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YUCCA MOUNTAIN

BIOLOGICAL RESOURCES MONITORING PROGRAM

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Permission to handle and attach radio transmitters to desert tortoises was granted by the U. S. Fish and Wildlife Service (FWS) through permit PRT 683011 and permits S 5041 and S 6941 granted by the Nevada Department of Wildlife. Permission to capture, mark and release, and collect small mammal species, reptiles, and quail was provided by the Nevada Department of Wildlife through permits S 5041 and S 6941. Maps (except Figure 1) were produced by the EG&G/EM Remote Sensing Laboratory, Yucca Mountain Support Office. These maps were produced in November and December 1992 using the Transverse Mercator projection. These maps should not be used for quality-affecting work.

This is a continuing program, and interpretation of data contained in this report may change as new data are acquired. Results should not be cited in scientific literature without consultation.

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1. INTRODUCTION

The U. S. Department of Energy (DOE) is required by the Nuclear Waste Policy Act of 1982 (as amended in 1987) to study and characterize Yucca Mountain as a potential site for a geologic repository for high-level nuclear waste. During site characterization, the DOE will conduct a variety of geotechnical, geochemical, geological, and hydrological

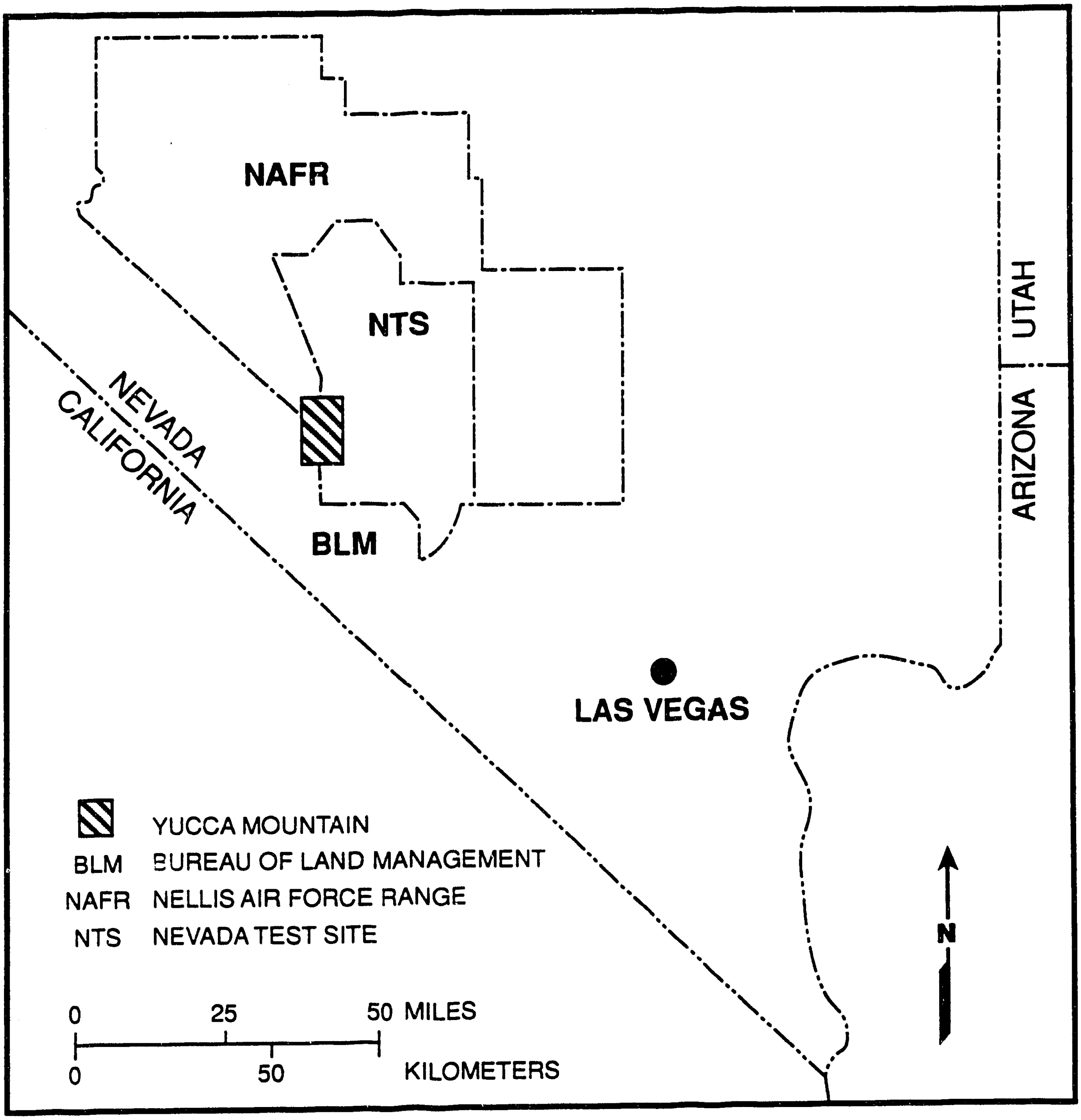


Figure 1. Location of the Yucca Mountain Study Area, Nye County, Nevada.

2. SITE CHARACTERIZATION EFFECTS PROGRAM

The studies in the Site Characterization Effects Program were designed to assess the effects of SCA on the terrestrial ecosystem by monitoring attributes of selected ecological components. The program includes studies of the vegetation, small mammals

reptiles, invertebrates, the spotted bat, disturbance levels, and climate.

2.1 STUDY DESIGN

SCA includes a wide variety of activities with different spatial and temporal scales; therefore, studies were designed to assess the combined effects of the most common disturbances caused by SCA. The experimental approach is a split-plot design of paired treatment and control plots with repeated measures over time. Since the Yucca Mountain area is a single "site," true replications cannot be attained. Consequently, the field method for data collection can be regarded as analytical sampling involving subsamples (Eberhardt and Thomas, 1991). The sample units are 200- x 200-m ecological study plots (ESPs). Treatment plots are adjacent to existing SCA that are

2.2.2.1 Cover

Vegetation cover was sampled between April and June. Vegetation cover in 1992 was approximately double that measured in 1991 (Table 1). Percent cover was highest in the *Larrea-Lycium-Grayia* vegetation association (36.3) and lowest in the *Larrea-Ambrosia* association (20.1). The *Coleogyne* and *Lycium-Grayia* associations had intermediate cover values.

The increase in vegetation cover from 1991 to 1992 probably resulted from the above average precipitation that southern Nevada received during the winter of 1991-1992. The nearly identical cover on control and treatment ESPs indicates that Site Characterization Activities have probably not affected vegetation cover; however, data analyses is necessary before any conclusion can be made. Data analyses will also be done to evaluate percent cover by species and lifeform and whether perennial species are recovering from the drought that occurred in the late 1980's.

2.2.2.2 Production

Annual production was measured during June - August. The current year's biomass was harvested separately by four lifeforms (perennial grass, perennial forb, shrub, and annual species) in 32 and 40, 1 x 1-m quadrats on control and treatment ESPs, respectively. Ocular biomass estimates were made in an additional 64 (control) and 80 (treatment) quadrats on each ESP. All samples were weighed the day of collection to obtain a fresh (wet) biomass estimate. Dry weights have not been obtained for all samples.

Biomass estimates from 1991 and the wet weights obtained in 1992 were entered into a computer database. Oven-dry weights from 1992 will be entered into the database after samples are weighed in the winter of 1992-1993.

Table 1. Percent plant cover during 1989-1992 at Ecological Study Plots (ESPs) in four vegetation associations. For all vegetation associations and years n = 12 (6 treatment and 6 control) unless indicated otherwise.

		1989		1990		1991		1992	
Vegetation Association	Experimental Unit	Mean	sd	Mean	sd	Mean	sd	Mean	sd
Coleogyne	All ESPs	22.0[1]	1.9	17.4	4.4	15.0	6.4	26.9	7.6
	Treatment	21.9	2.5	16.7	1.7	15.2	6.8	26.3	7.9
	Control	22.2	1.0	18.1	6.1	14.8	6.6	27.8	7.2
Larrea-Lycium-Grayia	All ESPs	17.8[2]	3.4	13.6[3]	2.4	17.1	1.9	36.3	8.5
	Treatment	17.1	4.1	12.9	3.2	16.5	2.3	36.3	8.5
	Control	19.0	1.6	14.1	1.6	17.7	1.2	36.3	6.6
Larrea-Ambrosia	All ESPs	17.0	3.1	14.5	2.1	10.4	2.6	20.1	5.7
	Treatment	15.3	2.5	13.7	2.0	9.0	2.6	20.5	5.6
	Control	18.7	2.7	15.4	2.0	11.7	2.0	19.6	5.8
Lycium-Grayia	All ESPs	20.4[4]	2.9	15.7	1.8	16.7	3.2	31.5	8.6
	Treatment	20.5	1.8	15.8	2.3	16.9	4.1	32.4	7.7
	Control	20.2	5.1	15.6	1.4	16.4	2.6	30.4	9.7

[1] n = 8 (4 treatment, 4 control)
[2] n = 8 (5 treatment, 3 control)
[3] n = 11 (5 treatment, 6 control)
[4] n = 5 (3 treatment, 2 control)

2.2.2.3 Density

Perennial Plant Species. Perennial species density was measured in September - October 1992. Field personnel used preprinted species location maps (using an X-Y coordinate system), generated from 1991 data, to locate all plants still alive, to identify new plants in the community, plants that have died, and plants incorrectly identified during previous years. Changes in each belt transect's (2 x 50 m) species composition were made on the maps in the field.

During sampling of the *Larrea-Ambrosia* vegetation association in 1991, no live Indian ricegrass (*Oryzopsis hymenoides*) was found; however, numerous seedling Indian ricegrass were found in 1992. Similarly, young shadscale (*Atriplex confertifolia*) and Virgin River Encelia (*Encelia virginensis*) were uncommon or absent in the low-elevation *Coleogyne* and *Larrea-Lycium-Grayia* ESPs in 1991, but were common in 1992. The recruitment of new individuals and the absence of mortality in 1992 suggest at least some vegetation associations are recovering from the drought of the late 1980s. Additional data analysis is necessary to determine if there are differences in plant recruitment, mortality, and species composition between treatment and control ESPs.

Annual Plant Species and Perennial Seedlings. During the winter of 1991 - 1992, five, 1 x 1-m quadrats were randomly located in each 2 x 50-m belt transect on each ESP. A total of 40 and 50 quadrats occur on control and treatment ESPs, respectively. Two corners of each quadrat were permanently marked with 30-cm wood stakes. Sampling occurred on 46 ESPs during the spring and summer of 1992. Two ESPs were not sampled because soil moisture had been depleted and both annual species and seedlings had died and could not be identified.

Initially field personnel sampled every quadrat in each ESP. All annual species present were identified and counted by species. Perennial seedlings were identified by species and mapped using an X-Y coordinate system. This mapping system will allow seedlings to be relocated in subsequent years and seedling survival determined. After 12 ESPs were sampled, the sampling technique was modified because counting the large number of annual species was too time consuming and would prevent sampling all the ESPs. Species counts for annuals occurred in the first quadrat in each belt transect. Total density was measured in the lower left quarter (0.25-m^2) of the other four quadrats in each belt transect. Estimates were multiplied by 4 to obtain annual species density/m^2. This technique allowed measuring of both species composition and density. Sample size was also reduced to three transects on treatment ESPs (from 5) and two transects on control ESPs (from 4).

Annual species density data have not been analyzed; however, observations indicate density ranged from zero to about 2,000 plants/m^2, and that large differences in both species composition and density appear to have occurred between vegetation associations.

Average density over all plots was 0.96/m^2 (Table 2). Seedling density was highest in the *Larrea-Ambrosia* vegetation association (1.81/m^2), and was dominated by two species; Indian ricegrass and shadscale. Shadscale and Indian ricegrass seedlings accounted for 25 and 50 percent, respectively, of all seedlings counted. Seedlings were produced by 25 species of perennial plants. Fifteen of these species produced fewer then seven seedlings over all the plots sampled. Precipitation in 1992 was much higher then the long-term average, but seed germination was not consistent for all vegetation associations. The *Larrea-Ambrosia* association had the lowest mean precipitation (see Section 2.9), but the greatest seedling density.

Mountain in 1992.

um-Grayia	Total
1	43
0	16
0	264
7	8
0	23
18	118
1	10
0	11
2	558
0	8
8	44
206	1154
37	1104
0.18	0.96
213	

flexuosa, Ceratoides
ecum, Erioneuron
ra spinescens, Stipa

2.3 SMALL MAMMAL STUDY

The objective of this study is to monitor effects of SCA on the small mammal community by measuring changes in demographic attributes of the most abundant small mammal species through time. Small mammal populations at Yucca Mountain have been live-trapped on ESPs since FY89. Each study plot consists of a 12- x 12-trap grid of 144 trap-stations (two live-traps/station). There is one treatment and one control ESP in each of the four vegetation associations. Trapping is conducted in 4-day trap sessions five times during the year (EG&G/EM, 1991). The sampling effort for all the trap sessions was 46,080 trap-nights.

Eleven small mammal species were captured (Table 3). The number of individuals captured increased for most species compared to previous years. The large increase in individuals was caused by high reproduction, a probable response to above-average precipitation (see Section 2.9) and plant production. The long-tailed pocket mouse (*Perognathus formosus*) was the most abundant species captured in all habitats except the *Larrea-Ambrosia* association, where the little pocket mouse (*Perognathus longimembris*) was more abundant. The little pocket mouse was captured only in the *Larrea-Ambrosia* association. Merriam's kangaroo rat (*Dipodomys merriami*) was common in all vegetation associations, but was least abundant in the higher elevation study plots in the *Lycium-Grayia* vegetation association. In the *Lycium-Grayia* sites, the canyon mouse (*Peromyscus crinitus*) was relatively abundant (Table 3).

New species captured this year but not in FY91 included the cactus mouse (*Peromyscus eremicus*) and desert cottontail (*Sylvilagus audubonii*). Among the less common species, the southern grasshopper mouse (*Onychomys torridus*) and desert woodrat (*Neotoma lepida*) increased the most. Desert woodrat populations increased most on the *Lycium-Grayia* study plots.

One of the assumptions of the experimental design being used to assess impacts on biological resources at Yucca Mountain is that population abundance on control and treatment plots change proportionately through time (Green et al., 1991, Skalski and Robson, 1992). Graphical analysis of numbers of individual long-tailed pocket mice and Merriam's kangaroo rats captured since trapping started in 1989 suggest that population trends on control and treatment study plots have been parallel (Figures 2 and 3). Although the magnitude of response does vary in some vegetation associations, the changes are largely proportionate. Detailed interpretations of the data cannot be made until estimates of demographic attributes (i.e., population density, survival, and recruitment) are calculated and additional data are collected.

Table 3. Number of individual small mammals captured on ecological study plots, March - September 1992.

Species	Month	Vegetation Association and Plot Number							
		Larrea-Ambrosia		*Coleogyne*		*Larrea-Lycium-Grayia*		*Lycium-Grayia*	
		LA5T	LA2C	COL1T	COL2C	LLG5T	LLG8C	LG6T	LG4C
Perognathus formosus Long-tailed pocket mouse	March	10	0	132	136	93	222	87	70
	May	5	2	119	107	73	187	53	50
	June	37	5	276	291	223	385	216	158
	August	79	1	216	243	199	309	188	139
	September	60	1	206	213	189	298	179	122
Perognathus longimembris Little pocket mouse	March	35	28	0	0	0	0	0	0
	May	26	16	0	0	0	0	0	0
	June	73	41	0	0	0	0	0	0
	August	77	67	0	0	0	0	0	0
	September	65	39	0	0	0	0	0	0
Dipodomys merriami Merriam's kangaroo rat	March	39	30	32	42	87	56	20	24
	May	47	22	26	32	69	41	10	13
	June	63	37	24	52	117	53	12	13
	August	68	47	27	47	118	48	16	16
	September	93	99	34	43	115	71	25	18

Table 3. Continued.

Species	Month	Vegetation Association and Plot Number							
		Larrea-Ambrosia		*Coleogyne*		*Larrea-Lycium-Grayia*		*Lycium-Grayia*	
		LA5T	LA2C	COL1T	COL2C	LLG5T	LLG8C	LG6T	LG4C
Dipodomys microps Great Basin kangaroo rat	March	1	0	8	4	5	1	2	10
	May	4	0	7	12	4	0	0	6
	June	8	0	8	14	8	0	4	10
	August	7	0	8	7	8	0	3	6
	September	5	0	9	8	8	1	5	8
Onychomys torridus Southern grasshopper mouse	March	4	2	3	6	4	10	5	5
	May	5	2	3	8	15	2	2	0
	June	7	3	11	0	16	5	4	7
	August	7	4	13	12	23	13	8	7
	September	7	3	9	14	20	9	8	6
Neotoma lepida Desert woodrat	March	0	0	0	0	0	1	0	0
	May	0	0	0	0	0	2	0	1
	June	3	2	1	0	1	8	13	26
	August	0	0	1	1	1	7	17	31
	September	0	0	1	3	1	7	15	22

…nd Plot Number			
…rrea-Lycium-Grayia		*Lycium-Grayia*	
…G5T	LLG8C	LG6T	LG4C
2	13	92	53
[illegible]	2	17	21
0	10	86	152
7	13	69	92
9	23	56	74
2	4	0	0
3	1	0	0
1	3	5	2
0	9	9	0
3	6	4	4
0	0	7	0
0	0	4	1
0	0	5	5
0	0	3	0
0	0	2	0

Table 3. Continued.

