

**THE 1993 BASELINE BIOLOGICAL STUDIES AND  
PROPOSED MONITORING PLAN FOR THE DEVICE  
ASSEMBLY FACILITY AT THE NEVADA TEST SITE**

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## EXECUTIVE SUMMARY

This report contains baseline data and recommendations for future monitoring of plants and animals near the new Device Assembly Facility (DAF) on the Nevada Test Site (NTS). The facility is a large structure designed for safely assembling nuclear weapons.

Baseline data was collected in 1993, prior to the scheduled beginning of DAF operations in early 1995. Studies were not performed prior to construction and part of the task of monitoring operational effects will be to distinguish those effects from the extensive disturbance effects resulting from construction. Baseline information on species abundances and distributions was collected on ephemeral and perennial plants, mammals, reptiles, and birds in the desert ecosystems within three kilometers (km) of the DAF. Particular attention was paid to effects of selected disturbances, such as the paved road, sewage pond, and the flood-control dike, associated with the facility. Radiological monitoring of areas surrounding the DAF is not included in this report.

The ephemeral plant community was surprisingly diverse, containing more species than most NTS study sites. Even some scraped areas had 50 species, an unusual number not expected to persist. Several introduced annual weeds were associated with the roads and scraped areas. Disturbance had less effect on the perennial plants, although areas near the DAF had fewer shrubs and a higher ratio of live to dead shrubs, both attributable to extensive removal of shrubs during construction. Dominant plants were the Joshua tree (*Yucca brevifolia*) and creosote bush (*Larrea tridentata*). A relatively high proportion of dead shrubs was attributable to recent drought.

The small mammal community included 9 species. Merriam's kangaroo rat was the most numerous species south of the DAF, while the long-tailed pocket mouse was most common north of the DAF.

Reptile species included occasional desert tortoises, but lizards were by far the most abundant reptiles. The common side-blotched lizard was excluded from cleared areas, but was present in summer at increased densities at the margin of the paved access road. One species (*Callisaurus draconoides*) was dominant in the flood-dike ditch and uncommon elsewhere.

The DAF sewage ponds were used extensively by migratory birds and species nesting near the DAF. The ponds were also an area of heavy bird predation. Ravens made only occasional use of the sewage ponds.

One federally listed threatened species (Mojave desert tortoise, *Gopherus agassizii*) and two candidate species (loggerhead shrike, *Lanius ludovicianus*, and chuckwalla, *Sauromalus obesus*) were observed in the vicinity of the DAF. The candidate species are both category 2 at this time.

These pre-operational baseline measurements will allow assessment of future operational effects on the ecosystem surrounding the DAF and will help distinguish construction effects from operational effects.

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## INTRODUCTION

This report describes the first year's work performed near the DAF in northwestern Frenchman Flat on the Nevada Test Site (NTS). BECAMP began DAF work in 1993 by developing study techniques, setting up permanent plots, and initiating biological studies. BECAMP sampling efforts focused on ephemeral and perennial plants, birds, mammals, and reptiles. The first year's work was designed to determine patterns of species' distributions and abundances prior to operation of the DAF. These baseline studies ask what current patterns exist in this area. This information is important to understand and document changes that may emerge after DAF operations begin. Two types of patterns were looked for, those emanating from natural causes (e.g., changes associated with shifts in position along the slope), and those associated with nonnuclear DAF operations (such as construction, or use of roads or the physical plant). Separation of these factors was somewhat problematic as baseline studies were not begun until after a considerable amount of construction had occurred. This prevented study of preconstruction conditions, and made selection of appropriate control sites somewhat subjective. Given these results we developed methods to detect effects of future DAF operations on plants and animals.

The NTS is a 3479 km<sup>2</sup> U.S. Department of Energy (DOE) site located 110 km north of Las Vegas. It consists of playa valleys separated by mesas and mountains with valley bottoms at 900 to 1500 m and mesa and mountain tops at 1700 to 2200 m. The NTS is located across the transition zone between the Mojave (*Larrea-Ambrosia*) and Great Basin (*Artemisia*) desert communities. These deserts differ in vegetation, soil type, and elevation. While typical habitats of both deserts occur on the NTS, aspects of each are present in the transition zone. Plant communities on the NTS (Allred et al. 1963; Beatley 1976; O'Farrell and Emery 1976) support biotic communities that typify each desert, with mixing occurring in transitional areas (Jorgensen and Hayward 1965).

The DAF is located in habitat most like the Mojave but also near the transition zone on an alluvial fan in northwestern Frenchman Flat, 27 km north of Mercury, the main entrance to the NTS. The area is characterized by gentle slopes cut by shallow arroyos 1 to 3 m deep with shallow soils and high rock content at the surface. The DAF buildings are located two to three km south and east of steep rocky hillsides and several km west of Frenchman Lake.

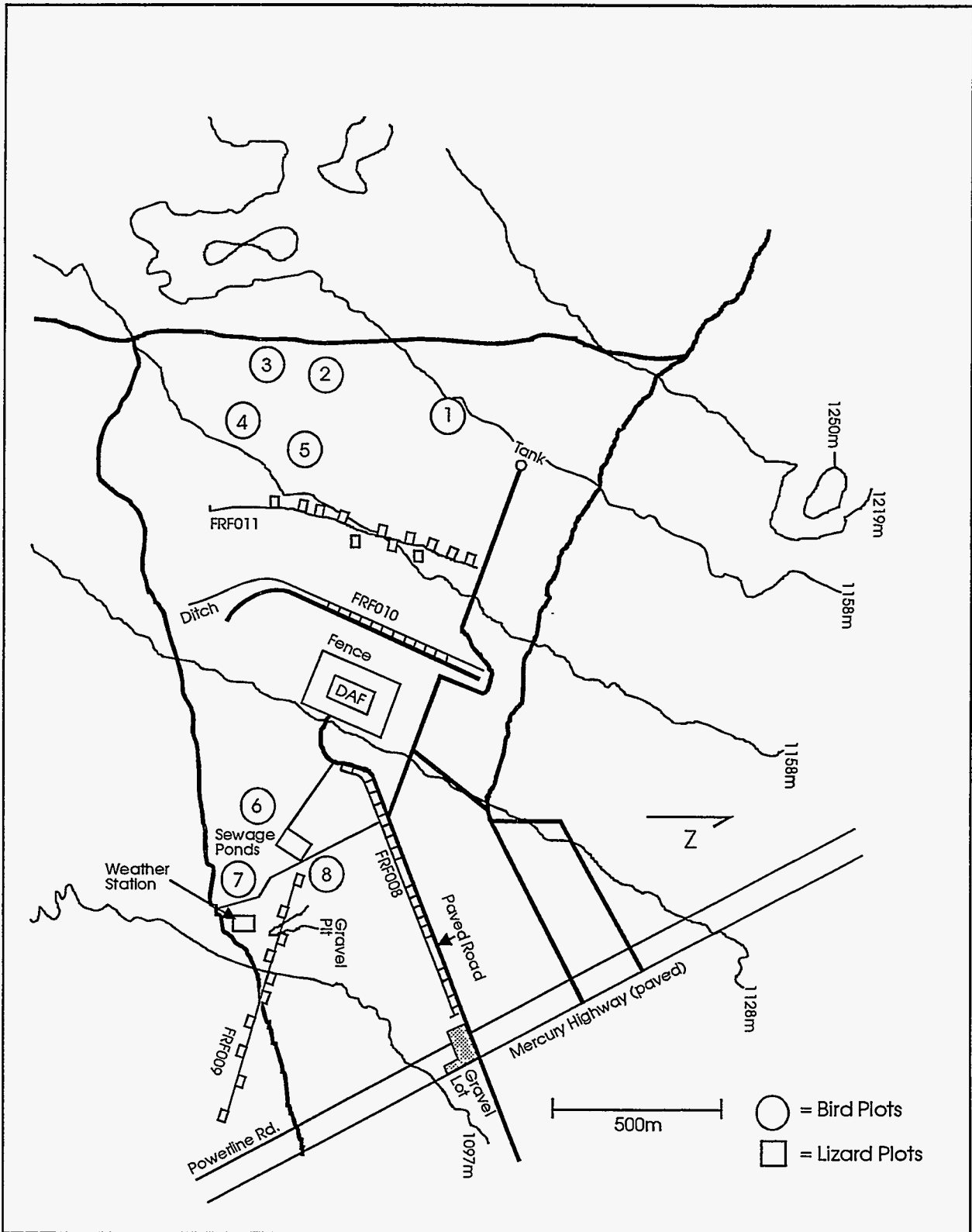


Figure 1 - Physical layout in the vicinity of the DAF buildings showing structures with important potential ecological consequences, and the distribution of BECAMP study areas.

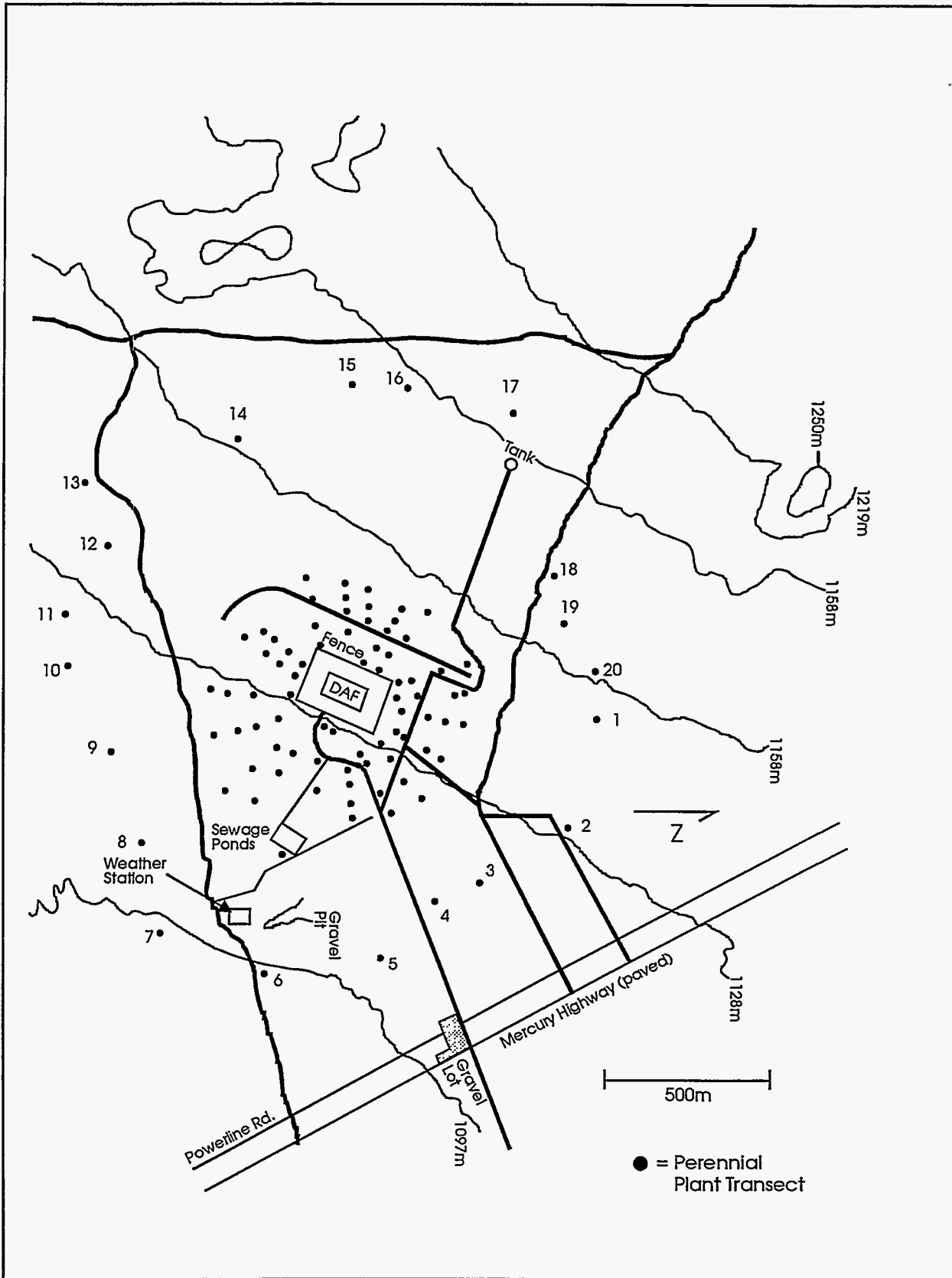


Figure 2 - Distribution of plant sampling area near the DAF.

Sampling was concentrated on gentle slopes within 3 km of the buildings, although some sampling was done in the rocky foothills. The buildings were still under construction and in pre-operational phase during spring and summer surveys in 1993. As such, disturbances were those associated with construction of any large building project: trampling, grading, road construction and road use, and human use of the site.

The DAF complex is a cluster of buildings where final phases of nuclear weapon assembly is to occur. During DAF construction, a sizeable area surrounding the buildings was cleared, graveled, and used as a parking lot. The main building is also surrounded by two chain link fences and ringed by powerful lights on tall poles. Several DAF support facilities have potential ecological impacts including a paved access road, power poles, a water storage tank, a diversion ditch uphill of the buildings, and sewage evaporation ponds (Figures 1, 2). Although there will be no release of radioactive material during normal operations, the DAF can potentially influence the environment through accidental release of radioactive material, or through nonnuclear effects of DAF operation (Table 1).

## **METHODS**

Annual and perennial plants, birds, large mammals, small mammals, and reptiles were studied at the DAF. Both common species and species of special concern to federal or state agencies were studied. In the following sections each of these groups is discussed in turn.

### **EPHEMERAL PLANTS**

Ephemeral plants (annuals) play an important role in desert systems (Inouye 1991). Their stems, leaves, and seeds serve as forage for mammals, nesting material for birds and mammals, and as a major fuel load for fires. Their seeds are an important nutrient source for birds, mammals and ants, even long after vegetative parts of the plant have died (Reichman 1991). In disturbed areas, they are commonly the major component of the vegetation - and thus the local energy source for the system. BECAMP's studies were designed to document ephemeral populations in undisturbed areas of Frenchman Flat, establish baseline values for future comparisons, examine effects of roads or construction activity on ephemeral populations, and increase the efficiency of the sampling approach. Efficient sampling is important at the DAF because DAF



effects might emanate in any direction from it, requiring numerous baseline samples to be collected.

Table 1. Nonnuclear effects of DAF operations and their potential ecological consequences.	
DAF Structure	Potential Ecological Consequences
1. Cleared areas (gravel roads, parking lots, ditch)	Removes plants, eliminates habitat for animals, creates habitat for weedy species. Dispersal of seeds or young animals from this area may affect species composition or relative abundance in surrounding areas. Clearings may restrict movement or limit dispersal and contribute to population fragmentation of some species.
2. Roads	All functions listed under number 1; potentially increases mortality of some animals via road kills; may increase predator/scavenger densities which may be important for tortoise mortality; influences water runoff and use, which may influence species composition along the road.
3. Flood control ditch	All functions listed under number 1; may influence soil water potential and thus influence species distributions.
4. Fence	May restrict dispersal leading to concentration of some species along fence, some animals may get caught in fence and die.
5. Trash	May create habitat, increasing local densities of some species.
6. Building, especially guard towers	May create new habitat for some species, most notably roost, perch or nest sites for birds and mammals. Birds may collide with towers and be killed or injured.
7. Power poles	All functions listed under number 6.
8. Lights and light poles	All functions listed under number 6; may attract insects, and birds, bats, and lizards that feed on insects.
9. Sewage settling ponds	All functions listed under number 1; increases water availability which allows species with higher water requirements to use this area.

Several ephemeral sampling techniques were used near the DAF to evaluate the speed of data collection and quality of results. Parameters varied across techniques included dispersion of sampled areas and method of density estimation (total count, estimates to base 10, or estimates to base 2). In addition to technique evaluation, plots were also arranged to evaluate the effect of a graveled area (DAF 1, 2, Table 2), a paved road (DAF 3, 4, Table 2) or a dirt road (DAF 5, 6, Table 2) on ephemerals.

Species presence, their densities and total production (biomass), relative dominance and evidence for changing dominance were parameters desired from all locations. Along the scraped verges of the paved road leading to the DAF there were dense concentrations of one ephemeral species (*Eriogonum deflexum*), and lower densities of some introduced species (particularly the small grass *Schismus arabicus* and the toxic weed *Halogeton glomeratus*). In this area a study was initiated to characterize the distance to which these species' populations had already increased by construction and operation of the paved road. This study gives an idea of how far into undisturbed vegetation effects of the extensive disturbances around the DAF might eventually affect ephemeral populations.

