected on March 28, 2008 at Pahute Pond, on Pahute Mesa. This is possibly an undescribed species. Individuals measured 8–12 mm [0.3–0.5 in.] in length. Mature females were observed with egg sacks and males with well-developed second antennae. Specimens were preserved and sent to Dr. Christopher Rogers, at Richmond, California, a leading authority in fairy shrimp, for identification.

7.5 Constructed Water Source Monitoring

NSTec biologists conducted quarterly monitoring of constructed water sources. These sources, located throughout the NTS (Figure 7-3) include 38 plastic-lined sumps at 20 sites. Several ponds or sumps are located next to each other at the same project site. Many animals rely on these human-made structures as sources of free water. However, wildlife and migratory birds may drown in steep-sided or plastic-lined sumps as a result of entrapment, or ingest contaminants in sumps with drilling-fluids or evaporative ponds. Ponds are monitored to assess their use by wildlife and to develop and implement mitigation measures to prevent them from causing significant harm to wildlife. Where sumps had adverse impacts to wildlife (e.g., the northern NTS where deer abundance is high) construction of sediment ramps were recommended to prevent the unnecessary death of wildlife. The effectiveness of these ramps is validated by the presence of fresh tracks on the sediment ramps and lack of dead animals. Sediment ramps, where installed, have been very effective in allowing animals to exit sumps without becoming entrapped.

Constructed water sources (Figure 7-3) were visited during March, September, and December 2008. At each site, the presence or absence of standing water and the presence of animals or their sign around the water source were recorded. The presence of sediment ramps or plastic ladders, which allow animals to escape if they fall in, have also been installed at many plastic-lined sumps, and the presence, absence, and condition of these structures were also noted. All dead animals (or any remains of an animal) in or adjacent to a human-made water source are recorded (Table 7-4).

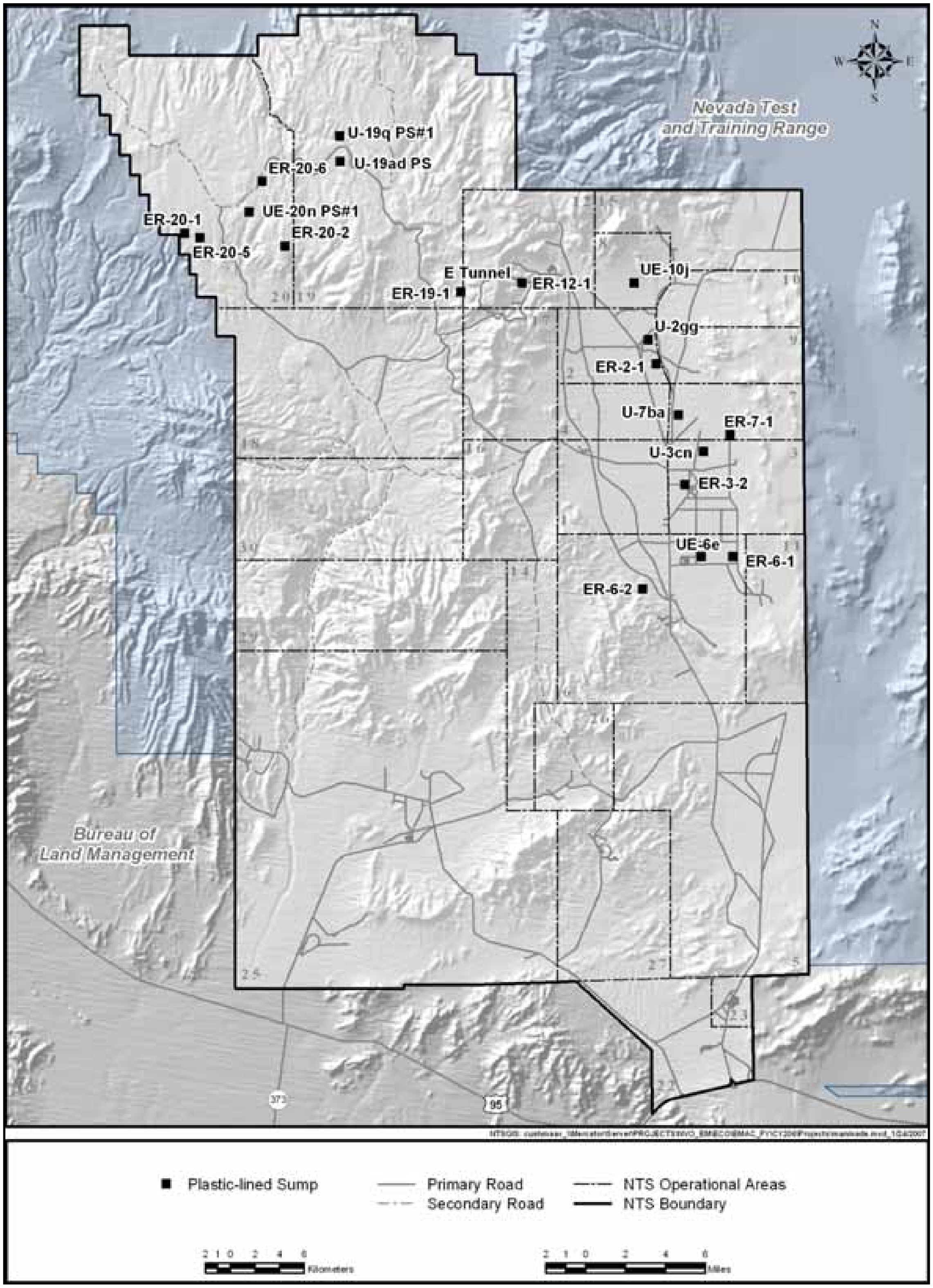

Figure 7-3. Constructed water sources monitored for wildlife use and mortality on the NTS during 2008

Due to low rainfall during spring and summer, monitoring was much reduced (Table 7-4). Limited rainfall occurred in September–October, which allowed some sporadic accumulation of rainwater in some areas (Table 7-4). No dead animals were detected from sumps during 2008. Most sumps were filled with water from snows in mid to late December. Use was limited to common species, including passerine birds, hawks, shorebirds, ducks, common ravens *(Corvus corax)*, marsh hawks, horned larks *(Eremophila alpestris)*, house finches *(Carpodacus mexicanus)*, and teal *(Anas* spp*)*. Sumps are commonly used by coyotes and sometimes mountain lions searching for deer. Some late snowfall allowed for moderate accumulations of water in most sumps on the NTS in December.

Table 7-4. Results of monitoring plastic-lined sumps for wildlife mortality at the NTS for 2008

Quarter	Number of ponds monitored	Number of ponds with water	Surface area (m^2)	Number of sediment ramps	Number of dead animals detected
Jan–Mar	10	5	350	0	none
April–June[a]	0	NA	NA	NA	NA
July–Sept	20	8	800	12	none
Oct–Dec	33	33	8600	17	None

[a] No data taken (NA)

8.0 HABITAT RESTORATION MONITORING

An objective of the habitat restoration monitoring is to evaluate the success of previous revegetation efforts on the NTS. Sites that have been revegetated are periodically sampled and the information obtained is used to develop site-specific revegetation plans for future restoration efforts on the NTS. Typically, reference areas are also sampled to provide a standard for determining revegetation success.

Growing conditions in 2008, as measured by the amount of precipitation received during the growing season, were better than the last two years but still below the long-term average (Table 8-1). Total annual precipitation was about what it was in 2007, but the amount of precipitation received between September of the previous year and June of the current year (defined as the growing season) was more than double in 2008 what it was in 2007. Most of the precipitation came in September 2007 and January 2008. Between those two months and after January 2008, small, rather insignificant, amounts of precipitation were received.

Table 8-1. Millimeters (mm) (inches [in.]) of precipitation received at Goldfield, Nevada, weather station (Community Environmental Monitoring Program, 2009)

	Average 1948–2006	Yr 3 2000	Yr 5 2002	Yr 10 2007	Current Yr 2008
Calendar Year	165.1 (6.5)	88.9 (3.5)	50.8 (2.0)	88.9 (3.5)	91.4 (3.6)
Growing Season*	137.2 (5.4)	77.0 (3.0)	51.1 (2.0)	48.3 (1.9)	109.2 (4.3)

* Precipitation from September of previous year through June of current year

Five sites on the Tonopah Test Range (TTR) and one site on the NTS were monitored in 2008. At the TTR four staging areas and three cover caps were sampled. The single site sampled on the NTS was the U-3ax/bl closure cover in Area 3. Results of monitoring efforts are reported in the following sections.

8.1 Staging Areas

All four staging areas monitored in 2008 are located on the TTR. During cleanup activities at each of the sites, surface soils were disturbed but not removed. Revegetation occurred after compacted soils at each of the sites was ripped and disked. In 2008 CAU 400–Bomblet Pit and Five Points Landfill, CAU 426–Cactus Spring Waste Trenches, and CAU 404–Roller Coaster Lagoons were monitored. Plant cover and density data are reported for the current year and the third, fifth, and tenth year after revegetation was completed in 1997.

8.1.1 CAU 400–Five Points Landfill

CAU 400–Five Points Landfill was remediated and revegetated in the fall of 1997. Six transects, two on the section revegetated in the fall of 2000, three in the area that was revegetated in the fall of 2004 and subsequently flooded, and the reference area, were sampled in 2008. Plant cover and density were averaged over the respective transects. Data presented in Tables 8-2 and 8-3 are from the two transects on the area that has not flooded.

Plant cover – Overall plant cover in 2008 was the highest it has been since 2003 and only lower than total plant cover in 2002. Only about 8 percent of the total cover (Table 8-2) is from perennial plants; the other almost 19 percent is from annual plants. The 19 percent annual plant cover is more than double the previous high of 9 percent annual plant cover in 2005. Shrubs make up all of the perennial cover. In fact, one species, *Atriplex canescens* (fourwing saltbush), accounts for 100 percent of perennial plant cover in 2008. This is the first year that there has not been any perennial grass cover on the staging area at the CAU 400–Five Points Landfill site. Annual cover in 2008 was the highest it has ever been, primarily from a carpet of *C. stevioides*. Three other annuals were present, but *C. stevioides* accounted for 90 percent of all annual cover.

Of the 27 percent total plant cover in 2008, only 30 percent is from perennial plants. In previous years perennial plants made up 80 to 100 percent of total plant cover.

Litter in 2008 is the lowest recorded since the site was revegetated. The low amount of litter may be a result of the lack of plant production the last few years because of the poor growing conditions.

Table 8-2. Plant cover on CAU 400–Five Points Landfill

	Yr 3 2000	Yr 5 2002	Yr 10 2007	Current Yr 2008	Reference 2008
Shrub	2.5	8.3	10.6	8.1	5.8
Grass	10.0	23.3	3.8	0.0	2.5
Annuals	3.3	0.8	0.0	18.8	9.2
Total Plant Cover	15.8	32.5	14.4	26.9	17.5
Bare Ground	66.6	50.0	57.5	56.3	74.2
Litter	17.5	17.5	28.1	16.9	8.3

Plant density – Total plant density in 2008 is the second highest recorded to date, only lower than it was in 2005. However, if the density of annuals is removed from the analysis and only perennial plant density is considered, it represents the lowest plant density recorded on the CAU 400–Five Points Landfill staging area. Shrub density was at an all time low last year (Table 8-3) but increased in 2008 to 1 shrub/m^2 (1.2 shrubs/square yard [yd^2]). *A. canescens* continues to be not only the most dominant but also the only shrub present at this site. Occasionally there will be some *Picrothanmnus desertorum* (bud sagebrush), but none were encountered in 2008.

Grass density was the lowest in 2008 that it has been so far at this CAU. The decrease was pronounced, dropping from 1.4 grasses/m^2 (1.7 grasses/yd^2) last year to just 0.2/m^2 (0.24/yd^2) in 2008 (Table 8-3). The last four years *Achnatherum humenoides* (Indian ricegrass) has been the only perennial grass present and continues to be the single species found at this site.

Table 8-3. Plant density on CAU 400–Five Points Landfill in plants/m^2 with plants/yd^2 in parentheses

Species	Yr 3 2000	Yr 5 2002	Yr 10 2007	Current Yr 2008	Reference 2008
Shrubs					
Atriplex canescens (fourwing saltbush)	0.7 (0.84)	1.0 (1.20)	0.5 (0.60)	1.0 (1.20)	0.03 (0.04)
Chrysothamnus greenei (Greene's rabbitbrush)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.6 (0.72)
Picrothamnus desertorum (bud sagebrush)	0.0 (0.00)	0.1 (0.12)	0.1 (0.12)	0.0 (0.00)	0.0 (0.00)
Grasses					
Achnatherum hymenoides (Indian ricegrass)	4.8 (5.74)	3.2 (3.83)	1.0 (1.20)	0.2 (0.24)	1.4 (1.67)
Elymus elymoides (squirreltail)	2.2 (2.63)	0.3 (0.36)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
Summary by Life-form					
Shrubs	0.7 (0.84)	1.1 (0.10)	0.6 (0.72)	1.0 (1.20)	0.6 (0.72)
Grasses	7.1 (8.49)	3.6 (4.31)	1.4 (1.67)	0.2 (0.24)	1.4 (1.67)
Annuals	10.2 (12.20)	0.4 (0.48)	0.0 (0.00)	39.5 (47.24)	30.7 (36.72)
Total Plant Density	18.0 (21.53)	5.0 (5.98)	2.0 (2.39)	40.7 (48.68)	32.7 (39.11)

The density of annuals was the highest reported on this site in last three years. The last two years annual density has been insignificant, but in 2008 there were eight different species of annuals. *Chaenactis stevioides* (Steve's pincushion) is the most abundant on the staging area and, like at other sites in 2008 on the TTR, accounted for the majority of the annual plant density.