Species	Month	Vegetation Association and Plot Number							
		Larrea-Ambrosia		*Coleogyne*		*Larrea-Lycium-Grayia*		*Lycium-Grayia*	
		LA5T	LA2C	COL1T	COL2C	LLG5T	LLG8C	LG6T	LG4C
Ammospermophilus leucurus White-tailed antelope squirrel	March	2	2	1	1	0	1	0	0
	May	0	0	0	0	0	0	1	1
	June	8	6	0	2	3	1	6	6
	August	2	4	3	4	3	1	4	7
	September	3	5	0	3	1	1	0	4
Sylvilagus audubonii Desert cottontail	March	0	0	0	0	0	0	0	0
	May	0	0	0	0	2	0	1	0
	June	0	0	0	0	0	0	0	0
	August	0	0	0	0	0	0	0	0
	September	0	0	0	0	0	0	0	0
Totals for all species	March	98	62	180	191	193	308	213	162
	May	89	42	158	159	166	235	88	93
	June	207	94	322	369	379	465	351	379
	August	249	123	272	326	379	400	317	298
	September	241	147	271	296	366	416	294	258

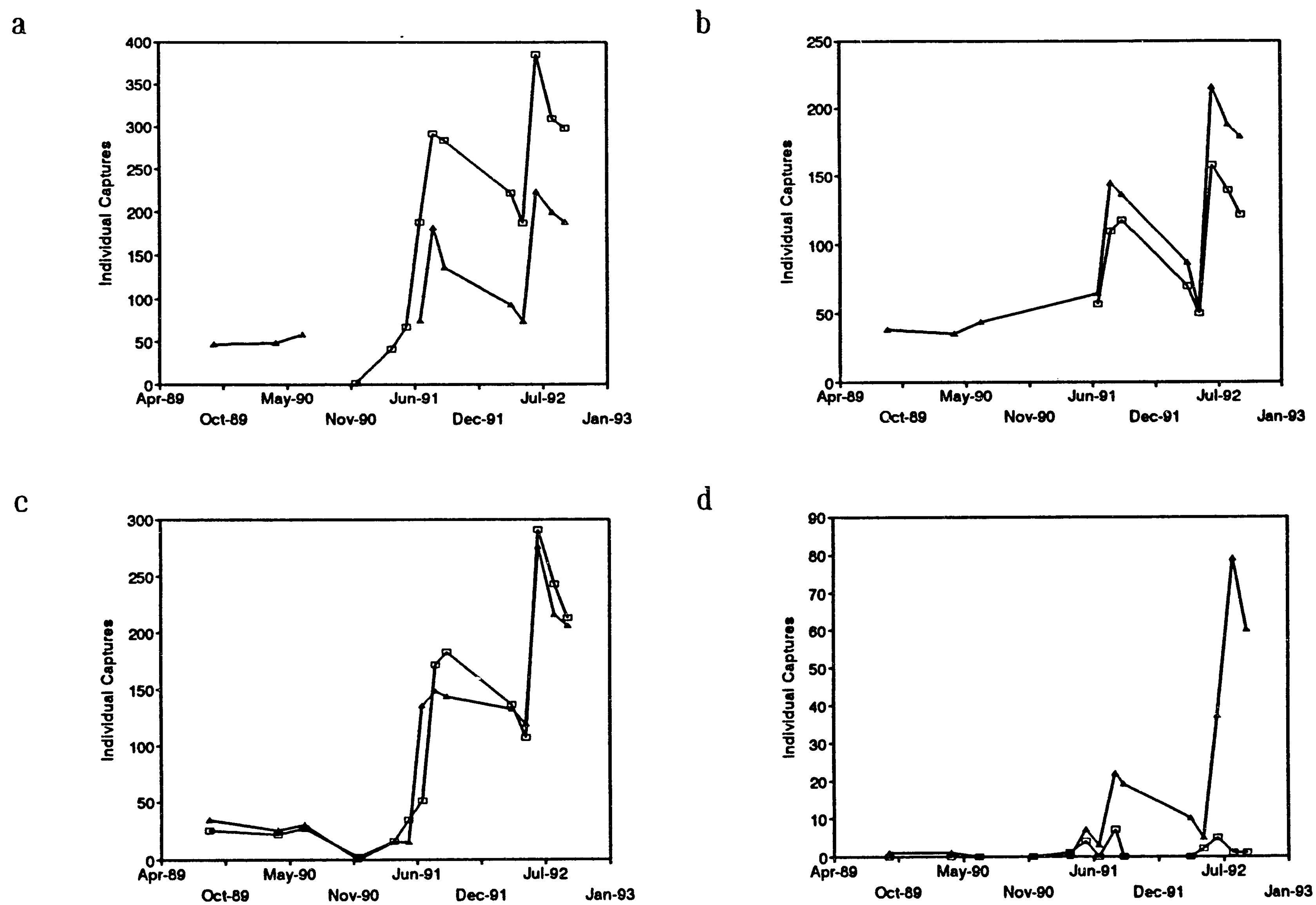


Figure 2. Population trends of the long-tailed pocket mouse in control (□) and treatment (▲) study plots from August 1989 through September 1992 in: a) *Larrea-Lycium-Grayia*, b) *Lycium-Grayia*, c) *Coleogyne*, and d) *Larrea-Ambrosia* vegetation associations at Yucca Mountain.

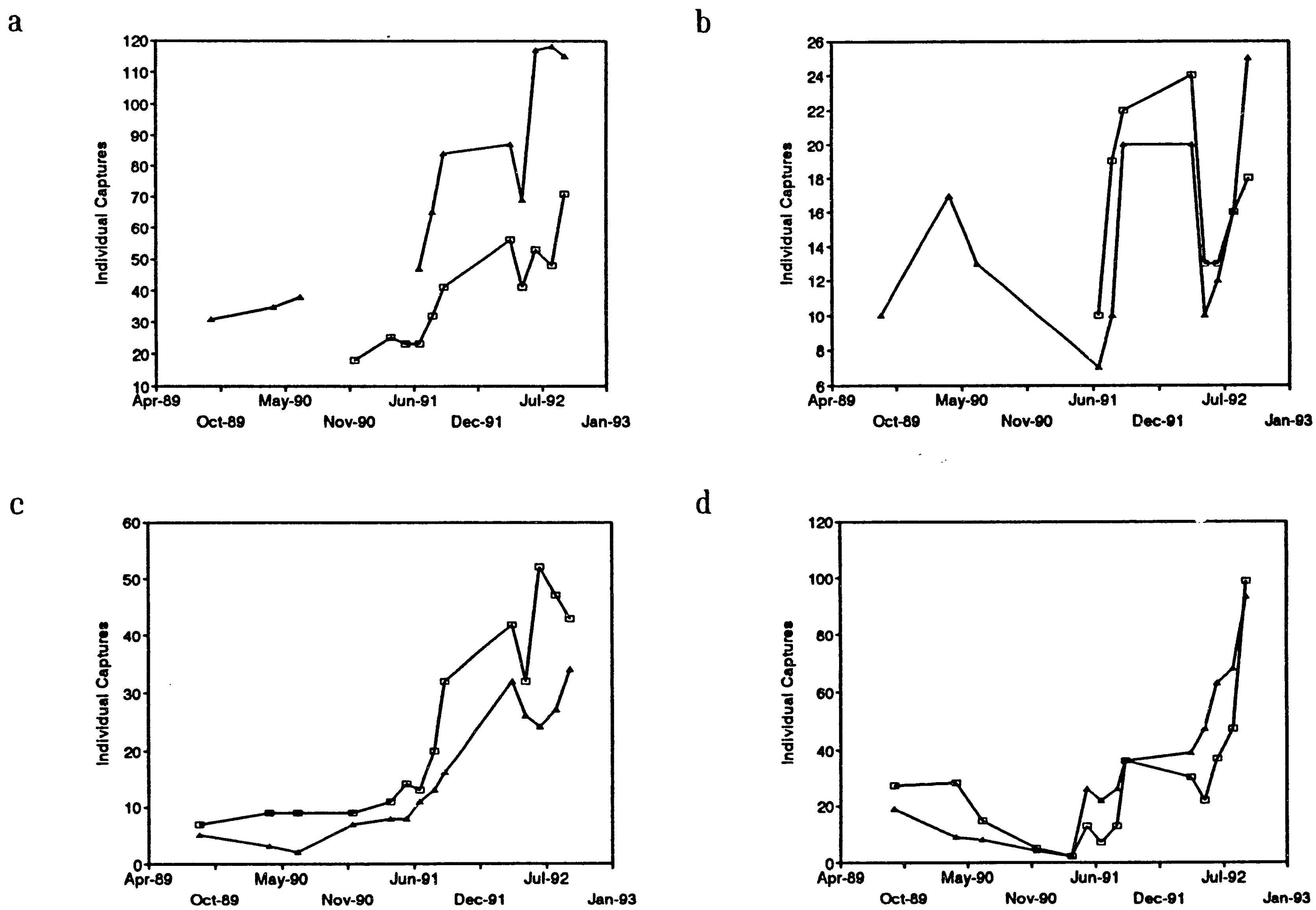


Figure 3. Population trends of Merriam's kangaroo rat in control (□) and treatment (▲) study plots from August 1989 through September 1992 in: a) *Larrea-Lycium-Grayia*, b) *Lycium-Grayia*, c) *Coleogyne*, and d) *Larrea-Ambrosia* vegetation associations at Yucca Mountain.

2.4 REPTILE STUDIES

The objectives of these studies are to determine species composition and to monitor changes in abundance of the most common lizard species. Mark-recapture sampling was conducted on three ESPs using traps and noosing and six ESPs using only noosing. Counts of lizards were then conducted on the six ESPs plus an additional five ESPs to determine if estimates of relative abundance from counts and recapture methods were comparable.

Methods used for mark-recapture sampling were the same as in 1991 (EG&G/EM 1992). Because the wooden funnel traps on these plots were rapidly deteriorating, they were replaced with metal traps. Wood shades were placed on the side and top of the traps to reduce solar heating.

Six new plots were established to increase the sample size for mark-recapture estimates. Noosing was conducted on all six plots during a four-day session in September. Traps were not placed on the newly established plots due to the extreme difficulty of installing pitfall traps and drift fences. Mark-recapture sampling on these plots will rely solely on noosing to capture animals.

To determine if censuses could be used to estimate relative abundance, lizards were counted on 11 ESPs for three consecutive mornings in June. On each ESP, a 1-ha plot was surveyed by 3-5 persons walking about 5 m apart and recording all lizards observed. Successive passes were made until the entire plot had been surveyed. Two of the plots were trapped and noosed the two weeks preceding the census so that population size could be estimated and used to calculate an abundance index. Counts of lizards varied by up to 300% on the same plot due to the effects of wind and temperature. The counting technique did not provide accurate estimates because wind and temperature frequently changed over a very short period of time and plots were not counted simultaneously due to lack of manpower.

Fourteen species of reptiles were captured during mark-recapture sampling (Table 4). The side-blotched lizard (*Uta stansburiana*) and western whiptail (*Cnemidophorus tigris*) were the most common species. Nearly all captures on the six newly established plots were of side-blotched lizards. The number of individual side-blotched lizards captured on these plots was 55 on LLG5C, 39 on LLG7T, 71 on LG6T, 61 on LG7T, 36 on LG3C, and 80 on COL5T.

Eight species were captured opportunistically: desert collared lizard (*Crotaphytus insularis*), desert iguana (*Dipsosaurus dorsalis*), zebratail lizard (*Callisaurus draconoides*), chuckwalla (*Sauromalus obesus*), glossy snake (*Arizona elegans*), striped whipsnake (*Masticophis taeniatus*), speckled rattlesnake (*Crotaphytus mitchellii*), and sidewinder (*Crotaphytus cerastes*). It was the first time the desert iguana, zebratail lizard, and striped whipsnake were captured at Yucca Mountain.

Table 4. Number of individual reptiles captured on three plots during one week trap sessions in June and September, 1992.

Species	LA3T		LLG2T		COL2T	
	June	Sept.	June	Sept.	June	Sept.
Lizards						
Uta stansburiana Side-blotched lizard	17	28	95	55	70	61
Cnemidophorus tigris Western whiptail	40	19	40	12	57	16
Coleonyx variegatus Western banded gecko	2	2	4	1	1	2
Gambelia wislizenii Longnose leopard lizard	4	3	0	0	0	3
Sceloporus magister Desert spiny lizard	2	1	0	0	0	0
Phrynosoma platyrhinos Desert horned lizard	1	9	0	0	9	5
Snakes						
Sonora semiannulata Ground snake	2	0	3	0	3	0
Chionactis occipitalis Western shovelnose snake	3	0	0	0	0	0
Rhinocheilus lecontei Longnose snake	1	2	2	1	0	1
Masticophis flagellum Coachwhip	0	1	5	1	3	2
Salvadora hexalepis Western patchnose snake	1	0	0	0	1	0
Hypsiglena torquata Night snake	0	0	0	0	2	0
Pituophis melanoleucus Gopher snake	0	0	0	0	1	1
Lampropeltis getula Common kingsnake	0	1	0	0	0	0

2.5 SPOTTED BAT STUDY

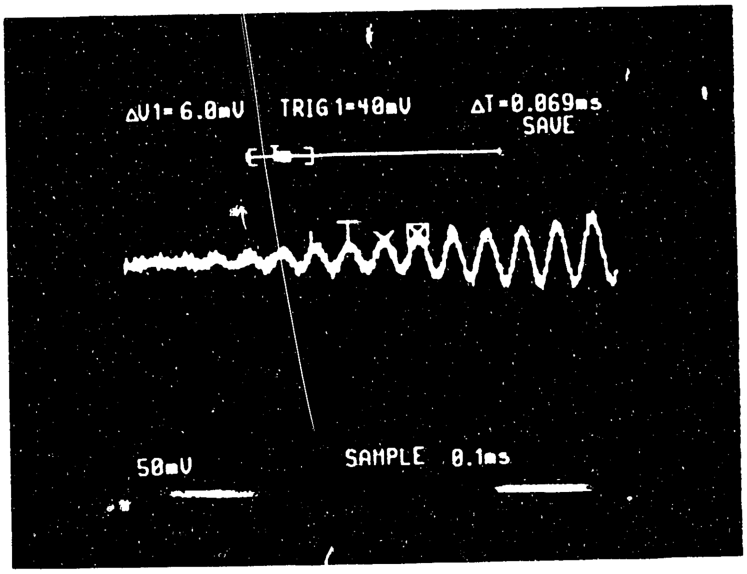
The spotted bat (*Euderma maculatum*) is classified as a Category 2 species by the U.S. Fish and Wildlife Service and has been found in adjacent Clark and Lincoln counties (Best, 1988). A study was initiated in FY91 to determine if the spotted bat is present at Yucca Mountain. No previous field study had been conducted to determine the species' presence at Yucca Mountain. The spotted bat often occurs in desert scrub located near coniferous forest. Juniper (*Juniperus* spp.) and pine (*Pinus* spp.) communities are located 13 km north of Yucca Mountain.

In FY91 mist netting and listening for vocalizations were used to detect the presence of the spotted bat. In FY92 surveys were conducted by listening for vocalizations and recording all possible calls with a digital audio tape recorder in addition to occasional mist-netting efforts. Recording vocalizations is the best known method of detecting the presence of the spotted bat (Fenton et al., 1987; Navo et al., 1992).

Field surveys during FY91 were conducted near Yucca Mountain, at man-made ponds. In FY92, surveys were conducted near Yucca Mountain and at sites on NTS in more typical spotted bat habitat (Woodsworth et al., 1981; Leonard and Fenton, 1983; Navo et al., 1992). Surveys were done distant from Yucca Mountain to increase the probability of detecting spotted bats and improve confidence in surveys conducted at Yucca

On May 27 and 28, 1992 surveys were conducted in Forty-Mile Wash near Yucca Mountain along rock faces containing crevices. On July 7, 1992, surveys were conducted on a pond north of the intersection of Stockade Wash and Pahute Mesa Road, approximately 40 km northeast of Yucca Mountain. On July 8, surveys were conducted in Yucca Wash and Paintbrush Canyon near Yucca Mountain. On August 17, the J-13 pond in Forty-Mile Wash was surveyed. The following night a well pond along Pahute Mesa Road in Silent Canyon was surveyed, approximately 70 km north of Yucca Mountain.

No spotted bat vocalizations were heard during surveys in May, July, or on August 17. On August 18 at the Silent Canyon site, two mist nets were erected over the well pond (UTMs = 559764 E, 4124575 N) and observations began at dusk (1930 hours). At 2117 hours the first of six spotted bat vocalizations were heard. Vocalizations were heard again at 2126, 2155, 2215, 2225, and 0200 hours. Vocalizations averaged 10 to 30 a.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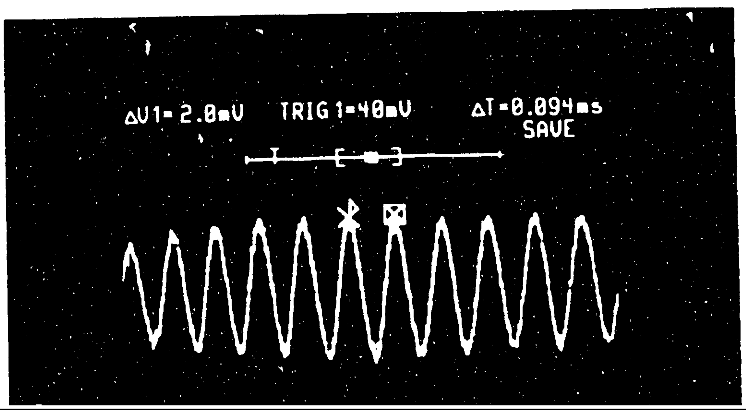
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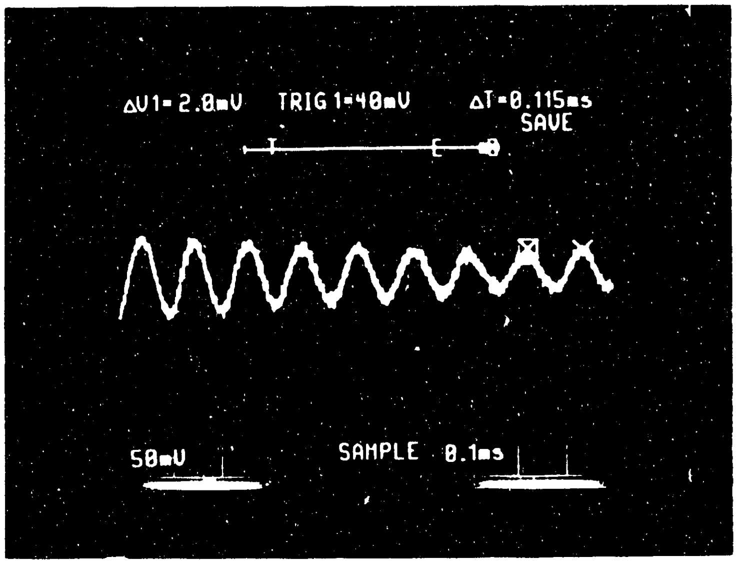

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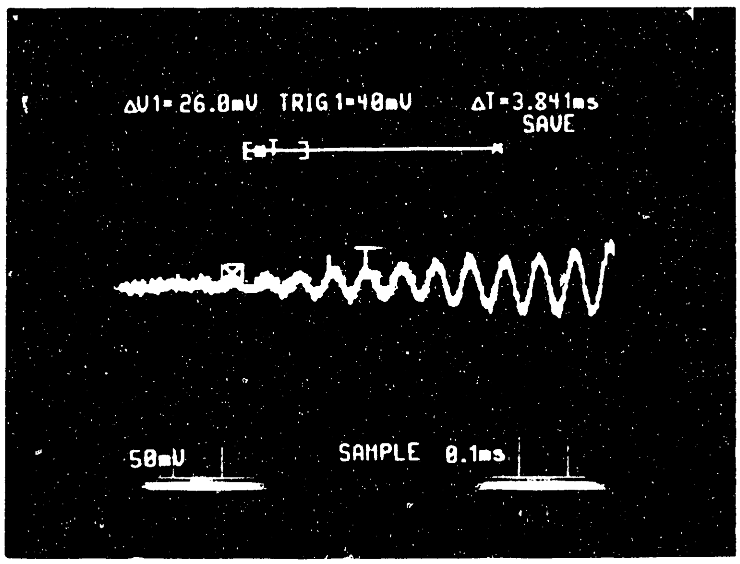


Figure 5. Spotted bat vocalization: a) the frequency towards the end of the vocalization (8.696 kHz) and b) the length of the vocalization (3.841 milliseconds).