An important goal was to find a way to reduce the time needed to sample ephemeral populations. Because DAF operational effects are expected to be stronger near the facilities, but the direction of effects is not predictable, it is desirable to look for changes in many directions. However, current techniques for characterizing ephemeral populations are time consuming, and early May of most years. Characterizing many areas surrounding the DAF was considered time available for sampling is limited to several weeks in late April and early May of most years. Characterizing many areas surrounding the DAF was considered desirable, but not practical, in the absence of more rapid techniques.

### **Standard Ephemeral Technique**

BECAMP's standard ephemeral sampling procedure (AAHBCD.02.02 revised 5/11/92) was used on sites DAF1 and DAF2 (Table 2) to characterize ephemeral populations in disturbed and undisturbed areas near the DAF. Briefly, it involved laying out a 50-m tape in a random location, then harvesting all ephemeral plants from twenty random 0.025 m<sup>2</sup> quadrats placed along the tape. Harvested plants were separated by species, dried, weighed, and identified to determine population parameters. Other species not seen in the 20 quadrats but

present within one meter of the tape (100 m<sup>2</sup> area) or within ten meters of the tape (1000 m<sup>2</sup>) were recorded. This allowed calculation of densities and biomass for common species, and determination of presence/absence and a rough limit of density for the rarer species. A t-test was used to compare density, biomass, or surface characteristics between disturbed and undisturbed areas.

A sample was taken of each species when first encountered, to allow identification or confirmation of identity by comparison to herbarium specimens. Taxonomy of plant species followed Munz (1974), with synonymy following Kartesz and Kartesz (1980).

At a randomly chosen spot (DAF3, Table 2) on the paved road a modification of the standard technique was used. Only 10 quadrats were harvested, and as the area was not wide enough to sample the 1000 m<sup>2</sup> area, only the 100 m<sup>2</sup> area was censused. Samples were collected in the center of the scraped area on the south-facing road shoulder, one m into the undisturbed vegetation next to the shoulder, and again 50 m south of the pavement edge, in undisturbed vegetation. One way analysis of variance was used to compare parameters among the three areas.

### **Log<sub>10</sub> Ephemeral Technique**

To determine if road effects dissipated with distance, a 50-meter tape was laid perpendicular to the paved road (starting at the edge of the pavement) at ten randomly selected locations (DAF4, Table 2). Ephemeral density was estimated for each species in a one m<sup>2</sup> area at each meter from 0 to 12, and at 15, 20, 25, 30, 35, 40, 45, and 50 meters from the road. In each square meter a count of zero to four members of a species was given a log-density of 0, 5 to 49 (estimated) was given a 1, 50 to 499 a 2, 500 to 4999 a 3, and >5000 a 4. Oneway ANOVA was used to compare mean log<sub>10</sub> densities of species on the ten roadside scraped areas with those for the ten undisturbed sections.

### **Log<sub>2</sub> Ephemeral Technique**

A set of nested quadrats was placed at a randomly chosen point along a 50 meter tape in the middle of the dirt road to the water tank (DAF5, Table 2) and a control area 50 meter east of that road (DAF6, Table 2). Each quadrat was roughly twice the size of the next-innermost. Embroidery hoops of areas 0.0327, 0.0726, and 0.299 m<sup>2</sup> were surrounded by rectangular areas of 0.5, 1.0, 2, 4, 8, 16, 32, 64, 128, 256 and 400 m<sup>2</sup> laid along a 50-meter surveyors'

tape. Within each area species numbers were counted or estimated in powers of two with a technique similar to that of McAuliffe (1990). In addition, ten individuals of the most common species were harvested, dried and weighed to determine approximate biomass for their populations. The technique was intended to improve speed of population characterization.

Means, standard errors, and ANOVA were calculated with the program RS1 (BBN Software). t-tests were done by hand following Zar (1984) or with MINITAB (Minitab, Inc.).

Site	Location	Description
DAF1	36° 54.02'N; 116° 3.03'W	Undisturbed, ~50 m N of dike/ditch
DAF2	36° 53.70'N; 116° 2.89'W	Scraped, graveled area W of DAF
DAF3	36° 54.05'N; 116° 2.18'W	South side of paved access road
DAF4	36° 53.96'N; 116° 2.47'W	South edge of paved access road
DAF5	36° 54.39'N; 116° 3.55'W	Center of dirt road to water tank
DAF6	36° 54.31'N; 116° 3.33'W	50 m East of dirt road to water tank

## PERENNIAL PLANTS

The primary goal of perennial plant measurements was to document perennial plant germination, death, and growth. A secondary goal was to determine pre-operational effects of construction disturbance on perennial plant communities surrounding the DAF.

Perennial plants were measured on five sets of 20 plots arranged in concentric bands around the DAF (Fig. 2). The closest set was located between the outer security fence surrounding the DAF buildings and 300 m from the front door of the DAF. Other sets were located between 300 and 400 m, 400 and 500 m, 500 and 600 m, and 1000 and 1500 m from the front door. The outer group was considered a control, representing a subjective balance between the distance where the DAF might exert an influence, and a distance where vegetation would no longer resemble the plant community surrounding the DAF buildings. Five distances were randomly chosen at each of 20 random angles in 18° arcs,

resulting in 100 plots surrounding the DAF. Distances and directions within 600 m of the DAF were measured with a Rolatape 1000 m Measure Master<sup>®</sup> and a hand-held compass. Plot locations beyond 1000 m were determined with a Magellan<sup>®</sup> GPS (global positioning system) unit. Each plot was marked with two metal stakes five meters apart oriented North-South, with a white polyvinylchloride (PVC) pipe placed on the southern post and marked with a brass tag labelled 1-1 to 20-5. Plots located on dirt roadways were marked with 15 cm by 2 cm aluminum stakes pounded in and bent over flush with the ground.

To measure plants, a fiberglass tape was strung between the two plot markers, and each perennial plant whose base was within 1 m of the tape was examined. Its size (height, greatest width, and width perpendicular to the greatest) was measured to the nearest cm; species, reproductive state (production of flower buds only, flowers, or fruit this year), and percent dead (approximate % of canopy) were recorded. We recorded each plant's location (the center of the base) to the nearest centimeter perpendicular to the tape, and to the nearest decimeter mark along the tape. All living and dead plants within the ten m<sup>2</sup> area were included. Plant species with numerous individuals were counted within 1 m<sup>2</sup> areas and an individual of median size was measured to characterize the group.

Because some dominant plant species were too dispersed to fall regularly within small plots, individual plants of the dominant species were also marked and measured at most of the 100 plot locations surrounding the DAF. The individual *Yucca brevifolia* (Joshua tree), *Larrea tridentata* (creosotebush), and *Ephedra nevadensis* (Nevada Mormon tea) nearest to the southern post of each perennial plot was measured, along with its distance and angle (degrees E of N from the post), using a hand-held compass and a fiberglass surveyor's tape. Only live plants within 25 meters of the post were selected, with some exceptions where individual Joshua trees were easily seen just outside that limit.

Biomass (oven dry weight) was estimated from plant size using linear regressions on volume determined in the 1970's for the NTS (Hunter and Medica 1989). Biomass of *Yucca brevifolia* was estimated from size-class/weight data for trees from Area 11 on the NTS (Tueller and Bostick, unpublished manuscript). Biomass of dead plants was not determined.

Analysis of variance, Chi-square, and means and standard errors were calculated in RS1 (BBN Software, Inc.). Kruskal-Wallis tests were done with MINITAB (Minitab, Inc.). Comparisons of plant characteristics were made across the 5 concentric rings around the DAF to determine if perennial vegetation changed with distance from it.

Finally, because disturbance has such a major effect on the vegetation, the frequency of disturbance was examined near the DAF. To do this a Rolatape Measure Master<sup>®</sup> was used to measure distance to the nearest disturbance from the south post of each plant transect. The nature of the disturbance and whether it appeared related to DAF construction were recorded for each of the 100 plots. Disturbances related to DAF utility lines, roads, or recent staging areas were considered DAF related. Older disturbances, on which shrubs had generally regrown, could usually be related to structures or activities not related to the DAF. Relation of two disturbances to the DAF was ambiguous. Mean distance to disturbance was compared among the different plot-rings (Figure 2) using a Kruskal-Wallis test (Minitab; Minitab Inc.).

Taxonomy of plants follows Munz (1974) with names updated following Kartesz and Kartesz (1980). Common names of plants follow Scott and Wasser 1980.

## REPTILES

Reptiles near the DAF include lizards, snakes, and desert tortoises. Lizards are widespread and common in deserts, including around the DAF (Tanner and Jorgensen 1963; Medica et al. 1994). They also are primarily diurnal, easily seen, and relatively easy to study. These attributes, combined with results (Turner and Medica 1977) suggesting lizards may be especially sensitive to radiation, make this a useful group for studying the potential effects of the DAF. BECAMP set up two sets of plots to examine DAF effects on lizards. One was designed to assess effects of the paved road into the DAF. The other set was designed to assess effects of a diversion ditch upslope of the DAF building complex. In addition, lizard transects were walked to assess the relative abundances of more mobile species that are poorly sampled by plot techniques. Timed searches were also performed to contrast lizard abundances in areas near and far from the DAF. Finally, from all these studies a reptile species list was generated for the DAF. Several techniques were used to determine the most suitable for detecting DAF effects in the future.

## Roadside Studies

Ten 20 x 40 m lizard plots were placed along the southeastern edge of a paved road that runs from Mercury Highway to the main DAF building (Figure 1). Plots were placed in a uniform pattern 50 - 70 m apart. Several abandoned roads and parking areas adjoin this road. Plot locations were adjusted to avoid major cleared areas not characteristic of typical roadsides. Each plot was separated into eight, 10 x 10 m sections delimited by numbered stakes or by paint spots in the road. Each grid started at road center, ran 20 m perpendicular to it, and 40 m along the road. The first 10 m away from the road midline consisted of about 4 m of pavement, and 6 m of graded surface. The surface is infrequently graded and last year's dead annual plants were present. The next ten m away from the road contained 0 - 2 m of graded surface, then 8 to 10 m of visibly taller and wider shrubs associated with the berm at the margin of roadside disturbance. In some places the area 10 to 20 m from the road contained up to 2 m of vegetation of a height more typical of shrubs away from the road. Thus the first 10 m away from the road encompassed highly disturbed areas, potentially containing negative road effects, while the second 10 m away largely contained potential positive road effects. Ten 20 x 40 m control plots were placed in a similar vegetative community 300 to 1000 m from the main DAF entry road. Both roadside and control plots were arranged along lines that went outward away from the DAF.

Plots were searched for lizards which were noosed, measured from snout to vent (SVL) to the nearest 0.5 mm, weighed to the nearest 0.05 g on a top loading balance, marked, and released as described in Medica and Hunter (1989). Plots were sampled one to three hours after sunrise over a temperature range favorable for lizard activity. For most of the sampling period, temperatures favored lizards basking on the edge of shrub clumps. Lizard plots were not surveyed on overcast or exceptionally windy days. Sampling started from opposite ends of the lines of plots on successive days so that each plot was sampled early and late during the sampling period. These plots were sampled on five days from 29 March 1993 to 6 April 1993, and resampled for five days from 2 to 6 August. Results are reported separately for spring and summer studies. Four people collected lizards, and each spent some time on each plot.

Data were analyzed in several ways to facilitate comparisons across three areas: the first 10 m away from the road center (= potential area of negative effect, treatment 1), area from 11 to 20 m from the road (= potential area of



positive effect, trt 2), and the control area well removed from the road (= trt 3). In each plot, two estimates of numbers were used: total number of separate individuals caught per plot over 5 days, and mean number of lizards caught per plot per day. The former represents total number of lizards using the plot, while the latter represents average daily plot use. The mean  $\pm$  two standard errors of the mean (2 se) was used to describe variation across plots within each treatment. Average daily plot use was expressed on a per hectare basis. Mean weight, mean snout-vent length, and the proportion of the population that was female, were also computed per plot and compared across treatments. Proportion of the population that was female (a measure of the sex ratio) was arc sine transformed to facilitate parametric comparisons. Lizards were assigned to cohorts (this year's young, last year's young, young born prior to last year) based on relationships between SVL and age established on individuals of known ages on the NTS (unpublished data). A chi square test was used to compare frequency of individuals in each cohort, to determine if age structure differed across treatments. Number of recaptures from spring to summer surveys was compared between roadside and control areas with a chi square test. This test asks whether survival or dispersal off plots differs between these two areas.

To assess overall road effects on lizard traits, estimates from treatments 1 and 2 were combined, and compared to those from treatment 3 with an analysis of variance (ANOVA). Next, to tease apart the potentially negative and positive effects of the road, treatments 1, 2, and 3 were contrasted with an ANOVA, and post hoc comparisons made with Tukey tests. Finally, Spearman rank correlations were performed to test for an association between lizard traits and proximity to the DAF buildings.

In an attempt to determine causal factors that could explain differences in lizard distributions, 100 vegetative transects were arranged along the road side, and 100 more in the control area. One transect was randomly assigned a position within each 10 m along the road edge or the control. Transects ran perpendicular to the road, or the long axis of the control line, and were designed to assess shrub density. Shrub density was examined by recording number of each shrub species present in 10 1 m sq plots located at 1, 3, 5, 7, 9, 11, 13, 15, 17, 19 m from road center, or at 1, 5, 9, 13, and 17 m north of the small mammal line located along the south edge of the control plots. Number of shrubs per species per transect (= per 5 m sq) were compared across treatments with an ANOVA.



## DAF Diversion Ditch Studies

To assess effects of the ditch located upslope of the DAF buildings and associated disturbances, 12 plots were placed in undisturbed vegetation approximately 200 m NW (up slope) of the main DAF building, and six plots were arranged in the ditch-bottom created to divert water around the DAF building (Figure 1). Each plot was 20 x 50 m and laid out with wooden stakes on a 10 m rectangular grid. Half of the 12 control plots were placed in arroyo bottoms, and half on flat areas located between arroyo bottoms. Plot locations were determined by walking in a predetermined direction roughly parallel to the edge of the disturbed area associated with the DAF. A plot was placed on each aspect-type as it was encountered, as long as it was large enough to contain a plot.

Lizards were noosed, measured, marked, and released as discussed by Medica and Hunter (1989). A small fraction of attempted captures were successful with *Cnemidophorus tigris* (whiptails) and *Callisaurus draconoides* (zebra-tailed lizards). Missed lizards were added to daily plot totals for this analysis. Other survey aspects were similar to those given under roadside studies. Plots were sampled five times from 30 April 1993 to 10 May 1993, and resampled five times from 9 to 13 August, with all plots sampled each day. Statistical analyses were similar to those discussed for roadside studies, with arroyo and flat data pooled and compared with the disturbed ditch site, and then all three treatments compared. In addition, total number of species and total number of individual lizards seen on each plot (pooled across species) were also compared across treatments.

## Lizard Transects

Lizard transects were walked on three consecutive days from 30 May 1993 to 2 June 1993. On each day three investigators walked abreast along the long axis (1000 m) of a transect and recorded numbers of each species seen per 50 m interval. Three transects were walked each day: one 15 m wide located in undisturbed vegetation along lizard control plots south of the DAF; one 15 m wide centered on the berm approximately 20 m S of the paved DAF road; and one 10 m wide line located from the center of the paved DAF access road out into the bladed area along the road edge. These transects were designed to assess habitat well removed from road effects, habitat containing vegetation of natural height and taller vegetation associated with the berm (but close to the road), and highly disturbed habitat in or at the margin of the road. The

three transects examine habitats similar to those examined with the lizard plots, but are designed to examine more mobile species that are ill suited to examination with our plot-sampling techniques. Raw counts (number/50 m) were extrapolated to 1 hectare-sized areas to facilitate comparisons across transects of unequal widths, and compared with a two way analysis of variance with days and transect location as factors.

### **DAF Timed Surveys**

To assess reptile species distributions near the DAF, a series of walking censuses (Campbell and Christman 1982) were performed from 29 June to 1 July. The DAF area was divided into five areas: disturbed area immediately surrounding the DAF buildings (including the diversion ditch), area south of the DAF out to 1 km, area north of the DAF to the water tank, area from the water tank to the foothills, and 0.2 km into the foothills (Figure 1). Within each area an investigator walked slowly, rolled rocks, fallen *Yucca* or other debris, and searched for 30 minutes, recording number of each reptile species encountered per search. Next, investigators moved to one of the other four areas and did another 30 minute search. Over three days, each investigator searched two 30 minute periods in each of the five areas. Number of lizards per species seen per 30 minute period, total number of lizard species seen per 30 minutes, and total number of lizard individuals seen per 30 minute period were recorded and compared with an ANOVA with location and investigator as main effects. Effect of time of search on lizard counts was examined with a one way ANOVA. These analyses test for differences in relative abundances across locations, and ask how large temporal and investigator effects were on estimates of lizard numbers.

### **Reptile Species**

A reptile species list was generated from our sampling efforts at the DAF. Most of our time was spent in some sort of quantitative sampling, however, some effort was spent simply searching for resident reptiles. All observations of living or dead reptiles were noted.