Revegetation Success – Using 70 percent of the plant cover and plant density on the reference area as a standard for successful revegetation, the CAU 400–Five Points Landfill site exceeds success standards in 2008 (Tables 8-2 and 8-3, Figure 8-1). Shrub cover was almost double the cover standard. There was no grass cover in 2008, but annuals more than make up for the loss of grass cover and is about three times the standard for annual cover. Historically grass cover has exceeded the standard for revegetation success seven out of the last eight years. Precipitation patterns in 2008 did not favor perennial plant growth.

Total plant density shows a pattern similar to plant cover. Overall plant density exceeds the revegetation success standards in 2008. Shrub density not only exceeds but is almost double the shrub density standard for revegetation success (Table 8-3). The density of grasses was less than the standard this year, but has exceeded the standard six of the last eight years. The loss of vegetation on the flooded area impacts grasses the most. The area lost to flooding typically supported higher amounts of grasses, both in density and cover.

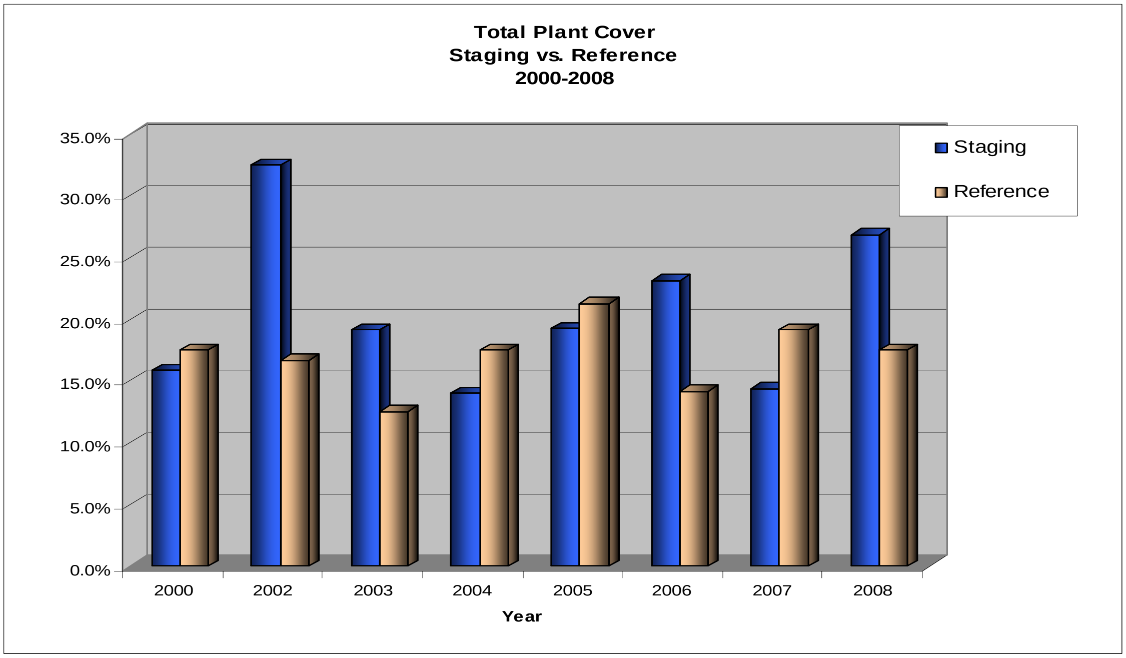

Figure 8-1. Plant cover on the staging area compared to reference area on CAU 400–Five Points Landfill from 2000 to 2008

Annual density, like shrub density, is almost double the revegetation success standard for in 2008 (Table 8-3). There were eight different species of annuals in 2008 on the staging area, compared to nine on the reference area. Other than the *Malacothrix glabrata* (smooth desert dandelion), which is found exclusively on the reference area, all other annuals are found on both the reference area and the staging area; all are native to the area. The similarity of the flora, including shrubs, grasses, and annuals, between the staging area and reference area indicates that the vegetation that has established on the CAU 400–Five Points Landfill site is a stable plant community.

Summary – The overall status of the CAU 400–Five Points Landfill site that has not been flooded is good. The objectives of revegetation have essentially been achieved in that a native plant community has established on the non-flooded areas. In 2008 there was a decrease in both perennial grass cover and density, but it is anticipated that when more favorable growing conditions occur, both grass cover and density will increase. Native shrubs have established on the site from earlier revegetation efforts, and native annuals have invaded the site from adjacent undisturbed habitat.

8.1.2 CAU 400–Bomblet Pit

The Bomblet Pit located near the bottoms of Cactus Flat was seeded in the fall of 1997. The site prior to revegetation efforts was heavily disturbed and dominated by *Halogeton glomerata* (halogeton) a noxious weed. The main concern at this site was that *H. glomerata* would return to the site after revegetation and impede the establishment of native plants, especially native shrubs and grasses. Sampling at this site consists of two transects, one located in the revegetated area and another in the reference area directly east of the site.

Plant Cover – There was a major decrease in the amount of total plant cover at the CAU 400–Bomblet Pit site in 2008 compared to the previous two years. About 70 percent of the total plant cover was from native shrubs; the remaining 30 percent was from annuals.

Shrub cover in 2008 was about half of what it was last year (Table 8-4). Grasses have had a hard time establishing on the revegetated area and, like the previous six years, did not contribute to overall plant cover. Annuals have only contributed to overall plant cover two of the last nine years. The amount of annual cover is 5 percent in 2008. Annuals contributing to total plant cover are all native species, no noxious weeds such as *H. glomerata*.

The amount of litter recorded for the site in 2008 was the lowest recorded to date. This may be an indication of the poor growing conditions experienced over the last several years, which in turn has resulted in less plant litter.

Table 8-4. Plant cover on CAU 400–Bomblet Pit

	Yr 3 2000	Yr 5 2002	Yr 10 2007	Current Yr 2008	Reference 2008
Shrub	15.8	18.8	22.5	11.3	7.5
Grass	2.6	0.0	0.0	0.0	1.3
Annuals	0.0	0.0	0.0	5.0	5.0
Total Plant Cover	18.4	18.8	22.5	16.3	13.8
Bare Ground	63.2	61.3	60.0	73.8	66.3
Litter	18.4	20.0	17.5	10.0	20.0

Plant Density – Overall plant density (perennial and annual) was the highest ever recorded for the CAU 400–Bomblet Pit site, primarily the results of the highest annual density recorded at this site since it was revegetated in 2000. About 91 percent of the plants found at the site are annual species, 8 percent are shrubs, and perennial grasses make up less than 1 percent. Shrub density is about the same as it was last year (Table 8-5), and the composition of shrub density is about the same as it has been the last three years. *A. confertifolia* is the most abundant shrub, followed by *P. desertorum* and *A. canescens*. The average shrub density since 2004 is about 6 shrubs/m^2 (7 shrubs/yd^2), which is slightly more than was recorded in 2008 for the site. As noted previously, grasses have not successfully established on the site. There were a few plants of *A. hymenoides* in 2008, which is an improvement over 2007 and is as high as it has been the last five years.

As is the case on most of the CAUs in 2008, annual density was the highest ever recorded. *C. stevioides* was the most abundant of the three annual species found on the site. No *H. glomerata* was present and has not been since 2004.

Revegetation Success – Revegetation success standards were exceeded for the CAU 400–Bomblet Pit site in 2008. Both total plant cover and total plant density on the revegetated area were higher than the standards used for this site. Cover and density were actually equal to or higher than on the reference area. Shrub cover and density, grass density, and annual cover and density all exceeded revegetation success standards. Only grass cover was lower than the standard. *A. hymenoides* was found on the site in 2008, which implies that maybe with better growing conditions, grasses, such as *A. hymenoides*, may eventually become established on the site. Even in the native plant community (reference area), grasses are not abundant; they only contribute 1 percent to cover and 0.1 plant/m^2 (0.1 plants/yd^2) to plant density.

The objectives of revegetation have been met at CAU 400–Bomblet Pit. Revegetation success standards have been achieved and exceeded. Native species are established, and the invasion of non-native noxious weedy species has been avoided. The vegetation at this site became established early during the revegetation process (Figure 8-2). Total plant cover at this site has exceeded total plant cover on the reference site six of the eight years that vegetation data has been collected. The last three years total plant cover has been significantly higher on the revegetated area than on the adjacent undisturbed native plant community.

Table 8-5. Plant density (plants/m^2 [plants/yd^2]) at CAU 400–Bomblet Pit

Species	Yr 3 2000	Yr 5 2002	Yr 10 2007	Current Yr 2008	Reference 2008
Shrubs					
Atriplex canescens (fourwing saltbush)	0.5 (0.60)	0.3 (0.36)	0.1 (0.12)	0.1 (0.12)	0.0 (0.00)
Atriplex confertifolia (shadscale)	6.8 (8.13)	6.5 (7.77)	3.7 (4.43)	3.7 (4.43)	1.1 (1.32)
Krascheninnikovia lanata (winterfat)	0.3 (0.36)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.4 (0.50)
Picrothamnus desertorum (bud sagebrush)	3.8 (4.54)	2.5 (2.99)	1.8 (2.15)	1.7 (2.03)	2.5 (2.99)
Grasses					
Achnatherum hymenoides (Indian ricegrass)	2.5 (2.99)	0.2 (0.24)	0.0 (0.00)	0.1 (0.12)	0.1 (0.12)
Elymus elymoides (squirreltail)	3.1 (3.71)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
Summary by Life-form					
Shrubs	11.3 (13.51)	9.2 (11.00)	5.5 (6.58)	5.5 (6.58)	3.9 (4.66)
Grasses	5.6 (6.70)	0.2 (0.24)	0.0 (0.00)	0.1 (0.12)	0.1 (0.12)
Annuals	5.4 (6.46)	0.3 (0.36)	0.0 (0.00)	67.7 (80.97)	70.6 (84.44)
Total Plant Density	22.3 (26.67)	9.6 (11.48)	5.5 (6.58)	73.3 (87.67)	74.6 (89.22)

Summary – The goals of revegetation have been accomplished at CAU 400–Bomblet Pit. Native species are established and contribute significantly to overall plant cover and density. Revegetation success standards have been exceeded. The contribution of native perennial grasses to overall plant cover and density is lower than expected, but grasses do not contribute significantly in the native plant community either.

The potential for the invasion of non-native species, specifically *H. glomerata*, was a concern at the onset of revegetation activities. *H. glomerata* was present the first couple years after revegetation but has not been encountered on the site since.

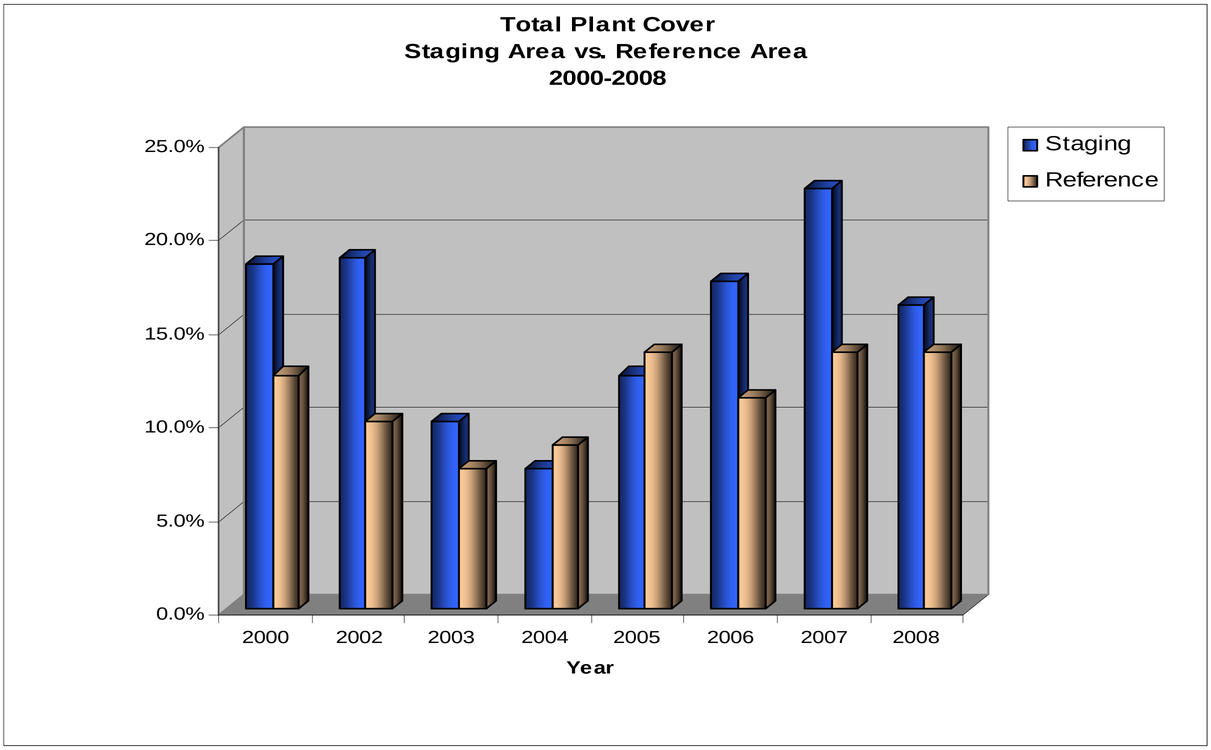

Figure 8-2. Plant cover on the CAU 400–Bomblet Pit Staging Area compared with reference area from 2000 to 2008

8.1.3 CAU 426–Cactus Spring Waste Trenches

CAU 426–Cactus Spring Waste Trenches is located on the eastern slope of the Cactus Range just south and east of Cactus Peak and within 200 meters (220 yards) of Cactus Spring. The site consists of a staging area and a cover cap, both revegetated in fall of 1997. A single transect is sampled in each revegetated area as well as in a reference area directly north of the site.