The recorded vocalization is similar to that reported by Fenton and Bell (1981) (Table 5). The spotted bat vocalizations were distinct and loud. EG&G/EM biologists had not heard vocalizations like it during any previous survey. This confirms that surveys at Yucca Mountain would have detected spotted bats if they were present. Compared to sites with known spotted bat populations (Leonard and Fenton, 1983; Woodsworth et al., 1981), Yucca Mountain lacks roosting habitat and permanent water. Even with increases in man-made water sources during site characterization, it is unlikely that Yucca Mountain could support a spotted bat population.

Prior to this study, there were four known bat species on NTS (Jorgensen and Hayward, 1965). During the two-year study all four previously known species and six new species were either captured or observed. (Table 6).

Table 5. Comparsion of the recorded spotted bat vocalization to that previously published by Fenton and Bell (1981).

Source	High (kHz)	Low (kHz)	Loudest (kHz)	Time (ms)
Fenton and Bell	14.5	8.6	10.9	3-5
Silent Canyon, 1992	14.493	8.696	10.638	3.8+

Table 6. Number of times each bat species were captured during mist-net sessions near Yucca Mountain in 1991-1992.

Species	FY91	FY92
Pipistrellus hesperus Western pipistrelle	303	300
Myotis californicus California myotis	26	7
Antrozous pallidus Pallid bat	30	7
Lasiurus cinereus[b] Hoary bat	3	0
Tadarida brasiliensis[b] Mexican free-tailed bat	6	5
Myotis volans[b] Long-legged myotis	1[a]	7
Myotis thysanodes[b] Fringed myotis	0	3
Myotis evotis[b] Long-eared myotis	0	2
Plecotus townsendii Townsend's big-eared bat	0	1

[a]Captured in Field Operation Center building in Area 25
[b]Not previously documented to occur on NTS

2.6 INVERTEBRATE STUDIES

Invertebrates associated with specific plant species are a convenient unit for study. Many arthropods are host (i.e., plant) specific while others are generalists, using many species of plants. Invertebrates decompose plant material and are important for nutrient cycling. Decomposition of plant litter in desert habitats may decrease up to 53% in the absence of invertebrates (Santos and Whitford, 1981). Knowledge of the distribution and diurnal and nocturnal cycles of invertebrates associated with the vegetation of Yucca Mountain will provide information for assessing whether SCA affect invertebrate populations or communities. Two studies of invertebrates were started. One study was designed to examine effects of adjacent disturbances on invertebrate-plant associations. The second study investigated the association of invertebrates with specific host plants in the area above the potential repository (Conceptual Drift Area). This study was designed to characterize the invertebrate populations and communities in this area.

For both studies, shrubs were sampled by clipping randomly selected branches. Samples were placed into plastic bags, sealed, and held at 0 °C for a minimum of 36 hours before

Eighty-eight vegetation samples were collected from the four plant species for the conceptual drift study. Collection occurred during the months of July, August, and September. Samples were still being processed at the end of FY92.

2.7 BIRD SURVEYS

SCA may affect the abundance and distribution of birds in small localities at Yucca Mountain but its unlikely that the entire avian community will be affected. Some locations may have increases in avian species abundance because of new water sources during SCA, whereas, other sites may have nesting habitat eliminated by ground disturbing activities. The objective of this study was to collect data on species composition of avian communities and to document nesting occurrence.

Biologists recorded information on birds and nests observed during other work. Information recorded included date observed, species, nest present, number of eggs or nestlings present, and location.

There were 57 bird species observed at Yucca Mountain. Twelve of these species were confirmed to have nested: mourning dove (*Zenaida macroura*), chukar (*Alectoris chukar*), Gambel's quail (*Callipepla gambelii*), raven (*Corvus corax*), Costa's hummingbird (*Calypte costae*), lesser nighthawk (*Chordeiles acutipennis*), poorwill (*Phalaenoptilus nuttallii*), Leconte's thrasher (*Toxostoma lecontei*), Say's phoebe (*Sayornis saya*), horned lark (*Eremophila alpestris*), rockwren (*Salpinctes obsoletus*), and black-throated sparrow (*Amphispiza bilineata*)

Mourning dove nests were observed most frequently, with most of the observations in June. Black-throated sparrow nests were the second most frequently observed, with most seen in May.

2.8 DISTURBANCE STUDIES

Disturbance monitoring studies are designed to quantify disturbance levels by sampling selected abiotic parameters (traffic volume, fugitive dust, and vegetation attributes immediately adjacent to disturbances). Knowledge of how SCA frequency, intensity, and duration indirectly affects biotic resources allows the development of predictions of how plant and animal communities and populations may respond to similar future activities.

The objectives of these studies are to: 1) measure motor vehicle activity on Yucca Mountain; 2) measure levels of fugitive dust deposition and the spatial distribution of fugitive dust on ESPs; 3) determine if roads alter soil moisture, soil temperature, soil compaction, and vegetation growth and structure in immediately adjacent undisturbed habitat (hereafter referred to as the transition zone study); and 4) measure the number, frequency, and spatial distribution of animal-vehicle collisions

2.8.1 Traffic Volume

Data collection occurred with 12 portable traffic counters (TCs) rotated weekly (usually Friday to Friday) between 24 treatment ESPs (Figure 6). The number of ESPs sampled in FY92 increased by two because Crater Flat was not sampled in FY91).

Figure 6 and Table 7 summarize traffic volume in average vehicle passes per day. Traffic volume was highest at LLG5T, averaging 65 passes per day. This was caused by drilling operations at UZ 16. Two other areas of high traffic volume were the road to the top of Yucca Mountain (LA3T, LA5T, LLG4T, and LG3T), and the road between wells J-12 and J-13 (LA1T LA2T, and LA4T). Little traffic occurred in Crater Flat (LA7T and LG5T) and the extreme south end of Yucca Mountain (LG4T).

Traffic volume in FY92 increased by over 700% on the access road to UZ 16, by 95% on the road to the top of Yucca Mountain, and by 71% on the road between wells J-12 and J-13. Traffic volume at other ESPs was similar to that in FY91. Total traffic volume throughout the Yucca Mountain area increased 71% from FY91 to FY92.

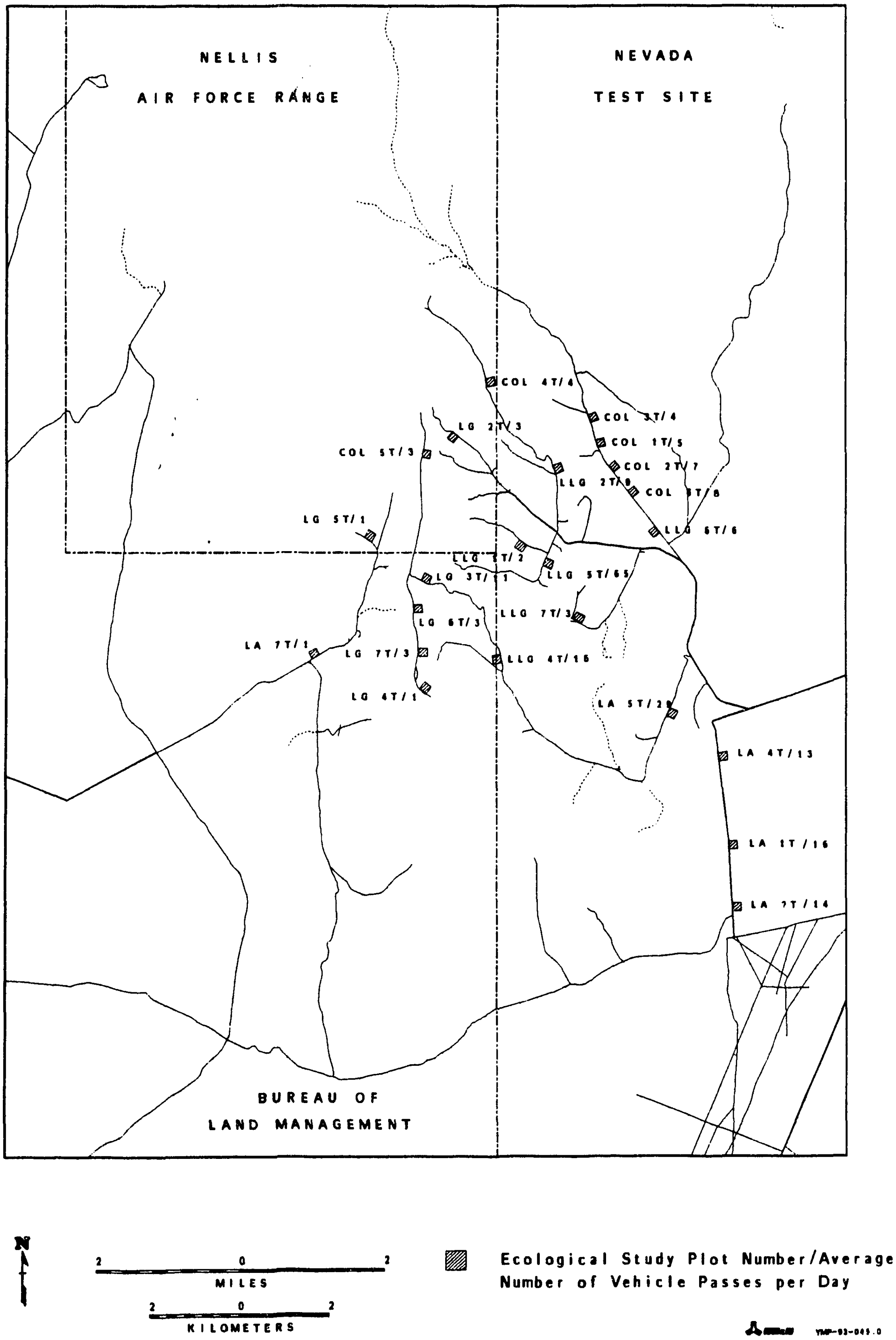


Figure 6. Distribution of vehicle traffic in the Yucca Mountain area in FY92. Traffic volume is expressed as average vehicle passes per day.

Table 7. Traffic volume (vehicle passes per day) at 24 ecological study plots in FY91 and FY92 at Yucca Mountain. Two ESPs (LA7T and LG5T) were not sampled in FY91.

	FY91			FY92		
ESP	Low	High	Mean	Low	High	Mean
COL1T	1.3	8.9	4	1.3	11.4	5
COL2T	3.4	14.1	7	1.3	15.7	7
COL3T	0.9	5.5	3	0.1	10.3	4
COL4T	0.4	7.0	2	0.3	31.7	4
COL5T	1	1	1	0.1	31.6	3
COL6T	0.9	12.0	6	1.4	16.5	8
LA1T	4.8	27.3	10	3.6	48.1	16
LA2T	3.3	12.9	6	3.3	34.3	14
LA3T	12.6	26.1	17	2.0	83.6	29
LA4T	3.8	9.3	6	2.5	34.6	13
LA5T	12.6	26.1	17	2.0	83.6	29
LA7T				0	2.0	1
LG2T	0	6.1	3	0.3	11.6	3
LG3T	5.9	23.6	13	0.7	22.4	11
LG4T	0.3	6.3	2	0.1	1.7	1
LG5T				0.1	2.4	1
LG6T	2.1	7.4	3	1.3	7.1	3
LG7T	0	5.0	3	0.1	6.0	3
LLG1T	0	2.0	1	0.4	5.3	2
LLG2T	1.9	49.0	10	1.0	39.6	9
LLG4T	5.5	48.0	19	4.5	50.9	16
LLG5T	0.6	40.4	8	6.1	116.7	65
LLG6T	1.7	11.7	5	1.7	12.6	6
LLG7T	0.6	3.9	2	0.3	4.7	3
Total			148			253

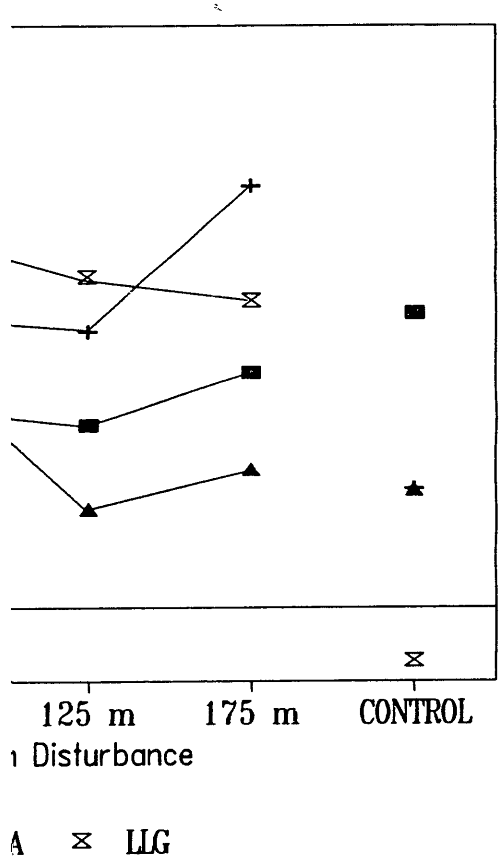
2.8.2 Fugitive Dust

Fugitive dust was measured monthly from February-September, 1992, as described in EG&G/EM (1992). The only change in sampling methodology (from EG&G/EM (1992)) was to collect samples monthly all year, instead of bi-weekly during the growing season and monthly the remainder of the year. Samples were collected and weighed each month, and new samplers placed in the field. All data collected in FY92 was entered into a database.

Dust weights on transects 10 and 25-m from the road generally were greater than dust weights on control ESPs, and greater than dust weights on transects 75, 125, and 175-m from the edge of the ESP (Figure 7). The one exception was treatment ESPs in the *Lycium-Grayia* vegetation association. Dust weight was highest on the 10-m transect, lowest on the 25-m transect, and rose steadily from the 75 to 175-m transects. Reasons for this anomaly are unknown, but it may be related to the steep slopes on ESPs in this vegetation association. The high mean weights observed on *Coleogyne* control ESPs were attributable to nine samplers on three ESPs that had high dust values. If the nine high values are eliminated from the data, mean dust deposition on control *Coleogyne* ESPs is the same as mean dust deposition on the control ESPs in the other vegetation associations. Reasons for the high values are unknown. The relationship between dust deposition and vehicle traffic will be evaluated in FY93.

2.8.3 Transition Zones

Vegetation cover was measured on two, 50-m line transects (called the A-line) located at the interface between undisturbed habitat and roads on 20 treatment ESPs. Vegetation cover on the A-line in the *Larrea-Ambrosia*, *Larrea-Lycium-Grayia*, and *Coleogyne* associations was greater than cover throughout the ESPs (Table 8). The *Lycium-Grayia* vegetation association had similar percent cover on both the A-line and throughout the ESPs. This may be a result of the small sample size in the *Lycium-Grayia* association. Additional data analyses will be done in FY93 to determine if differences in vegetation cover between the A-line and other transects in treatment ESPs, and between the A-line and transects in control ESPs is statistically significant, and how each lifeform (perennial grasses, perennial forbs, shrubs, and annuals) responds to the presence of roads.



:tment ecological study plots in the *Larrea-Ambrosia* (LA),)L) vegetation associations at increasing distance from

Table 8. Average percent vegetation cover on control and treatment study plots and on transects (A-line) immediately adjacent to disturbances on the treatment study plots in 1992.

Vegetation association	ESP type	Number of ESPs sampled[1]	Average cover	Standard deviation
Larrea-Ambrosia	Treatment	6	20.5	5.6
	Control	6	19.6	5.8
	A-line	5	35.7	12.3
Larrea-Lycium-Grayia	Treatment	6	36.3	9.8
	Control	6	36.3	6.6
	A-line	6	47.6	10.0
Coleogyne	Treatment	6	26.3	7.9
	Control	6	27.8	7.2
	A-line	6	36.1	11.9
Lycium-Grayia	Treatment	6	32.4	7.7
	Control	6	30.4	9.7
	A-line	3	33.6	16.7

[1] Treatment and control ESPs have ten and eight line transects, respectively. The A-line occurs on treatment ESPs only, and consists of two 50-m line transects adjacent to the road.

2.9 CLIMATE STUDY

Climate monitoring occurred weekly on all 48 ESPs in FY92 from late February to early June, the period when both soil moisture and air temperatures are normally adequate for vegetation growth. After soil moisture dropped to low levels (electrical resistance < 200 ohms) sampling occurred monthly. Data recorded at each ESP were maximum and minimum treatment (n=6) ecological study plots in four

Precipitation (mm) 1992		
Mean	sd	Range
232	30.4	206-273
223	20.8	200-251
218	5.3	210-224
222	15.0	202-247
216[3]	12.4	150-230[4]
222	18.1	195-240
157	22.0	142-193
176	26.7	138-213

991 snow accumulated on top of precipitation collection cylinder.

ad precipitation gauges established after

LG7C was lost because a wild burro kicked over

ol ESPs where data was collected the week of

3. DESERT TORTOISE PROGRAM

The goals of the desert tortoise program are to develop a better understanding of the biology and status of the desert tortoise population at Yucca Mountain, assess impacts of SCA on the population, and minimize those impacts. The objectives and program design developed to achieve these goals are described in EG&G/EM (1991, 1992) and Rautenstrauch et al. (1991).