## BIRDS

### Sewage Pond Effects

Bird use at DAF sewage ponds was recorded from March through November and compared to an undisturbed habitat nearby to gain understanding of how addition of a settling pond may influence a desert bird community. The pond provided unlimited water to birds, which otherwise would be limited. Bird populations near water sources in arid regions are known to benefit from increased water availability (Szaro and Jakle 1985).

Pond use was estimated by recording bird visits per hour. Most birds were flushed from the pond area before a count began. A visit occurred when an individual entered, spent some time and left the area of the pond or its sloping banks. Birds were difficult to count when numerous (some were missed), in many cases leading to underestimates of total birds. Birds were counted in 12 consecutive 5 minute intervals at the sewage pond and then repeated at a natural location (Plot 1, Figure 1).

Different counting techniques were used because of marked differences in visibility of birds in the two areas. At Plot 1, counts were made from the center (first 3 visits) and thereafter the plot was searched by flushing birds from cover out to the 150 m radius. The natural area searched (8 ha) was much larger (>50 times) than the sewage pond area (0.15 ha). This was done because many birds staged in areas near the sewage pond before arriving, making the actual area occupied much larger. Counts were recorded between 0800 and 1300 h. The sewage pond was censused before the undisturbed habitat on most dates. Order was reversed on one date and done at the same time on several occasions.

Because this was a pilot study, several methods-modifications were evaluated. Initially, counts at the sewage pond (N = 6) were made from outside the vehicle from a fixed location. On 5 May 1993, dove visits were estimated from outside and then inside a parked vehicle to determine observer effects. Thereafter, counts were made from inside the vehicle. Air temperature (in shade at waist height) was recorded for seven dates after sampling was complete and compared (t-test) between pond and natural areas.

Total visits per hour were compared across species and date using analysis of variance (ANOVA) and *post hoc* Tukey comparisons. Five minute counts were used to test for differences in species use between sewage pond and natural plots

for most dates using t tests, or Kruskal-Wallis tests when parametric assumptions could not be met.

Ravens were counted during each pond visit and expressed as number/hour of observation. An ANOVA was used to test for seasonal differences in raven counts at the sewage pond.

### **Natural Habitat Sampling**

Breeding bird density was estimated for selected species at the DAF using a variable circular plot technique (Reynolds et al. 1980). Birds were identified by sight and vocalization (song and calls) from a central location. Eight replicate plots were chosen in undisturbed habitat, five located away and three near the sewage ponds (Figure 1). The black-throated sparrow (*Amphispiza bilineata*) was chosen for initial monitoring efforts because it was locally abundant. Plots in natural habitat were compared with ANOVA, to examine possible effects of the pond.

Observer counts were made between the hours of 0700 and 1000 during peak activity patterns (singing) of passerine species. Two minutes after arrival at the plot center (allowing birds to adjust to the observer), all species seen during a nine minute period were recorded. Birds were located and identified with binoculars (7x), and radial distance to the spot where they were first observed was visually estimated. Numbered stakes were located at radii of 25, 30, 40, 50, 60, 75, 100 and 150 m from the center to aid the observer in distance estimation. The procedure was repeated for each plot on 6 dates.

Before density could be estimated, counts were used to compute the radius of detectability (RD) for each species. This was the distance where numbers of birds observed per concentric band reached a peak, defined by declines of 50 percent or more in more distant bands, because birds were not detected as well. All bird locations were mapped in concentric band areas of the plot as defined above, and RD was estimated.

Species density was calculated from number of birds seen out to RD, divided by the plot area also defined by RD. Mean density was estimated by averaging counts by plot and date over the breeding season of a species (April-May). Bird densities in desert ecosystems are generally low. Therefore, the null

- hypothesis that bird density was not significantly greater than 0 was tested (t-test).

- Numbers of nests, eggs, hatchlings, and fledglings were recorded during field efforts when time permitted. Finally, a bird species list was summarized for 1993. All descriptive statistics shown include  $\pm 2$  se.

## SMALL MAMMALS

Animal ecology studies on the NTS were initiated in 1959 when Brigham Young University cataloged fauna of the NTS (Allred and Beck 1963; Jorgensen and Hayward 1965). The University of California Los Angeles sponsored several projects in Rock Valley on the southern edge of the NTS to determine animal abundance, home range, effects of chronic radiation, and life spans in a population of desert rodents (French 1964; French et al. 1966, 1967; French et al. 1974; French et al. 1968; Maza et al. 1973). Additional small mammal studies were done in Rock Valley as part of the International Biological Program during the 1970s (Chew 1975; Dingman 1975; Turner 1973, 1975; Turner and McBrayer 1974). During the late 1970s and early 1980s, the Nevada Applied Ecology Group studied rodents at several contaminated sites (Moor and Bradley 1974, 1987; Bradley and Moor 1975, 1976, 1978; Moor et al. 1976; Bradley et al. 1977a, b; Moor et al. 1977; O'Farrell and Sauls 1987). Currently, BECAMP monitors the flora and fauna of the NTS (Hunter and Medica 1989; Hunter 1992).

Fifty-seven mammal species occur on or near the NTS (Appendix A), mostly rodents (Jorgensen and Hayward 1965; O'Farrell and Emery 1976; Medica 1990). Three bat species, *Lasiurus noctivagans* (silver-haired bat), *Eptesicus fuscus* (big brown bat), and *Tadarida brasiliensis* (Mexican free-tail bat) were overlooked in the earlier species accounts, although three specimens collected in 1963, 1964, and 1978 exist (Saethre 1994). Five other species, *Euderma maculatum* (spotted bat), *Lasiurus cinereus* (hoary bat), *Myotis evotis* (long-eared myotis), *Myotis thysanoides* (fringed myotis), and *Myotis volans* (long-legged myotis), were first recorded on the NTS in 1992 and 1993 (EG&G/Energy Measurements 1992, 1993). Overlooking so many bat species is not surprising as intensive studies had not been undertaken until recently. Another eight bats are possible residents of the NTS based on geographic distributions (Hall 1981). Two ungulates, elk (wapiti) and bighorn sheep, reside outside NTS boundaries and are rarely observed on site. Burros are found only on the southwestern edge of the NTS.

Of 23 rodents inhabiting the NTS, the most ubiquitous are heteromyids (kangaroo rats and pocket mice). Abundance and species diversity vary among the habitats present on the NTS. In general, *Dipodomys merriami* (Merriam's kangaroo rat) and *Perognathus longimembris* (little pocket mouse) are most common in the southern half of the NTS (Mojave desert) while *D. microps* and *P. parvus* (Great Basin kangaroo rat and pocket mouse) are more prevalent in the northern extremes (Great Basin Desert). However, in the last two years, *P. longimembris* has persisted at low densities while *Chaetodipus formosus* (long-tailed pocket mouse) has increased. A murid rodent, the deer mouse (*Peromyscus maniculatus*) also increased in abundance in the last few years. The increase of this rodent has been linked to an outbreak of Adult Respiratory Distress Syndrome off the NTS. This illness is caused by a hantavirus carried by the deer mouse and passed on to humans via contact with rodent excreta.

The objective of the small mammals portion of the pre-operational monitoring at the DAF was to obtain baseline data on species diversity and relative abundance. Simple site characterization of small mammal populations was deemed a priority to facilitate future monitoring needs. Effect of the roadside was also considered tantamount to operational effects of the DAF itself, and was also given consideration in pre-operational surveys.

### **Rodent Presence and Abundance**

Three traplines were constructed around the DAF (Figure 1). One line (FRF008) ran parallel to the entire length (1180 m) of the paved road from the DAF to Mercury Highway. 119 trap stations were located at 10-m intervals. FRF008 was 20 m from the road centerline and approximately 7 m from the graded area of the road. A line of equal length ran from the east side of the sewage ponds to the southeast (FRF009). This line went through generally undisturbed habitat, but small localized disturbances such as gravel pits and old roads were present. A third line of 1180 m (FRF011) was approximately 300 meters north of the flood dike. This line was parallel to the dike with the entire length in undisturbed habitat of arroyos and flats. Line designations continue from other study areas in Frenchman Flat (FRF) and will sometimes be abbreviated as 8, 9 or 11.

Areas close to the DAF were not trapped as they were severely disturbed: most of the disturbance around the DAF involved removal of all vegetation and



compaction of soil or the addition of several centimeters of gravel. None of these are conducive to small mammal activities such as foraging and burrowing.

Traps were of two types: standard sheet metal (Sherman live trap, 8 x 9 x 30 cm) or galvanized-after-welding wire mesh (A Thru Z Consulting and Distributing, North Hollywood, CA, Trip-itt live mesh trap, 7.5 x 8 x 26 cm, 0.5 x 1.0 cm mesh). Wire mesh traps were shown to be more effective in trapping *Dipodomys stephensi* and *D. merriami* (O'Farrell et al. 1992). O'Farrell et al. also found that for all heteromyid rodents and one cricetid the trend was to enter mesh more readily than Sherman traps.

Traps were handled at all times with gloves to minimize human scent on traps and one of each trap was placed at each stake. Half-cylinder sheet metal trap covers were used to protect animals from heat stress. Bait (rolled oats and birdseed) was placed in traps just before sunset. Traps were checked at sunrise the following morning and all traps were closed for the day.

Kangaroo rats (*Dipodomys* spp) were given individually numbered ear tags while all other rodents were marked with a unique toe clip. Each field worker was assigned a different toe to clip when using ear tags to facilitate identifications of animals with lost ear tags. Species, animal number, sex, age, reproductive status, location, trap type, weight, and any notes were recorded on data sheets and the animals were released where captured.

For the initial trapping session, all three lines were trapped simultaneously for three nights with both traps activated each night. This gave animals the opportunity to choose which trap was preferred and test the hypothesis that trap type had no effect on trap success. Traps were checked on 8-10 June 1993. Lines were divided into eleven 10-stake units for analyses with the odd number traps on the ends trapped but not included in the analysis. This was done to limit the edge effect in the sections tested. Since trap success generally increases from day one to day three (personal observation), the 3-day average for each 10-stake section was used in statistical calculations.

Lines 8 and 9 were trapped again on the nights of 28-30 June. To test if trap success would increase or decrease after a change in trap type, only one trap was set per stake. On each line, five 10-stake sections were set with Sherman traps and the other five with mesh. Traps were set in blocks and not alternated so that animals would not have the opportunity to choose a different trap type 10 m away. The appointed trap was activated two nights

with the other trap substituted on the third night. Although trapped, a 10-stake section in the center of each line and traps on the ends were not included in the analyses. Effectiveness of mesh versus Sherman traps was assessed by trap success (percent of traps with captures/traps available).

Trap success by site and trap-type and site and date were analyzed using two-factor analysis of variance with an interaction term (ANOVA, RS/1, BBN Software). Mean weights of adult rodents were compared by two-way ANOVA across site and sex to determine overall effect of site on mean biomass, which may vary by sex. Mean weights of adult females (*a priori* assay of reproduction) of the most abundant species were compared across sites and dates with a twoway ANOVA. Single factor ANOVA was used with a multiple comparison test (Newman-Keuls multiple range test) to evaluate significant results. Contingency tables with the chi-square ( $\chi^2$ ) statistic were used to test for differences in weight distributions of the most common species. Gart's test for effect of treatment and order ( $\chi^2_c$ , Zar 1984:159-160) was used to determine if trap type and order of presentation (late June only) had any effect on trap success. Species diversities ( $H'$ ) on the three lines were estimated using the Shannon Index and associated t-test (Zar 1984:146-148).

DAF maintenance personnel used kill traps to catch rodents inside the structure. Because permanent doors were not in place, numerous rodents were caught inside and passed on to BECAMP workers for identification.

### Presence of Other Species

Mist nets (Avinet, Inc, Los Angeles, CA) were set for one night along the edge of one of two DAF sewage lagoons. One pond was empty and therefore not included. Nets were black and 3' x 42', 2 shelf or 3' x 21', 3 shelf with no more than 1-1/2" mesh. All nets were low visibility, nylon strand either monofilament, 40 denier or two-ply, 30 denier. Nets were hung just above the water surface at the shallow end (north and west) on poles of various heights (Figure 3). Nets were in place before sunset (approximately 2000 hrs) on 19 July 1993 and struck at 0230 hrs next morning due to high winds.

Mammal observations, including tracks and scats were recorded. Jackrabbit observations were recorded from natural areas, expressed as number/hr and examined with ANOVA for seasonal change.



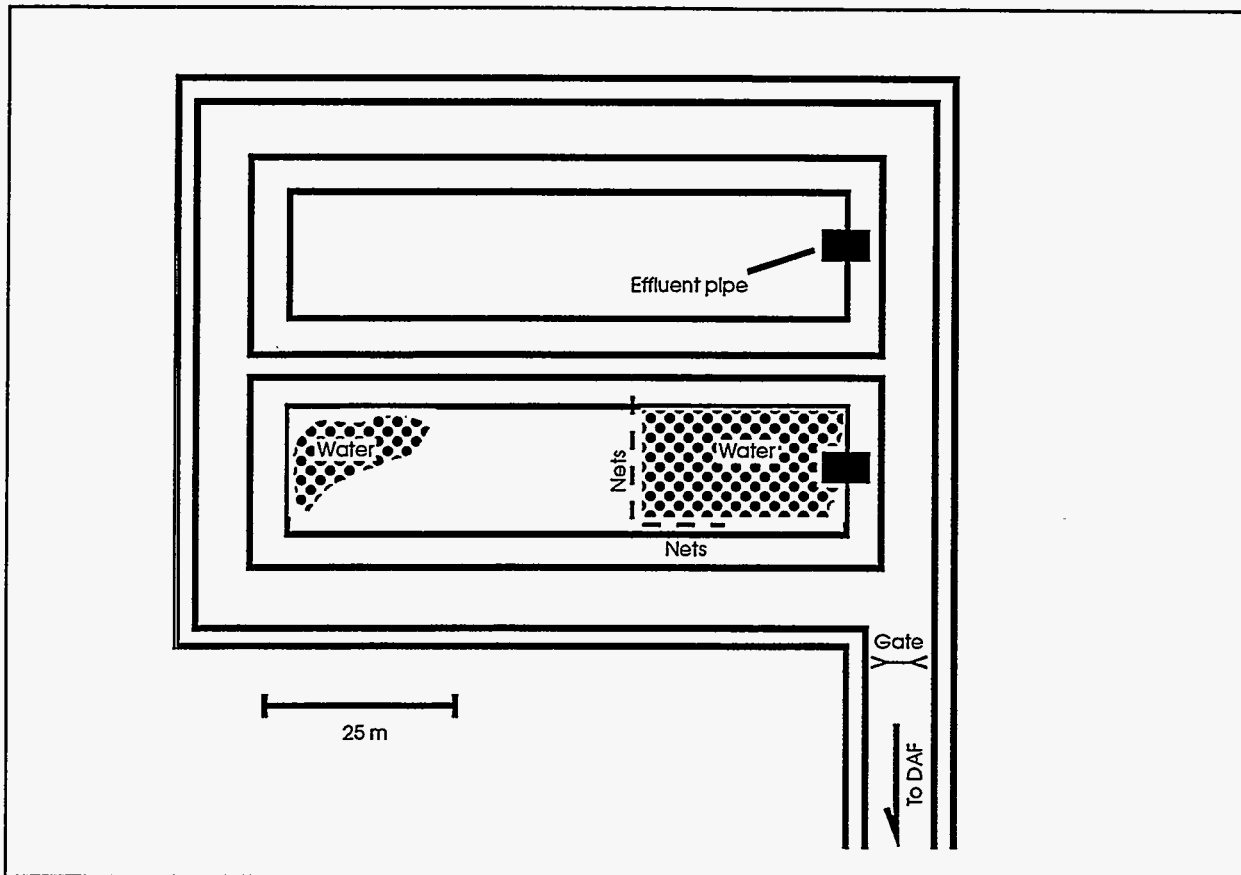


Figure 3 - Location of mist nets at the DAF sewage ponds on 19 July 1993.

## RESULTS

### EPHEMERALS

Ephemerals were sampled in four locations. There were 89 species (Appendix B) identified in all study sites. Twenty-six were seen at all locations and can be considered common. Only one introduced species, *Bromus rubens*, was found at all locations. Fifteen species were present in three of the four locations (including 6 introduced), twenty were present in two (two introduced), and the remaining 28 were seen in only one (none introduced). Although species seen in only one location could be considered rare on the NTS, none have been suggested for listing as a threatened or endangered species, and there were none on the list of sensitive plant species for Nevada (Moorefield and Knight, 1991). Four species were grasses, *Bromus rubens* and *B. tectorum*, *Schismus arabicus*, and *Vulpia octoflora*. *Vulpia* was the only native annual grass seen at the DAF.

**Table 3.** Summary statistics on two 1000 m<sup>2</sup> transects.

DAF1 was about 50 m north of the ditch above the flood protection dike, DAF2 was on a scraped, graveled area south of the DAF. \* = the two plots differ in this parameter at P < 0.05; \*\* P < 0.01, d.f. = 38.