Plant Cover – Total plant cover last year was the lowest recorded at CAU 426–Cactus Spring Waste Trenches since 2000. Total plant cover in 2008 was almost three times what it was last year and the second highest amount of plant cover since the site was revegetated (Table 8-6). The increase in plant cover was due to an increase in the amount of annual cover. Perennial shrub and grass cover combined was higher than it was last year.

The 5 percent shrub cover in 2008 is double what it was last year (Table 8-6). Most of the cover is from *A. canescens*, although *Ephedra nevadensis* (Nevada jointfir) plants are establishing and contributing more. The 4.2 percent grass cover in 2008 represents the lowest amount of grass cover at this site. In previous years *Elymus elymoides* (squirreltail) has contributed as much as 14 percent cover, but contributed nothing to grass cover in 2008. *A. hymenoides* accounts for about 60 percent of the grass cover in 2008, and *Pleuraphis jamesii* (galleta) the remaining 40 percent. The highest grass cover was recorded in 2005, but there has been a progressive decline since then. Annual cover in 2008 was the highest ever recorded at this site. About two-thirds of the cover was from *Erodium cicutariu* (filaree) and the other third from *C. stevioides*. Shrubs account for 20 percent of the total plant cover, grasses 17 percent, and annuals 63 percent.

Table 8-6. Plant cover on CAU 426–Cactus Spring Waste Trenches: Staging Area

	Yr 3 2000	Yr 5 2002	Yr 10 2007	Current Yr 2008	Reference 2008
Shrub	0.8	5.0	2.5	5.0	7.5
Grass	5.8	12.5	5.0	4.2	0.0
Annuals	0.0	1.7	0.0	15.8	4.2
Total Plant Cover	6.7	19.2	7.5	25.0	11.7
Bare Ground	50.0	42.5	67.5	46.7	82.5
Litter	43.3	38.3	25.0	28.3	5.8

Plant Density – Total plant density at the CAU 426–Cactus Spring Waste Trenches site is the highest recorded to date. The majority of the density, however, is annual plants; perennial plants only make up 3 percent of the total plant density.

Although perennial species did not contribute significantly to overall plant density, the number of shrubs did increase from 2007 to 2008 and actually represents the highest shrub density at this site. Four different species contributed to shrub density in 2008: *Artemisia nova* (black sagebrush) and *P. desertorum,* encountered for the first time since 2002, and *Atriplex confertifolia* (shadscale) and *Krascheninnikovia lanata* (winterfat), which have occurred sporadically at this site over the years (Table 8-7).

The density of perennial grasses decreased to the lowest it has ever been. Grass density is only one-fourth what it was last year. It peaked at 6.3 plants/m^2 (7.5 plants/yd^2) in 2005 and has declined each year since then (Table 8-7). *E. elymoides*, *P. jamesii*, and *A. hymenoides* have contributed to grass density over the years, but all three declined to their respective lowest density recorded to date. *E. elymoides* and *A. hymenoides* have declined each year since 2005 when they reached their highest densities (Table 8-7). The density of *P. jamesii* has been sporadic over the years and has only contributed from 0.1 to 0.3 plants/m^2 (0.1 to 0.3 plants/yd^2) to overall grass density.

There is a good mix of annuals on the staging area in 2008. Of the eight species of annuals encountered, *E. cicutarium* is the most abundant. However, several other species were common and contributed to the dominance of annuals at the CAU 426–Cactus Spring Waste Trenches site.

Revegetation Success – Plant cover and density exceeded the revegetation success standards this year. Total plant cover on the staging area was almost three times the revegetation standard. Shrub cover was slightly less than the standard, but perennial grass and annuals more than made up the difference (Table 8-6). Shrub cover on the staging area was 5.0 percent compared to the standard of 5.3 percent. Perennial grass cover was 4 percent on the staging area; because there is no perennial grass cover on the reference area, the standard is 0 percent. The amount of annual cover on the staging area is more than five times the revegetation success standard.

Table 8-7. Plant density (plants/m^2 [plants/yd^2]) at CAU 426-Cactus Spring Waste Trenches: Staging Area

Species	Yr 3 2000	Yr 5 2002	Yr 10 2007	Current Yr 2008	Reference 2008
Shrubs					
Artemisia nova (black sagebrush)	0.0 (0.00)	0.1 (0.12)	0.0 (0.00)	0.1 (0.12)	1.1 (1.32)
Atriplex canescens (fourwing saltbush)	0.1 (0.12)	0.0 (0.00)	0.1 (0.12)	0.1 (0.12)	0.0 (0.00)
Atriplex confertifolia (shadscale)	0.1 (0.12)	0.0 (0.00)	0.0 (0.00)	0.1 (0.12)	0.2 (0.24)
Chrysothamnus viscidiflorus (Douglas' rabbitbrush)	0.1 (0.12)	0.1 (0.12)	0.0 (0.00)	0.0 (0.00)	0.2 (0.24)
Ephedra nevadensis (Nevada jointfir)	0.3 (0.36)	0.2 (0.24)	0.4 (0.48)	0.6 (0.72)	0.1 (0.12)
Ericameria nauseosa (rubber rabbitbrush)	0.1 (0.12)	0.0 (0.00)	0.1 (0.12)	0.0 (0.00)	0.0 (0.00)
Krascheninnikovia lanata (winterfat)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.1 (0.12)	0.0 (0.00)
Picrothamnus desertorum (bud sagebrush)	0.0 (0.00)	0.1 (0.12)	0.0 (0.00)	0.0 (0.00)	0.4 (0.48)
Grasses					
Achnatherum hymenoides (Indian ricegrass)	1.4 (1.67)	0.6 (0.72)	0.2 (0.24)	0.1 (0.12)	0.0 (0.0)
Elymus elymoides (squirreltail)	5.2 (6.22)	2.9 (3.47)	2.1 (2.51)	0.5 (0.60)	0.0 (0.00)
Pleuraphis jamesii (galleta)	0.2 (0.24)	0.1 (0.12)	0.1 (0.12)	0.0 (0.00)	0.9 (1.08)
Summary by Life-form					
Shrubs	0.7 (0.84)	0.5 (0.60)	0.5 (0.60)	0.9 (1.08)	1.9 (2.27)
Grasses	6.8 (8.13)	3.5 (4.19)	2.3 (2.75)	0.6 (0.72)	0.9 (1.08)
Annuals	16.9 (20.21)	1.8 (2.15)	0.1 (0.12)	42.4 (50.7)	16.3 (19.49)
Total Plant Density	24.4 (26.79)	5.8 (6.94)	2.9 (3.47)	43.9 (52.50)	19.1 (22.84)

Total plant density on the staging area was almost three times the revegetation success standard. When considering revegetation standards by life-form, shrub density was only 70 percent of the shrub density standard (Table 8-7), grass density was the same as the standard, and annual density was four times the revegetation success standard for annual density.

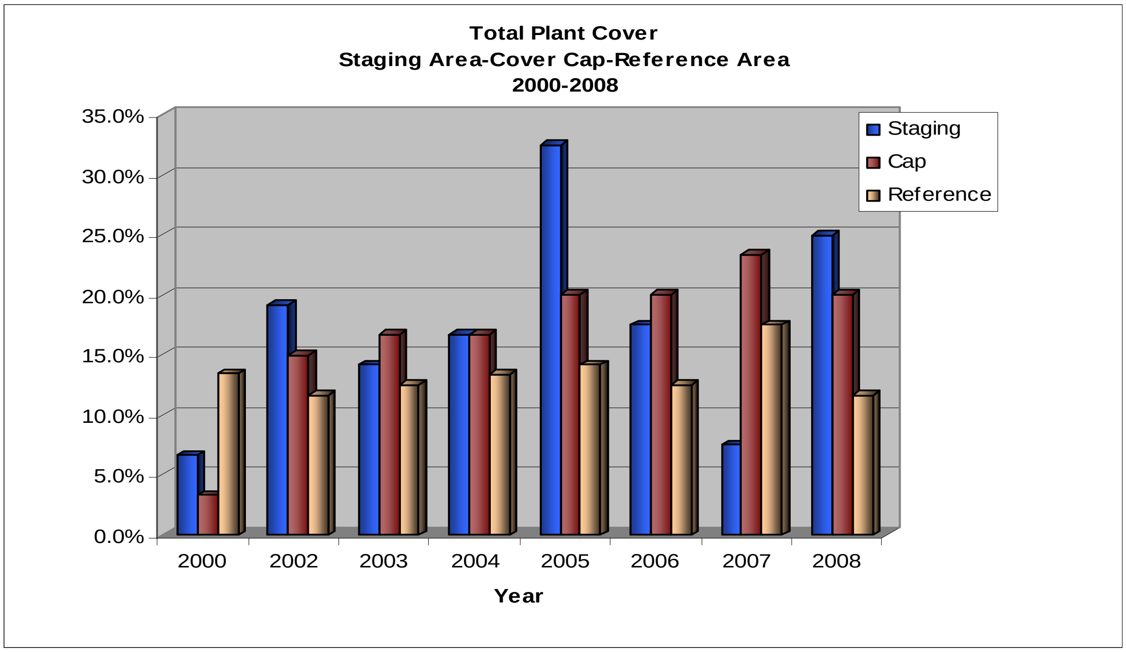

Figure 8-3. Comparison of plant cover on the staging area, cover cap, and reference area at the CAU 426–Cactus Spring Waste Trenches Site from 2000 to 2008

Summary – Based on the amount of plant cover and the density of plants on the staging area at CAU 426–Cactus Spring Waste Trenches, revegetation success standards were achieved in 2008. A plant community composed of native shrubs, grasses, and annuals has established on the site. Although plant diversity is low, perennial plant diversity is still higher than the revegetation success standards (Tables 8-6 and 8-7). There are no signs of excessive use of the site by local wildlife within the fenced area and currently there does not appear to be any severe erosion problems.

8.1.4 CAU 404–Roller Coaster Lagoons and Trench

CAU 404–Roller Coaster Lagoons and Trench is located midslope between the playa bottoms and the foothills of the Cactus Range, just east of Main Road and Roller Coaster Spring. The site covers approximately 2.2 ha (5.5 ac) and is the largest of the five CAUs monitored. About three-fourths of the site was disturbed during the construction of the cover cap and is designated as the staging area. The cap over the remediated sewage lagoons is about a meter above the level of the staging area. Three transects on the staging area, three on the cover cap, and three on the reference area were sampled in 2008. The reference area is located west and north of the main gate to the site.

Plant Cover – The 30 percent plant cover in 2008 on the staging area is the highest recorded on the CAU 404–Roller Coaster Lagoons site to date. Unlike other CAUs, about 70 percent of the total plant cover was from perennial species in 2008, not annuals. Shrub cover increased to 20 percent in 2008, up from 17 percent in 2007. Grass cover increased from 0 percent in 2007 to 1 percent in 2008, and annual cover is 9 percent, the highest annual cover recorded to date (Table 8-8).

The 20 percent shrub cover was slightly higher than the previous highs for shrub cover in 2005 and 2006. *A. confertifolia* accounts for about 80 percent of the 20 percent shrub cover, *P. desertorum* contributed another 19 percent, and the remaining cover was from *K. lanata*, the first it has contributed to total plant cover since 2004. The amount of cover contributed by *A. confertifolia* has maintained at about 16 percent for the last several years, a good indication that this plant has successfully established on the site. *P. desertorum* increased from about 1 percent cover the last couple years to more than 3 percent cover in 2008. *P. desertorum* was flowering and setting seed in 2008 (Figure 8-4).

Figure 8-4. *P. desertorum* in full flower and early seed on the staging area of the CAU 404–Roller Coaster Lagoons Staging Area

(Photograph by D. Anderson, 2008)

The amount of cover from perennial grasses rebounded from 0 percent last year to 1 percent in 2008 (Table 8-8). Since 2002, grass cover has varied from 0.5 percent to 1.1 percent. *P. jamesii* is the most common grass and has consistently occurred on the site. *A. hymenoides* was present initially but has declined on the site the last two years.

The 9 percent annual plant cover in 2008 is the highest recorded to date. As at other sites, *C. stevioides* is the most abundant species. All annuals present were native species; none were weedy or noxious plant species.