Eight interrelated studies were continued for this program and one study, habitat evaluation, was discontinued. Four studies share a common design: population monitoring, movements and habitat use, health monitoring, and food habits. They were developed to monitor cumulative impacts of SCA. A fifth study was designed to evaluate and mitigate direct impacts of large-scale or long-term activities. The remaining two studies evaluate mitigation techniques and monitor raven abundance.

During field work in FY92, EG&G/EM biologists captured and marked 101 previously unmarked desert tortoises; 30 of these were hatchlings (Figure 8). Radio transmitters were attached to 29 hatchlings and 40 older tortoises. Since 1989, 229 tortoises have been marked; transmitters were attached to 171. One hundred eleven radiomarked tortoises still were being monitored at the end of the 1992 tortoise activity period (March through October). The remainder of these tortoises had died (*n* = 24), were missing (*n* = 23), had their transmitters fall off (*n* = 10), or had their transmitters removed (*n* = 3). Figure 9 shows the latest location prior to September 30, 1992 of all tortoises found on or near Yucca Mountain during 1989-1992.

3.1 POPULATION MONITORING STUDY

The objectives of the Population Monitoring Study are to assess the effects of SCA on reproductive success and survival of tortoises at Yucca Mountain. These parameters are measured from sampling populations representing three levels of impacts from SCA. These levels are long-term, large-scale disturbances, hereafter referred to as "high-impact"; small, widely-scattered disturbances, hereafter referred to as "area-wide"; and no impact, or control. For a more in-depth discussion, see EG&G/EM (1992:31-33). At the end of the 1992 tortoise activity period, 44 tortoises were being monitored for the high-impact sample, 21 for the area-wide sample, and 22 for the control sample. In addition, 28 hatchling tortoises across all sampling populations were radiomarked as they emerged from their nests in August-September 1992.

3.1.1 Reproductive Success

A pilot study initiated in FY91 was continued to further develop techniques for measuring reproductive success (i.e., clutch size, number of clutches, and natality). Attempts were made to weigh 21 adult female tortoises weekly from May through July to detect the number of clutches laid by each tortoise. Also, eight adult male

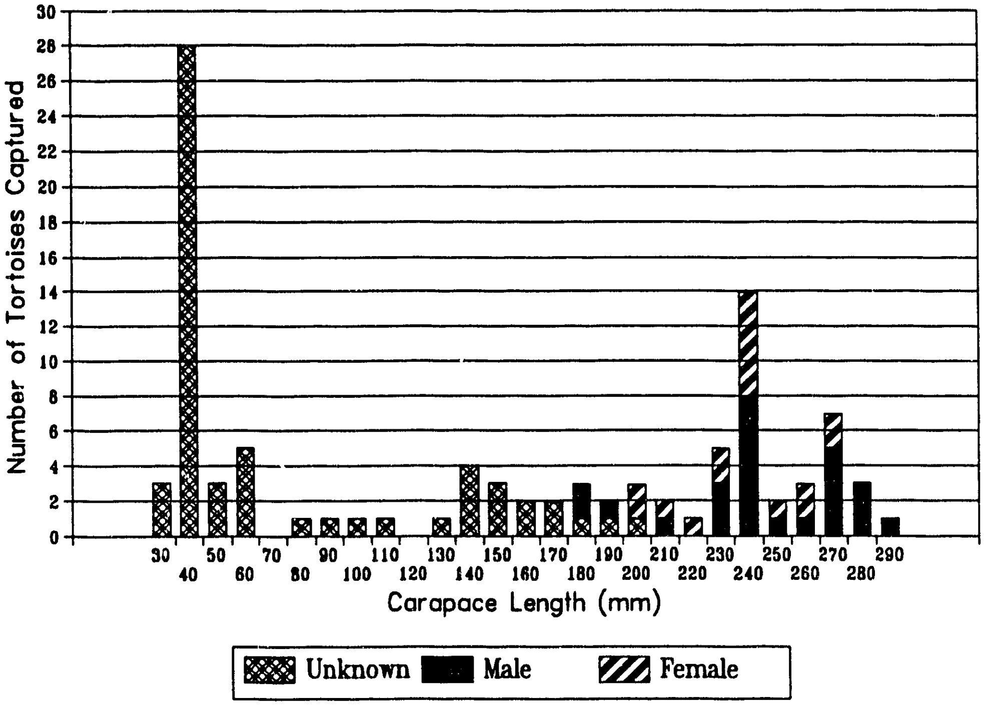


Figure 8. Number of previously unmarked desert tortoises captured at Yucca Mountain during 1992 in 10-mm size classes.

tortoises were weighed to evaluate the effects of environmental fluctuations on weight change. Thread trailers were attached to ten of the female tortoises to locate nests. These tortoises were located three times per week. When a ≥100-g weight loss was detected the thread trail was followed and all potential nest sites searched. The number of eggs were counted by excavating the nests. Eggs were measured, weighed, and then replaced in their original location within the nest. Nests were checked once per week for signs of predation. Nests were encircled with hardware cloth no longer than 85 days after eggs were laid so hatchlings could be captured as they emerged. Hatchlings were measured, marked with paint, and radiomarked.

Eleven nests containing 63 eggs were found. Clutch size ranged from 3 to 10 eggs ($\bar{x}$=5.7 eggs) and individual egg mass ranged from 24 to 39 g ($\bar{x}$=30.2 g). Clutch mass ranged from 87 to 282 g ($\bar{x}$=178.5 g). Weight loss by the females during the period when oviposition occurred ranged from 66 to 375 g ($\bar{x}$=230.8 g). Incubation time was 81 to 94 days ($\bar{x}$=85.9 days). All but one egg hatched. One deformed hatchling was found in a nest and died while still underground.

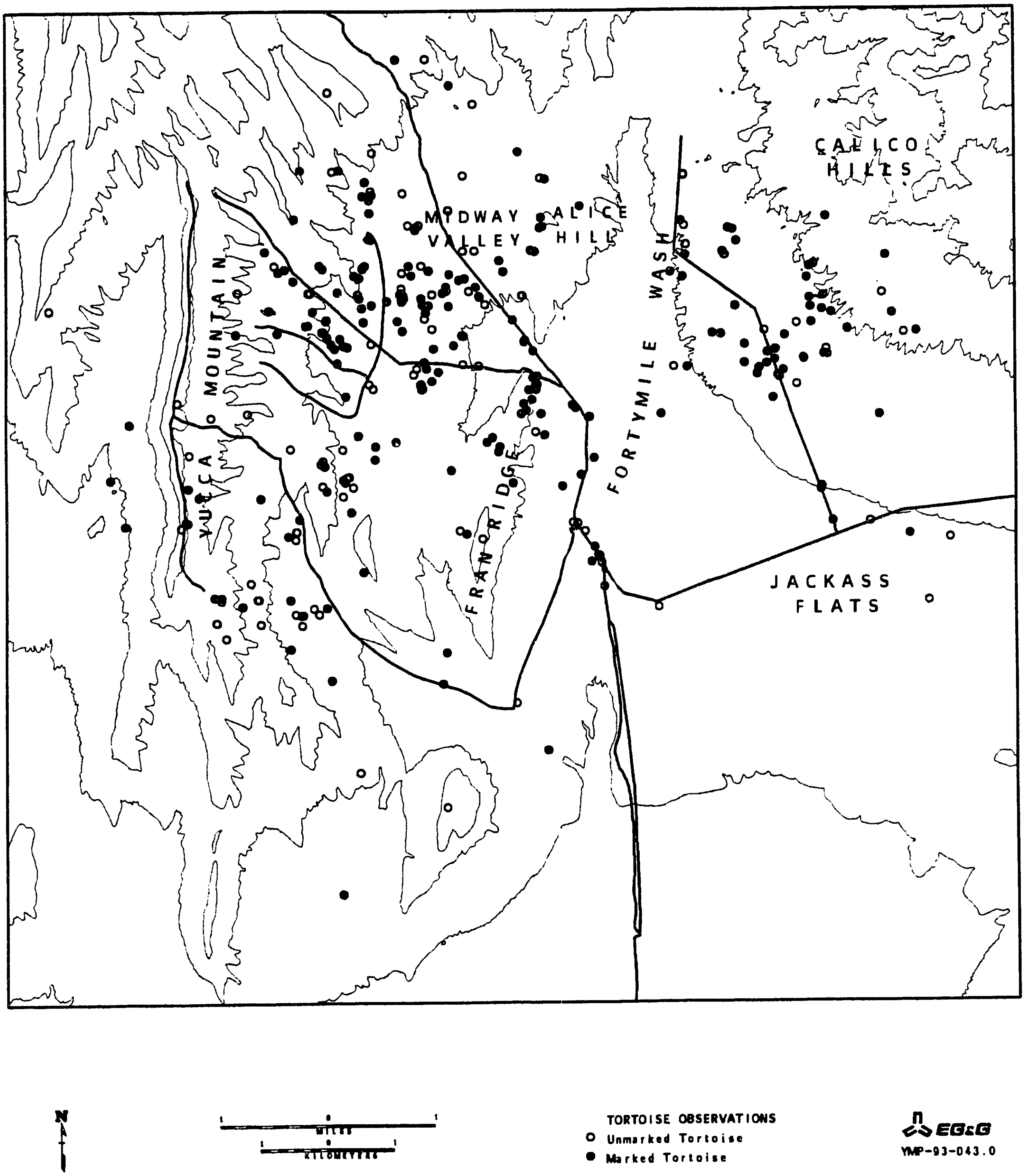


Figure 9. The location of all marked and unmarked tortoises found at Yucca Mountain and the adjacent control area during 1989-1992. The most recent location is shown for all tortoises found > 1 time.

We conclude that the thread-trailing technique can be used to find nests if oviposition is detected quickly. Females must be weighed more than once per week because weight loss from egg laying can be masked by intake and output of food and water. The technique used in FY92 was successful at finding hatchlings to radiomark for the survival study. However, an unknown number of nests were not found. For this reason, a more reliable technique is required to measure clutch size and frequency. X-raying tortoises has been identified as the best technique for this purpose (Turner et al., 1984, 1986). Approval to X-ray tortoises was requested from the U.S. Fish and Wildlife Service in 1992, and when approved may be used for this study.

3.2.2 Survival

To measure survival rates of the three samples, tortoises were located at least every other week. Twenty radiomarked tortoises died during the 1992 tortoise activity period. Fourteen of these were hatchlings: 12 from the 1992 cohort and 2 from the 1991 cohort. Of the older tortoises that died, four were first radiomarked in 1991 and two in 1992.

There was no evidence that any of the radiomarked tortoises were killed due to human factors. Of the six older tortoises, four showed signs of mammalian predation. Coyote, kit fox, badger, bobcat, and mountain lion are the most likely mammalian predators. One small tortoise (mid-carapace length = 53 mm) was killed when its burrow collapsed and it became stuck under a rock. One tortoise was found in the open with no predator wounds, but had been scavenged by ants.

All of the dead hatchlings were found in burrows with most of their flesh removed. Harvester ants (*Pogonomyrmex* sp.) were observed attacking a live hatchling and found scavenging nearly all of the carcasses. Bleeding bite marks that appeared to be from rodents were observed on one live hatchling and rodents had chewed on some of the hatchling carcasses. All carcasses were found in burrows and showed no sign of bird or large-mammal predation. This evidence indicates that at least some of the hatchlings were killed by ants or rodents.

3.2 MOVEMENTS AND HABITAT USE STUDY

The objectives of the Movements and Habitat Use Study are to (1) evaluate the effects of SCA on the desert tortoise population, (2) monitor the reaction of individual tortoises to SCA within or near their home ranges, and (3) study selected aspects of the behavior and habitat use of tortoises for which more knowledge is required to better conserve this species at Yucca Mountain. The populations sampled are the same as those for the Population Monitoring Study.

Seventy-four radiomarked tortoises were located twice per week during the activity period and two to four times per month during hibernation. Methods were the same as in FY91 (EG&G/EM, 1992:36) except for the following. Composition and texture of the soil around tortoise burrows were no longer recorded. Each time a tortoise was found in a burrow, sticks were placed at the burrow entrance to determine if the tortoise exited the burrow before it was next located.

Five of the 74 tortoises monitored for this study died. They were replaced by six tortoises radiomarked during 1992. Five other tortoises were missing for part of 1992. The following summary only includes information from 58 tortoises monitored throughout the entire 1992 activity period.

Tortoises were located 65 to 122 times ($\bar{x}=80$) from October 1991 through September 1992. These tortoises entered their hibernacula between September 28 and December 7, 1991 ($\bar{x}$=October 24). All but one tortoise was hibernating by November 16. They exited their hibernacula between February 28 and May 2 ($\bar{x}$=March 28). During the activity period, 5 to 20 burrows ($\bar{x}=12$) were used by each tortoise.

To evaluate the effects of SCA on tortoises the following parameters will be calculated and compared among the control, area-wide, and high-impact samples: home range size, home range and core-use area overlap from the previous year, shift in center of activity, number of burrows used, number of new burrows used, timing and length of hibernation, and portion of time active.

Only one new disturbance or group of disturbances >0.5 ha (the drill pad, trenches, and access roads associated with the North Portal Exploratory Studies Facilities) occurred within the home range of radiomarked tortoises in FY92. To achieve the second objective of this study, changes in movements and behavior of the 12 tortoises with home ranges overlapping this disturbance will be compared to changes in behavior of tortoises that did not have disturbances within their home ranges.

For the third objective, information collected while locating tortoises monitored for this study will be compiled and analyzed to better understand the ecology of the tortoise population at Yucca Mountain. Information from tortoises monitored for other studies (e.g., impact mitigation) will be included if appropriate. In addition, 58 tortoise hibernacula used by 79 tortoises were measured during the winter of 1992 to determine characteristics that may be useful for identifying potential hibernacula. The following was recorded at each hibernaculum: entrance height and width, maximum length, dimensions of burrow at tortoise, depth of tortoise below ground, depth of tortoise in tunnel, slope of tunnel, number of passages, aspect of opening, number of

3.3 HEALTH MONITORING STUDY

The objective of the Health Monitoring Study is to evaluate the effects of SCA on the desert tortoise population at Yucca Mountain by monitoring changes in the health of individual tortoises. All tortoises encountered in the field were examined for signs of Upper Respiratory Disease Syndrome, a disease that contributed to the listing of the Mojave population of the desert tortoise as threatened. Also, all tortoises with radio transmitters were weighed at the end of the activity season. This annual measurement will be used as an index to gauge the general health of the animals. A study to collect and analyze blood to compare health profiles among the three sample populations was not developed.

One tortoise with possible signs of Upper Respiratory Disease Syndrome was found. An adult female that was observed mating was captured and radiomarked immediately afterwards. She was wheezing and had mucus coming out of her nose. She did not exhibit these signs when checked one month later.

All radiomarked tortoises were weighed between mid-September to mid-October. At that time, adult tortoises were an average of 8.6% lighter than at the same time a year earlier. However, on October 24-30 several storms passed over the Yucca Mountain area dropping 10-15 mm of rain. During and after these storms all radiomarked tortoises left their burrows, most likely to drink. Ten tortoises were weighed after this rain and found to have gained 9 to 613 g ($\bar{x}$=300.1 g), or 0.9 to 35.9% of their body weight ($\bar{x}$=14.7%), since about one month earlier. As a result of the late October rain, most tortoises at Yucca Mountain entered the 1992-1993 hibernation with their weight at the same level as or slightly above their 1991-1992 hibernation weight.

3.4 FOOD HABITS STUDY

The objectives of the Food Habits Study are to determine diet of tortoises at Yucca Mountain, relative nutritional and quantitative importance of forage components, and large-scale effects of SCA on tortoise diet.

Thirty fecal samples collected at Yucca Mountain during 1991 were sent to Colorado State University for microhistological analysis; analysis was not completed during FY92. During the 1992 activity period fresh fecal samples were collected in the Yucca Mountain and control areas. In addition, species eaten by 43 radiomarked tortoises during 56 foraging bouts were recorded. Red brome (*Bromus rubens*) was eaten during 34% of these observations. Twenty-four other species were seen being eaten ≤5 times.

3.5 IMPACT MITIGATION STUDY

Most SCA will be small (<2 ha), short-term, and have relatively minor impacts on tortoises. However, some activities will disturb large areas, last throughout site characterization, and have potentially significant impacts on tortoises. The objective of this study is to identify large-scale, long-term SCA and obtain information necessary to mitigate their impacts by collecting and assessing the abundance, movements, and habitat use of tortoises in close proximity to these disturbances. Tortoises potentially impacted are identified and their movements and habitat use evaluated to determine the best means for mitigating impacts.

Searches for tortoises were conducted in two high impact areas and monitoring of tortoises continued. The first search was conducted in February 1992 in the area around Drill Hole Wash. Thirty-two burrows found in the Drill Hole Wash study area during the original survey in August 1991 were searched in February 1992 to find previously unmarked tortoises. The search was limited to burrows within 100 meters of existing (roads, subdock, drill pads) and proposed (borrow pit, batch plant) disturbances. One unmarked tortoise was found, but could not be removed from its burrow. After monitoring the animal throughout the winter, it came out of hibernation earlier than expected and was not captured.

The second search was an initial survey of 135 ha around the proposed South Portal Exploratory Studies Facility and topsoil/muck storage area. The area was surveyed in April-June 1992. Four tortoises had been found in the area prior to the survey and were already radiomarked. Four additional tortoises were found and radiomarked during the survey. At the end of FY92, one of these tortoises was missing and the rest were still being monitored.

Tortoises found during these searches and radiomarked tortoises found in previous years in Midway Valley and Drill Hole Wash were monitored. These tortoises were located at least twice per month. Most were located twice each week. Data collected on the tortoises in Midway Valley were used to develop mitigation recommendations for trenching and other excavation activities there.