	DAF2, Scraped, Graveled	DAF1, Undisturbed
Total species in 1000 m <sup>2</sup>	52	37
TOTAL SPECIES IN 100 m <sup>2</sup>	38	35
SPECIES IN 20 QUADRATS	4	17
AVG. SPECIES PER QUADRAT + 2 se**	0.55 + 0.37	3.2 + 0.7
<i>Bromus rubens</i> n/m <sup>2</sup> + 2 se*	4 + 6	280 + 167
<i>Bromus rubens</i> g/m <sup>2</sup> + 2 se**	0.3 + 0.7	34 + 17
Total n/m <sup>2</sup> + 2 se**	22 + 15	694 + 327
Total g/m <sup>2</sup> + 2 se**	7 + 10	52 + 21
Average weight/plant mg + 2 se**	316 + 42	114 + 50
Surface % rock + 2 se**	99.8 + 0.4	57 + 15
Surface % litter + 2 se	0.15 + 0.22	9.9 + 8.3
Surface % shrub cover + 2 se	0 + 0	20 + 15
Surface % mound + 2 se	0 + 0	0.5 + 1.0
Rabbit pellets n/m <sup>2</sup> + 2 se*	0 + 0	12 + 8

On plot DAF2, ephemeral densities were low by historical standards (Hunter 1991, 1994a, b, Table 3), but the number of species present in 100 and 1000 m<sup>2</sup> was unusually large. The species with highest densities were *Salsola australis* (Russian thistle - introduced) and *Phacelia fremontii*, both with 8 ± 7 plants per square meter (± 2 se, Appendix C). *Eriogonum deflexum*, which was extremely common and dominant on most disturbed areas around the DAF in 1993, was present at <2 plants per square meter at this site. *Salsola australis* is common on disturbed areas on the NTS, but 8 plants per square meter is a low density.

The environments of these two sites were very different due to the scraping and gravel spread on DAF2. There was better growth (larger average size) on DAF2 ( $t = 4.26$ , 38 d.f.,  $P < 0.001$ ), but far fewer plants ( $t = 2.83$ , 38 d.f.,  $P < 0.01$ ), and far less biomass produced ( $t = 2.67$ , 38 d.f.,  $P = 0.0115$ , Table 3.). The large number of species present, and the sparse plant populations, suggest the DAF2 area was recently scraped and had not yet had several generations of plant growth. Most such areas would, after several years, be dominated by *Salsola australis*.

The standard BECAMP technique was also used to characterize ephemerals near the paved roadside (Table 4). *Eriogonum deflexum* dominated the scraped area and *Bromus rubens* the undisturbed areas. There were more species in the undisturbed areas, more litter on the surface, and greater shrub cover. Rabbit pellets were only seen on and adjacent to the scraped area, but variability was too great to show a statistical difference (Table 4, Appendix C).

Table 4. Summary statistics on three 100 m<sup>2</sup> transects at DAF3. One was on the scraped road shoulder, one immediately adjacent to the scraped area, and the third fifty meters from the pavement edge. \* = significant at  $P =$

	Scraped	Border	+50 Meters
TOTAL SPECIES IN 100 m <sup>2</sup>	9	21	26
SPECIES IN 10 QUADRATS	2	9	12
AVG. SPECIES PER QUADRAT*	1.4 <sub>±0.3</sub>	2.7 <sub>±0.7</sub>	2.6 <sub>±1.0</sub>
<i>Bromus rubens</i> n/m <sup>2</sup> ± 2 se	16 <sub>±13</sub>	336 <sub>±496</sub>	468 <sub>±373</sub>
<i>Bromus rubens</i> g/m <sup>2</sup> ± 2 se*	0.3 <sub>±0.3</sub>	9.7 <sub>±10.2</sub>	32.1 <sub>±24.8</sub>
<i>Eriogonum deflexum</i> n/m <sup>2</sup> ± 2 se**	1952 <sub>±728</sub>	1260 <sub>±372</sub>	8 <sub>±16</sub>
<i>Eriogonum deflexum</i> g/m <sup>2</sup> ± 2 se**	8.9 <sub>±3.0</sub>	14.2 <sub>±6.9</sub>	0.15 <sub>±0.3</sub>
Total ephemerals/m <sup>2</sup> ± 2 se*	1968 <sub>±732</sub>	1652 <sub>±768</sub>	560 <sub>±395</sub>
Total biomass, g/m <sup>2</sup> ± 2 se*	9 <sub>±3</sub>	25 <sub>±11</sub>	40 <sub>±26</sub>
Average weight/plant mg ± 2 se*	10 <sub>±6</sub>	24 <sub>±12</sub>	89 <sub>±67</sub>
Surface % rock + 2 se	62 <sub>±6</sub>	46 <sub>±13</sub>	54 <sub>±16</sub>

Table 4. continued.			
	Scraped	Border	+50 Meters
Surface % litter $\pm$ 2 se	3 $\pm$ 1	22 $\pm$ 16	19 $\pm$ 13
Surface % shrub cover $\pm$ 2 se*	0 $\pm$ 0	15 $\pm$ 20	48 $\pm$ 30
Surface % mound $\pm$ 2 se	0 $\pm$ 0	1.3 $\pm$ 2.6	11 $\pm$ 18
Rabbit pellets n/m <sup>2</sup> + 2 se	4+8	28+48	0+0

The most obvious difference at this location along the paved road was the dense concentration of *Eriogonum deflexum* on the scraped edge. Across the three locations the difference in *Eriogonum deflexum* densities was highly significant ( $F_{2,27} = 17.41$ ,  $P = 0.000014$ ). Dense concentrations were present in the bordering vegetated area, but not 50 meters from the road (Table 4). The control area differed from both the road shoulder and bordering area (Tukey test). When sampled, these plants were small and not reproductive (the species blooms late spring to early fall, depending on conditions). They therefore represented seed concentrations existing in the soil, rather than 1993 seed production estimates. Besides the increased density of *Eriogonum deflexum*, fewer species were found in the scraped area, average plant size was reduced, and total biomass was reduced (Table 4).

Estimating the  $\log_{10}$  densities of all species in 1 m<sup>2</sup> quadrats within 50 m of the paved road edge produced a species list rankable by average log-density (Table 5). In the 200 one-square-meter quadrats examined, *Eriogonum deflexum* was one of the most frequently encountered (occurring on all ten lines), and had the highest average log density ( $\log_{10} = 1.71$ , Table 5). The introduced grass *Bromus rubens* was next most dense. *Bromus rubens* is the dominant ephemeral on most of the NTS Mojave Desert areas.

Table 5. Ephemeral mean  $\log_{10}$  densities/m<sup>2</sup> within 50 meters of the paved road to the DAF (DAF4), from most to least frequent (ranked by average  $\log_{10}$  density). Densities of 0 were given for plants with less than 5 per m<sup>2</sup>.

Species	number of	mean $\log_{10}$	sd
<i>Eriogonum deflexum</i>	10	1.71	0.35
<i>Bromus rubens</i> <sup>1</sup>	10	1.06	0.21
<i>Vulpia octoflora</i>	10	0.31	0.27
<i>Phacelia fremontii</i>	10	0.31	0.13
<i>Lepidium lasiocarpum</i>	10	0.10	0.13
<i>Lupinus shockley</i> <sup>1</sup>	10	0.10	0.09
<i>Ipomopsis polycladon</i>	10	0.075	0.068
<i>Chaenactis carphoclinia</i>	10	0.035	0.041
<i>Mentzelia albicaulis</i>	10	0.025	0.035
<i>Chaenactis stevioides</i>	10	0.01	0.02
<i>Schismus arabicus</i> <sup>1</sup>	9	0.17	0.21
<i>Nemacladus glanduliferus</i>	9	0.04	0.08
<i>Cryptantha pterocarya</i>	9	0.039	0.033
<i>Eriogonum trichopes</i>	9	0	0
<i>Gilia sinuata</i>	8	0.13	0.21
<i>Linanthus jonesii</i>	8	0.05	0.07
<i>Cryptantha nevadensis</i>	8	0.02	0.04
<i>Ustilago bullata</i> <sup>1</sup>	8	0.025	0.027
<i>Cryptantha recurvata</i>	8	0.01	0.02
<i>Descurainia pinnata</i>	8	0.006	0.018
<i>Salsola australis</i> <sup>1</sup>	7	0.07	0.15
<i>Camissonia boothii</i>	7	0.007	0.019
<i>Malacothrix glabrata</i>	7	0.007	0.019
<i>Gilia transmontana</i>	6	0.15	0.20

Table 5. continued.

Species	number of	sd	
<i>Linanthus dichotomus</i>	6	0.025	0.027
<i>Chorizanthe brevicornu</i>	6	0.017	0.026
<i>Pectocarya heterocarpa</i>	6	0	0
<i>Phacelia vallis-mortae</i>	6	0	0
<i>Rafinesquia neomexicana</i>	6	0	0
<i>Halogeton glomeratur</i> <sup>1</sup>	5	0.1	0.2
<i>Cryptantha gracilis</i>	5	0.01	0.02
<i>Astragalus acutirostris</i>	5	0	0
<i>Eriogonum inflatum</i>	5	0	0
<i>Caulanthus lasiophyllus</i>	5	0	0
<i>Cryptantha circumscissa</i>	4	0.025	0.029
<i>Caulanthus cooperi</i>	4	0	0
<i>Chorizanthe rigida</i>	4	0	0
<i>Eschscholzia glyptosperma</i>	4	0	0
<i>Phacelia crenulata</i>	4	0	0
<i>Oxytheca perfoliata</i>	3	0.017	0.029
<i>Gamissonia claviformis</i>	3	0	0
<i>Langloisia setosissima</i>	3	0	0
<i>Nama demissum</i>	3	0	0
<i>Prenantheella exigua</i>	3	0	0
<i>Streptantheella longirostris</i>	3	0	0
<i>Nama pusillum</i>	2	0.1	0.1
<i>Sisymbrium altissimum</i> <sup>1</sup>	2	0.025	0.035
<i>Chaenactis fremontii</i>	2	0	0
<i>Chorizanthe thurberi</i>	2	0	0
<i>Langloisia schottii</i>	2	0	0

Table 5. continued.			
Species	number of	sd	
<i>Linanthus demissus</i>	2	0	0
<i>Pectocarya platycarap</i>	2	0	0
<i>Nama aretoides</i>	1	0.2	-
<i>Eucrypta micrantha</i>	1	0.05	-
<i>Antirrhinum filipes</i>	1	0	-
<i>Astragalus lentiginosus fremontii</i>	1	0	-
<i>Bromus tectorum</i> <sup>i</sup>	1	0	-
<i>Camissonia brevipes</i>	1	0	-
<i>Camissonia munzii</i>	1	0	-
<i>Cryptantha micrantha</i>	1	0	-
<i>Delphinium parishi</i> <sup>i</sup>	1	0	-
<i>Descurainia sophia</i> <sup>i</sup>	1	0	-
<i>Eriogonum maculatum</i>	1	0	-
<i>Eriogonum nidularium</i>	1	0	-
<i>Erodium cicutarium</i> <sup>i</sup>	1	0	-
<i>Machaeranthera canescens</i>	1	0	-
<i>Malacothrix sonchoides</i>	1	0	-
<i>Monoptilon bellidiforme</i>	1	0	-
<i>Pectocarya setosa</i>	1	0	-
<i>Stephanomeria exigua</i>	1	0	-
<i>Stephanomeria pauciflora</i>	1	0	-

The log<sub>10</sub> sampling technique was intended to show the relationship of the more common species to the road disturbance. Figures 4 to 8 show the changes in mean log<sub>10</sub> densities of selected species with distance from the pavement edge. *Eriogonum deflexum* was present in high numbers (hundreds to thousands per square meter) along both edges of this road (Figure 4). Numbers appeared to drop off to a near-constant low level between 25 and 50 meters from the road, around 2 to 3 plants per square meter. It was only present at about 0.25/m<sup>2</sup>



on the dirt road to the water tank, suggesting it behaves differently in the two areas. It is possible, too, that the 2-3 plants per square meter near 50 m from the paved road may represent seed pressure from the roadside plants.

The most abundant ephemeral species on the NTS is *Bromus rubens*, an introduced species which invaded higher elevations of the Mojave Desert early this century. It was present in unusually low densities (3-4/m<sup>2</sup>) on the scraped roadside shoulder, but present at 10 times those densities outside the roadside scraped area (Figure 4). Two other grasses were of interest: one was a small native grass, *Vulpia octoflora*, which was very abundant before *Bromus rubens* became dominant (Turner and McBrayer 1974), and the other was a very similar introduced grass, *Schismus arabicus* (Figure 6). *Vulpia* was absent from the scraped shoulder, concentrated slightly at the boundary, and present

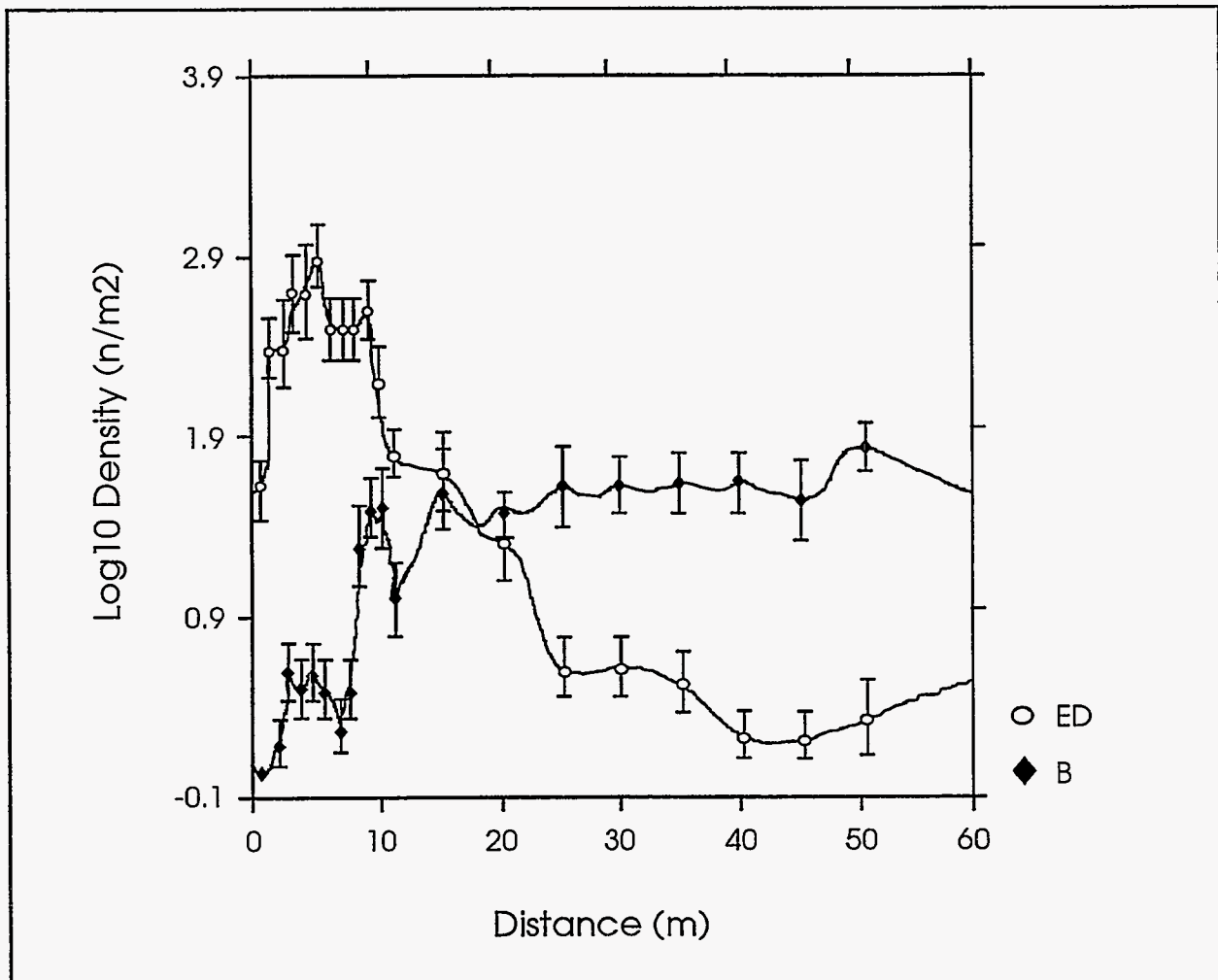


Figure 4 - Log<sub>10</sub> densities (n/m<sup>2</sup> ± se) of the two dominant ephemeral species (*Eriogonum deflexum* and *Bromus rubens*) within 50 m of the paved road to the DAF.



at several plants per square meter in the undisturbed areas (Figure 5). *Schismus* was present on the shoulders of the paved road and in very low density out to 20 meters, then absent from undisturbed vegetation (Figure 6).