Table 8-8. Plant cover on CAU 404–Roller Coaster Lagoons: Staging Area

	Yr 3 2000	Yr 5 2002	Yr 10 2007	Current Yr 2008	Reference 2008
Shrub	9.0	18.5	16.7	20.0	9.7
Grass	3.5	0.5	0.0	1.0	0.0
Annuals	0.0	0.0	0.6	9.2	8.2
Total Plant Cover	12.5	19.0	17.2	30.2	17.9
Bare Ground	56.5	53.0	61.7	50.8	68.3
Litter	31.0	28.0	21.1	19.0	13.8

Plant Density – Plant density is the highest it has ever been on the CAU 404–Roller Coaster Lagoons site. Annuals were the most abundant. The density of shrubs and grasses in 2008 was about the same as in 2007. Last year perennial shrubs and grasses accounted for all of the plant density. In 2008 shrubs and grasses make up about 13 percent of the density, and annuals make up the rest (Table 8-9).

The density of shrubs in 2008 is less than it was last year, primarily due to a decrease in the density of *P. desertorum*. Plant density for *A. confertifolia*, the other shrub present on site, increased slightly. *P. jamesii* is the only perennial grass present on the staging area in 2008. The density of *A. hymenoides* has been 0.1 plants/m^2 (0.1 plants/yd^2) or less since 2003, and it was not present on the site in 2008. *C. stevioides* was the most abundant annual on the CAU 404–Roller Coaster Lagoons site in 2008. *Lepedium densiflorum* (common pepperweed), *Machaeranthera canescens* (hoary tansyaster), and *Sphaeralcea ambigua* (globemallow) were present in 2008, but only a few plants of each species were encountered.

Revegetation Success – The revegetation success standards established for the CAU 404–Roller Coaster Lagoons site were exceeded in 2008 on the staging area. On the staging area, total plant cover was more than double the success standard of 12.5 percent total plant cover (Table 8-8). The amount of cover contributed by each of the three life-forms (shrubs, grasses, and annuals) exceeded the revegetation success standard. Shrub cover was three times the standard. Because there is no grass cover on the reference area in 2008, the 1 percent grass cover on the staging area obviously exceeded the revegetation success standard. The 9 percent annual cover on the staging area exceeded the 6 percent revegetation success standard for annual cover.

Plant density is 42 plants/m^2 (51 plants/yd^2) on the staging area in 2008 compared to a revegetation success standard of 26 plants/m^2 (31 plants/yd^2) (Table 8-9). Shrub density in 2008 is double the revegetation success standard. Grass density, however, was lower. There were 0.1 grasses/m^2 (0.1 grasses/yd^2) on the staging area compared to the revegetation success standard of 0.6 grasses/m^2 (0.7 grasses/yd^2) (Table 8-9). This was the only revegetation success standard not exceeded in 2008 on the CAU 404–Roller Coaster Lagoons site.

Native species have successfully established on the CAU 404–Roller Coaster Lagoons site. Annual density was the highest it has ever been in 2008 on both the staging area and the reference area. There were 37 annuals/m^2 (44 annuals/yd^2) compared to the revegetation standard of 23 annuals/m^2 (27 annuals/yd^2).

Table 8-9. Plant density (plants/m^2 [plants/yd^2]) at CAU 404–Roller Coaster Lagoons: Staging Area

Species	Yr 3 2000	Yr 5 2002	Yr 10 2007	Current Yr 2008	Reference 2008
Shrubs					
Atriplex canescens (fourwing saltbush)	0.3 (0.36)	0.2 (0.24)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
Atriplex confertifolia (shadscale)	10.0 (11.96)	6.9 (8.25)	3.9 (4.66)	4.2 (5.02)	0.7 (0.84)
Krascheninnikovia lanata (winterfat)	0.0 (0.00)	0.1 (0.12)	0.0 (0.00)	0.0 (0.00)	0.1 (0.12)
Picrothamnus desertorum (bud sagebrush)	1.7 (2.03)	1.2 (1.44)	1.4 (1.67)	1.0 (1.20)	2.8 (3.35)
Grasses					
Achnatherum hymenoides (Indian ricegrass)	2.5 (2.99)	0.5 (0.60)	0.1 (0.12)	0.0 (0.00)	0.3 (0.36)
Elymus elymoides (squirreltail)	6.2 (7.42)	0.1 (0.12)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
Dasyochloa pulchella (low woolygrass)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.3 (0.36)
Pleuraphis jamesii (galleta)	0.8 (0.96)	0.3 (0.36)	0.1 (0.12)	0.1 (0.12)	0.2 (0.24)
Summary by Life-form					
Shrubs	12.1 (14.47)	8.4 (10.05)	5.4 (6.46)	5.2 (6.76)	3.7 (4.43)
Grasses	9.5 (11.36)	0.9 (1.08)	0.2 (0.24)	0.1 (0.12)	0.9 (1.08)
Annuals	3.5 (4.19)	0.7 (0.84)	0.0 (0.00)	37.1 (44.37)	32.6 (38.99)
Total Plant Density	25.0 (29.90)	10.0 (11.96)	5.6 (6.70)	42.4 (50.71)	37.2 (44.49)

Summary – Overall plant cover and plant density on revegetated areas at the CAU 404–Roller Coaster Lagoons site exceeds the revegetation success standards. The diversity of plants has declined over the years but still exceeds the diversity on the adjacent reference area. Annuals in 2008 are abundant and all native to the area. No noxious weeds have established on the site. In general a native plant community has established on the staging area as a result of revegetation efforts completed in the fall of 2000.

The decline of two plant species common to the area is of concern. The density of *A. hymenoides* and *P. desertorum*, important species in the native plant communities, has declined over the last few years. This may be a result of the less than favorable growing conditions during this same time frame, but the contribution of these two species to both overall plant cover and density is important. Other than the concern for these two species, overall plant cover, density, and the diversity of plant species are good in comparison to the adjacent undisturbed plant community.

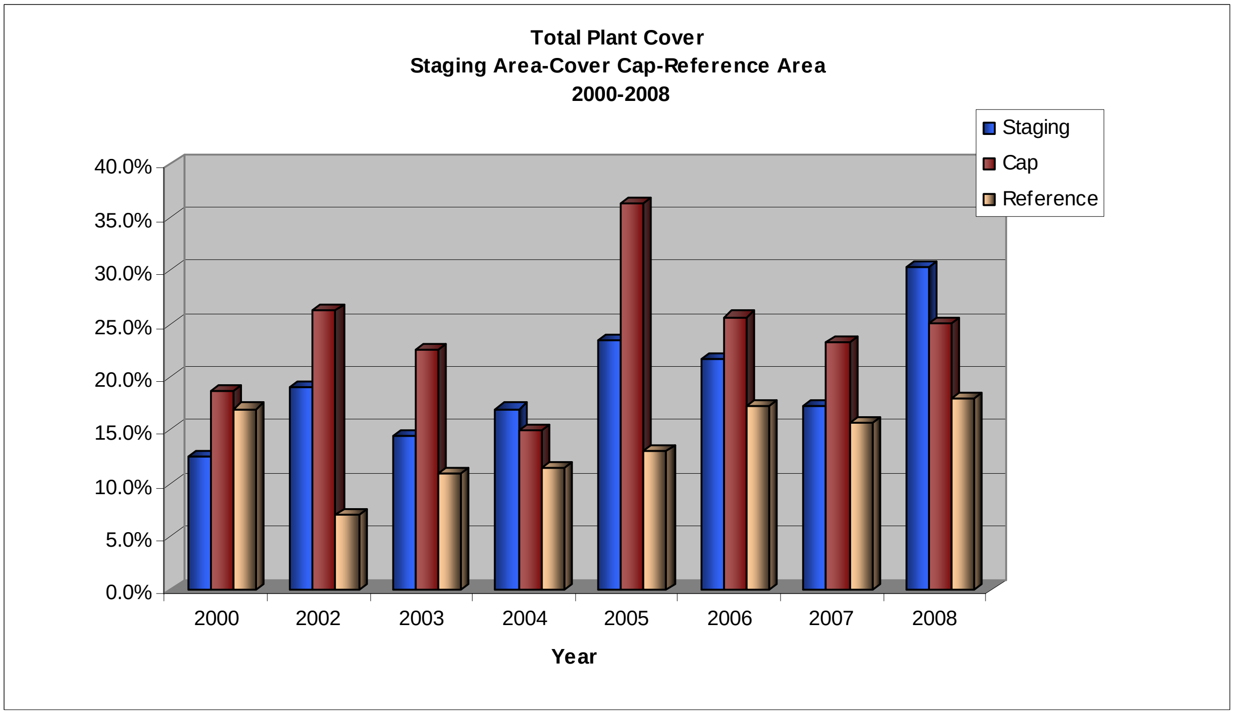

Figure 8-5. Comparison of plant cover on the staging area, cover cap, and reference area on CAU 404–Roller Coaster Lagoons site from 2000 to 2008

8.2 Vegetative Cover Caps

Part of the closure cover remediation process involved the placement of an engineered cover cap followed by the establishment of a vegetative cover. The objective of the vegetative cover is to control surface soil erosion and to minimize the quantity and depth of water infiltration. Shallow rooted native plants capture and remove soil moisture via evapotranspiration. In 2008 cover caps at U-3ax/bl, Cactus Spring, Roller Coaster Lagoons, and Roller Coaster RADSAFE were monitored. Results are presented in the following sections.

8.2.1 CAU 426–Cactus Spring Waste Trenches: Cover Cap

The cover cap at the Cactus Spring Waste Trenches is relatively small compared to the cover cap at the Roller Coaster Lagoons or U-3ax/bl sites. The site is adjacent to Cactus Spring at the base of the Cactus Range and was revegetated in the fall of 1997 using a mix of seeds native to the area and has been monitored periodically since it was revegetated.

Plant Cover – Overall plant cover on the CAU 426–Cactus Spring Waste Trenches site has been around 20 percent over the last few years. It has ranged from 15 percent in 2002 to 23 percent last year (Table 8-10).

Shrub cover decreased from 20 percent in 2007, which was the highest plant cover recorded to date, to about 17 percent in 2008 (Table 8-10). Shrub cover is a mix of *E. nevadensis* and *Ericameria nauseosa* (rubber rabbitbrush). There was no perennial grass cover in 2008. This marks the second time that there has not been any grass cover at the CAU 426–Cactus Spring Waste Trenches site. The two years prior to 2008 grass cover was about 3 percent (Table 8-10).

Table 8-10. Plant cover at CAU 426–Cactus Spring Waste Trenches: Cover Cap

	Yr 3 2000	Yr 5 2002	Yr 10 2007	Current Yr 2008	Reference 2008
Shrub	0.0	6.7	20.0	16.7	7.5
Grass	3.3	8.3	3.3	0.0	0.0
Annuals	0.0	0.0	0.0	3.3	4.2
Total Plant Cover	3.3	15.0	23.3	20.0	11.7
Bare Ground	85.0	78.3	66.7	71.7	82.5
Litter	11.7	6.7	10.0	8.3	5.8

There was 3 percent annual cover in 2008 (Table 8-10). Annuals have only contributed to total plant cover two years since this site was revegetated. Two pincushion plants, *C. stevioides* and *Cheanactis fremontii* (pincushion flower), make up all of the annual cover on the cover cap. *E. cicutarium* was abundant on both the staging area and the reference area, but none were encountered on the cover cap.

Plant Density – As with several of the CAUs in 2008, plant density was the highest ever recorded, but it was not because of an increase in the density of perennial shrubs and grasses. More than 90 percent of the density on the CAU 426–Cactus Spring Waste Trenches site was from annuals. Shrub density did increase from 2007 to 2008, but only by 0.3 plants/m^2 (0.36 plants/yd^2) (Table 8-11). The increase is primarily due to an increase in the density of *E. nevadensis*, which also accounted for much of the plant cover. *E. nevadensis* is abundant on the cover cap, and most individuals were flowering and setting seed in 2008. Two other important species are *Chrysothamnus douglasii* (Douglas' rabbitbrush) and *E. nauseosus*; both species have occurred on the site every year since it was revegetated. *E. nauseosus* is the most abundant of the two species, but the density of *E. nauseosus* declined in 2008 for the fourth year in a row.

Grass density decreased below the previous all time low last year of 0.4 plants/m^2 (0.48 plants/yd^2) to 0.3 plants/m^2 (0.36 plants/yd^2). *A. hymenoides* experienced a 50 percent decrease, which marks the fourth consecutive year that the density of this species has declined. On the positive side, *P. jamesii* was again found on site. The density of *P. jamesii* grass has varied over the years, but it has never been abundant and occasionally has been absent.

The density of annuals is the highest ever recorded at the CAU 426–Cactus Spring Waste Trenches site. It is about six times the previous high of 3 plants/m^2 (4 plants/yd^2) in 2005. Annuals accounted for 90 percent of total plant density in 2008. The two most abundant annuals were *C. stevioides* and *Eriogoun nidularium* (birdnest buckwheat). For the second time since this site was revegetated, *B. tectorum*, a weedy annual grass, was found on the site. It was more abundant than any of the perennial grass species.

Revegetation Success – Total plant cover on the CAU 426–Cactus Spring Waste Trenches cover cap is more than double the standard for revegetation success. By life-form, shrub cover is about three times the standard (Table 8-10). There is no grass cover on the cover cap nor is there any grass cover on the reference area in 2008, so the standard is zero. Just like on the staging area, annual cover on the cover cap is five times the revegetation success standard.