3.6 DISPLACEMENT AND RELOCATION STUDY

More than 180 ha of desert tortoise habitat will be disturbed during SCA. Disturbances that impact tortoises or their burrows will be modified or moved if possible (DOE, 1991a). If a disturbance cannot be moved or sufficiently modified to ensure that a tortoise will not be harmed, the tortoise may be displaced (i.e, moved to or near a distant part of its home range) or relocated (i.e., moved to an approved relocation site out of its home range). The Displacement and Relocation Study was designed to develop, implement, and test methods for moving tortoises from areas to be disturbed while minimizing impacts on those tortoises and tortoises residing in the relocation site.

Procedures were written in FY92 that describe the methods to be used to displace and relocate tortoises. These procedures include instructions for selecting appropriate release sites, ensuring that tortoises are not heat stressed during handling, and monitoring tortoises after release to ensure their safety and study their responses to being moved. The procedures also included a decision matrix for determining whether a tortoise should be displaced or relocated. This decision matrix will be evaluated annually to ensure that information gained during the previous year is used to improve the decision-making process.

No tortoises were displaced in FY92. One tortoise, number 423 (mid-carapace length of 178 mm), was relocated to ensure that it was not harmed by trenching and other activities to occur in preparation for the North Portal Exploratory Studies Facility. This tortoise's 1991-1992 hibernaculum was to be destroyed during excavation of a test pit in February 1992. In addition, >30% of its known home range and an unknown number of its burrows were to be destroyed during other disturbances planned for this area in 1993-1994. This tortoise was relocated, instead of being displaced, because of the large amount of its known home range that was to be destroyed during the next three years.

Tortoise 423 was moved on February 24, 1992 from its hibernaculum east of Exile Hill to a relocation site 5 km away on the south bajada of the Calico Hills. The tortoise was released into a burrow originally dug by a predator and the entrance to the burrow was blocked. The burrow was unblocked on March 31, after 50% of the other radiomarked tortoises had emerged from hibernation. This tortoise was then located one to two times daily for the first two weeks after being released and two to seven times per week for the remainder of the activity period.

After being released, tortoise 423 traveled south and then east toward the Area 25 base camp (Figure 10). At the eastern-most point in its travels, tortoise 423 was 10.3 km east of the release site about 0.5 km east of the base camp. The tortoise then returned to the west and north before settling into an area about 2.5 km east of the release site. After arriving in that area about July 10, tortoise 423 used five burrows and stayed within a 250-m-wide area for the remainder of the 1992 activity period. During April-July, this tortoise traveled a minimum of 31.6 km.

Tortoise 423 was never within 500 m of the two radiomarked tortoises that were residents of the relocation site. Therefore, no information was gained about the effects of this relocation on resident tortoises.

A search was conducted to find additional relocation sites for tortoises that may have to be moved from the North and South Portal Exploratory Studies Facilities. Five 25-ha sites in the southwest part of Rock Valley were selected. The sites were searched for sign of tortoises to ensure that they are adequate tortoise habitat. Tortoise burrows and other sign were found at all sites. Permission to use these sites was requested from the Project Office and the DOE Nevada Field Office.

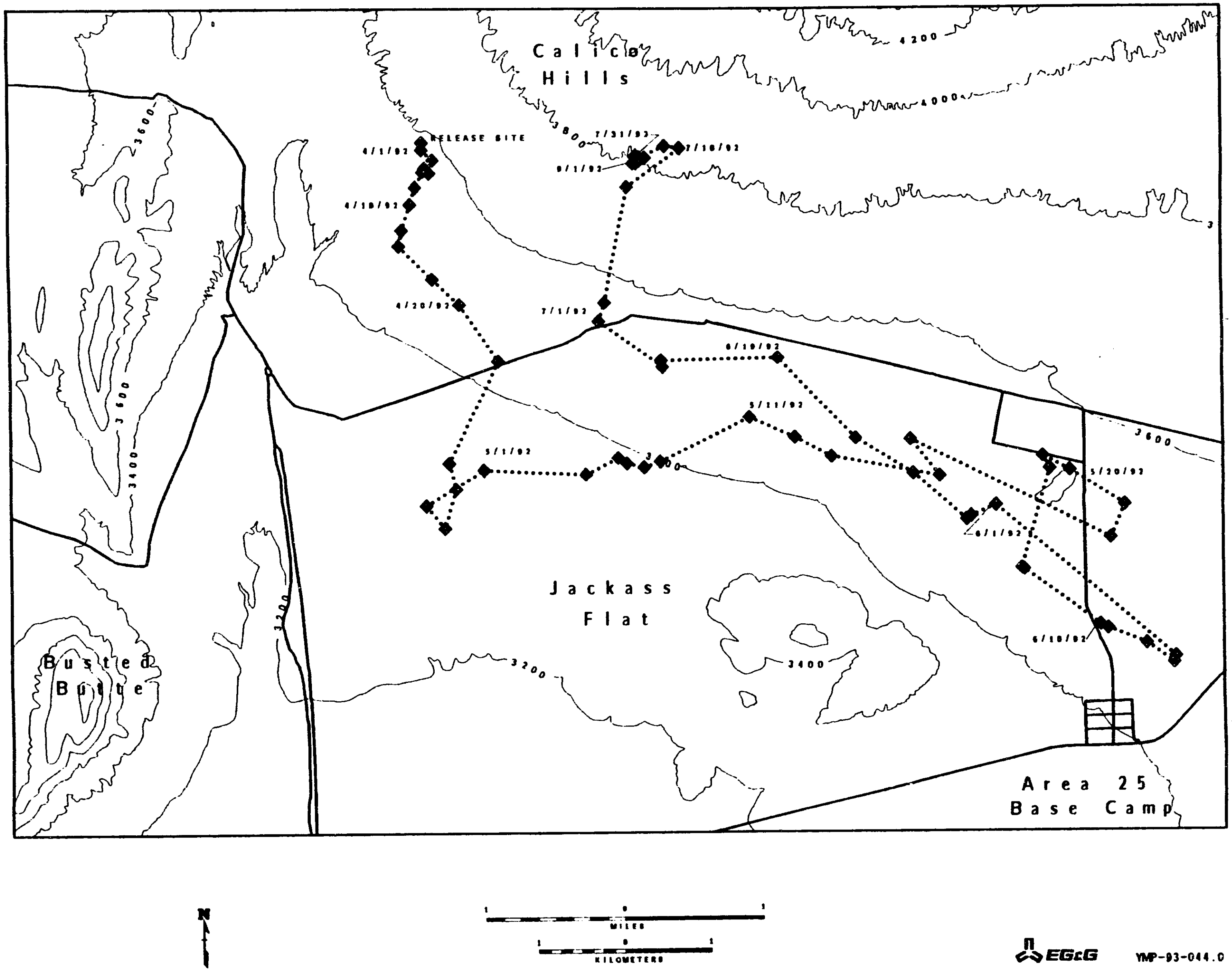
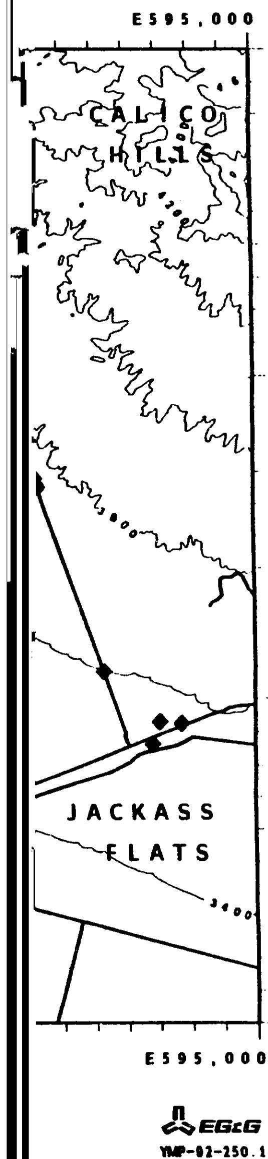


Figure 10. Movements of relocated tortoise 423 from April 1, 1992 through September 1, 1992.

3.7 ROADWAY MONITORING STUDY

If the Yucca Mountain Site Characterization Project surpassed its permitted incidental take of 15 desert tortoises (FWS, 1990), it must request a revised incidental take provision and could be required to initiate additional, expensive measures to prevent mortalities. One of the most likely locations where tortoises will be killed during SCA is along roads. The objectives of the Roadway Monitoring Study are to monitor [illegible]


E595,000
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HILLS
N775,000
N765,000
N755,000
N745,000
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FLATS
3400
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YMP-92-250.1

during FY92.

As required for this study, EG&G/EM biologists reviewed the information on tortoise sightings along roads to determine if mitigation measures should be implemented. Because only two mortalities occurred, and because sightings have not been concentrated along any sections of road at Yucca Mountain, it was determined that mitigation measures are not needed at this time.

3.8 RAVEN MONITORING STUDY

The objectives of the Raven Monitoring Study are to determine if SCA cause an increase in raven abundance and to identify facilities where ravens congregate. Results of this study will be used to determine the effects of SCA on raven abundance and distribution at Yucca Mountain and the efficacy of raven deterrent equipment on Project facilities if it is installed. This study is required by the Biological Opinion on the effects of SCA on desert tortoises (FWS, 1990).

Road surveys were conducted simultaneously along a treatment (Project area) and control route on five randomly selected weekdays every other month (see EG&G/EM 1992:44-47). In FY92, ravens were counted 78 times along the Project route and 53 times along the control route (Table 10).

In addition to the survey routes, three raven nests were found and one was monitored. This nest, located on the Sample Management Facility building in the Area 25 base camp, was first found on March 19 at which time it contained no eggs. On April 10 the nest contained seven eggs and on April 27 there were six nestlings. By May 1 only five young remained in the nest and they appeared capable of flying. Fate of the nestlings is unknown. In addition, recommendations on raven deterrents for a proposed power line were provided to Project Office upon their request.

Table 10. Number of times ravens were counted on five 25-km raven surveys per month at Yucca Mountain and a control area, October 1991 - August 1992.

	Month						
Treatment	October	December	February	April	June	August	Average
Area 25	11	6	28	14	5	14	13.0
Control	9	20	6	6	8	4	8.8
Total	20	26	34	20	13	18	21.8

3.10 HABITAT EVALUATION STUDY

The objective of this study is to develop a model of tortoise habitat quality at Yucca Mountain that can be used during land-use planning. This model was to be developed by measuring habitat features and the abundance of tortoise sign in sample plots throughout Yucca Mountain. Multivariate analysis then would be used to identify those habitat features that best predict abundance of tortoises. During a review of this study in FY92 it was determined that additional work should not be conducted at this time for the following reasons.

1. During a pilot evaluation of this study in 1991, 48 4-ha sites were searched and only three tortoises were found (EG&G/EM, 1992:47-48). Because so few tortoises were found, abundance of tortoise sign must be used as an index of tortoise abundance and habitat quality. Unfortunately, the relationship between abundance of tortoise sign and abundance of tortoises is unknown, and probably highly variable. Therefore, a model based on abundance of sign could provide a false indication of tortoise abundance and habitat quality.

2. Most SCA, such as drill pads and trenches, will be <2 ha. Because most of these disturbances must be located over specific geological features, they can be moved only short distances to avoid tortoises or good tortoise habitat. Therefore, for a habitat-quality model to be useful for Site Characterization it must discriminate between areas 1-2 ha in size. Because most tortoises move at a scale larger than this, and because the abundance of sign at Yucca Mountain is so variable, it was determined that this scale of discrimination would be difficult or impossible to achieve.

3. Because so few tortoises were counted during the pilot study, and because the

4. HABITAT RECLAMATION PROGRAM

EG&G/EM has been tasked to conduct disturbed habitat studies and reclamation feasibility trials, and to implement site-specific reclamation actions for SCA as part of the Yucca Mountain Project Reclamation Program. The objective of the Program is to restore sites distured by SCA to a stable ecological state of similar form and productivity as the pre-disturbance state (DOE, 1989). The Project's Reclamation Feasibility Plan (RFP) (DOE, 1990) describes how disturbed habitat studies and site-specific reclamation trials will be used to identify effective reclamation techniques for reclaiming areas disturbed by SCA. The Project's Reclamation Implementation Plan (DOE, 1991b) describes how disturbed sites being used for Site Characterization investigations can be temporarily stabilized (interim reclamation) and how disturbed sites can be restored when investigations have been completed (final reclamation).

4.1 DISTURBED HABITAT STUDIES

Studies of the pattern and timing of natural revegetation (i.e., plant succession) in disturbed sites provide insight into the factors that control revegetation and how those factors can be manipulated to improve reclamation success. Disturbed habitat studies conducted by EG&G/EM at Yucca Mountain involve the creation of a computer inventory of existing disturbed sites and conducting plant succession studies at selected disturbed sites. Disturbed sites mentioned in this section refer to non-reclaimed areas disturbed before 1984.

Disturbed habitat studies in FY92 focused almost entirely on establishing plant succession study plots and measuring vegetation cover and density on them. Annual biomass was not measured because peak biomass production had passed, and the amount of information obtainable was not justified by the expense. EG&G/EM (1992) describes the methodology used to inventory disturbed habitats and measure vegetation cover and density on succession study plots.

4.1.1 Disturbed Habitat Inventory

Data collected at 75 sites inventoried in FY91 (EG&G/EM, 1992) were entered into a computer database.

4.1.2 Plant Succession

The goal of the plant succession study is to describe the vegetation that invades disturbed sites at Yucca Mountain. Knowledge of plant species composition, density, and cover at sites of varying disturbance type and severity, and knowledge of the time required for secondary succession, can be used to select plant species which are best suited for reclaiming areas disturbed by SCA.

Succession study plots can also be used to measure reclamation success. The species composition, density, and cover from natural succession study plots can be compared with these parameters measured at sites where reclamation treatments and techniques have been implemented. Even if these vegetation parameters from reclaimed areas are different from those of undisturbed areas, it may be possible to demonstrate that plant establishment on reclaimed areas is significantly better than in disturbed habitats where only natural succession has occured.

Study plots were selected at 47 disturbed sites (Table 11). Species composition, vegetation cover, and density were measured once at each of these sites using methods described in EG&G/EM (1992). Twenty of these plots were permanently marked in the field. Data obtained from repeated sampling of these plots will be used to monitor natural changes in species composition, cover, and density over time. Permanent 1-m^2 quadrats also were established to measure seedling density in each of the 20 permanent succession plots. Either 12 or 24 quadrats were set up, depending on the size of each disturbance site. Seedling density data recorded through time may be used to track long-term seedling survival (funding permitted).

Table 11. Plant succession study plots sampled in FY92.

Disturbance Type	Number of Plots Sampled
Drill Pad	17
Cutslope	12
Borrow Area	9
Scraped Areas[1]	4
Other[2]	5

[1] Areas where the vegetation was removed but most if not all the soil material was left in place

[2] Includes one of each of the following disturbance types: pavement study, seismic line, road, fill slope, and a rock fill area.

4.2 RECLAMATION TRIALS

Reclamation field trials will be used to evaluate the success of site-specific reclamation techniques and plant materials. Results of these trials will be used to modify and improve techniques of stabilizing and revegetating topsoil salvaged during SCA (interim reclamation) and at sites released for final reclamation. During FY91, five previously-disturbed sites were selected as potential locations for reclamation trials (Figure 12). They are located in an elevational range from 1,015-1,460 m and in all four major vegetative associations (*Coleogyne, Larrea-Lycium-Grayia, Lycium-Grayia,* and *Larrea-Ambrosia*). The soils at the five sites range in depth from shallow (0-20 cm) to deep (>60cm). The disturbances at these include borrow pits, scraped areas, drill pads, old roadbeds, and staging areas.

The soil surface was modified prior to implementation of the reclamation trials. A road grader was used at Sites 2, 3, 4, and 5 to rip the sites to relieve soil compaction. On Site 1, the remaining soil was spread evenly over the area to cover exposed bedrock.

Several pieces of equipment were purchased during FY92 for use during reclamation trials and during interim and final reclamation implementation: a tractor, hydromulcher, strawblower, straw crimper, post hole digger, and a harrow. Field studies were started at Site 1 and Site 3 during FY92.

4.2.1 Pilot Study at Site 1

A pilot study was established at Site 1 to evaluate 1) seedling emergence differences between drill-seeded and broadcast-seeded treatments, 2) effect of soil depth in redistributed subsoil on seedling emergence, 3) effect of straw mulch on seedling emergence, and 4) the variability of native seedling emergence for use in designing future field trials. The study examines two factors: seeding method and mulching. Each factor has two treatments: broadcast versus drill-seeding, and crimped straw mulch versus no mulch. Control plots where no seeding or mulching occurred were established for comparison. Each treatment combination, including the control plots, has five replicates for a total number of 25 plots. Each replicate plot is 7 x 17 m. Plots are adjacent to one another and were randomly assigned within the study area. Twenty-four 1-m^2 sample quadrats were set up along the central long-axis of each replicate plot.

Seedling density and species diversity will be measured during the first and second month of FY93. Soil depth to bedrock also will be measured at five points within each sample quadrat.