*Lepidium lasiocarpum*, a common native ephemeral, appeared to be concentrated along the boundary between the scraped and undisturbed vegetation at the edge of the road (Figure 7). Another common native in the DAF area, *Phacelia fremontii*, declined precipitously in density at the boundary, and appeared to increase in density with increasing distance from the scraped area.

More species were found per square meter in undisturbed vegetation than on the scraped roadside (ANOVA,  $F_{1,18} = 33$ ,  $P = 0.00002$ ). The average number of species on the scraped road shoulder was  $5.4 \pm 1.4$  per square meter while on adjacent undisturbed areas there were  $10.4 \pm 0.8$  species ( $\bar{x} \pm 2$  se,  $n = 11$  and 9 respectively, data based on mean values).

The sampling technique employing nested quadrats expanded in multiples of two was used at a site along the center of the dirt road leading to the DAF water tank, and at an undisturbed site approximately 50 meters east of that road. Species observed and densities estimated were similar to those seen elsewhere (Appendix B, C, Table 5). However, densities of the most common species (Plots DAF5, DAF6; Table 6) depended strongly on the starting location, and densities of some patchy species were clearly either under- or over-estimated depending on the quadrat size in which they happened to fall. No replicates were produced by this technique, so estimates of standard errors were not possible. This method was as time consuming as those that did give statistical estimates, and was therefore abandoned. It would have been useful if it had allowed sampling multiple sites quickly. Biomass estimates, derived from one weight and one density, were similarly suspect (Table 7), and could not be tested statistically. In this location it is obvious that ephemeral densities and biomass were much greater in the undisturbed area than on the road. However, the numbers of species in the two locations were nearly identical (49 and 50), and species compositions were generally similar.

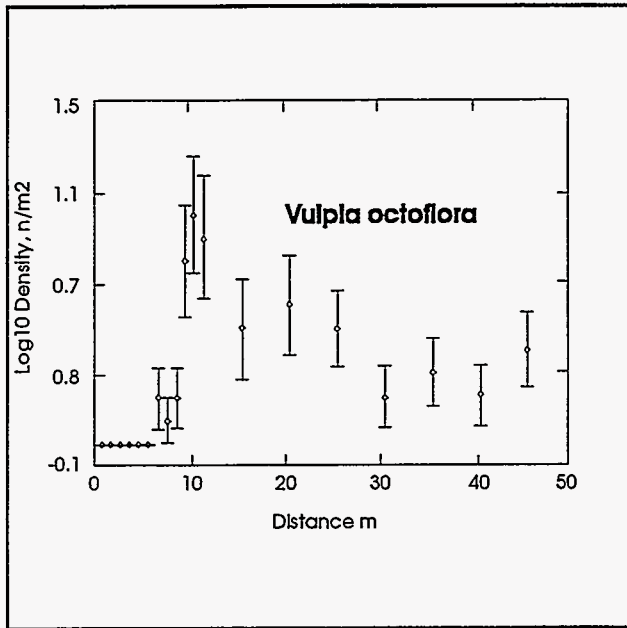


Figure 5 - *Vulpia octoflora* log<sub>10</sub> densities as a function of distance from the paved road.

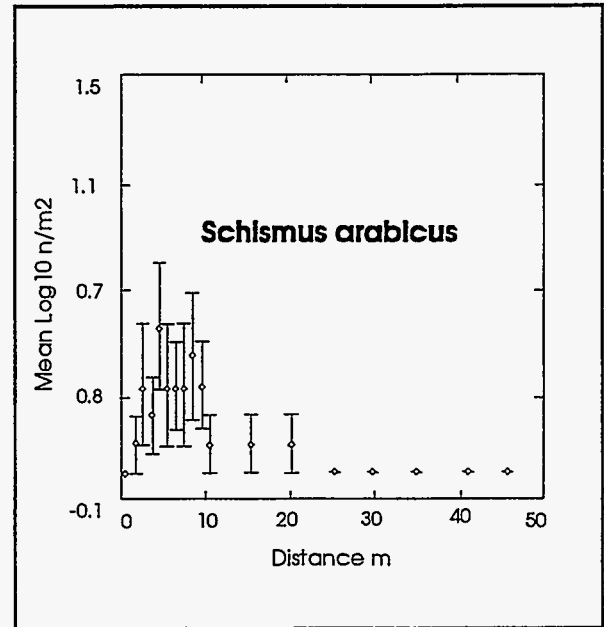


Figure 6 - *Schismus arabicus* log<sub>10</sub> density in relation to the paved road.

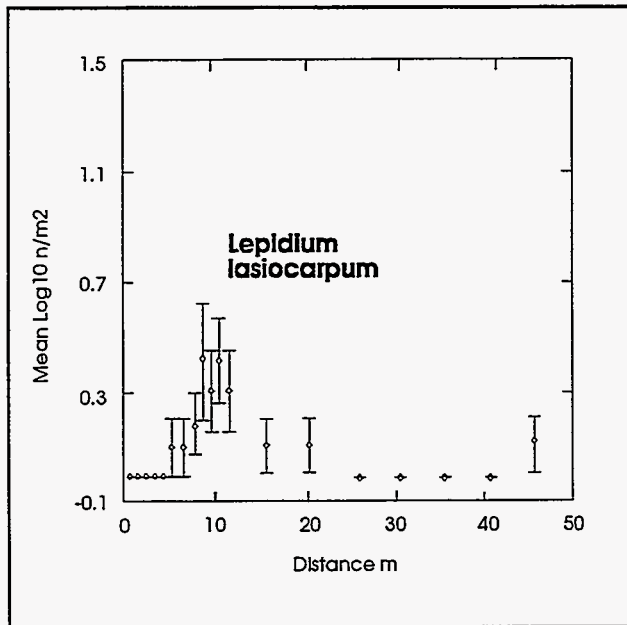


Figure 7 - *Lepidium lasiocarpum* log<sub>10</sub> density vs distance from the paved road.

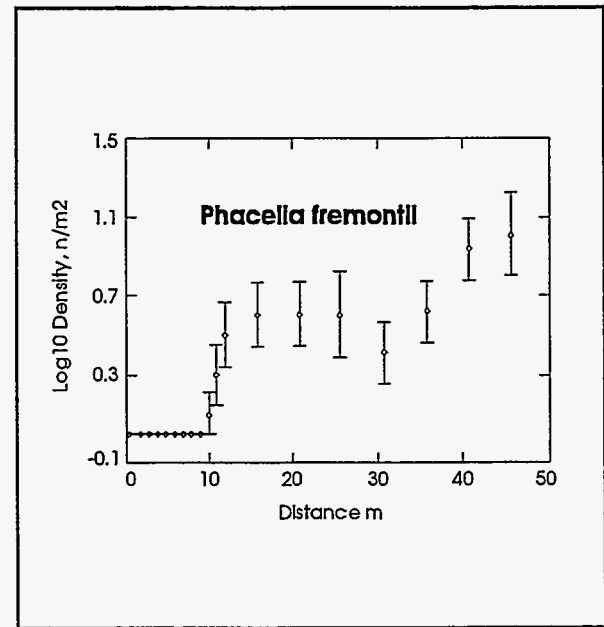


Figure 8 - *Phacelia fremontii* log<sub>10</sub> densities vs distance from the paved road.

Table 6. Densities (n/m<sup>2</sup>) of ephemeral plant species on the dirt road to the DAF water tank (DAF5) and an adjacent undisturbed area (DAF6). Estimates are based on densities in twofold expanding quadrats. <sup>1</sup> indicates introduced species. *Ustilago* is a smut fungus infecting *Bromus rubens*.

Species	Road Density	Undisturbed Density
<i>Bromus rubens</i> <sup>1</sup>	8	1722
<i>Nemacladus glanduliferus</i>	4	331
<i>Phacelia fremontii</i>	4	179
<i>Ustilago bullata</i>	0.12	179
<i>Linanthus dichotomus</i>	0	37
<i>Gilia sinuata</i>	0	28
<i>Cryptantha circumscissa</i>	0.03	20
<i>Gilia transmontana</i>	1.25	12
<i>Erodium cicutarium</i> <sup>1</sup>	0.06	6.7
<i>Gilia filiformis</i>	0	5.5
<i>Monoptilon bellidiforme</i>	0.02	4.5
<i>Chaenactis stevioides</i>	0.01	4.0
<i>Descurainia pinnata</i>	0.38	3.8
<i>Linanthus demissus</i>	0	3.5
<i>Cryptantha nevadensis</i>	0.03	3.4
<i>Eriogonum trichopes</i>	4	2.0
<i>Camissonia claviformis</i>	0.38	2.0
<i>Mentzelia albicaulis</i>	0.75	2.0
<i>Cryptantha pterocarya</i>	0.03	2.0
<i>Ipomopsis polycladon</i>	0.38	1.5
<i>Vulpia octoflora</i>	0.12	1.2
<i>Eschscholzia glyptosperma</i>	0.03	1.0
<i>Chaenactis carphoclinia</i>	0.04	0.75

Table 6. continued.

Species	Road Density	Undisturbed Density
<i>Eriogonum deflexum</i>	0.25	0.62
<i>Bromus tectorum</i> <sup>i</sup>	0	0.34
<i>Eriogonum maculatum</i>	0.05	0.26
<i>Cryptantha gracilis</i>	0.12	0.25
<i>Amsinckia tessellata</i>	0.01	0.20
<i>Camissonia brevipes</i>	0.004	0.18
<i>Lupinus shockleyi</i>	0.12	0.12
<i>Nama demissum</i>	0	0.12
<i>Eriogonum nidularium</i>	0.36	0.09
<i>Linanthus arenicola</i>	0	0.09
<i>Chorizanthe brevicornu</i>	0.04	0.08
<i>Phacelia vallis-mortae</i>	0	0.07
<i>Caulanthus lasiophyllus</i>	0.004	0.06
<i>Astragalus acutirostris</i>	0.01	0.06
<i>Astragalus lentiginosus fremontii</i>	0.38	0.05
<i>Eriogonum inflatum</i>	0.02	0.02
<i>Malacothrix glabrata</i>	0.06	0.02
<i>Caulanthus cooperi</i>	0	0.02
<i>Lupinus flavoculatus</i>	0.02	0.02
<i>Lotus humistratus</i>	0.04	0.01
<i>Camissonia pterosperma</i>	0	0.008
<i>Pectocarya heterocarpa</i>	0.002	0.008
<i>Machaeranthera canescens</i>	0	0.008
<i>Cryptantha recurvata</i>	0	0.008
<i>Cryptantha dumetorum</i>	0	0.002

Table 6. continued.

Species	Road Density	Undisturbed Density
<i>Malacothrix sonchoides</i>	0	0.002
<i>Camissonia kernensis</i>	0.02	0.002
<i>Salsola australis</i> <sup>1</sup>	0.09	0
<i>Descurainia sophia</i> <sup>1</sup>	0.002	0
<i>Cryptantha micrantha</i>	0.004	0
Unknown 2	0.02	-
<i>Pectocarya platycarpa</i>	0.002	0
<i>Nama pusillum</i>	0.02	0
<i>Lepidium lasiocarpum</i>	0.25	0
<i>Schismus arabicus</i> *	0.01	0
Unknown 1	0.03	-
<i>Eschscholzia minutiflora</i>	0.03	0
<i>Chenopodium incanum</i>	0.04	0
<i>Camissonia refracta</i>	0.02	0
<i>Gilia cana</i>	0.06	0

Table 7. Biomass (g/m<sup>2</sup>) and mean plant size (mg) of common ephemeral plant species on the dirt road to the DAF water tank and adjacent undisturbed site. Biomass was not determined on low-density species (-).

Species	Road		Undisturbed	
	g/m <sup>2</sup>	mg	g/m <sup>2</sup>	mg
<i>Bromus rubens</i>	0.70	88	71	41
<i>Nemacladus glanduliferus</i>	0.03	7	11.3	3
<i>Phacelia fremontii</i>	0.10	26	7.2	40
<i>Gilia sinuata</i>	-	-	2.3	81

Table 7. continued.				
Species	Road		Undisturbed	
	<i>Gilia transmontana</i>	-	-	1.08
<i>Cryptantha circumscissa</i>	-	-	0.97	48
<i>Erodium cicutarium</i>	-	-	0.85	127
<i>Linanthus dichotomus</i>	-	-	0.75	20
<i>Linanthus demissus</i>	-	-	0.53	15
<i>Eschscholzia glyptosperma</i>	-	-	0.27	27
<i>Camissonia claviformis</i>	-	-	0.12	59
<i>Mentzelia albicaulis</i>	-	-	0.10	52

## PERENNIAL PLANTS

The perennial plant community around the DAF was characterized by census results from the 100 - 5 X 2 m transects (Table 8). By volume and cover the dominant species was *Larrea tridentata* (creosotebush; LARTRI), a very drought-hardy evergreen shrub found throughout the deserts of the American southwest. On the NTS it is dominant on the southern portions, but north of Frenchman Flat it occurs only in patches where it is somewhat protected from frost-kill (Beatley 1974a, 1975). It was accompanied by a co-dominant shrub, *Ambrosia dumosa* (white bursage, AMBDUM), which is drought-deciduous. The DAF is located very close to the northern limits of *Larrea* and *Ambrosia*, where they are replaced by mixed shrubs in a transition zone between the Mojave and Great Basin deserts (Beatley 1976). This was also near the northern limit of *Krameria parvifolia*, (littleleaf krameria; KRAPAR), on the NTS.

In terms of biomass, the area around the DAF was dominated by *Yucca brevifolia* (Joshua tree; YUCBRE), a tree-like succulent which survives drought by storing water in its trunk and leaves. It is normally found in the Mojave and transition deserts at higher elevations, on rocky soils, and significant slopes. The DAF was constructed at the southern boundary of its distribution on the NTS (Beatley 1976). Perennial plant numbers were dominated by a small grass, *Erioneuron pulchellum* (fluffgrass false-tridens; ERIPUL), most of which germinated in 1992 and 1993. Another species contributing significant cover

and numbers was *Sphaeralcea ambigua* (Desert globemallow; SPHAMB), an herbaceous perennial that also germinated and grew during the last two years. The remaining two species in Table 8 were *Ephedra nevadensis* (Nevada ephedra; EPHNEV), a drought hardy plant which is nearly ubiquitous on the NTS, and prefers cool weather, and *Krameria parvifolia* a low Mojave Desert shrub which grows during hot weather.

Table 8. Dominant perennial plant species near the DAF. The columns give data for the five most-dominant species in terms of live volume (l), cover (m<sup>2</sup>), biomass (Kg), or numbers per 1000 m<sup>2</sup>. Totals summarize results for all perennial species combined.

Live Volume		Live Biomass		Live Cover		Live Numbers	
Species	liters	Species	Kg	Species	m <sup>2</sup>	Species	n
LARTRI	41,299	YUCBRE	564	LARTRI	47	ERIPUL	5831
YUCBRE	22,813	LARTRI	53.7	KRAPAR	28	AMBDUM	159
AMBDUM	8,441	AMBDUM	21.1	AMBDUM	24	SPHAMB	106
KRAPAR	8,168	KRAPAR	16.4	SPHAMB	8.4	KRAPAR	84
EPHNEV	4,427	EPHNEV	6.2	ERIPUL	7.7	LARTRI	77
Total live	94,919		678		141		6407
Total dead	37,255		-		95		4100

Other perennial plant species found in the 100 plots (1000 m<sup>2</sup> of transect) around the DAF are listed in Table 9. The total of 23 species is low, as Beatley (1976) cited a range of 20 to 75 species found on 1000 m<sup>2</sup>. Species common on the NTS and which could be expected in the DAF area also include *Atriplex canescens*, *Hymenoclea salsola*, and *Lepidium fremontii*. Other species which were seen near the DAF included *Mirabilis bigelovii* and a seedling *Pinus monophylla* (pinyon pine). Excluding herbaceous perennials, whose populations vary greatly with rainfall, there were 447 live and 640 dead shrubs on the 1000 m<sup>2</sup> censused.

Table 9. Perennial plant species found on 100, 10 m<sup>2</sup> transects, total live volumes by species (liters per 1000 m<sup>2</sup>), and the desert affinity (Mojave = M, Transition = T, Great Basin = G) for each species.