Total plant density on the cover cap exceeds the standard for reclamation success (Table 8-11). Shrub density is 1.8 plants/m^2 (2.2 plants/yd^2) on the cap compared to the revegetation success standard of 1.3 plants/m^2 (1.6 plants/yd^2). The density of grasses on the cover cap is half the success standard of 0.6 plants/m^2 (0.7 plants/yd^2). The density of annual species is at an all time high in 2008 and is almost double the revegetation success standard (Table 8-11).

Summary – Except for last year plant cover has exceeded plant cover on the reference area, the staging area, and the cover cap since 2002 (Figure 8-2). Last year plant cover on the cover cap exceeded the amount of plant cover on the reference area, but cover on the staging area was less than on the reference area. The failure to meet revegetation success criteria in 2007 was probably the result of a minimal amount of growth by grasses and shrubs, specifically, *A. confertifolia* and *A. canescens*.

Table 8-11. Plant density (plants/m^2 [plants/yd^2]) at CAU 426–Cactus Spring Waste Trenches: Cover Cap

Species	Yr 3 2000	Yr 5 2002	Yr 10 2007	Current Yr 2008	Reference 2008
Shrubs					
Artemisia nova (black sagebrush)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	1.1 (1.32)
Picrothamnus desertorum (bud sagebrush)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.4 (0.48)
Atriplex confertifolia (shadscale)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.2 (0.24)
Ephedra nevadensis (Nevada jointfir)	0.1 (0.12)	0.1 (0.12)	0.9 (1.08)	1.6 (1.91)	0.1 (0.12)
Chrysothamnus viscidiflorus (Douglas' rabbitbrush)	1.0 (1.20)	1.3 (1.55)	0.3 (0.36)	0.1 (0.12)	0.2 (0.24)
Ericameria nauseosa (rubber rabbitbrush)	0.1 (0.12)	1.1 (1.32)	0.2 (0.24)	0.1 (0.12)	0.0 (0.00)
Krascheninnikovia lanata (winterfat)	0.1 (0.121)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
Grasses					
Achnatherum hymenoides (Indian ricegrass)	1.3 (1.55)	0.7 (0.84)	0.4 (0.48)	0.2 (0.24)	0.0 (0.00)
Elymus elymoides (squirreltail)	1.0 (1.20)	0.2 (0.24)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
Pleuraphis jamesii (galleta)	1.4 (1.67)	0.7 (0.84)	0.0 (0.00)	0.1 (0.12)	0.9 (1.08)
Summary by Life-form					
Shrubs	1.3 (1.55)	2.5 (2.99)	1.5 (1.79)	1.8 (2.15)	1.9 (2.27)
Grasses	3.7 (4.43)	1.6 (1.91)	0.4 (0.48)	0.3 (0.36)	0.9 (1.08)
Annuals	0.1 (0.12)	1.1 (1.32)	0.0 (0.00)	19.0 (22.72)	16.2 (19.38)
Total Plant Density	5.0 (5.98)	5.3 (6.34)	1.9 (2.27)	21.0 (25.12)	19.0 (22.72)

8.2.2 CAU 404–Roller Coaster Lagoons: Cover Cap

The Roller Coaster Lagoons site covers approximately 2.2 ha (5.5 ac) midslope between the Cactus Mountain Range and Cactus Flats on the TTR. About one-quarter of the site is a cover cap that is 1 m (3.2 ft) higher than the rest of the site. The cover cap was seeded with a mix of native shrubs and grasses in the fall of 1997. Plant cover and density as well as overall condition of the cover cap have been monitored since the spring of 1998.

Plant Cover – Plant cover on the cover cap at the CAU 404–Roller Coaster Lagoons has not changed significantly over the last three years. It was 36 percent in 2005, declined to 26 percent and 23 percent the next two years, and was 25 percent in 2008.

Shrub cover is higher than it was in 2007 and 2002 (Table 8-12), primarily due to increased cover of shadscale and *A. canescens*. *P. desertorum* is a common shrub on the adjacent undisturbed plant community and is commonly found on the staging area but did not contribute to shrub cover on the cover cap.

Grass cover on the cover cap increased from 2004 to 2007, but decreased from 2007 to 2008 by almost 40 percent. All of the grass cover on the cover cap is from *P. jamesii*. Annual cover is 5 percent in 2008, the second highest annual cover recorded at this site. All of the annual cover was from *C. stevioides*.

Table 8-12. Percent plant cover at CAU 404–Roller Coaster Lagoons: Cover Cap

	Yr 3 2000	Yr 5 2002	Yr 10 2007	Current Yr 2008	Reference 2008
Shrub	6.3	10.0	10.0	11.7	9.7
Grass	12.5	16.3	13.3	8.3	0.0
Annuals	0.0	0.0	0.0	5.0	8.2
Total Plant Cover	18.8	26.3	23.3	25.0	17.9
Bare Ground	73.8	65.0	67.5	62.5	68.3
Litter	7.5	8.8	9.2	12.5	13.8

Plant Density – Overall plant density on CAU 404–Roller Coaster Lagoons is the highest recorded to date. The last two years perennial shrubs and grasses accounted for more than 90 percent of total plant density. In 2008 perennial plant density is only 16 percent of the total plant density (Table 8-13).

Shrub density decreased from 2007 to 2008, mainly as a result of a 50 percent decrease in the density of *P. desertorum*. The density of *A. confertifolia* and *A. canescens* remained about the same as in 2007.

The density of grasses has declined each year since this site was revegetated in 2000. Grass density reached a low of 3.0 grasses/m^2 (3.6 grasses/yd^2) in 2007. Grass density in 2008 was 3.7 grasses/m^2 (4.4 grasses/yd^2), which represents a 23 percent increase over 2007. For the first time since the site was revegetated, there was no *A. hymenoides* present. *P. jamesii* continues to be the most abundant perennial grass on the site (Table 18-13).

Like most other CAUs in 2008, the density of annuals is at an all time high. *C. stevioides* is the most abundant annual.

Revegetation Success – Revegetation success standards were exceeded on the cover cap at CAU 404–Roller Coaster Lagoons by all life-forms based on both plant cover and plant density. Shrub cover on the cover cap is 12 percent compared to a standard of 7 percent (Table 8-12). Grass cover is 8 percent compared to the revegetation success standard of 0 percent. Annual cover in 2008 is double the standard of 12.5 percent.

Shrub density is 50 percent higher than the standard, and the density of grasses is six times the standard (Table 8-13). The density of annuals in 2008 was more than 60 percent greater than the revegetation success standard of 23 annuals/m^2 (27 annuals/yd^2).

Summary – With the exception of the first year after revegetation when newly establishing plants are small and do not provide much plant cover, total plant cover on the CAU 404–Roller Coaster Lagoons site has exceeded the amount of plant cover on the reference area cover every year (Figure 8-4). There has been a consistent pattern over the years showing higher total plant cover on the two revegetated areas than on the reference area.

Table 8-13. Plant density (plants/m^2 [plants/yd^2]) at CAU 404–Roller Coaster Lagoons: Cover Cap

Species	Yr 3 2000	Yr 5 2002	Yr 10 2007	Current Yr 2008	Reference 2008
Shrubs					
Picrothamnus desertorum (bud sagebrush)	2.1 (2.51)	1.7 (2.03)	0.8 (0.96)	0.4 (0.48)	2.8 (3.35)
Atriplex canescens (fourwing saltbush)	0.9 (1.08)	0.6 (0.72)	0.3 (0.36)	0.2 (0.24)	0.0 (0.00)
Atriplex confertifolia (shadscale)	10.9 (13.04)	7.0 (8.37)	3.0 (3.59)	2.9 (3.47)	0.7 (0.84)
Krascheninnikovia lanata (winterfat)	0.3 (0.36)	0.1 (0.12)	0.0 (0.00)	0.0 (0.00)	0.1 (0.12)
Grasses					
Achnatherum hymenoides (Indian ricegrass)	3.8 (4.54)	2.8 (3.35)	0.3 (0.36)	0.0 (0.00)	0.3 (0.36)
Elymus elymoides (squirreltail)	10.8 (12.92)	1.6 (1.91)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
Dasyochloa pulchella (low woolygrass)	0.0 (0.00)	0.0 (0.00)	0.0 (0.0)	0.0 (0.00)	0.3 (0.36)
Pleuraphis jamesii (galleta)	8.6 (10.29)	4.7 (5.62)	2.8 (3.35)	3.7 (4.43)	0.2 (0.24)
Summary by Life-form					
Shrubs	14.2 (16.98)	9.3 (11.12)	4.1 (4.90)	3.4 (4.07)	3.7 (4.43)
Grasses	23.2 (27.75)	9.0 (10.76)	3.0 (3.59)	3.7 (4.43)	0.9 (1.08)
Annuals	0.5 (0.60)	0.3 (0.36)	0.1 (0.12)	38.5 (46.05)	32.6 (38.99)
Total Plant Density	37.8 (45.21)	18.6 (22.25)	7.2 (8.61)	45.6 (54.54)	37.2 (44.49)

8.2.3 CAU 407–Roller Coaster RADSAFE: Closure Cover

The CAU 407–Roller Coaster RADSAFE site was originally reseeded in 2000. Subsequent work on the cover resulted in the loss of most of the vegetation on the cover cap. Without a protective cover of vegetation on the cover cap, erosion gullies formed on the slopes of the cover cap that could potentially expose the buried material at the site unless erosion was controlled. In 2004 some remedial work was done on the site to fill in the gullies that were cutting into the edges of the cover cap. Following the remediation work, the site was reseeded in the fall of 2004, and an erosion netting was installed to prevent erosion on the slopes of the cover cap and reduce the potential of the formation of any gullies that would compromise the integrity of the site. The site was irrigated during the fall of 2004 and spring of 2005 to improve seed germination and plant establishment (Hall and Anderson, 1999).

Three transects were sampled on the cover cap in 2008. Only plant density was recorded. Plant cover is collected after plants have matured, which is typically five years after revegetation is completed.

Plant Density – Total plant density has declined dramatically over the last couple of years. This is not unexpected. The seeding rate was relatively high for this site to increase good seed germination and establishment as quickly as possible. The use of irrigation increases the percentage of the number of seeds that germinated, so plant densities were expected to be abnormally high the first couple of years, and they were (Table 8-14).

Table 8-14. Plant density (plants/m^2 [plants/yd^2]) at CAU 407–Roller Coaster RADSAFE: Cover Cap

Species	Yr 1 2005	Yr 2 2006	Yr 3 2007	Current Yr 2008	Reference 2008
Shrubs					
Picrothamnus desertorum (bud sagebrush)	2.9 (3.47)	1.3 (1.55)	1.3 (1.55)	0.5 (0.60)	2.8 (3.35)
Atriplex canescens (fourwing saltbush)	2.3 (2.75)	3.2 (3.83)	2.4 (2.87)	1.8 (2.15)	0.0 (0.00)
Atriplex confertifolia (shadscale)	17.5 (20.93)	17.9 (21.41)	14.2 (16.98)	18.1 (21.65)	0.7 (0.84)
Ericameria nauseosa (rubber rabbitbrush)	0.0 (0.00)	0.3 (0.36)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
Krascheninnikovia lanata (winterfat)	0.7 (0.84)	2.0 (2.39)	1.2 (1.44)	0.7 (0.84)	0.1 (0.12)
Grasses					
Elymus elymoides (squirreltail)	42.9 (51.31)	53.3 (63.75)	22.3 (26.67)	2.0 (2.39)	0.0 (0.00)
Pleuraphis jamesii (galleta)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.2 (0.24)
Achnatherum hymenoides (Indian ricegrass)	16.4 (19.61)	1.1 (1.32)	5.4 (6.46)	0.0 (0.00)	0.3 (0.36)
Dasyochloa pulchella (low woolygrass)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)	0.3 (0.36)
Shrubs	23.4 (28.99)	24.8 (29.66)	19.1 (22.96)	21.1 (25.24)	3.7 (4.43)
Grasses	59.3 (71.04)	54.5 (65.29)	27.7 (33.01)	2.0 (2.39)	0.9 (1.08)
Annuals	4.8 (5.75)	7.7 (9.22)	0.0 (0.00)	13.7 (16.39)	32.6 (38.99)
Total	87.5 (104.82)	86.9 (103.93)	46.8 (55.97)	36.8 (44.01)	37.2 (44.49)

The density of shrubs increased slightly from 2007 to 2008 (Table 8-14). This can be attributed to an increase in the density of *A. confertifolia*. All other shrubs experienced a decrease in density. Of the species of shrubs present on the site, *A. confertifolia* is probably the species best adapted to the dry conditions experienced the last few years. Its density and overall vigor have remained high even during less than favorable growing conditions (Figure 8-6). *P. desertorum*, *A. canescens*, *K. lanata*, and especially *E. nauseosus* are not as well adapted to the drier conditions, and the density of these species has declined the last couple years (Table 8-14).

The decrease in the density of grasses was the most pronounced. *E. elymoides* decreased from 22.3 plants/m^2 (26.67 plants/yd^2) last year to just 2.0 plants/m^2 (2.39 plants/yd^2) in 2008. Of some concern is the complete absence of *A. hymenoides* in 2008. Last year there were over 5 plants/m^2 (6.5 plants/yd^2), but no *A. hymenoides* was encountered in 2008. *C. stevioides* is the most abundant annual. *M. canescens* was occasionally encountered.