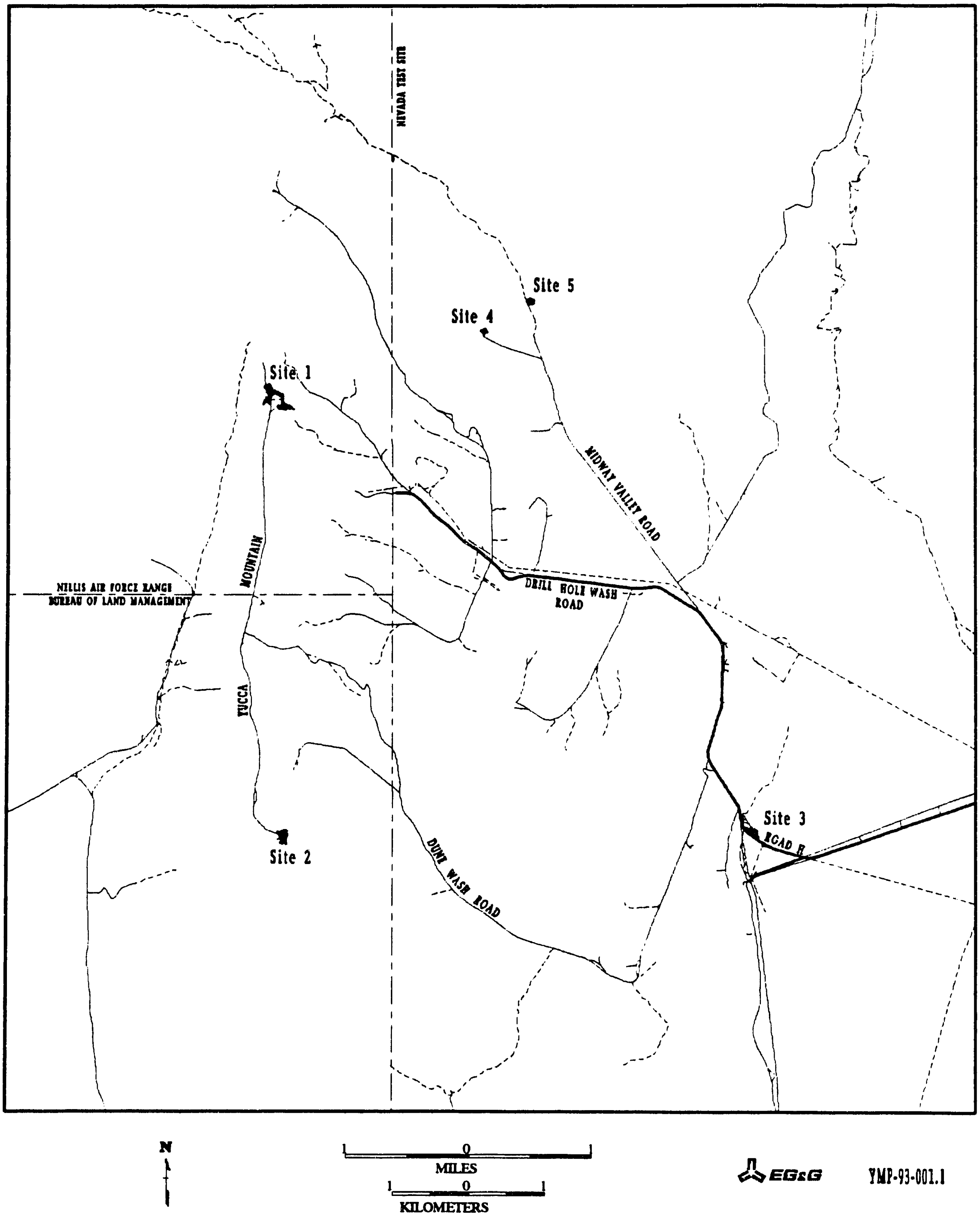


Figure 12. Location of reclamation trial sites for the Yucca Mountain Site Characterization Project

4.2.2 Demonstration Plots at Site 3

Site 3 was the first reclamation trial site established at Yucca Mountain. A series of demonstration plots were established at this site in February to examine techniques that can be used for reclaiming areas disturbed by SCA.

Fifty-nine 4- x 15-m plots, and 12 4- x 10-m plots were established for 33 treatment combinations (Table 12). Each treatment has 2 replications, except for treatments nine and eleven, which have four. The smaller 4- x 10-m plots were used for irrigation treatments. Two plots are being used as control plots (treatments #1 and 3, Table 12). One-half of the plots were fenced to exclude lagomorphs.

Seedling density data was measured during April by counting all seedlings within 13 randomly located, 1-m^2 quadrats within each study plot. The non-seeded control plot had an average density of 1.7 ± 3.7 plants/m^2. The seeded control had an average density of 57 ± 32 plants/m^2. The other plots had an average density of 27.6 ± 22.6 plants/m^2. The highest average density recorded was 64.1 ± 32.5 plants/m^2 and was found in the treatment #28 plots (Table 12). The affects that fencing had on seedling density will be evaluated after one growing season. Additional sampling at the same quadrats to determine seedling survival will occur at the beginning of the second growing season in Spring 1993. Plant establishment will be examined by measuring plant densities at the beginning of the third growing season in Spring 1994.

4.3 RECLAMATION IMPLEMENTATION

Yucca Mountain Project policy (DOE, 1989) requires that areas disturbed by SCA be managed with long-term reclamation as a goal. Therefore, topsoil is routinely salvaged and stockpiled at or near each disturbance based on the results of field surveys (see section 5.2). These stockpiles are managed to prevent wind and water erosion and to maintain soil viability through seeding if necessary. Eighteen short-term stockpiles (stockpiles that will erimental treatments applied at reclamation trial Site 3.

urface eparation	Water Conservation Treatment	Soil Amendments	Revegetation Treatment	Mulch	Irrigation
p/Harrow	None	None	Not Seeded	None	None
p/Harrow	None	None	Drillseed 21 PLS kg/ha	None	None
p/Harrow	None	None	Broadcast 21 PLS Kg/ha	Straw mulch/Crimp 5,000 kg/ha	None
p/Harrow	None	None	Broadcast 31.5 PLS Kg/ha	Straw mulch/Crimp 5,000 kg/ha	None
p/Harrow	None	None	Broadcast 42 PLS Kg/ha	Straw mulch/Crimp 5,000 kg/ha	None
p/Harrow	None	Compaction level 1	Drillseed 21 PLS Kg/ha	Straw mulch/Crimp 5,000 kg/ha	None
p/Harrow	None	Compaction level 2	Drillseed 21 PLS Kg/ha	Straw mulch/Crimp 5,000 kg/ha	None
p/Harrow	None	None	Drillseed 10.5 PLS Kg/ha	Straw mulch/Crimp 5,000 kg/ha	None
p/Harrow	None	None	Drillseed 21 PLS Kg/ha	Straw mulch/Crimp 5,000 kg/ha	None
p/Harrow	None	None	Drillseed 42 PLS kg/ha	Straw mulch/Crimp 5,000 kg/ha	None
p/Harrow	None	None	Drillseed 21 PLS Kg/ha	Straw mulch/Net 5,000 kg/ha	None
p/Harrow	None	None	Drillseed 21 PLS Kg/ha	Straw mulch/Tackify 5,000 kg/ha	None
p/Harrow	None	None	Drillseed 21 PLS Kg/ha	Gravel Mulch level 1	None
p/Harrow	None	None	Drillseed 21 PLS Kg/ha	Gravel Mulch level 2	None
ip/Harrow	Imprint	None	Drillseed 21 PLS KG/ha	Straw mulch/Crimp 5,000 kg/ha	None
ip/Harrow	Pit	None	Drillseed 21 PLS Kg/ha	Straw mulch/Net 5,000 kg/ha	None
ip/Harrow	Desert Strips	None	Drillseed 21 PLS Kg/ha	Straw mulch/Crimp 5,000 kg/ha	None
ip/Harrow	None	None	Drillseed 21 PLS kg/ha	Straw mulch/Crimp 5,000 kg/ha	0.635 cm
ip/Harrow	None	None	Drillseed 21 PLS Kg/ha	Straw mulch/Crimp 5,000 kg/ha	1.27 cm
ip/Harrow	None	15-15-0 Fert.; 44.8 kg/ha	Drillseed 21 PLS Kg/ha	Straw mulch/Crimp 5,000 kg/ha	None
ip/Harrow	None	15-15-0 Fert.; 89.7 kg/ha	Drillseed 21 PLS Kg/ha	Straw mulch/Crimp 5,000 kg/ha	None
ip/Harrow	None	15-15-0 Fert.; 44.8 kg/ha	Drillseed 21 PLS Kg/ha	Straw mulch/Crimp 5,000 kg/ha	0.635 cm
ip/Harrow	None	15-15-0 Fert.; 89.7 kg/ha	Drillseed 21 PLS Kg/ha	Straw mulch/Crimp 5,000 kg/ha	1.27 cm
ip/Harrow	None	None	Transplants	None	None
ip/Harrow	None	None	Transplants	None	0.635 cm

Table 12. Continued.

Treatment #	Surface Preparation	Water Conservation Treatment	Soil Amendments	Revetetation Treatment	Mulch	Irrigation
26.	Rip/Harrow	None	None	Transplants	None	1.27 cm
27.	Rip/Harrow	None	Live Earth 1,121 kg/ha	Drillseed 21 PLS Kg/ha	Straw mulch/Crimp 5,000 kg/ha	None
28.	Rip/Harrow	None	Polyacrylamide gel 22.4 kg/ha	Drillseed 21 PLS Kg/ha	Straw mulch/Crimp 5,000 kg/ha	None
29.	Rip/Harrow	None	Live Earth 2,242 kg/ha	Drillseed 21 PLS Kg/ha	Straw mulch/Crimp 5,000 kg/ha	None
30.	Rip/Harrow	None	Polyacryamide gel 44.8 kg/ha	Drillseed 21 PLS Kg/ha	Straw mulch/Crimp 5,000 kg/ha	None
31.	Rip/Harrow	None	Topsoil 40% OM	Drillseed 21 PLS Kg/ha	Straw mulch/Crimp 5,000 kg/ha	None
32.	Rip/Harrow	None	Topsoil 40% OM & Polyacryamide gel 44.8 kg/ha	Drillseed 21 PLS Kg/ha	Straw mulch/Crimp 5,000 kg/ha	None
33.	Rip/Harrow	None	None	Drillseed 21 PLS Kg/ha & Transplants	Straw mulch/Crimp 5,000 kg/ha	None

5. MONITORING AND MITIGATION PROGRAM

A primary goal of the Monitoring and Mitigation Program is to preserve important plant and animal species; their associated habitats; and important biological resources, such as topsoil, that may be affected by SCA (DOE, 1991a). Important species include federally listed and candidate species and species of commercial and recreational value.

Preactivity surveys are conducted to identify potential effects of each SCA on important species and to develop mitigation recommendations including resurveys and monitoring. Post-activity surveys are conducted after a land-disturbing activity has been completed and

Ecosystems Environmental Field Activity Plan (DOE, 1991a)

5.1 Preactivity Surveys

Table 13. Preactivity surveys conducted for the Yucca Mountain Site Characterization Project in FY92.

Project Type	No. of requests	No. sites	Area (ha)	Distance on roads (km)
Boreholes/infiltration tests	5	11	25.3	0.2
Hydrological studies	5	8	9.1	0
Soil/volcanism studies	5	47	59.1	0
Seismic studies/stations	3[a]	42	10.1	0
Radiological monitoring stations/plots	1	11	15.9	0
Biological research plots	1	5	0	0
Facility improvements, road access/repair	1	1	15.2	2.0
Borrow pits	2	2	46.3	0
Pavement studies	2	2	23.9	0
Exploratory Studies Facility	1	10	162.2	9.25
Fault studies	2	8	31.0	0
Other	4	4	2.6	0
Total	32	151	400.7	11.45

[a]Including one real-time survey for University of Nevada, Reno Seismic Stations.

Radio-marked tortoises were monitored at five sites where monitoring was recommended and where construction occurred in FY92 (Table 16): NRG-1, NRG-1 Pavement Studies, Soil and Rock Property Test Pits at the North Portal Pad, Trench MWVT-5a, and Quaternary Fault Studies. During tortoise monitoring, biologists collapsed one empty burrow during excavation of trench SCR-T3 (Quaternary Fault Studies) southwest of Busted Butte. No tortoises entered activity areas during construction. One tortoise came within 10 m of heavy equipment during excavation of a soil test pit east of Exile Hill. All other tortoises stayed >50 m from construction sites.

Radiomarked tortoise #423 was moved to a Calico Hills Relocation Plot prior to excavation of a test pit at the proposed North Portal Pad in February 1992 (Table 16). Movements of this tortoise are described in Section 3.6.

Table 14. Results of the FY92 preactivity surveys for Yucca Mountain Site Characterization Project activities conducted in desert tortoise habitat.

Project Type	No. sites	Area (ha) or distance (km)	Tortoise sign[a]	Important plants	Chuckwallas	Important biological resource
Boreholes/ infiltration tests	11	25.35 0.2	14 (2) 0	0	2	0
Hydrological studies	8	9.1	13	0	0	0
Soil/volcanism studies	47	59.1	32	0	0	2
Seismic studies/stations	42	10.1	4	0	0	0
Radiological monitoring stations/plots	11	15.9	6	0	0	0
Biological research plots	5	0[b]	---	---	---	--
Facility improvements, road repair/access	1	15.2 2.0	0 0	0	0	0
Borrow pits	2	46.3	38 (3)	0	0	0
Pavement studies	2	23.9	2	0	0	0
Exploratory Studies Facility	10	162.2 9.25	70 26 (4)	0	0	1
Fault studies	8	31.0	15 (1)	0	0	0
Other	4	2.6	3	0	0	0
Total	151	400.7 11.45	197 (6) 26 (4)	0	2	3

[a] Includes tortoises and tortoise burrows found; number of tortoises found is in parentheses.

[b] Biological research plots do not cause any surface disturbance, therefore field surveys were not conducted for this activity.

Table 15. Type of mitigation recommendations and actions included in preactivity survey reports submitted during FY92 for Site Characterization activities .

Project Type	Relocate or Redesign Activity	Salvage Topsoil	Conduct tortoise resurvey	Conduct tortoise monitoring	Displace or relocate tortoises
Boreholes /infiltration tests	1	2	1	2	0
Hydrological studies	0	0	2	0	0
Soil studies/ volcanism studies	1	2	3	2	0
Seismic studies/ stations	0	0	0	0	0
Radiological monitoring	0	0	1	0	0
Facility improvements, road repair/access	0	0	0	0	0
Borrow pits	0	0	1	1	1
Pavement studies	0	1	1	1	0
Exploratory Studies Facility	1	5	6	5	0
Fault studies	0	4	4	4	0
Other	0	0	0	0	0
Total	3	14	19	15	1

5.2.2 Trench Monitoring

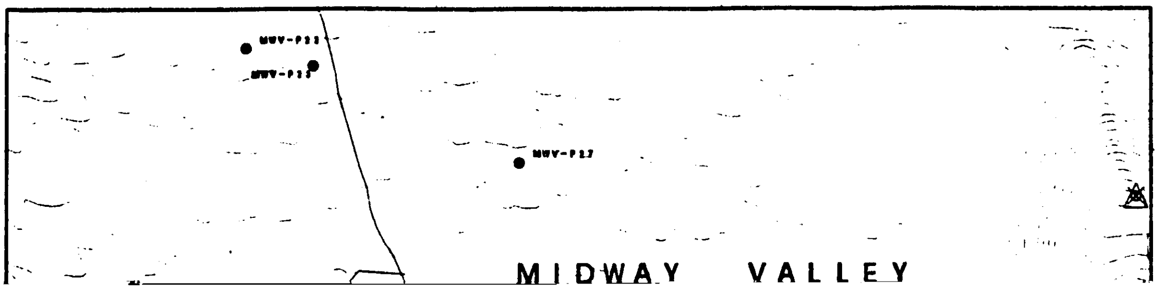
Approximately 60 trenches were excavated in Midway Valley as part of the Soil and Rock Properties Test Pits and Midway Valley Trenches projects (Figure 13). Most trenches are about 12 m long. Some were backfilled after one month; most were still open at the end of FY92. Because these trenches were constructed with a slope of <45 degrees at one end, it was not anticipated that tortoises would become entrapped. However, this has never been verified by monitoring open trenches. One long trench (344 m long, 3.7 m wide, and 3.3 m deep) was excavated east of the North Portal Pad (Trench MWVT-5A). Because of its length, there were concerns that tortoises may fall into the trench and not be able to walk out before overheating and dying. EG&G/EM recommended that this trench be examined daily during trench construction and periodically while the trench remained open. While implementing this recommendation, 29 other open trenches in Midway Valley (Figure 13) were monitored to assess the impact of open trenches on animals at Yucca Mountain. These trenches averaged 12.0 m long, 3.0 m wide, and 3.4 m deep. The slope of each entrance end averaged 35.7 degrees.

Table 16. Mitigation actions conducted for Site Characterization Project activities during FY92.

Project Type	No. Activities topsoil salvaged	Tortoise resurveys conducted	Tortoise monitoring conducted	Tortoises displaced or relocated	Post-activity surveys conducted
Boreholes /infiltration tests	1	4	0	0	0
Hydrological Studies	0	0	0	0	1
Soil Studies/ Volcanism Studies	2	3	1	1	0
Seismic Studies/ Stations	0	0	0	0	0
Radiological Monitoring	0	0	0	0	0
Facility Improvements, Road Repair/Access	0	0	0	0	0
Borrow Pits	0	0	0	0	0
Pavement Studies	1	1	1	0	0
Exploratory Studies Facility	1	1	1	0	0
Fault Studies	2	2	2	0	0
Other	0	0	0	0	0
Total	7	11	5	1	1

Trench monitoring began June 22, 1992 and continued until November 23, 1992 when Trench MWVT-5a was backfilled. Trench MWVT-5A was monitored each workday morning during construction and at least once per week after excavation was completed. All other trenches were examined once a week. Trenches were examined by walking along the trench bottom and recording all species of reptiles, invertebrates, and mammals found and noting if animals were dead or alive. The dimensions of each trench were recorded at the beginning of monitoring.

Trench MWVT-5A was examined 69 times. No desert tortoises were observed. A total of 332 animals were found in the trench: 265 side-blotched lizards, three western whiptail lizards, one ground snake, one coachwip snake, and 54 invertebrates (unidentified beetles, spiders, and ants). No mammals were found. Only eight dead animals were recorded in Trench MWVT-5A: one speckled rattlesnake, one moth, and six beetles (unidentified species). The other 29 trenches were checked a total of 429 times. No desert tortoises were observed in any of the short trenches. A total of 55 animals were found: 42 side-blotched lizards, two blacktailed jackrabbits (*Lepus californicus*), and 11 invertebrates. All animals observed were alive. The open trenches did not cause significant mortality to animal populations in the vicinity.