Species and authority	Live volume	Desert affinity
<i>Acamptopappus shockleyi</i> Gray	55	M, T
<i>Ambrosia dumosa</i> (Gray) Payne	8,441	M
<i>Atriplex confertifolia</i> (Torr. & Frem.) S. Watts	689	M, T, G
<i>Ceratoides lanata</i> (Pursh) J.T. Howell	104	M, T, G
<i>Coleogyne ramosissima</i> Torr.	165	T
<i>Dyssodia cooperi</i> Gray	1	M, T, G
<i>Echinocereus engelmannii</i> Parry	<1	M, T, G
<i>Ephedra nevadensis</i> S. Wats.	4,427	M, T, G
<i>Erioneuron pulchellum</i> (H.B.K.) Tateoka	355	M, T
<i>Grayia spinosa</i> (Hook.) Moq.	607	M, T, G
<i>Krameria parvifolia</i> Benth.	8,168	M
<i>Larrea tridentata</i> (Sesse & Moc. ex DC.) Coville	41,299	M
<i>Lycium andersonii</i> Gray	2,287	M, T
<i>Menodora spinescens</i> Gray	331	M, T
<i>Opuntia basilaris</i> Engelm. & Bigelow	1	M, T, G
<i>Opuntia echinocarpa</i> Engelm. & Bigelow	116	M, T
<i>Oryzopsis hymenoides</i> (Roemer & Schultes) Ricker	1	M, T, G
<i>Salazaria mexicana</i> Torr.	626	M, T
<i>Sphaeralcea ambigua</i> Gray	4,274	M, T
<i>Stephanomeria pauciflora</i> (Torr.) Nutt.	84	M, T
<i>Stipa speciosa</i> Trin. & Rupr.	<1	T
<i>Xylorhiza tortifolia</i> (Torr. & Gray) Greene	74	M
<i>Yucca brevifolia</i> Engelm.	22,813	M, T



## Effects of the DAF on Perennial Plants

Transects were placed at different distances from the DAF to monitor changes occurring near the DAF. There were some differences in the perennial plants associated with distance from the DAF, primarily in the density of live shrubs. With all shrubs from all plots lumped together, the proportion of live to dead shrubs censused in 200 m<sup>2</sup> differed among the five sampled distances (Table 10;  $\chi^2 = 13.1$ , 4 d.f.,  $P = 0.011$ ), as did the proportion of live to dead herbs ( $\chi^2 = 694$ , 4 d.f.,  $P < 0.001$ ).

Distance (meters)	shrubs		herbs and grasses		undisturbed live shrub density $\pm$ 2 se
	live	dead	live	dead	
0 - 300	46	41	723	117	4.6 $\pm$ 2.4
300 - 400	88	129	1454	965	6.5 $\pm$ 2.0
400 - 500	74	130	1538	431	4.9 $\pm$ 1.4
500 - 600	124	141	1297	781	6.8 $\pm$ 2.6
1000 - 1500	115	199	948	1166	6.8 $\pm$ 2.2

Numbers of live shrubs found per 10 m<sup>2</sup> plot increased with distance from the DAF (ANOVA,  $F_{4,95} = 2.44$ ,  $P = 0.052$ ), as did the number of dead shrubs per plot (ANOVA,  $F_{4,95} = 2.96$ ,  $P = 0.024$ ). Considering only undisturbed plots, there were no significant differences with distance from the DAF in numbers of live or dead shrubs or herbs per plot (ANOVA, maximum  $F_{4,261} = 1.39$ ,  $P = 0.248$ ) suggesting differences were related to the greater disturbance near the DAF.

Four species were numerous enough to test for effects of distance from the DAF. *Larrea tridentata* and *Krameria parvifolia* volumes did not vary with distance (ANOVA,  $F_{4,72} = 1.51$ ,  $P = 0.208$ ;  $F_{4,79} = 1.34$ ,  $P = 0.263$  respectively). However, the volumes of *Ambrosia dumosa* increased with distance between the 0 - 300 m band of plots and the 500 - 600 m band (ANOVA,  $F_{4,154} = 4.52$ ,  $P = 0.002$ ), and the volumes of *Sphaeralcea ambigua* varied significantly among the different distances (ANOVA,  $F_{4,101} = 3.84$ ,  $P = 0.006$ ) (Table 11).

**Table 11.** Mean volumes (liters  $\pm$  2 se) of the most common shrubs near the DAF and their variation with distance (m) from the DAF in summer 1993.

Distance (m)	<i>Larrea tridentata</i>		<i>Krameria parvifolia</i>		<i>Ambrosia dumosa</i>		<i>Sphaeralcea ambigua</i>	
	vol	n	vol	n	vol	n	vol	n
0-300	599 + 329	10	73 + 66	8	34 + 22	24	82 + 82	12
301-400	446 + 286	19	70 + 30	22	43 + 20	28	4 + 4	6
401-500	583 + 353	12	85 + 33	19	71 + 25	29	72 + 42	25
501-600	360 + 139	24	140 + 69	17	93 + 43	25	37 + 17	35
1000-1500	933 + 734	12	114 + 63	18	38 + 11	53	6 + 4	28

*Ambrosia dumosa* in the band closest to the DAF were concentrated in two plots (5-1 and 12-1), which held 19 of the 24 plants censused. Eight of the smallest plants were in a clump containing one large live and two large dead *Ambrosia*, on a plot (12-1) 16 m west of a large scraped and graveled area south of the DAF. Those were probably seedlings that germinated in 1992 and survived in 1993 in a crowded and shaded microhabitat. The nearby scraped and graveled area may have enhanced survival or germination due to water used for dust control or water built up in the vicinity by the absence of vegetation and the presence of a thick gravel mulch.

*Sphaeralcea ambigua* is a species which occasionally invades disturbed areas on the NTS. It is normally present in undisturbed vegetation as small plants which grow large and reproduce only in wet years such as 1993. It was not seen in 1993 on scraped areas, but the greater sizes seen near the DAF could be partially related to the shorter distances to disturbance. *S. ambigua* distribution of sizes and numbers was complex and patchy, and may have been affected by soil variation and recent drought kill of other species.

### Disturbances

Disturbances around the DAF were extensive. From the perimeter fence to 600 m from the front door, the flood-control dike and bladed roads leading to and around it were the DAF-related disturbances with the widest distribution (Table 12). Most of the disturbances within 600 m of the DAF were DAF-related

(Table 13). As distance increased proportionately more non-DAF disturbances were encountered. Mean distance to nearest disturbance differed among the five bands (Kruskal Wallis,  $H = 26.3$ , d.f. = 4,  $P = 0.0001$ ), increasing from 8 m within 300 m of the DAF to 180 m between 1 and 1.5 km (Table 13).

**Table 12.** Nearest disturbances to 98 random points (perennial plots) in bands around the DAF.

Disturbance	Number of Plots
Flood dike and associated roads	21
Miscellaneous DAF-related scraped areas	17
Dirt roads associated with 1950's testing	13
DAF water tank and associated roads	12
Scraped areas immediately surrounding DAF fence	12
DAF sewage pond, and associated road and pipeline	8
Transmitter station, road and buried cables	8
Paved road to DAF	5
Other non-DAF disturbances	2

**Table 13.** Mean distances to nearest disturbances, and type of disturbance, within five bands at varying distances from the DAF.

Distance From DAF	Numbers by Disturbance Type		Distance from Plot $\bar{x} \pm 2 \text{ se}$
	DAF-Related	Non-DAF	
0 - 300 m	20	0	8 + 7
301 - 400 m	18	1	24 + 20
401 - 500 m	17	3	53 + 27
501 - 600 m	15	5	67 + 31
1000 - 1500 m	2	17	180 + 42

## Sensitive Perennial Plants

There are no woody vascular plants on the NTS listed as endangered, threatened, or candidates for those listings. Sensitive species on the NTS are all herbaceous ephemerals or short-lived perennials. If seen, they would have been reported under ephemeral plant studies.

## REPTILES

### Roadside Studies

#### Spring Samples

Average number of side-blotched lizards using plots each day was lower on roadside plots (trts 1 and 2 pooled,  $12.8 \pm 1.8$ ,  $\bar{x} \pm 2$  se/ha) than on control plots ( $28.3 \pm 2.8$ /ha,  $F_{1,18} = 11.05$ ,  $P = 0.004$ , Fig. 9). Similarly, total number of individuals using roadside plots ( $2.8 \pm 0.3$ /plot) was fewer than that using control plots ( $6.5 \pm 0.6$ /plot,  $F_{1,18} = 32.3$ ,  $P = 0.00002$ ). Average SVL did not differ between lizards occupying roadside ( $42.6 \pm 2.68$  mm,  $\bar{x} \pm 2$  se), or control plots ( $42.1 \pm 1.22$  mm,  $F_{1,18} = 0.09$ ,  $P = 0.77$ ). Average weight also did not differ between roadside ( $2.37 \pm 0.32$  g) and control plots ( $2.35 \pm 0.18$ ,  $F_{1,18} = 0.02$ ,  $P = 0.90$ ). Females were a higher proportion of the population along the roadside ( $64.2 \pm 14\%$ ), than in the control plots ( $42.1 \pm 6\%$ ,  $F_{1,18} = 5.98$ ,  $P = 0.025$ ). Age class composition did not differ between roadside (75% <1 yr, 25% 1 yr, 0% >1 yr) and control areas (88% <1 yr, 12% 1 yr, 0% >1 yr, chi square = 2.49, 1 d.f.,  $P > 0.10$ ).

There were differences in average number of lizards using each treatment ( $F_{2,27} = 17.7$ ,  $P = 0.00001$ , Fig. 10) with no side-blotched lizards using the first 10 m from the center of the road (area of negative effect), many ( $25.5 \pm 3.5$ /ha) using the next 10 m (area with potential positive effect), and the control area ( $28.3 \pm 2.8$ /ha) well removed from the road. Total number of individual *Uta* seen per five day period per plot differed across the three treatments ( $F_{2,27} = 39.5$ ,  $P < 0.0001$ ). Total number of lizards per plot in the area from 0 to 10 m from road center was zero, total number in the area from 10 to 20 m from road center was  $5.6 \pm 0.6$ /plot, and number on control plots was  $6.5 \pm 0.6$ /plot. Comparisons across all three treatments are not possible for the other characters discussed above because treatment 1 (area within 10 m of the center of the road, or area of potential negative effect) contained no *Uta*. Statistical results presented above for SVL, weight, and proportion of

females in the population, do hold for comparisons between treatment 2 (area 10 to 20 m from road center) and treatment 3 (control plots). Probability of recapture from spring to summer surveys was greater in the control area (25.4%) than on the roadside (7.1%, chi square = 3.99, 1 d.f., P = 0.046).

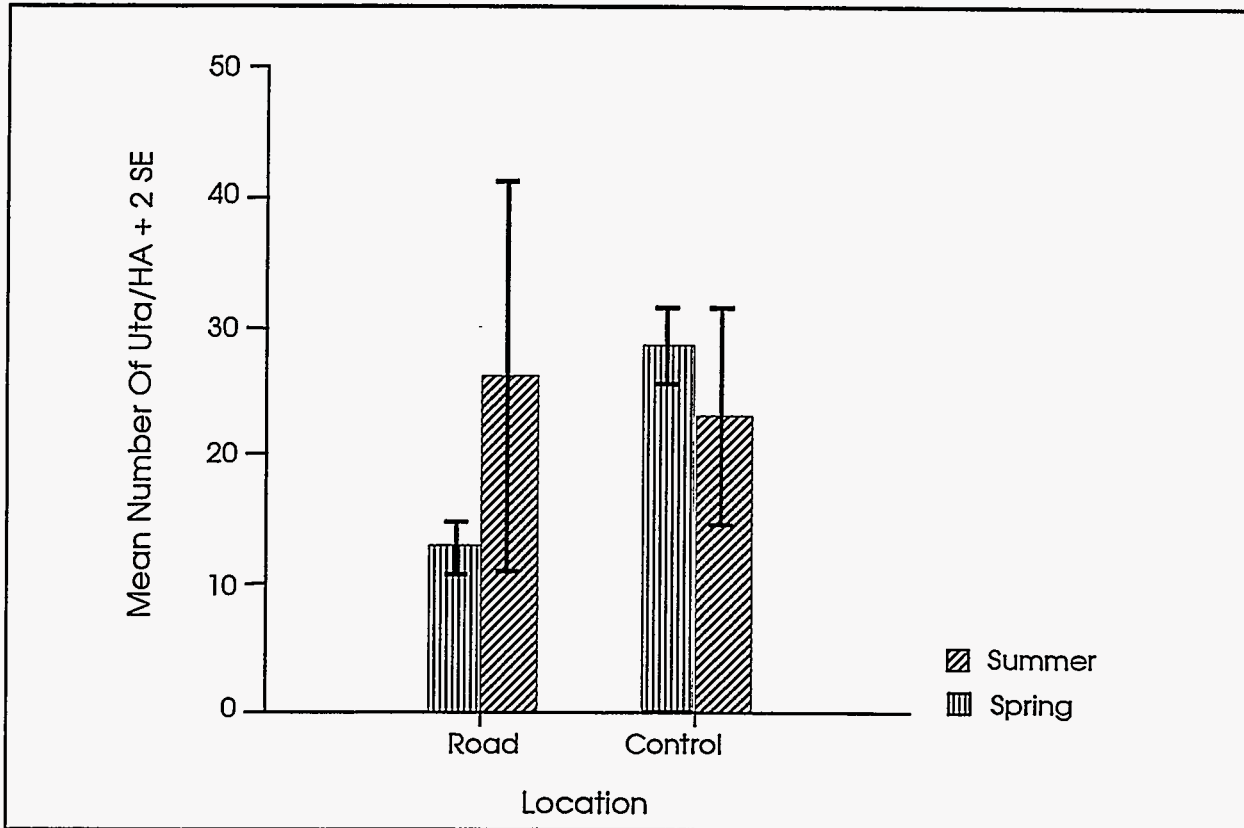


Figure 9 - Mean number of side-blotched lizards/ha seen on roadside or control plots near the DAF in spring and summer 1993.

### Summer Samples

In summer, average number of side-blotched lizards present did not differ between roadside ( $26.0 \pm 15.3/\text{ha}$ ) and control plots ( $22.8 \pm 8.7/\text{ha}$ ,  $F_{1,18} = 0.34$ ,  $P = 0.57$ , Fig. 9). Similarly, number of individuals marked per plot over five days did not differ between roadside ( $6.6 \pm 2.4/\text{plot}$ ) and control plots ( $5.9 \pm 1.1/\text{plot}$ ,  $F_{1,18} = 0.29$ ,  $P = 0.598$ ). Average SVL did not differ between side-blotched lizards occupying roadside ( $33.9 \pm 2.9$  mm) or control areas ( $36.8 \pm 3.2$  mm,  $F_{1,18} = 1.83$ ,  $P = 0.19$ ). Average body weights were heavier for side-blotched lizards in control areas ( $1.96 \pm 0.33$  g) than in roadside areas ( $1.42 \pm 0.35$  g,  $F_{1,18} = 5.13$ ,  $P = 0.036$ ). Proportion of the

population that was female did not differ between roadside ( $44.8 \pm 15.0\%$ ) and control areas ( $58.2 \pm 3.3\%$ ,  $F_{1,18} = 0.95$ ,  $P = 0.343$ ). Age composition of side-blotched lizards again did not differ between treatments (roadside 71.4% <1, 22.1% 1, 6.5% >1; control 53.5% <1, 36.2% 1, 10.3% >1;  $\chi^2 = 4.66$ , 2 d.f.,  $P = 0.098$ ).

Average number of side-blotched lizards present per day differed greatly across the three areas ( $F_{2,27} = 19.5$ ,  $P < 0.0001$ , Fig. 10, 1 - 10 m from road center = none, 10 - 20 m =  $52.0 \pm 19.3/\text{ha}$ , control =  $22.75 \pm 5.5/\text{ha}$ ). Number of individual side-blotched lizards seen per plot over five days also differed across all treatments ( $F_{2,27} = 22.4$ ,  $P < 0.0001$ ). The area from 0 - 10 m from the road contained no side-blotched lizards, 10 - 20 m contained  $13.2 \pm 4.7/\text{plot}$ , and control areas contained  $5.9 \pm 1.1/\text{plot}$ ).

Spearman rank correlations between distance from the DAF building and lizard traits were all nonsignificant for both lines (Table 14). Eight perennial plant species were encountered commonly enough in roadside or control areas to merit comparison. Six of eight species had different distributions across treatments, with the roadside treatment always differing from the other treatments (Table 15). Roadside graded areas also had fewer total live perennials relative to the other two areas. Total number of live perennials and number of shrub species most typically did not differ between the berm area (10 - 20 m from the road center) and the control area (Table 15). These plant patterns mimic those for number of lizards observed.