Perennial plant density on the CAU 407–Roller Coaster RADSAFE site is higher than on the reference area even after substantial declines in plant density over the last four years. There is no evidence that water is moving off the cover cap and creating erosion gullies on the side slopes. Some burrowing is evident along the edges of the cover cap; nonetheless, the volume and characteristics of the excavated soils suggest the burrows are shallow. The young shrubs and grasses that are found on the cover cap are protected from large grazing animals by the perimeter fence. It is recommended that this fence remain in place until plants have a chance to become better established.

Figure 8-6. *A. canescens*, foreground, and *A. confertifolia*, background: common shrubs at CAU 407–Roller Coaster RADSAFE

(Photograph by D. C. Anderson, 2008)

8.2.4 CAU 110–Area U-3ax/bl: Closure Cap

A closure cover for the U-3ax/bl disposal unit in Area 3 of the NTS was approved and constructed in the fall of 2000. Immediately after the construction of the closure cover, it was revegetated using a seed mix of native plant species. The amount and composition of the vegetative cover on the U-3ax/bl cover has been monitored annually since the spring of 2001.

Each year plant cover and density are measured on the U-3ax/bl closure cover to evaluate the success of the revegetation efforts. Field sampling in 2008 was completed on May 5, 2008. Five 100-m (328-ft) long permanent transects were randomly selected for sampling (transects 2, 7, 9, 10, and 13). Two of the five 50-m (164-ft) permanent transects, located between the closure cover and the perimeter fence and representing a non-seeded area, were also sampled.

To assess the revegetation success of a site, comparisons are typically made to a reference site and revegetation standard. However, no reference site or revegetation standards were established for the U-3ax/bl closure cover. Permanent study plots established on the NTS in the 1960s (Webb et al., 2003) provide somewhat of a reference for the revegetation effort at U-3ax/bl. One of the study plots was located in a *A. confertifolia*/*K. lanata* plant assemblage, which is similar to the composition of the plant community that has established on the U-3ax/bl closure cover. Data from this study plot in 1963 and 1975 shows a range in plant cover from 16 percent to 26 percent. Precipitation was below normal in 1963 and above normal in 1975, which may explain the difference in plant cover. The study plot, like much of the habitat in the immediate vicinity of the U-3ax/bl site, was heavily disturbed during testing activities and cannot be used as a reference site.

Based on precipitation records from 1961 to 2008, precipitation received during the growing season, which is defined as the period from September of the previous year through June of the current year, has only been above average three years since the site was revegetated in 2000 (Table 8-15). The 47-year average amount of precipitation received during the growing season as recorded at the BJ Wye weather station, just north and west of the U-3ax/bl closure cover, is 13.4 cm (5.3 in.). In 2001, 10.9 cm (4.3 in.) of precipitation were received, slightly below the average. In 2002, 4.1 cm (1.6 in.) were received, which was followed by 8.6 cm (3.4 in.) in 2003, for the third consecutive year of below normal precipitation. Few significant precipitation events occurred from 2001 to 2003. Storms were typically small and failed to provide sufficient moisture for either seed germination or sustained plant growth. Finally normal or above normal precipitation was experienced in 2004 with 14.8 cm (5.8 in.) followed by 25.4 cm (10.0 in.) in 2005. Good growing conditions were short lived as 2006 and 2007 experienced below normal precipitation. Although precipitation for the 2008 growing season was above normal, it was spread over the last eight months. About half of the total precipitation was received during September 2007. Then about 2.5 cm (1 in.) was received in December, January, and February. Between February and June less than 0.5 cm (0.2 in.) of rain was received.

Table 8-15. Precipitation (cm [in.]) received at BJ Wye Weather Station on the NTS (NOAA, 2008b)

	47-Year Average	2000	2001	2002	2003	2004	2005	2006	2007	2008
Calendar Year	16.8 (6.63)	16.8 (6.6)	15.5 (6.1)	3.8 (1.5)	14.6 (5.8)	26.5 (10.4)	23.3 (9.2)	11.0 (4.3)	14.3 (5.6)	5.5 (2.2)
Growing Season*	13.4 (5.3)	15.3 (6.0)	10.9 (4.3)	4.1 (1.6)	8.6 (3.4)	14.8 (5.8)	25.4 (10.0)	10.2 (4.0)	4.4 (1.7)	15.8 (6.2)

* Precipitation from September of previous year through June of current year.

Plant Cover – The amount of plant cover on the U-3ax/bl closure cover has been measured by species since 2003. Prior to 2003 plant cover was only estimated by life-form. Typically plant cover on newly revegetated sites is not sampled in arid regions, such as is typical of the NTS, until about the fifth year after revegetation. In the instance of the U-3ax/bl closure cover, plant cover was high even after the first growing season, due primarily to the use of supplemental irrigation. Plant cover data for the U-3ax/bl closure cover are reported for 2003 (the third year after revegetation), 2005 (the fifth year after revegetation), and the current year (Table 8-16). Cover data for other years are available in previous reports.

Total plant cover, including perennial and annual plant species, was the highest it has ever been on the U-3ax/bl closure cover. Perennial plant cover was higher than last year but still less than 2005 and 2006. All of the perennial plant cover is from shrubs. Perennial grasses have not contributed to overall plant cover to date on the closure cover. Annual plant cover was more than four times higher in 2008 than it was in 2004 and 2005, the last years that there was any annual plant cover on the closure cover (Table 8-16).

Table 8-16. Plant cover at CAU 110 U-3ax/bl: Closure Cover

	2003	2005	2008	Unseeded
Shrub	2.4	16.8	12.6	0.0
Grass	0.0	0.0	0.0	0.0
Annuals	0.8	3.4	14.0	27.4
Total Plant Cover	3.2	20.2	26.6	27.4
Bare Ground	68.8	53.6	61.4	65.5
Litter	28.0	26.2	11.8	7.1

The increase in total plant cover in 2008 is the result of an increase in the abundance of annual plants. Shrub cover increased slightly over last year but is not the four-fold increase experienced with annual plants. Shrub cover in 2008 is slightly less than the five-year average of 13.9 percent. Annual forbs and annual grasses have only contributed to overall plant cover three of the last five years.

A. confertifolia remains the most abundant plant on the closure cover. This perennial shrub along with *E. nevadensis* and *K. lanata* has persisted from year to year on the closure cover. The amount of cover contributed by these species is usually related to the amount of precipitation received that particular year. Neither *E. nevadensis* nor *K. lanata* contributed to total plant cover last year. However, both shrubs showed an increase in cover. The 0.4 percent *E. nevadensis* cover and the 0.2 percent *K. lanata* cover in 2008 are less than the five year averages for these species, but they have showed signs of recovery from the below normal precipitation in recent years.

The dominant annual plant species varies from year to year. *C. stevioides* had the highest cover of all annual plants in 2008. This was the first year *Sisymbrium altissimum* (tumblemustard) was encountered on the closure cover. *Salsola iberica* (prickly Russian thistle) has occurred in previous years but did not contribute to overall annual plant cover in 2008. This plant species germinates and grows later in the year, June and July, and may increase in abundance later. *B. tectorum* also contributed to plant cover this year. This is an introduced, weedy, plant species that dominates much of the rangelands in the western United States. In 2005, the only other time this species contributed to overall plant cover, it made up less than 1 percent of the total cover. In 2008 it was almost 5 percent of the total cover. Although there was an increase in *B. tectorum* cover in 2008, the amount of plant cover from noxious weeds has declined since 2000. In 2004 noxious weeds accounted for about 23 percent of total plant cover. By 2005 they only made up 7 percent, and in 2008 about 5 percent of total plant cover was from noxious weeds.

The lack of perennial grasses at this site is not unexpected. Historically (Webb et al., 2003) perennial grass cover ranged from 1 to 2.5 percent. Perennial grasses have established on the site but have not endured the unfavorable growing conditions the last few years (Table 8-15).

Overall plant cover in 2008 on the U-3ax/bl closure cover was 26.6 percent, which is slightly higher than was historically recorded on ecological monitoring plots in *A. confertifolia*/*K. lanata* plant assemblage (Webb et al., 2003). The data collected at the ecological monitoring plot serve as a standard or reference for the revegetation effort on the U-3ax/bl closure cover.

The other difference between the U-3ax/bl closure cover and the ecological monitoring plot is in the amount of perennial grasses. Grasses have not contributed to plant cover on the closure cover to date (Table 8-16 and Figure 8-7). On the ecological monitoring plot, grasses made up less than 1 percent in 1963 but increased to 2.5 percent in 1973. Grasses contribute a small amount to overall plant cover in this vegetation type; however, it should be more than is currently measured on the closure cover. *A. hymenoides* and *E. elymoides* are present on the closure cover, but a greater contribution to plant cover may require more time and better growing conditions.

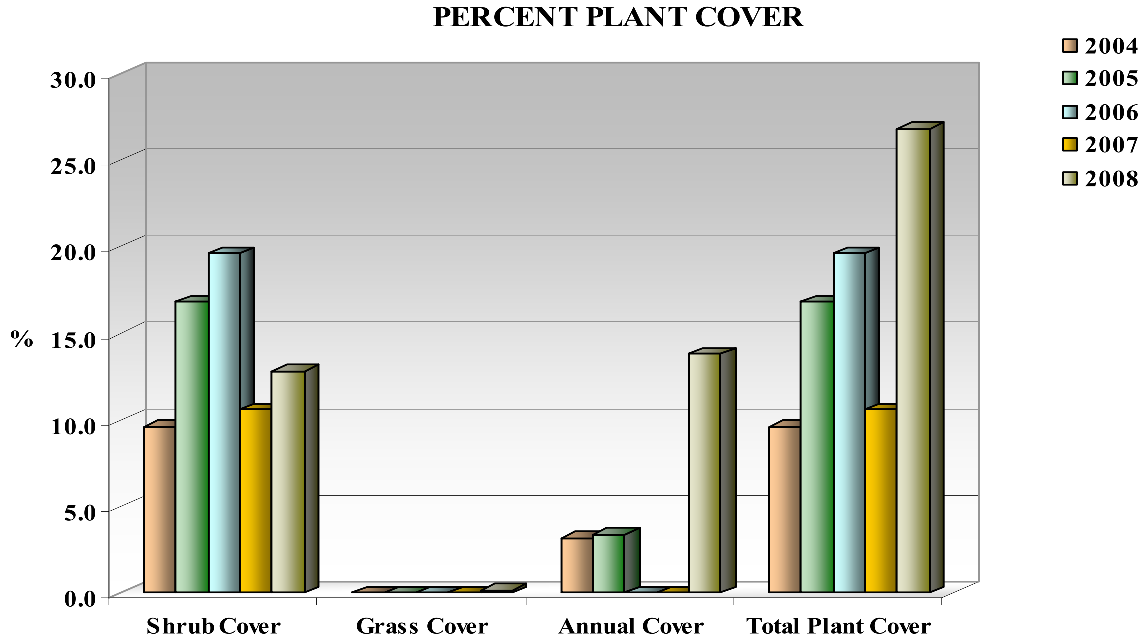

Figure 8-7. Percent plant cover on U-3ax/bl Closure Cover from 2004 to 2008

With the lack of precipitation, noxious annual plants, such as *S. iberica* and *H. glomerata*, have not been present in either the seeded or non-seeded areas. Reseeding the closure cover with perennial native plant species, followed by a short-term intensive irrigation, has resulted in a viable perennial plant cover somewhat resistant to typical drought conditions, thus providing a persistent vegetative cover, even during below normal precipitation periods. Without such a persistent perennial plant cover, active evapotranspiration would be dependent on annual plant growth, which as noted in the last five years is limited in time and duration. Annual plants are non-existent during severe or continuous periods of drought, and even during favorable growing conditions their short lifespan (weeks) limits their contribution to evapotranspiration.

The amount of exposed soil as measured by the percentage of bare ground has averaged a little more than 60 percent over the last four years (Table 8-16), not much different than the amount of bare ground on the non-seeded areas. The amount of litter on the closure cover averages 22 percent, notably lower than the 41 percent on the non-seeded areas.