MIDWAY VALLEY

5.2 RECLAMATION INVENTORIES

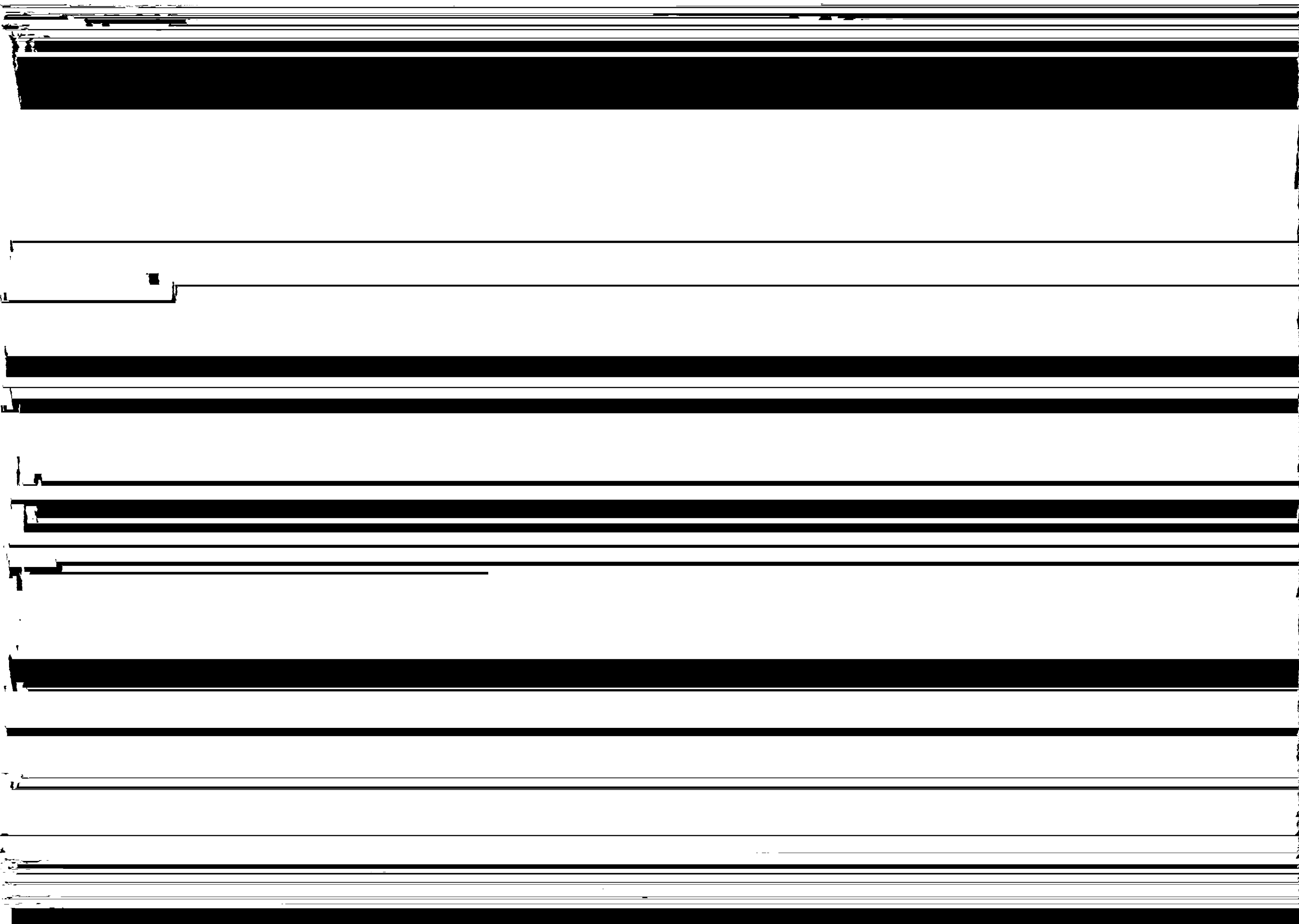
Reclamation inventories were conducted and topsoil salvaging was recommended for 14 activities (Table 15). Site-specific reclamation stipulation reports were prepared for each of these activities. Construction occurred at seven of these sites during FY92: NRG-1, NRG-1 Pavement Studies, Soil and Rock Property Test Pits at the North Portal Pad, Trench MWVT-5a, UZ-16, Quaternary Faults, and Soil Test Pits in Midway Valley. Topsoil was salvaged at all these sites (Table 16). EG&G/EM stabilized 18 topsoil stockpiles associated with the Soil and Rock Properties Test Pits and Midway Valley Trenches projects (see section 4.2.1).

5.3 POST-ACTIVITY SURVEYS

Two sites, Well JF-3 and Trench A'2, were released for final reclamation. The Project [illegible]

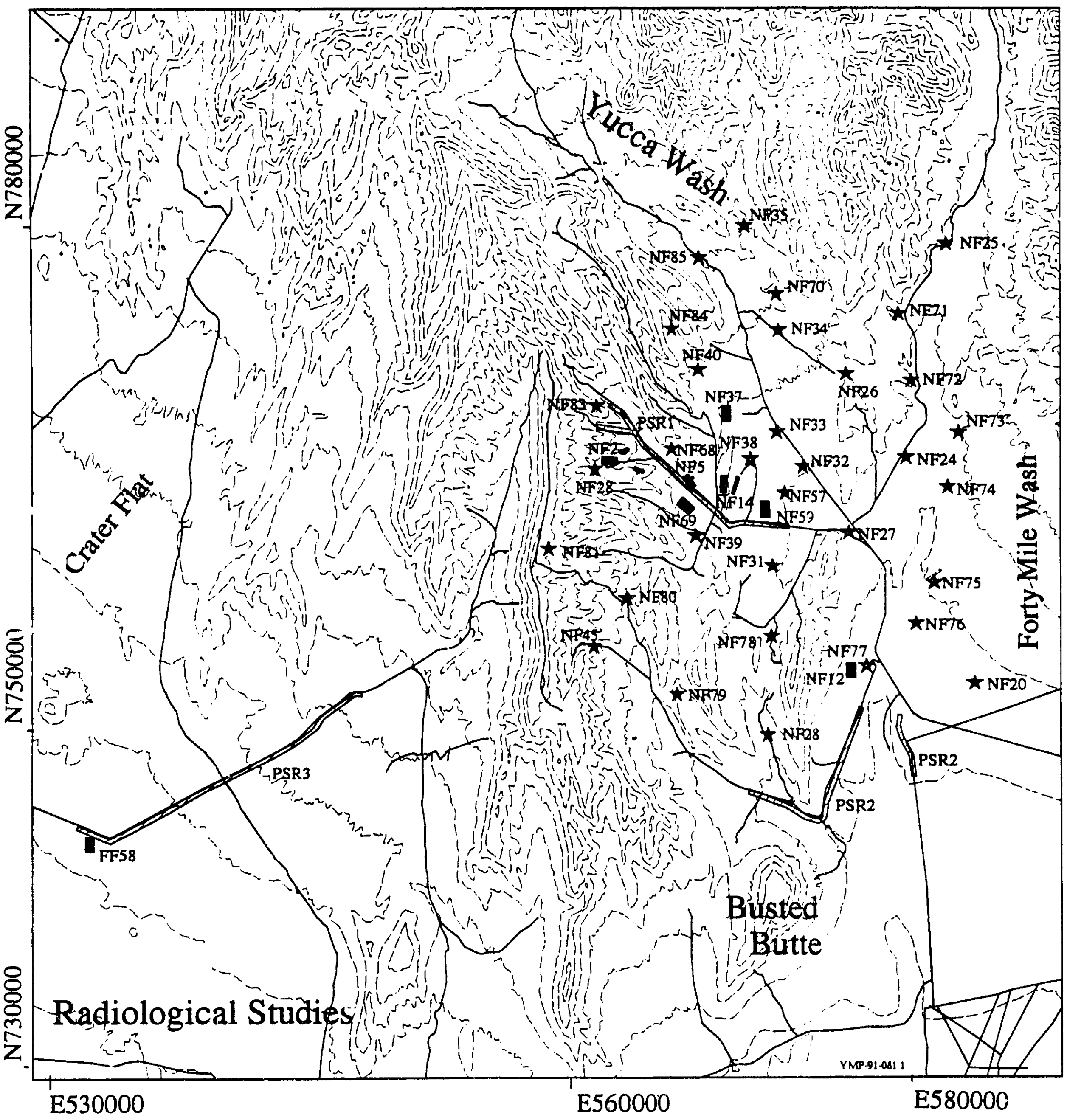
6. RADIOLOGICAL MONITORING PROGRAM

The objectives of the Radiological Monitoring Program are to collect plant and animal specimens for measurement of radionuclide concentrations in tissues and to monitor populations of animals that are being collected or may be collected in the future. Small mammals and deer forage were collected in FY92. Small mammal, quail, predator, and lagomorph populations were monitored (Figure 14).



Small mammals continued to be used as indicator species to characterize existing radionuclide levels in the environment as well as to monitor unsuspected release pathways of radionuclides. Small mammals were collected on six near-field (NF) treatment plots, one near-field control plot (NF12), and one far-field control plot (FF58) and transferred to the custody of Science Application International Corporation, Inc. (SAIC) (EG&G/EM, 1991).

The sampling effort totalled 19,690 trap-nights. This is a 24% reduction from FY91. The small number of animals collected each session since 1989 has never caused a population decline below a sustainable level on any plot (EG&G/EM, 1991:46; EG&G/EM, 1992:59). Therefore, long-term monitoring was stopped except for two plots (NF37 and NF59) which were trapped five times in FY92. The remaining plots were only trapped in October and



Yucca Wash
Crater Flat
Forty-Mile Wash
Busted Butte
Radiological Studies
N780000
N750000
N730000
E530000
E560000
E580000
NF35
NF25
NF85
NF70
NF71
NF84
NF34
NF40
NF26
NF72
NF37
NF83
PSR1
NF33
NF73
NF2
NF68
NF38
NF32
NF24
NF5
NF28
NF14
NF57
NF74
NF69
NF59
NF27
NF39
NF81
NF31
NF75
NF80
NF76
NF45
NF78
NF77
NF12
NF20
NF79
PSR3
PSR2
FF58
YMP-91-081.1

Table 17. Number of individual Merriam's kangaroo rats (DIME) and long-tailed pocket mice (PEFO) captured on the radiological monitoring small mammal plots, October 1991 - August 1992. Number of individuals collected is in parentheses.

Plot	Species	October	April	June	July	August
NF2	DIME	9	5			
	PEFO	192(26)	93(20)			
NF5	DIME	44	39(12)			
	PEFO	203(25)	97(20)			
NF12	DIME	63(13)	32(12)			
	PEFO	103	48(21)			
NF14	DIME	61(14)	50(11)			
	PEFO	208	117(20)			
NF37	DIME	46	72(12)	54	67	75
	PEFO	259(25)	240(21)	317	297	306
FF58	DIME	40(14)	41(12)			
	PEFO	14	0			
NF59	DIME	94(14)	77(12)	77	120	142
	PEFO	198	182(21)	266	211	207
NF69	DIME	50	38(12)			
	PEFO	218(25)	105(22)			

In 1992, 33 forage samples were collected from 26 sample plots (Table 17). One new plot was established on the ridge of Yucca Mountain and plot 76 was moved to the pond below J-13 well. Samples were transferred to the custody of SAIC in December 1992. Results of the radionuclide analysis of the forage samples will be published by SAIC when analyses are completed.

Table 18. Deer forage species collected in July 1992 for analysis of radionuclide levels.

Plot Number	Plant Species Collected	Wet Weight (g)
NF26	*Encelia virginensis*	620
	Purshia glandulosa	1005
NF28	*Krameria parvifolia*	565
NF32	*Krameria parvifolia*	995
	Encelia virginensis	800
NF33	*Krameria parvifolia*	1060
NF35	*Purshia glandulosa*	795
	Atriplex canescens	870
NF38	*Atriplex confertifolia*	910
	Larrea tridentata	640
NF40	*Ambrosia dumosa*	640
NF42	*Artemisia tridentata*	1315
NF45	*Atriplex canescens*	1270
NF57	*Krameria parvifolia*	690
NF68	*Atriplex polycarpa*	935
NF70	*Chrysothamnus nauseosus*	1060
NF71	*Krameria parvifolia*	525
	Encelia virginensis	670
NF73	*Atriplex polycarpa*	910
NF74	*Encelia virginensis*	710
NF75	*Krameria parvifolia*	720
NF76	*Carex* spp.	715
NF79	*Encelia virginensis*	600
NF80	*Krameria parvifolia*	635
NF81	*Atriplex canescens*	920
NF82	*Ceratoides lanata*	640
	Artemisia tridentata	635
NF83	*Artemisia tridentata*	1070
NF84	*Encelia virginensis*	910
NF85	*Purshia glandulosa*	900
	Chrysothamnus nauseosus	1015
NF109	*Artemisia tridentata*	1160

6.3 LAGOMORPH SURVEYS

Spotlight surveys were initiated in FY91 as an alternative to diurnal line transects for monitoring the relative abundance of lagomorphs. Spotlight surveys were determined to be the most reliable and accurate sampling method, and therefore, were continued during FY92.

The Crater Flat route (31 km) (far-field control sample) and the Yucca Mountain route (40 km) (near-field sample) sampled in FY91 were again sampled in FY92. The two routes were surveyed for three consecutive nights in December 1991 and July 1992. Sampling was conducted with one person operating a spotlight on each side of a vehicle and a third person driving the vehicle at speeds of 5-10 mph.

Few lagomorphs were observed in December 1991 (Table 18). A large increase in the number of lagomorphs observed occurred in July 1992. An average of 22.3 and 39.0 lagomorphs per night were observed along the Crater Flat and Yucca Mountain routes, respectively. All lagomorphs seen during both sessions were black-tailed jackrabbits (*Lepus californicus*) except for three desert cottontails (*Sylvilagus auduboni*). The increase in relative abundance was probably induced by high rainfall and plant production which lead to increased reproduction and recruitment. For comparison, in 1959-1960, a maximum of 3.0 hares/10 km were observed in nearby Jackass Flats (Hayden, 1966). In FY91, 1.26 lagomorphs were observed per night.

During both sessions, kit foxes (*Vulpes macrotis*) were the most consistently observed carnivore. Other large mammals were infrequently seen: coyote (*Canis latrans*), mule deer (*Odocoileus hemionus*), and burro (*Equus asinus*).

Three roadkilled jackrabbits were collected for radionuclide analysis. Jackrabbits were collected from Split Wash (near field sample), Forty-Mile Wash (near-field control sample), and Crater Flat (far-field control sample).

Table 19. Summary of lagomorphs counted during spotlight surveys at Yucca Mountain (YM) (40 km) and Crater Flat (CF) (31 km) in December 1991 and July 1992.

Location	Date	Maximum number/10 km of road	$\bar{x}$ number/route	SE[a]
YM	12/91	0.5	0.67	0.7
	07/92	10.3	39.0	1.1
CF	12/91	0.7	1.0	0.6
	07/92	8.0	22.3	1.4

[a] Standard error of $\bar{x}$ number/route

6.4 PREDATOR SURVEYS

Because predators are relatively long-lived and high on the food chain, they could provide information on the bioaccummulation and concentration of radionuclides in the ecosystem. Several mammalian predators have been observed at Yucca Mountain. However, limited site-specific information is available on abundance, distribution, and movements of these animals. This information should be obtained before specimens of mammalian predators can be collected for the Radiological Monitoring Program. The objective of this survey is to monitor the relative abundance of several mammalian predators at Yucca Mountain and Crater Flat.

Three predator survey routes (PSRs), each with 20 scent stations, were used to monitor abundance (Figure 13). PSRs are located in areas that represent three possible radionuclide contamination sources. PSR #1 is near the proposed Exploratory Studies Facilities and represents an area exposed to potential radionuclide sources associated with SCA and NTS activities. PSR #2 is located north of Busted Butte on both sides of Forty-Mile Wash. This route is the near-field control and represents an area exposed to potential contamination from NTS activities only. PSR #3 is located in Crater Flat and represents a far-field control.

The dust scent-station technique (EG&G/EM, 1992) was used in FY90 and FY91. Data collected using this technique is adequate for general comparisons of predator activity between areas and seasons. However, since sample size was substantially reduced because high winds destroyed plots, no valid conclusions can be drawn. For this reason the smoke-plate technique was considered, tested, and adopted. The smoke-plate technique was used in

Table 20. Summary of operable stations, visits, and visitation rates of kit foxes and coyotes for Predator Survey Routes (PSRs) 1, 2, and 3 at or near Yucca Mountain.

Technique Month	Route	Operable station-nights[b]	Visitation rate[a] Kit fox	Coyote	Total[c]
Dust					
September/ October 1990	PSR1	34	0	0.03(1)	0.03
	PSR2	36	0.33(12)	0	0.33
	PSR3	24	0	0	0
February 1991	PSR1	24	0	0	0
	PSR2	24	0.13(3)	0	0.13
May 1991	PSR1	33	0.03(1)	0	0.03
	PSR2	28	0	0	0
Smoke-plate					
December 1991	PSR2	20	0.10(2)	0	0.10
March 1992	PSR1	57	0.03(2)	0.02(1)	0.05
	PSR2	57	0.02(1)	0	0.02
	PSR3	59	0.08(5)	0	0.08
June 1992	PSR1	48	0.12(6)	0.04(2)	0.17
	PSR2	58	0.05(3)	0.02(1)	0.07
	PSR3	60	0.10(6)	0	0.10
September 1992	PSR1	60	0.08(5)	0.05(3)	0.13
	PSR2	59	0.22(13)	0.12(7)	0.34
	PSR3	60	0.32(19)	0	0.32

[a] - Visitation rate = number of stations visited during session/number operable station-nights.
[b] - Total number of station-nights conducted per route. Stations were considered inoperable when >50% of the station was destroyed due to wind, animals, or vehicles.
[c] - Total for kit fox and coyote only. Other predator visits occurred but positive identification could not always be verified.

Coyote tracks often were observed near but not on scent stations, suggesting that some coyotes were attracted to the scent station but would not walk onto the smoked plate. Therefore, coyote visitation rates may be underestimated. Other predator tracks were observed (i.e., spotted skunk, badger, long-tailed weasel) on the smoke plates but positive identification was difficult because the track prints were not clear.

Current plans do not include collecting predators to support the Radiological Monitoring Program. Therefore, scent stations will not be conducted in FY93. Spotlight surveys will continue to provide incidental observations on predator species occurrence at Yucca Mountain.

6.5 GAMEBIRD MONITORING

Mourning doves (*Zenaida macroura*) that pass through Yucca Mountain are a potential pathway for radionuclides to humans if they are harvested off NTS. Because migratory mourning doves may be exposed to radionuclides away from Yucca Mountain, it would be difficult to attribute any radionuclides in doves to potential sources at Yucca Mountain. Therefore, quail are proposed for modelling potential radionuclide body burdens in mourning doves. Gambel's quail (*Callipepla gambelii*) have foraging habits similar to mourning doves and are year-round residents at Yucca Mountain. A field study was initiated to monitor Gambel's quail populations at Yucca Mountain to determine whether samples could be collected at Yucca Mountain and in the Forty-Mile and lower Sever washes (which represent a near-field control sample).