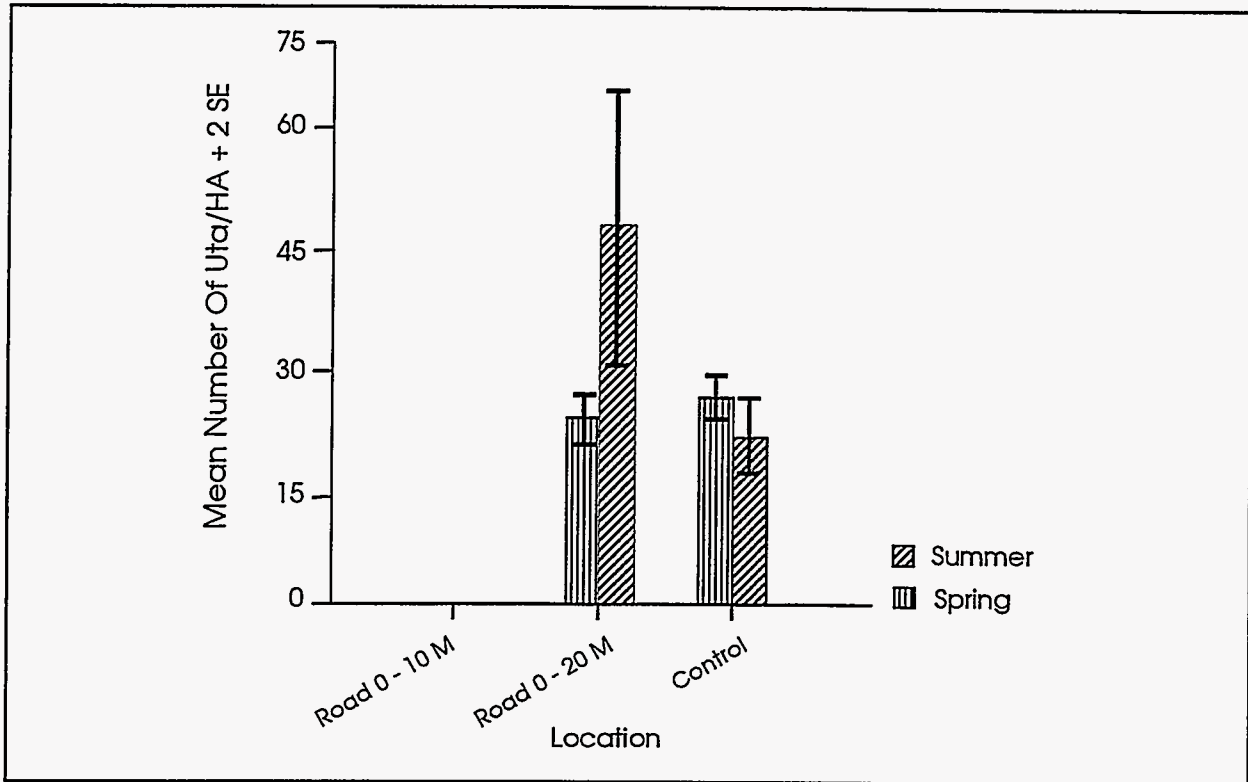


Figure 10 - Mean number of side-blotched lizards/ha seen from 0 to 10 m or 10 to 20 m from road center, or control plots near the DAF in spring and summer 1993.

Table 14. Spearman's rank correlations between plot location (= distance from DAF buildings) and traits of side-blotched lizards. All samples have 8 degrees of freedom.

Lizard trait	rank correlation, $\rho$	
	Roadside	Control
Mean Number Present/Day	0.275, $P > 0.05$	0.146, $P > 0.05$
Total Number of Individuals present	0.353, $P > 0.05$	0.331, $P > 0.05$
Mean SVL (mm)	0.297, $P > 0.05$	0.091, $P > 0.05$
Mean weight (g)	0.285, $P > 0.05$	0.097, $P > 0.05$
Proportion female in population	-0.485, $P > 0.05$	0.518, $P > 0.05$

Table 15. Mean  $\pm$  2 se of live perennial plant densities (no. per 5 m<sup>2</sup>) in three areas in 1993 near the Device Assembly Facility at the NTS. NS = not significantly different; \* = significantly different at P < 0.05 level. All comparisons have 2 and 274 degrees of freedom. With 9 tests of each hypothesis the appropriate Bonferroni adjusted critical P value = 0.05/9 = 0.0055.

Species	Location of Sample			Statistical Comparison			
	0-10 m from road (1)	10-20 m from road (2)	control (3)	overall comparison	1 vs 2	1 vs 3	2 vs 3
<i>Ambrosia</i>	0.00 $\pm$ 0.00	1.95 $\pm$ 0.42	1.09 $\pm$ 0.32	F= 36.9, P < 0.001*	*	*	*
<i>Krameria</i>	0.00 $\pm$ 0.00	0.30 $\pm$ 0.12	0.74 $\pm$ 0.16	F= 36.6, P < 0.001*	*	*	*
<i>Acamptopappus</i>	0.00 $\pm$ 0.00	0.24 $\pm$ 0.12	0.08 $\pm$ 0.06	F= 9.93, P < 0.001*	*	*	NS
<i>Larrea</i>	0.00 $\pm$ 0.00	1.58 $\pm$ 0.33	1.79 $\pm$ 0.26	F= 60.6, P < 0.001*	*	*	NS
<i>Ephedra</i>	0.00 $\pm$ 0.00	0.13 $\pm$ 0.07	0.07 $\pm$ 0.06	F= 4.79, P < 0.009	*	*	NS
<i>Sphaeralcea</i>	0.01 $\pm$ 0.02	0.19 $\pm$ 0.15	0.31 $\pm$ 0.20	F= 4.11, P < 0.018	*	*	NS
<i>Oryzopsis</i>	0.01 $\pm$ 0.02	0.17 $\pm$ 0.09	0.23 $\pm$ 0.09	F= 8.45, P < 0.001*	*	*	NS
<i>Lycium</i>	0.00 $\pm$ 0.00	0.27 $\pm$ 0.12	0.67 $\pm$ 0.09	F= 27.9, P < 0.001*	*	*	*
All live shrubs	0.00 $\pm$ 0.00	4.83 $\pm$ 0.53	4.64 $\pm$ 0.52	F= 146.0, P < 0.001*	*	*	NS



DAF lizard plots were small (0.08 ha for roadside studies) and undoubtedly there was much movement on and off plots because of their small size relative to lizard home range sizes. Numbers present per plot and number of recaptures were too low to facilitate mark-recapture studies. Therefore, number of lizards caught or observed was summed and used to represent lizard abundance. Observational counts like these can be influenced by visibility which can in turn be influenced by habitat characteristics. The control areas had much thicker and structurally more complex vegetation relative to either the DAF ditch or the roadside area. The berm area along the road was intermediate in these regards between the roadside and its control area. Differences in vegetational complexity between areas typically ran counter to observed differences in lizard abundances - that is, the higher counts came from the complex areas and the low counts from the simple areas where visibility is presumably greater. Because individuals were marked with paint patterns, recaptures were achieved simply by recording paint patterns observed. An index of recapture probability (number of observed recaptures/number of potential recaptures) was constructed to compare recapture rates across areas. Recapture rates did not differ between control areas or the berm in either the spring (control 32.6%, berm 37.7%,  $X^2 = 0.38$ , 1 d.f.,  $P = 0.54$ ) or summer (control 13.2%, berm 17.3%,  $X^2 = 0.69$ , 1 d.f.,  $P = 0.41$ ) suggesting that visual biases were not an important factor contributing to differences in counts of side-blotched lizards.

## Diversion Ditch Studies

### Spring Samples

*Callisaurus* were more abundant in the ditch ( $23.0 \pm 3.3/\text{ha}$ ,  $F_{1,88} = 78.04$ ,  $P < 0.0001$ , Fig. 11) than in the undisturbed control area ( $1.7 \pm 0.5/\text{ha}$ ). Number of *Uta* observed per plot per day was greater on pooled control plots ( $17.7 \pm 2.5/\text{ha}$ ,  $\bar{x} \pm 2 \text{ se}$ ,  $F_{1,88} = 23.48$ ,  $P < 0.0001$ , Fig. 12) than in the ditch in the DAF disturbed area ( $0.7 \pm 0.7/\text{ha}$ ). Number of *Cnemidophorus* seen per day per plot was also greater in the undisturbed control area ( $13.3 \pm 1.8/\text{ha}$ ,  $F_{1,88} = 26.02$ ,  $P < 0.0001$ ) relative to the disturbed ditch area ( $0.3 \pm 0.3/\text{ha}$ ).

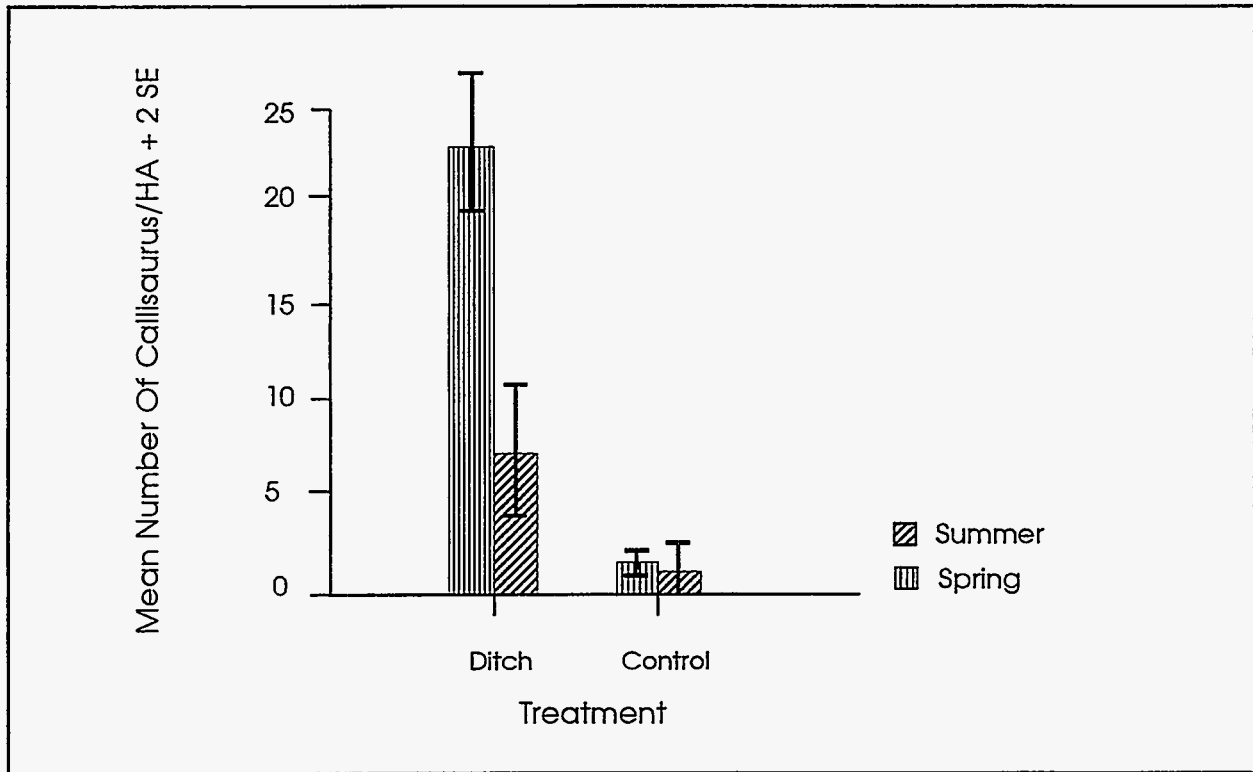


Figure 11 - Mean number of zebra-tailed lizards/ha seen in the DAF diversion ditch and nearby controls during spring and summer 1993.

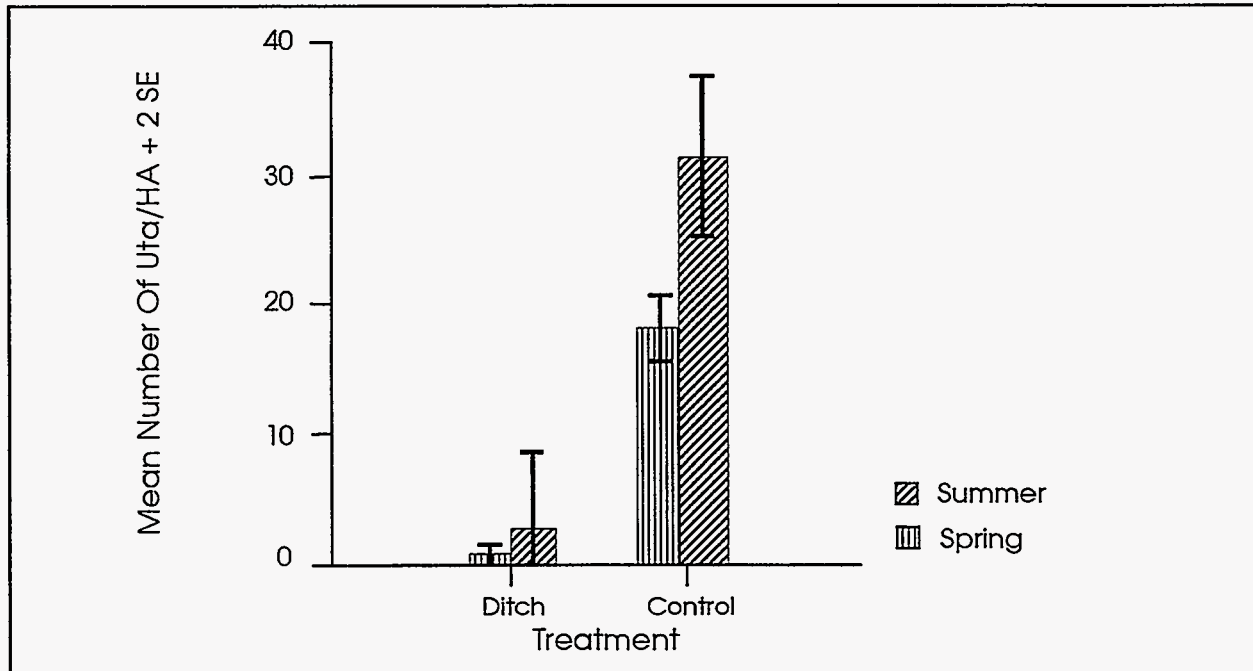


Figure 12 - Mean number of side-blotched lizards/ha seen in the DAF diversion ditch and control plots in spring and summer 1993.

Approximately twice as many lizard species were observed per plot on the control area ( $1.7 \pm 0.1$ ,  $F_{1,88} = 21.96$ ,  $P < 0.0001$ ) as in the ditch ( $0.9 \pm 0.1$ ). More lizards were observed per plot in control areas ( $34.2 \pm 3.0/\text{ha}$ ,  $F_{1,88} = 4.23$ ,  $P = 0.043$ ) than in the ditch ( $24.3 \pm 3.3/\text{ha}$ ). Lizard faunas of the two areas were so different (the control lizard community consisted mainly of *Uta*, the ditch mainly *Callisaurus*) that it was impossible to make intraspecific comparisons of individual lizard traits between disturbed and control areas.

Number of side-blotched lizards seen per plot per day differed across all three treatments ( $F_{2,87} = 15.7$ ,  $P < 0.0001$ ; flats  $13.0 \pm 5.0/\text{ha}$ ; arroyo bottoms  $23.0 \pm 8.0/\text{ha}$ ; DAF ditch  $1.0 \pm 1.0/\text{ha}$ ). Number of whiptail lizards did not differ between plots in flats ( $11.0 \pm 5.0/\text{ha}$ ) or plots in arroyo bottoms ( $15.0 \pm 6.0/\text{ha}$ ) but both did differ from the DAF ditch ( $0.3 \pm 1.8/\text{ha}$ ,  $F_{2,87} = 14.1$ ,  $P < 0.0001$ ). Zebra-tailed lizards were more abundant in the DAF ditch ( $23.0 \pm 7.0/\text{ha}$ ) than in flats ( $1.0 \pm 1.0/\text{ha}$ ) or arroyo bottoms ( $3.0 \pm 2.0/\text{ha}$ ,  $F_{2,87} = 39.1$ ,  $P < 0.0001$ ). Total number of species seen per plot also differed across treatments ( $F_{2,87} = 12.0$ ,  $P < 0.0001$ ), with flat ( $1.6 \pm 0.3$ ) and arroyo bottom plots ( $1.8 \pm 0.3$ ) containing more species than plots in the DAF ditch ( $0.9 \pm 0.2$ ). Finally, number of individual lizards seen per plot differed across treatments ( $F_{2,87} = 6.7$ ,  $P = 0.002$ ), with flats ( $26.0 \pm 6.0/\text{ha}$ ) and arroyo bottoms ( $42.0 \pm 26.0/\text{ha}$ ) containing more relative to the DAF ditch ( $24.0 \pm 18.0/\text{ha}$ ).