Table 8-17. Plant density (plants/m^2 [plants/yd^2]) on the Area 3 U-3ax/bl Cover Cap

Species	2003	2005	2008	Unseeded 2008
Shrubs				
Atriplex confertifolia (shadscale)	2.7 (3.23)	2.5 (2.99)	1.1 (1.32)	0.0 (0.00)
Ephedra nevadensis (Nevada jointfir)	1.3 (1.55)	1.8 (2.15)	0.3 (0.36)	0.0 (0.00)
Krascheninnikovia lanata (winterfat)	0.4 (0.48)	0.4 (0.48)	0.01 (0.12)	0.0 (0.00)
Grayia spinosa (Hopsage)	0.1 (0.12)	0.0 (0.00)	0.0 (0.00)	0.0 (0.00)
Grasses				
Achnatherum hymenoides (Indian ricegrass)	0.3 (0.36)	0.3 (0.36)	0.0 (0.00)	0.0 (0.00)
Elymus elemoides (Squirreltail)	0.0 (0.00)	0.1 (0.12)	0.0 (0.00)	0.0 (0.00)
Annuals				
Chaenactis stevioides (Steve's pincushion)	0.0 (0.00)	0.6 (0.72)	8.3 (9.94)	6.5 (7.79)
Eriogonum species (annual buckwheat)	15.1 (18.06)	13.7 (16.39)	26.6 (31.83)	43.0 (51.43)
Sisymbrium altisimum (Tall tansy mustard)	0.0 (0.00)	0.8 (0.96)	3.8 (4.55)	9.2 (11.02)
Other species	0.9 (1.08)	0.7 (0.84)	2.1 (2.52)	3.0 (3.59)
Annuals (Noxious weeds)				
Halogeton glomeratus (halogeton)	0.2 (0.24)	12.5 (14.95)	0.2 (0.24)	0.3 (0.36)
Salsola iberica (Russian thistle)	3.4 (4.07)	70.3 (84.08)	0.1 (0.12)	7.5 (8.97)
Bromus tectorum and *B. rubens* (Cheatgrass and red brome)	0.1 (0.12)	1.9 (2.27)	2.4 (2.87)	7.2 (8.61)
Summary by Life-form				
Shrubs	4.5 (5.38)	4.7 (5.62)	1.4 (1.67)	0.0 (0.00)
Grasses	0.3 (0.36)	0.3 (0.36)	0.0 (0.00)	0.0 (0.00)
Annuals, includes noxious weeds	19.7 (23.44)	100.5 (120.40)	43.5 (52.03)	76.4 (91.37)
Total Plant Density	24.4 (29.18)	105.5 (126.18)	44.8 (53.67)	76.4 (91.37)

Plant Density – Shrub density declined from 2.0 shrubs/m^2 (2.4 shrubs/yd^2) in 2007 to 1.4 shrubs/m^2 (1.67 shrubs/yd^2) in 2008 (Table 8-17). The decrease in shrub density in 2008 was not as large as the decrease experienced from 2006 to 2007, when there was more than a 40 percent decrease in shrub density. Shrub density is about one-third of what it was in 2005 (Figure 8-8). Grass density has never been as high as shrub density, but the last two years grass density has been zero. The density of annual plants was the highest it has been for the last three years, but still only about half the density experienced in 2004 and 2006 (Table 8-17).

A. confertifolia, *E. nevadensis*, and *K. lanata* are the only three shrub species found on the closure cover. The first few years after revegetation there were as many as 11 different shrub species present (see previous reports). All three of the species experienced a decline this last year. Although the density of these three species has declined, their vigor remains high. *A. confertifolia* plants, just like in previous years, flowered and were setting seed, as was *E. nevadensis*. The few plants of *K. lanata* observed on the closure cover in 2008 were robust and had flowered and were in early seed set. Of the three shrubs found on the closure cover, *K. lanata* is the most palatable for native browsing animals. It was noted last year that *K. lanata* had been under intensive browsing pressure. Animals had burrowed into its roots, which resulted in the death of many *K. lanata* plants. The density for *A. confertifolia* continues to be the highest of the three shrubs, although density has declined from about 2 plants/m^2 (2.4 plants/yd^2) in 2004 and 2005 to about 1 plant/m^2 (1.2 plant/yd^2) in 2008 (Table 8-17). As mentioned in previous years, the density of *A. confertifolia* the first couple years after revegetation was more than 10 plants/m^2 (12 plants/yd^2). Plant density decreased sharply the next few years and has reached an equilibrium with available resources.

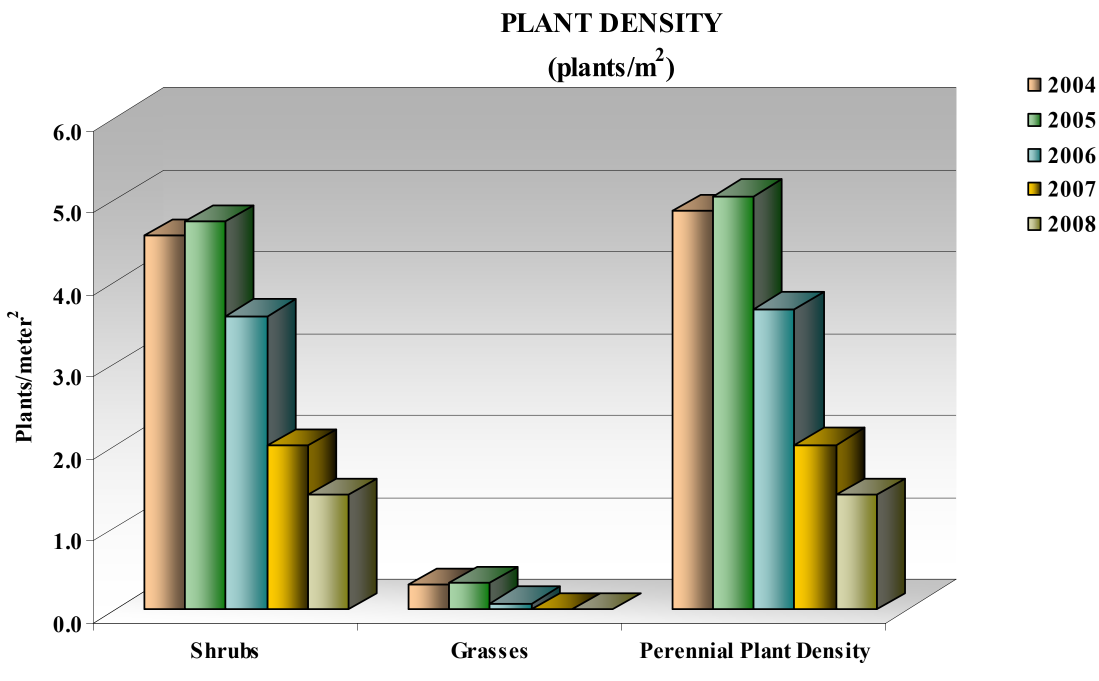

Figure 8-8. Perennial plant density on U-3ax/bl closure cover from 2004 to 2008

A. canescens has occasionally been found on the closure cover over the years. It was not seeded as part of the revegetation program but has established naturally. This past year all *A. canescens* plants were removed from the closure cover. The deeper rooting system of *A. canescens* posed a risk of penetrating the buried waste and compromising the integrity of the closure cover.

Two perennial grasses, *A. hymenoides* and *E. elymoides*, were commonly found on the closure cover until a couple years ago. The density of these two species was 0.4 plants/m^2 (0.5 plants/yd^2) in 2005, but neither species was found on the closure cover this year (Table 8-17). A few individuals of these species were infrequently observed on the closure cover in 2008, suggesting that with more favorable growing conditions, density of these species may increase.

The increase in overall plant density in 2008 is a direct result of the increase in the density of annual forbs and annual grasses. There were no annual plants last year. The 43.5 annuals/m^2 (52.0 annuals/yd^2) was an increase over the previous two years, yet it was only about half of the annual densities experienced in 2005 (Table 8-17). In 2008 there was a mix of native annual plants, whereas in previous years, *S. iberica* made up almost three-fourths of total annual density. In 2008 *Eriogonum deflexum* (flatcrown buckwheat), *C. stevioides*, and *S. altissimum* were the three most abundant annuals on the closure cover. These three annuals accounted for almost 95 percent of the total annual plant density (Table 8-17). The density for all three species was higher in 2008 than any other year since the site was revegetated in the fall of 2000. These three species were more abundant and contributed to both over plant density and cover (Table 8-17).

Over the last five years the density of annual grasses has ranged from 0 in 2007 to a high of 2.4 plants/m^2 (2.9 plants/yd^2) in 2008. Of the three annual grasses found on the closure cover, *B. tectorum* is the most abundant.

A concern on most newly revegetated sites is the invasion of non-native or noxious plant species. These noxious weeds quickly invade a newly disturbed site and use up the limited supplies of water and nutrients, leaving the slower establishing native species at a disadvantage. This was the situation on the U-3ax/bl closure cover. *B. tectorum*, *B. rubens*, and *S. arabicus*, all non-native annual grasses, along with *H. glomerata* and *S. iberica*, non-native annuals, made up from 50 percent to 80 percent of the total plant density between 2004 and 2006. In 2008 non-native species only accounted for 6 percent of the total plant density. It appears that the native species have become established, and both native perennial and annual species are able to compete with the aggressive noxious weeds for limited natural resources

Revegetation Success – In comparison to historic data collected from the permanent study plots (Webb et al., 2003) the amount of vegetative cover experienced in 2008 is lower than would be expected on native, undisturbed vegetation. Composition of the vegetative cover on the closure cover is different than was recorded on the permanent study plot. *P. desertorum, Grayia spinosa* (spiny hopsage), and *Lycium andersonii* (water jacket) are common in the native plant community but have not established on the closure cover. These species were included in the mix of seeds used to revegetate the site knowing that they are typically very difficult to establish from seed. Previously a few individual plants of *P. desertorum* and *G. spinosa* have been observed on the site, but neither species is present in sufficient numbers to contribute to overall vegetative cover.

The other difference between the U-3ax/bl closure cover and the ecological monitoring plot is in the amount of perennial grasses. Grasses have not contributed to plant cover on the closure cover to date. On the ecological monitoring plot, grasses made up less than 1 percent in 1963 but increased to 2.5 percent in 1973. Grasses contribute a small amount to overall plant cover in this vegetation type; however, it should be more than is currently measured on the closure cover. *A. hymenoides* and *E. elymoides* are present on the closure cover and with time and more favorable growing conditions may contribute more to total plant cover.

Summary – Perennial plant cover fluctuates from year to year with no apparent trend (Figure 8-7). The amount of perennial plant cover appears to be related to the timing and amount of annual precipitation. Several good precipitation events occurred early in the growing season and continued through February.

However, since February only insignificant amounts of precipitation have been received (Table 8-15). This pattern seems to favor certain annual species, such as *E. deflexum* and *C. stevioides*. Perennial plant growth as indicated by perennial cover was higher than last year but still less than was measured in 2005 and 2006. Similar fluctuations are expected in future years as established perennial species, essentially shrubs, continue to respond to different precipitation patterns. Perennial grasses are present on the site, but growing conditions over the past several years have not favored their growth. Perennial grasses may come back onto the U-3ax/bl closure cover when precipitation patterns and amounts are more conducive to their growth requirements.

Perennial plant density on the closure cover does not fluctuate from year to year like plant cover. Perennial plant density shows a gradual decline over the years (Figure 8-8). Plant densities were originally high but have declined as plants grow larger and demand for the limited resources (water and nutrients) increases, creating a natural thinning process. Harsh growing conditions are typical for this region, and casual observations of native plant communities have indicated similar declines in plant density and diversity over the last few years. Overall perennial plant densities have declined on revegetation sites monitored annually on the TTR, which is further north in the Great Basin ecoregion yet in a similar shrub/grassland plant community. Although the 1.4 plants/m^2 (1.7 plants/yd^2) (Table 8-17) is the lowest plant density recorded to date on the U-3ax/bl closure cover, perennial species on the closure cover appear to be well established. Shrubs are flowering, setting seed, and suggest an overall stable native plant community. Heavy browsing and tunneling into the roots of shrubs was not observed in 2008 as in previous years.

Figure 8-9. ***E. deflexum*, round silvery-green leaves, *C. stevioides*, white flower, and yellow-flowered *M. glabrata* (smooth desert dandelion), common native annuals on U-3ax/bl closure cover**

(Photograph By D. Anderson, May 2008)

The loss of perennial grasses has been a concern for several years. Over time with some good growing seasons they may return to the site. Any remedial revegetation would involve a major effort to establish perennial grasses on the site. Seeding could be used, but it would be labor intensive and the results marginal unless followed with above normal precipitation or irrigation. Currently the vegetation on the closure cover is stable and the plants that are there are well established, which meets the primary objectives of the vegetative cover.

Annual plants were more abundant, both in contributions to plant cover as well as plant density, than any other year. Typically in the past, weedy species made up the majority of annual plant cover and density. However, in 2008 the majority of the annuals were species native to the area. Although there was an increase in the amount of *B. tectorum* on the closure cover in 2008, for the most part the closure cover could be characterized as a native plant community. In previous years both *H. glomerata* and *S. iberica*, two noxious weeds, were found on the closure cover. Based on plant density and cover for these species in 2008, they were insignificantly present.

9.0 MONITORING THE NPTEC

9.1 Task Description

Biological monitoring at the NPTEC on the playa of Frenchman Lake in Area 5 is performed, if necessary, for certain types of chemical releases as per NPTEC's programmatic Environmental Assessment. In addition, the Environment, Safety, Health, and Quality Division has requested that NSTec monitor any test that may impact plants or animals downwind off the playa. A Biological Monitoring Plan for the NPTEC was prepared in FY 1996 and updated in FY 2002 (BN, 2002). It describes how field surveys will be conducted to determine test impacts on plants and animals and to verify that NPTEC's program complies with pertinent state and federal environmental protection requirements. The design of the monitoring plan calls for the establishment of three control transects and three treatment transects at three distances from the main chemical release points on the playa. The control and treatment transects have similar environmental and vegetation characteristics.

NSTec biologists are tasked to review chemical release test plans to determine if field monitoring along the treatment transects is required for each test as per the monitoring plan criteria. All test-specific field monitoring is funded through the NPTEC. Since 1996, the majority of chemical releases being studied at NPTEC have used such small quantities that downwind test-specific monitoring has not been necessary.

9.2 Task Progress Summary

NSTec reviewed chemical spill test plans for the following activities in 2008: Tarantula III and Black Widow 151. Chemicals were released at such low volumes or low toxicity that there was no need to monitor downwind transects for biological impacts. Baseline monitoring was not conducted at established control-treatment transects near the NPTEC in 2008 due to budget constraints.