Quail were trapped using ten walk-in traps from March 25-31. Baiting was conducted two weeks prior to trapping. Captured quail were weighed, aged (using molt stage), sexed, and legbanded. A sample of quail was radiomarked with solar-assisted radio transmitters attached to necklaces. Radiomarked quail were located daily during the first few days after capture to check whether transmitters adversely affected behavior. Then quail were located once each week. During the nesting season, number of eggs layed and hatched were recorded for each nest found. Minimum number alive (MNA) in the quail population was estimated from opportunistic observations.

Sixteen quail were captured and legbanded from five trap sites. Within the Sever and Forty-Mile washes, along the eastern edge of the Yucca Mountain area two males and three females were captured. Of these, two quail of each sex were radiomarked (referenced as "Wash quail"). Near Exile Hill, six females and five males were captured. Of these, two males and six females were radiomarked (referenced as "Yucca Mountain quail").

Only one Wash quail and one Yucca Mountain quail (both females) survived beyond November 1, 1992 (20% survival). There were no survival differences between sexes. Three quail died within 45 days after capture; one died in June, approximately 78 days after capture; and four died in July, 100 - 120 days after capture.

A survival rate of 20% from spring to fall is not uncommon in quail populations (Pollock et al., 1989). Direct causes of mortality were not confirmed but were thought to have been mammalian predators in most cases or possibly avian predators. Indirect mortalities from radio transmitters were not evaluated.

Between June 23 and July 1, one female quail (#9), moved from Forty-Mile Wash to the Subdock area at Yucca Mountain, a minimum straight-line distance of 6.5 km. The other three radiomarked Wash quail had died before June 23. Quail #9 remained at the Subdock for two weeks and then returned to Forty-Mile Wash. No other radiomarked quail dispersed from one area to the other. The nine other radiomarked quail had an average home range of 1.1 km^2 (SE = 0.26), based on the minimum convex polygon method (Stuwe and Blohowiak, 1985). Much of the quail activity near Yucca Mountain prior to and during nesting occurred from Exile Hill south about 2 km to Muckpile Hill in southwest Midway Valley. Following nesting many quail broods congregated at the Subdock. The pipeyard and boxcars were used for cover and a man-made water trough provided a source of water.

Four of the five radiomarked females alive during the nesting season were known to have nested. The earliest recording nesting was April 20; the latest date was July 4. Observations of quail chicks in August indicated that nests of unmarked quail may have hatched as late as August 1. The clutch size of nests found during this study ranged from 9 to 17 eggs ($\bar{x}$ = 15.8, SE = 0.7, n = 6). The number of hatched eggs of successful nests ranged from 9 to 16 ($\bar{x}$ = 13.5, SE = 1.5, n = 4). One radiomarked male incubated two nests. At least one radiomarked female had two clutches. The second nest of both birds was unsuccessful; both quail died before the eggs hatched. A third nest failed when the attending quail was killed by a predator before the eggs hatched.

An insufficient number of quail were captured to provide a MNA estimate in March prior to pairing and breeding. Based on observations made during the winter more than 50 quail were known to occur in Drill Hole Wash near the YMP Subdock area. On June 17, three separate quail groups containing mostly fledglings and totaling 136 quail were observed at Yucca Mountain and in Forty-Mile Wash. Taking into account adult quail known to exist at that time, additional fledgings recruited in August, and continuous mortality from June to August, a peak MNA of 180 quail was estimated for the post-nesting period in August.

Based on the information gathered, quail collections (3-4 quail) will not affect the population. Additional monitoring is needed to determine if a separate quail population exists in the Forty-Mile area that could represent a near-field control sample.

7. BIOLOGICAL SUPPORT

EG&G/EM completed special studies and reports, document reviews, presentations, tours, and permit acquisitions to provide biological support to the Yucca Mountain Site Characterization Project. Support was provided for quality assurance, safety, and facility/equipment acquisition. These activities ensured compliance with the Nuclear Waste Policy Act, Endangered Species Act, and DOE orders.

7.1 DOCUMENT REVIEW AND REVISION

Several documents were reviewed by EG&G/EM at Project Office request. EG&G/EM reviewed the State of Nevada's "Environmental Studies Plan" and "Impact Assistance Report: Inventory of Past DOE Land Disturbance, Yucca Mountain, Nevada, and Estimated General Reclamation Costs." A review was completed for the revision of the Terrestrial Ecosystems Environmental Field Activities Plan. Responses were provided to comments by the State of Nevada on the "Reclamation Implementation Plan" and the reclamation feasibility trials. EG&G/EM also provided input and comments on the "YMP Annual Environmental Report."

7.2 REPORTS AND SPECIAL REQUESTS

EG&G/EM provided the Project Office with monthly and weekly reports of activities and accomplishments. An annual report of progress and accomplishments for FY91 was written and published as a topical report (EG&G/EM, 1992). At the request of the Project Office, EG&G/EM reviewed comments by the U. S. Fish and Wildlife Service on the Bureau of Land Management's environmental assessment for the proposed gravel pit in Forty-Mile Wash. The annual report of animal collection and handling conducted under EG&G/EM's State of Nevada Scientific Collection Permit was submitted to the Nevada Department of Wildlife. Budget estimates and scopes of work for FY93 were submitted to the Project Office. EG&G/EM provided expertise in the areas of terrestrial ecology and endangered species during the application process for a State of Nevada Water Appropriations Permit. Assistance and expertise was provided for developing biological displays at the YMP Information Centers in Area 25 and in Pahrump, Nevada.

Substantial effort was made to implement a quality assurance program for Yucca Mountain Site Characterization Project. EG&G/EM prepared a Quality Program Description (QPD) that included the implementing procedures for the quality assurance program. The QPD was submitted to Project Office for review in May. Review comments were addressed and resolved. The QPD was sent to Project Office for final approval.

EG&G/EM continued to prepare Instructions for new studies and revise Instructions as needed. A management self-assessment was conducted in June to evaluate compliance for several Instructions. The self-assessment was conducted by the Department Manager with support from EG&G/EM quality assurance personnel.

7.5 SAFETY

Safety and compliance with established environmental and health standards have been priorities for EG&G/EM. Staff meetings have included discussion of operational safety topics. Monthly and quarterly YMP safety meetings were attended by EG&G/EM representatives to ensure compliance with the Environmental Safety Health Program

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Appendix A. Plant species EG&G/EM has found at Yucca Mountain.

PERENNIAL SPECIES

Code	Scientific Name	Common Name	Growth Form	Family
ACSH	*Acamptopappus shockleyi*	Shockley Goldenrod	Shrub	Compositae
AMDU	*Ambrosia dumosa*	White Bursage	Shrub	Compositae
ARMU	*Argemone munita*	Prickly Poppy	Forb	Papaveraceae
ARLU	*Artemesia ludoviciana*	Lousiana Sagewort	Forb	Compositae
ARSP	*Artemisia spinescens*	Budsage	Shrub	Compositae
ARTR	*Artemesia tridentata*	Big Sagebrush	Shrub	Compositae
ASLA	*Astragalus layneae*	Layne's Locoweed	Forb	Leguminousae
ATCA	*Atriplex canescens*	Four-wing Saltbush	Shrub	Chenopodiaceae
ATCO	*Atriplex confertifolia*	Shadscale	Shrub	Chenopodiaceae
ATHY	*Atriplex hymenelytra*	Desert Holly	Shrub	Chenopodiaceae
ATPO	*Atriplex polycarpa*	Cattle Saltbush	Shrub	Chenopodiaceae
BAMU	*Baileya multiradiata*	Desert Marigold	Forb	Compositae
BRWA	*Brickellia watsonii*	Watson Bricklebush	Shrub	Compositae
CAFL	*Calochortus flexuosa*	Desert Lilly	Forb	Liliaceae
CACH	*Castilleja chromosa*	Indian Paintbrush	Forb	Scrophulariaceae
CELA	*Ceratoides lanata*	Winterfat	Shrub	Chenopodiaceae
CHNA	*Chrysothamnus nauseosus*	Rubber Rabbitbrush	Shrub	Compositae
CHPA	*Chrysothamnus paniculatus*	Desert Rabbitbrush	Shrub	Compositae
CHTE	*Chrysothamnus teretifolia*	Needleleaf Rabbitbrush	Shrub	Compositae
CHVI	*Chrysothamnus viscidiflorus*	Douglas Rabbitbrush	Shrub	Compositae
CINE	*Cirsium neomexicanum*	Lavender Thistle	Forb	Compositae
CORA	*Coleogyne ramosissima*	Blackbrush	Shrub	Rosaceae
CUNE	*Cuscuta nevadensis*	Dodder	Forb	Cuscutaceae
DEPA	*Delphinium parishii*	Desert Larkspur	Forb	Ranunculaceae
DIPU	*Dichlostemna pulchellum*	Bluedick	Forb	Amaryllidaceae
ECPO	*Echinocactus polycephalus*	Cottontop Barrelcactus	Cactus	Cactaceae
ECEN	*Echinocereus engelmanii*	Hedgehog Cactus	Castus	Cactaceae

Appendix A. Continued.

PERENNIAL SPECIES

Code	Scientific Name	Common Name	Growth Form	Family
ECTR	*Echinocereus triglochidiatus*	Claretcup Cactus	Cactus	Cactaceae
ENVI	*Encelia virginensis*	Virgin River Encelia	Shrub	Compositae
EPNE	*Ephedra nevadensis*	Nevada Ephedra	Shrub	Ephedraceae
EPVI	*Ephedra viridis*	Green Ephedra	Shrub	Ephedraceae
ERFA	*Eriogonum fasciculatum*	Yellow Buckwheat	Shrub	Polygonaceae
ERIN	*Eriogonum inflatum*	Desert Trumpet	Forb	Polygonaceae
ERMI	*Eriogonum microthecum*	Buckwheat	Shrub	Polygonaceae
ERPU	*Erioneuron pulchellum*	Fluffgrass	Grass	Poaceae
EUAL	*Euphorbia albomarginata*	Rattlesnake Weed	Forb	Euphorbiaceae
GRSP	*Grayia spinosa*	Spiny Hopsage	Shrub	Chenopodiaceae
GUSA	*Gutierrezia sarothrae*	Broom Snakeweed	Shrub	Compositae
HACO	*Haplopappus cooperi*	Cooper's Goldenweed	Shrub	Compositae
HALI	*Haplopappus linearifolius*	Goldenweed	Shrub	Compositae
HIJA	*Hilaria jamesii*	Galleta	Grass	Poaceae
HYSA	*Hymenoclea salsola*	White burrobrush (Cheesebush)	Shrub	Compositae
KRPA	*Krameria parvifolia*	Range Ratany	Shrub	Krameriaceae
LATR	*Larrea tridentata*	Creosotebush	Shrub	Zygophyllaceae
LEFR	*Lepidium fremontii*	Desert Pepperweed	Shrub	Brassicaceae
LEPU	*Leptodactylon pungens*	Prickly Gila	Shrub	Polemoniaceae
LYAN	*Lycium andersonii*	Anderson Wolfberry	Shrub	Solanaceae
LYPA	*Lycium pallidum*	Pale Wolfberry	Shrub	Solanaceae
MATO	*Machaeranthera tortifolia*	Mojave Aster	Shrub	Compositae
MESP	*Menodora spinescens*	Spiny Menodora	Shrub	Oleaceae
MIBI	*Mirabilis bigelovii*	Desert Wishbone Bush	Forb	Nyctaginaceae
MUPO	*Muhlenbergia porteri*	Bush Muhly	Grass	Poaceae
OPBA	*Opuntia basilaris*	Beavertail Pricklypear	Cactus	Cactaceae
OPEC	*Opuntia echinocarpa*	Strawtop Pricklypear	Cactus	Cactaceae
ORHY	*Oryzopsis hymenoides*	Indian Ricegrass	Grass	Poaceae

ued.

PERENNIAL SPECIES

tific Name	Common Name	Growth Form	Family
emon floridus	Penstemon	Forb	Scrophulariacea
nyx nitidus	Sandpaper plant	Forb	Loasaceae
andbergii	Sandberg's Bluegrass	Grass	Poaceae
thamnus fremontii	Indigo Bush	Shrub	Fabaceae
thamnus mollissima	Indigo Bush	Forb	Fabaceae
thamnus polyadenius	Nevada Dalea	Shrub	Fabaceae
ia glandulosa	Desert Bitterbrush	Shrub	Rosaceae
aria mexicana	Bladdersage	Shrub	Lamiaceae
ocactus polyancistrus		Cactus	Cactaceae
ion hystrix	Squirreltail	Grass	Poaceae
ralcea ambigua	Desert Globemallow	Forb	Malvaceae
bolus cryptandrus	Sand Dropseed	Grass	Poaceae
anomeria pauciflora	Wirelettuce	Forb	Compositae
speciosa	Desert Needlegrass	Grass	Poaceae
dymia axillaris	Longspine Horsebrush	Shrub	Compositae
dymia glabrata	Littleleaf Horsebrush	Shrub	Compositae
brevifolia	Joshua Tree	Shrub	Agavaceae

Appendix A. Continued.

ANNUAL SPECIES

Code	Scientific Name	Common Name	Growth Form	Family
AMFI	*Amaranthus fimbriatus*	Pigweed or Amaranth	Forb	Amaranthaceae
AMAC	*Ambrosia acanthocarpa*	Sand Bur	Forb	Compositae
AMTE	*Amsinkia tessellata*	Bristly Fiddleneck	Forb	Boraginacea
ASAC	*Astragalus acutirostris*	Locoweed	Forb	Leguminousae
BAPL	*Baileya pleniradiata*	Drooping Marigold	Forb	Compositae
BOBA	*Bouteloua barbata*	Sixweeks grama	Grass	Poaceae
BRRU	*Bromus rubens*	Red Brome	Grass	Poaceae
CABR	*Camissonia brevipes*	Yollow Cups	Forb	Onagraceae
CHST	*Chaenactus stevioides*	Steves Duskymaiden	Forb	Compositae
CHAL	*Chenopodium album*	Lambsquarters	Forb	Chenopodiaceae
CHRI	*Chorizanthe rigida*	Devil's Spiny Herb	Forb	Polygonaceae
CHBR	*Chorizanthe brevicornu*	Brittle Spineflower	Forb	Polygonaceae
CHPE	*Chorizanthe perfoliata*	Roundleaf Spineflower	Forb	Polygonaceae
CRCI	*Cryptantha circumscissa*	Matted Cryptantha	Forb	Boraginaceae
CRMI	*Cryptantha micrantha*	Cryptantha	Forb	Boraginaceae
CRNE	*Cryptantha nevadensis*	Cryptantha	Forb	Boraginaceae
CRPT	*Cryptantha pterocarya*	Winged Cryptantha	Forb	Boraginaceae
DEPI	*Descurainia pinnata*	Pinnate Tansymustard	Forb	Cruciferae
ERDE	*Eriogonum deflexum*	Skeletonweed Eriogonum	Forb	Polygonaceae
ERMA	*Eriogonum maculatum*	rose/white	Forb	Polygonaceae
ERNI	*Eriogonum nidularium*	Buckwheat	Forb	Polygonaceae
ERPR	*Eriophyllum pringlei*	Prinlge's Wooly Leaf	Forb	Compositae
ERCI	*Erodium cicutarium*	Storksbill	Forb	Geraniaceae
ESMI	*Eschscholtzia minutiflora*	Pygmy Poppy	Forb	Papaveraceae
EUMI	*Euphorbia micromera*	Leafy Spurge	Forb	Euphorbiaceae
EUSE	*Euphorbia setiloba*	Leafy Spurge	Forb	Euphorbiaceae
GIFL	*Gilia flavocincta*	Gilia	Forb	Hydrophyllaceae

Appendix A. Continued.

ANNUAL SPECIES

Code	Scientific Name	Common Name	Growth Form	Family
HAGL	*Halogeton glomeratus*	Halogeton	Forb	Chenopodiaceae
LASC	*Langloisia schottii*	Shott's Calico	Forb	Hydrophyllaceae
LEDE	*Lepidium densiflorum*	Prairie Pepperweed	Forb	Brassicacae
LIDI	*Linanthus dichotomus*	Flaxflower	Forb	Hydrophyllaceae
LOHU	*Lotus humistratus*	Foothill Deervetch	Forb	Leguminosae
LUCO	*Lupinus concinnus*	Bajada Lupine	Forb	Leguminosae
LUFL	*Lupinus flavoculatus*	Lupine	Forb	Leguninosae
LUSP	*Lupinus sparsiflorus*	Coulter's Lupine	Forb	Leguminosae
MAGL	*Malocothrix glabrata*	Smooth Desert Dandelion	Forb	Compositae
MEOB	*Mentzelia obscura*	Silverstems	Forb	Loaceae
MOBE	*Monoptilon bellidiforme*	Desert Star	Forb	Compositae
OEDE	*Oenothera deltoides*	Birdcage Evening Primrose	Forb	Onagraceae
OEPR	*Oenothera primiveris*	Yellow Desert Evening Primrose	Forb	Onagraceae
OXPE	*Oxytheca perfoliata*	Roundleaf Spineflower	Forb	Polygonaceae
PEPA	*Pectis papposa*	Chinch Weed	Forb	Compositae
PEPL	*Pectocarya playcarpa*	Pectocarya	Forb	Boraginaceae
PHFR	*Phacelia fremontii*	Fremont's Phacelia	Forb	Hydrophyllaceae
PSAN	*Psathyrotes annua*	Turtleback	Forb	Compositae
RANE	*Rafinesquia neomexicana*	New Mexico Plumeseed	Forb	Compositae
SAIB	*Salsola iberica*	Russian Thistle	Forb	Chenopodiaceae
SCAR	*Schismus arabicus*	Arabian Schismus	Grass	Poaceae
SIAL	*Sisymbrium altissimum*	Tumblemustard	Forb	Cruciferae
STEX	*Stephanomeria exigua*	Small Wirelettuce	Forb	Compositae
SYFR	*Syntrichopappus fremontii*	Syntrichopappus	Forb	Compositae
VUOC	*Vulpia octoflora*	Sixweeks fescue	Grass	Poaceae

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