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APPENDIX A

This appendix contains summarized information describing species presence in 40 new woody-plant plots within four plant community types: black sagebrush *(Artemisia nova)* [ARNO], big sagebrush *(Artemisia tridentata* ssp. *tridentata)* [ARTR], pinyon/black sagebrush *(Pinus monophylla/Artemisia nova)* [PIMO-ARNO], and pinyon/big sagebrush *(Pinus monophylla/Artemisia tridentata)* [PIMO-ARTR]. Species presence is shown as the number of stands (sites) within each community type that the species occurred by scientific/common name as well as their alphanumeric code (used to facilitate database calculations and report preparation). As mentioned in this report, observations at the sites were made during the summer months of a dry year, and therefore some species' presence at the site might have been overlooked. Information presented here is useful to inform the reader as to the likely types of plant species located within these new plots. It is anticipated that additional information will be added to the database during favorable growing seasons and on a regular basis in order to detect changes or trends in community composition.

Presence of Plant Species by Community Type

				Plant Community Type (number of stands within type that species occurred in)			
ACODE	Genus	Species	Common Name	ARNO	ARTR	PIMO-ARNO	PIMO-ARTR
			Total Number of Sites:	8	10	10	12
ACAR14	*Achnatherum*	*aridum*	arid needlegrass				2
ACHY	*Achnatherum*	*hymenoides*	Indian ricegrass	6	8	8	5
ACSP12	*Achnatherum*	*speciosum*	desert needlegrass	4	3	1	2
AMTE3	*Amsinckia*	*tessellata*	bristly fiddleneck, common fiddleneck	4	3		1
ARCOS2	*Arenaria*	*congesta var. subcongesta*	subcongesta sandwort			7	6
ARDI	*Arabis*	*dispar*	pinyon rockcress			1	
ARNO4	*Artemisia*	*nova*	black sagebrush	8	1	10	4
ARPU9	*Aristida*	*purpurea*	purple threeawn			1	1
ARSP5	*Artemisia*	*spinescens*	budsage, Bud sagebrush		1		
ARTRT	*Artemisia*	*tridentata ssp. tridentata*	basin big sagebrush		10	1	12
ASCAC5	*Astragalus*	*calycosus var. calycosus*	Torrey milkvetch		1	1	1
ASLEF2	*Astragalus*	*lentiginosus var. fremontii*	Fremont's milkvetch	4	5	1	3
ASPUT	*Astragalus*	*purshii var. tinctus*	woollypod milkvetch	4			1
ATCAC	*Atriplex*	*canescens var. canescens*	fourwing saltbush	6	4		2
ATCO	*Atriplex*	*confertifolia*	shadscale saltbush			1	
BOGR2	*Bouteloua*	*gracilis*	blue grama			1	
BRRU2	*Bromus*	*rubens*	foxtail brome	5	4		1
BRTE	*Bromus*	*tectorum*	cheatgrass	7	6	9	8
CAAP4	*Castilleja*	*applegatei*	wavyleaf Indian paintbrush	3	2	4	1
CAFL	*Calochortus*	*flexuosus*	winding mariposa lily	2		1	
CALI4	*Castilleja*	*linariaefolia*	Wyoming Indian paintbrush		1		1
CETH3	*Centrostegia*	*thurberi*	red triangles	1	3		1
CHAL11	*Chamaesyce*	*albomarginata*	whitemargin sandmat		1		
CHDO	*Chaenactis*	*douglasii*	Douglas' dustymaiden			1	
CHER2	*Leucelene*	*ericoides*	rose heath	1	1	1	1
CHST	*Chaenactis*	*stevioides*	Steves duskymaiden, broadflower pincushion	5	5		
CHVIP4	*Chrysothamnus*	*viscidiflorus ssp. puberulus*	green rabbitbrush	3	4	9	8
CHVIS5	*Chrysothamnus*	*viscidiflorus ssp. viscidiflorus var. stenophyllus*	green rabbitbrush	2	1		
CHVIV2	*Chrysothamnus*	*viscidiflorus ssp. viscidiflorus*	green rabbitbrush	1	4	4	4
CORA	*Coleogyne*	*ramosissima*	blackbrush		1		
CRCI2	*Cryptantha*	*circumscissa*	cushion catseye	2	3		
CRMI	*Cryptantha*	*micrantha*	redroot catseye		1		
CRNEN	*Cryptantha*	*nevadensis var. nevadensis*	Nevada catseye	2	2	1	1
CROCO2	*Crepis*	*occidentalis ssp. occidentalis*	largeflower hawksbeard		1		1
CRVI5	*Cryptantha*	*virginensis*	Virgin River catseye	1	1	4	4
DEAN	*Delphinium*	*andersonii*	larkspur		2		
DEPIG	*Descurainia*	*pinnata ssp. glabra*	pinnate tansymustard	6	6	7	2
ECENA2	*Echinocereus*	*engelmannii var. armatus*	saints cactus	1			
ELELE	*Elymus*	*elymoides ssp. elymoides*	Bottlebrush squirreltail	5	10	9	11
EPNE	*Ephedra*	*nevadensis*	Nevada jointfir	8	5		
EPVI	*Ephedra*	*viridis*	Mormon tea	1	1	8	8
ERCA8	*Eriogonum*	*caespitosum*	matted buckwheat		1	8	8
ERCI6	*Erodium*	*cicutarium*	redstem stork's bill	1			
ERCO23	*Ericameria*	*cooperi*	Cooper's heathgoldenrod	1			
ERCOC3	*Erigeron*	*concinnus var. concinnus*	Navajo fleabane			3	

ACODE	Genus	Species	Common Name	ARNO	ARTR	PIMO-ARNO	PIMO-ARTR
ERER2	*Eriastrum*	*eremicum*	desert woolstar	4	6	3	4
ERFAP	*Eriogonum*	*fasciculatum var. polifolium*	eastern Mojave buckwheat	1			2
ERLI6	*Ericameria*	*linearifolia*	narrowleaf heathgoldenrod				
ERMIL	*Eriogonum*	*microthecum var. lapidicola*	slender buckwheat			4	1
ERMIS2	*Eriogonum*	*microthecum var. simpsonii*	Simpson's buckwheat	1		5	6
ERNA10	*Ericameria*	*nauseosa*	rubber rabbitbrush			3	
ERNA7	*Ericameria*	*nanus*	dwarf heathgoldenrod				1
ERNAL	*Ericameria*	*nauseosa ssp. consimilis var. leiosperma*	rubber rabbitbrush	1			
ERNI4	*Eriogonum*	*nidularium*	bird nest buckwheat	4	2		
ERNU4	*Eriogonum*	*nummulare*	money buckwheat		1		
EROVO5	*Eriogonum*	*ovalifolium var. ovalifolium*	cushion buckwheat	2	2		
ERRA3	*Eriogonum*	*racemosum*	redroot buckwheat		1		4
ERUM	*Eriogonum*	*umbellatum*	sulphur wildbuckwheat			1	
ERUMS2	*Eriogonum*	*umbellatum var. subaridum*	sulpherflower buckwheat		1	4	5
ERWI	*Eriastrum*	*wilcoxii*	Wilcox's woolstar		1		
ESVID	*Escobaria*	*vivipara var. deserti*	desert spinystar			3	
FAPA	*Fallugia*	*paradoxa*	Apache plume				1
GADIP	*Gayophytum*	*diffusum ssp. parviflorum*	sreading groundsmoke		1		
GARA	*Gayophytum*	*racemosum*	backfoot groundsmoke		1		
GILIA	*Gilia*	*species*	gilia	8	8	9	7
GINY	*Gilia*	*nyensis*	Nye gilia		1		
GRSP	*Grayia*	*spinosa*	spiny hopsage	8	5	1	
GUSA2	*Gutierrezia*	*sarothrae*	common snakeweed, broom snakeweed			2	
HAGL	*Halogeton*	*glomeratus*	halogeton		1		
HECOC8	*Hesperostipa*	*comata ssp. comata*	needle-and-thread	1	5	5	3
HEMUN	*Heliomeris*	*multiflora var. nevadensis*	Nevada goldeneye			1	2
HYCOC2	*Hymenoxys*	*cooperi var. cooperi*	Cooper's hymenoxys			2	1
IPCO5	*Ipomopsis*	*congesta*	ballhead gilia			2	
IPPO2	*Ipomopsis*	*polycladon*	manybranched gilia	2	3		
JUOS	*Juniperus*	*osteosperma*	Utah juniper	2	3	10	12
KOMA	*Koeleria*	*macrantha*	prairie junegrass				1
KRLA2	*Krascheninnikovia*	*lanata*	winterfat	1			
LECI4	*Leymus*	*cinereus*	basin wildrye		1		1
LEFLF2	*Lepidium*	*flavum var. flavum*	yellow pepperweed	1	1		
LEKIK	*Lesquerella*	*kingii ssp. kingii*	Kings bladderpod			1	
LELA	*Lepidium*	*lasiocarpum*	shaggyfruit pepperweed	1			
LINUN	*Linanthus*	*nuttallii ssp. nuttallii*	Nutall's deserttrumpets		2	5	9
LUCA	*Lupinus*	*caudatus*	tailcup lupine		2		1
LUFL	*Lupinus*	*flavoculatus*	yelloweyes	1			
LYAN	*Lycium*	*andersonii*	Anderson's wolfberry	3	1		
MACAC	*Machaeranthera*	*canescens ssp. canescens*	hoary aster	1	4	1	
MAGL3	*Malacothrix*	*glabrata*	smooth desertdandelion	1	1		
MEAL6	*Mentzelia*	*albicaulis*	whitestem blazingstar		2	1	
MEOB3	*Mentzelia*	*obscura*	Pacific blazingstar	1			
OPECE	*Opuntia*	*echinocarpa var. echinocarpa*	staghorn cholla	3	1		
OPPOR	*Opuntia*	*polyacantha var. rufispina*	hairspine pricklypear	2	2	10	11
OXPE2	*Oxytheca*	*perfoliata*	roundleaf puncturebract	2	1		
PEFLA2	*Penstemon*	*floridus var. austinii*	Austin's beardtongue				1
PEPA23	*Penstemon*	*pahutensis*	Paiute beardtongue				3
PEPL	*Pectocarya*	*platycarpa*	broadfruit combseed		2		

ACODE	Genus	Species	Common Name	ARNO	ARTR	PIMO-ARNO	PIMO-ARTR
PEPU7	*Petradoria*	*pumila*	grassy rockgoldenrod			3	3
PESE	*Pectocarya*	*setosa*	moth combseed	2			
PHBI	*Phacelia*	*bicolor*	two color phacelia			3	
PHFR2	*Phacelia*	*fremontii*	Fremont's phacelia	4	2		1
PHJU	*Phoradendron*	*juniperinum*	juniper mistletoe			1	4
PHST11	*Phlox*	*stansburyi*	colddesert phlox	2	4	6	4
PHVAV2	*Phacelia*	*vallis-mortae var. vallis-mortae*	Death Valley phacelia				2
PIMO	*Pinus*	*monophylla*	singleleaf pinyon	1		10	12
PLJA	*Pleuraphis*	*jamesii*	galleta grass	3	4	1	
PLOV	*Plantago*	*ovata*	desert Indianwheat	1			
POFE	*Poa*	*fendleriana*	muttongrass			6	5
POSE	*Poa*	*secunda*	Sandberg's bluegrass	3	2	10	12
POSU	*Polygala*	*subspinosa*	spiny polygala		1		
PUGL2	*Purshia*	*glandulosa*	desert bitterbrush	1			
PUST	*Purshia*	*stansburiana*	Stansbury cliffrose			6	5
PUTR2	*Purshia*	*tridentata*	antelope bitterbrush			5	8
QUGA	*Quercus*	*gambelii*	Gambel oak			2	4
RANE	*Rafinesquia*	*neomexicana*	New Mexico plumseed	2	1		
RIVEV	*Ribes*	*velutinum var. velutinum*	desert gooseberry			2	3
SAKAT3	*Salsola*	*kali ssp. tragus*	prickly russian thistle				
SEMU3	*Senecio*	*multilobatus*	lobeleaf groundsel		2	7	5
SIAL2	*Sisymbrium*	*altissimum*	tumblemustard		1		
SIVEA	*Silene*	*verecunda ssp. andersonii*	Anderson's campion				2
SPAMA	*Sphaeralcea*	*ambigua ssp. ambigua*	apricot globemallow	3	2		
SPGRP2	*Sphaeralcea*	*grossulariaefolia ssp. pedata*	gooseberryleaf globemallow	1	1		
STEXE	*Stephanomeria*	*exigua ssp. exigua*	small wire-lettuce	2	3	1	1
STMI2	*Stylocline*	*micropoides*	woollyhead neststraw		1		
STPIP	*Stanleya*	*pinnata var. pinnata*	desert princesplume	1			
STSP6	*Stephanomeria*	*spinosa*	Thorn skeletonweed				1
SYFR	*Syntrichopappus*	*fremontii*	yellowray fremontsgold	2	1	1	3
SYLO	*Symphoricarpos*	*longiflorus*	desert snowberry			2	1
TECA2	*Tetradymia*	*canescens*	spineless horsebrush	2	1	1	1
TEGL	*Tetradymia*	*glabrata*	littleleaf horsebrush	1			
YUBAV	*Yucca*	*baccata var. vespertina*	banana yucca	1		1	

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