### Summer Samples

Summer samples were analyzed as two way ANOVAs testing for differences across both treatment and date the sample was collected. Numbers were sufficient for comparisons of side-blotched lizards, whiptails, and zebra-tailed lizards. Number of side-blotched lizards observed per plot was greater on the pooled (flat and arroyo) control plots ( $30.7 \pm 6.1/\text{ha}$ ) relative to ditch plots ( $2.7 \pm 5.8/\text{ha}$ , Table 16, Fig. 12). Whiptail lizards were also more abundant on control plots ( $6.8 \pm 3.5/\text{ha}$ ) relative to ditch plots ( $1.0 \pm 1.1/\text{ha}$ , Table 16). In contrast, zebra-tailed lizards were more abundant in ditch plots ( $7.3 \pm 3.4/\text{ha}$ ) than control plots ( $1.2 \pm 1.5/\text{ha}$ , Table 16, Figure 11). Control plots tended to contain more species ( $1.6 \pm 0.7$ ) than ditch plots ( $0.8 \pm 0.7$ , Table 16). They also contained more individual lizards ( $40.0 \pm 22.4/\text{ha}$ ) relative to the ditch plots ( $11.3 \pm 11.7/\text{ha}$ , Table 16). Finally, there were no differences across days in number of side-blotched lizards, number of

whiptails, number of zebra-tailed lizards, total number of lizard species per plot, or number of individual lizards per plot (Table 16).

A closer look at location effects during the summer, revealed sizeable differences across locations for whiptails ( $F_{2,83} = 5.45$ ,  $P = 0.006$ ), side-blotched lizards ( $F_{2,83} = 38.61$ ,  $P < 0.0001$ ), zebra-tailed lizards ( $F_{2,83} = 10.16$ ,  $P < 0.0001$ ), number of lizard species ( $F_{2,83} = 11.38$ ,  $P < 0.0001$ ), and total number of lizard individuals seen ( $F_{2,83} = 20.89$ ,  $P < 0.0001$ ). Whiptails were uncommon in the ditch ( $1.0 \pm 1.1/\text{ha}$ ) relative to the flats ( $7.3 \pm 3.9/\text{ha}$ ) or the arroyo bottoms ( $6.3 \pm 3.0/\text{ha}$ ). Side-blotched lizards were also uncommon in the ditch ( $2.7 \pm 5.8/\text{ha}$ ) relative to their numbers on the flats ( $31.3 \pm 5.1/\text{ha}$ ), or in the arroyo bottoms ( $30.0 \pm 7.0/\text{ha}$ ). In contrast, zebra-tailed lizards were more abundant in the ditch ( $7.3 \pm 3.4/\text{ha}$ ) relative to the flats ( $0.0 \pm 0.0/\text{ha}$ ), or the arroyos ( $2.3 \pm 5.7/\text{ha}$ ). Number of lizard species per plot also differed across plots, with the ditch containing fewer species per plot ( $0.8 \pm 0.7$ ), than the flats ( $1.6 \pm 0.3$ ) or the arroyos ( $1.6 \pm 0.3$ ). Finally, number of lizards seen per plot differed between the ditch ( $11.3 \pm 6.1/\text{ha}$ ) and the flats ( $40.7 \pm 7.4/\text{ha}$ ), or the arroyos ( $39.3 \pm 9.0/\text{ha}$ ). In none of these comparisons did differences occur between flats and arroyos.

Table 16. ANOVA results testing for differences in lizard parameters across sample days and treatments.		
Lizard parameters	Statistics	
	Across treatments	Across dates
No. of side-blotched lizards per plot	$F_{1,84} = 77.9$ , $P < 0.0001$	$F_{4,84} = 0.56$ , $P = 0.692$
No. of whiptails per plot	$F_{1,84} = 10.77$ , $P = 0.002$	$F_{4,84} = 1.03$ , $P = 0.397$
No. of zebra-tailed lizards per plot	$F_{1,84} = 18.14$ , $P < 0.0001$	$F_{4,84} = 0.74$ , $P = 0.57$
No. of lizard species per plot	$F_{1,84} = 22.99$ , $P < 0.0001$	$F_{4,84} = 0.71$ , $P = 0.587$
No. of lizard individuals per plot	$F_{1,84} = 42.18$ , $P < 0.0001$	$F_{4,84} = 0.52$ , $P = 0.21$

## DAF Lizard Transects

Whiptails, leopard lizards, side-blotched lizards, zebra-tailed lizards, and horned-lizards were seen on plots in late spring, but only two species were abundant enough for analysis. Whiptails were more often seen in vegetated areas around 20 m from road center ( $12.0 \pm 3.3/\text{ha}$ ), or control areas well removed from the road ( $13.3 \pm 3.2/\text{ha}$ ), than in areas from 0 to 10 m from road center ( $2.7 \pm 1.7/\text{ha}$ , Kruskal-Wallis  $H = 34.91$ , 2 d.f.,  $P < 0.0001$ ). Side-blotched lizards were more often seen in the area approximately 20 m from road center ( $11.6 \pm 3.4/\text{ha}$ ), or the control area well removed from the road ( $13.3 \pm 1.5/\text{ha}$ ) than near the road ( $0.00 \pm 0.00/\text{ha}$ ,  $H = 53.13$ , 2 d.f.,  $P < 0.0001$ ). Number of lizard species seen per 50 m of transect also differed across areas, with highest numbers in the vegetated area near the road ( $1.36 \pm 0.19$ ) or the control area ( $1.03 \pm 0.20$ ) and fewer species seen in the bare area near the road ( $0.37 \pm 0.55$ ,  $H = 43.31$ , 2 d.f.,  $P < 0.0001$ ). Number of individual lizards seen was greatest on vegetated plots near the road ( $26.4 \pm 4.2/\text{ha}$ ), slightly lower in vegetated areas well removed from the road ( $18.2 \pm 3.7/\text{ha}$ ) and lowest in the nonvegetated areas near the road ( $5.8 \pm 2.4/\text{ha}$ ,  $F_{2,171} = 34.8$ ,  $P < 0.0001$ ). None of the correlations between number of lizards observed per species, number of species, or number of individual lizards seen per 50 m of transect and time of sample collection were significant (all probability values  $> 0.20$ ).

Lizard transects were walked from mid to late morning because this covers the temperature range over which the focal lizard species are active. Ground temperatures rise rapidly over this time period and can exceed lizard limits by late morning. Lack of a significant correlation between time of sample and counts within a sample (observations of number/species in a 50 x 15 m section of transect) suggests that our counts did not vary across the sampling period and imply that they did not extend into inordinately high temperatures. A one way ANOVA on time of sample collection yielded similar results for the DAF timed surveys.

## DAF Timed Surveys

Side-blotched lizards, whiptails, leopard lizards, collared lizards, horned-lizards, desert spiny lizards, and zebra-tailed lizards were seen. Only three of these species were abundant enough to merit analysis. There were differences in number of lizards seen by different observers for 2 of 3

species examined (Table 17), although differences tended to be small (Table 18). *Post hoc* Tukey tests could detect no differences between investigators. There were no differences across investigators in number of species seen or total number of individual lizards seen (Tables 17, 18). Differences across locations were present for all three species (Table 17) and some of these differences were quite large (Table 18, Figures 13 - 15). Lizard counts for side-blotched lizards, zebra-tailed lizards, whiptails, number of species pooled, or number of lizards pooled across species (Figure 16), did not differ significantly over the two one half hour sample periods (all probability values > 0.30).

Table 17. Results of analysis of variance tests examining effects of investigator, or search location on number of lizards seen per 30 minute				
Species	Investigator		Search Location	
	F	P	F	P
Side-blotched	2.80	0.038	7.84	0.0001
Whiptailed	1.38	0.258	2.89	0.034
Zebra-tailed	4.01	0.008	21.81	0.0001
No. of lizard	1.30	0.287	1.93	0.124
No. of lizard	1.68	0.172	2.96	0.031



Table 18. Reptile relative abundances (number seen per 30 minute period,  $\bar{x} + 2 \text{ se}$ ) near the DAF.

Species	Area A Inside disturbed area around building	Area B From disturbed area to water tank	Area C From water tank to base of foothills	Area D 200 m up into foothills	Area E South of DAF	Non- transect sightings
<i>Gopherus agassizii</i>	--	--	--	--	--	B - E
<i>Callisaurus draconoides</i>	12.5 $\pm$ 4.6	1.7 $\pm$ 0.9	2.2 $\pm$ 1.8	2.0 $\pm$ 1.4	0.7 $\pm$ 0.4	A - C, E
<i>Crotaphytus insularis</i>	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	0.0 $\pm$ 0.0	0.2 $\pm$ 0.4	0.0 $\pm$ 0.0	--
<i>Dipsosaurus dorsalis</i>	--	--	--	--	--	--
<i>Gambelia wislizenii</i>	0.6 $\pm$ 0.9	0.1 $\pm$ 0.2	0.1 $\pm$ 0.2	0.1 $\pm$ 0.2	0.2 $\pm$ 0.3	A, B, E
<i>Phrynosoma platyrhinos</i>	0.1 $\pm$ 0.2	0.1 $\pm$ 0.2	0.0 $\pm$ 0.0	0.1 $\pm$ 0.2	0.1 $\pm$ 0.2	B, E
<i>Sauromalus obesus</i>	--	--	--	--	--	D
<i>Sceloporus graciosus</i>	--	--	--	--	--	--
<i>Sceloporus magister</i>	0.2 $\pm$ 0.3	2.0 $\pm$ 1.1	1.3 $\pm$ 1.0	0.7 $\pm$ 1.0	2.0 $\pm$ 0.6	B - E
<i>Sceloporus occidentalis</i>	--	--	--	--	--	--
<i>Uta stansburiana</i>	0.7 $\pm$ 0.5	7.4 $\pm$ 3.0	5.9 $\pm$ 2.4	6.9 $\pm$ 1.8	4.2 $\pm$ 1.7	A - E
<i>Coleonyx variegatus</i>	--	--	--	--	--	E
<i>Xantusia vigilis</i>	--	--	--	--	--	--
<i>Cnemidophorus tigris</i>	1.1 $\pm$ 0.6	2.7 $\pm$ 1.7	0.8 $\pm$ 0.5	0.9 $\pm$ 0.6	1.2 $\pm$ 0.7	A - E
<i>Eumeces gilberti</i>	--	--	--	--	--	--
<i>Eumeces skiltonianus</i>	--	--	--	--	--	--
No. lizard species	2.8 $\pm$ 0.7	3.7 $\pm$ 0.4	3.3 $\pm$ 0.3	3.1 $\pm$ 0.6	3.5 $\pm$ 0.5	--

Table 18. continued.

Species	Area A Inside disturbed area around building	Area B From disturbed area to water tank	Area C From water tank to base of foothills	Area D 200 m up into foothills	Area E South of DAF	Non- transect sightings
No. lizard individuals	15.2 ± 4.6	13.7 ± 4.6	10.4 ± 2.1	10.9 ± 2.0	8.4 ± 1.6	A - F
<i>Leptotyphlops humilis</i>	---	--	--	--	--	--
<i>Arizona elegans</i>	--	--	--	--	--	--
<i>Chionactis occipitalis</i>	--	--	--	--	--	--
<i>Diadophis punctatus</i>	---	--	--	--	--	--
<i>Hypsiglena torquata</i>	--	--	--	--	--	--
<i>Lampropeltis getulus</i>	--	--	--	--	--	--
<i>Masticophis flagellum</i>	---	--	--	--	--	--
<i>Masticophis taeniatus</i>	--	--	--	--	--	--
<i>Phyllorhynchus decurtatus</i>	--	--	--	--	--	--
<i>Pituophis melanoleucus</i>	---	--	--	--	--	--
<i>Rhinocheilus lecontei</i>	--	--	--	--	--	--
<i>Salvadora hexalepis</i>	---	--	--	--	--	--
<i>Sonora semiannulata</i>	---	--	--	--	--	--
<i>Tantilla hobartsmithi</i>	--	--	--	--	--	--
<i>Trimorphodon biscutatus</i>	---	--	--	--	--	--
<i>Crotalus cerastes</i>	--	--	--	--	--	A
<i>Crotalus mitchelli</i>	---	--	--	--	--	A R



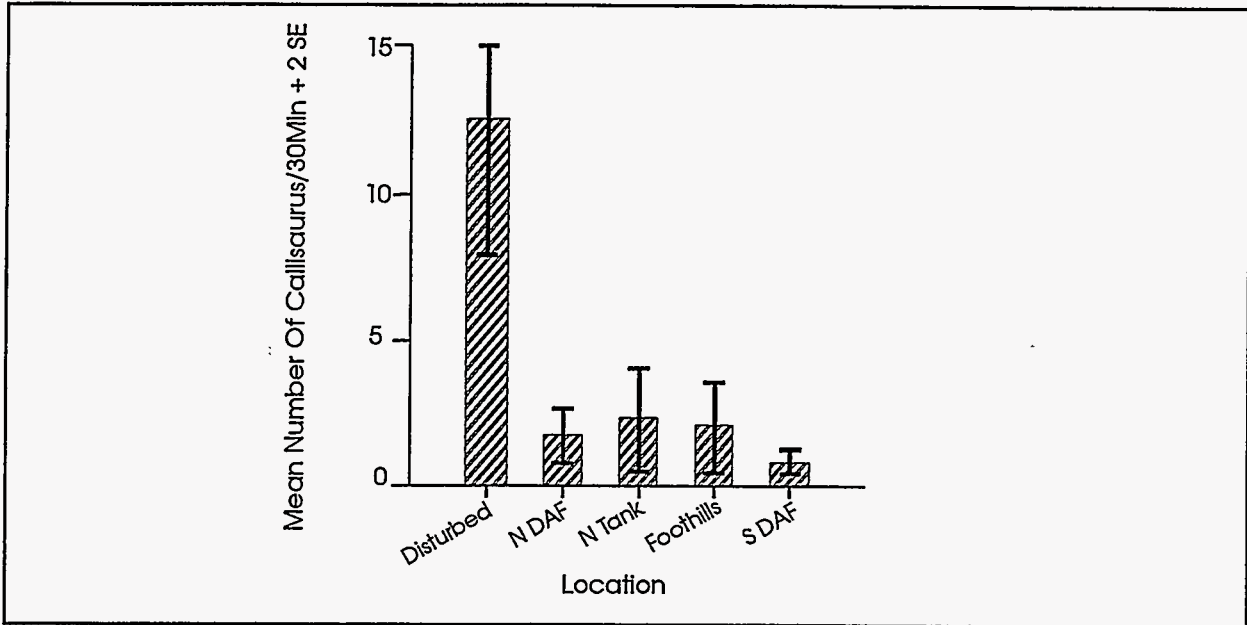


Figure 13 - Mean number of zebra-tailed lizards seen per 30 minute search in five areas near the DAF in summer 1993.

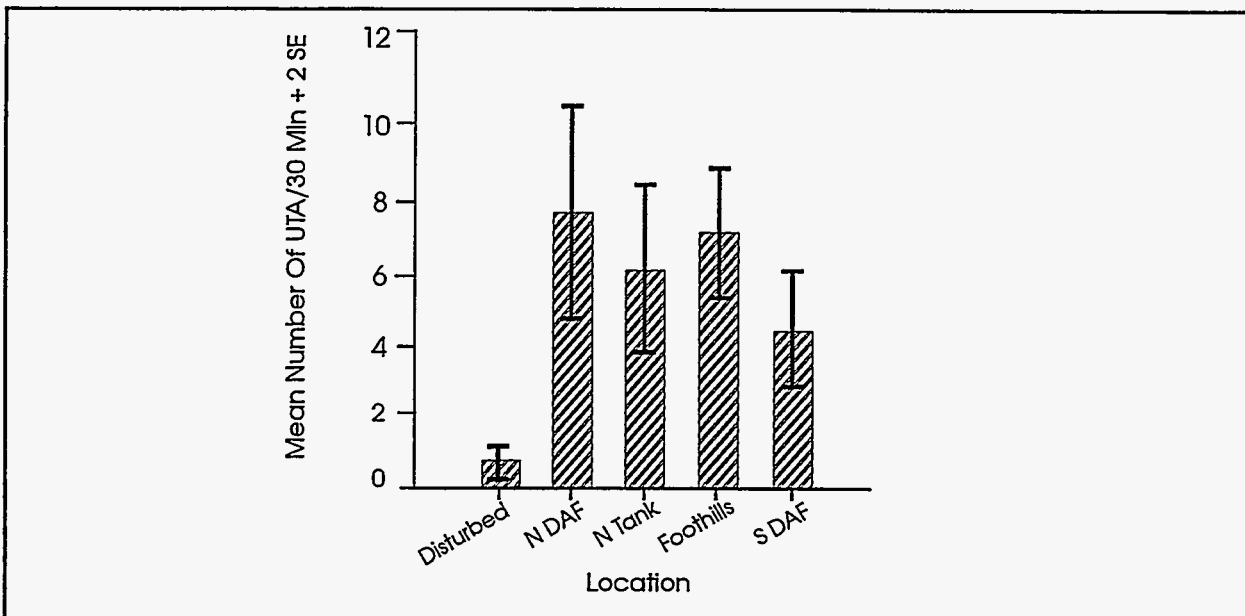


Figure 14 - Mean number of side-blotched lizards seen per 30 minute search in five areas near the DAF in summer 1993.

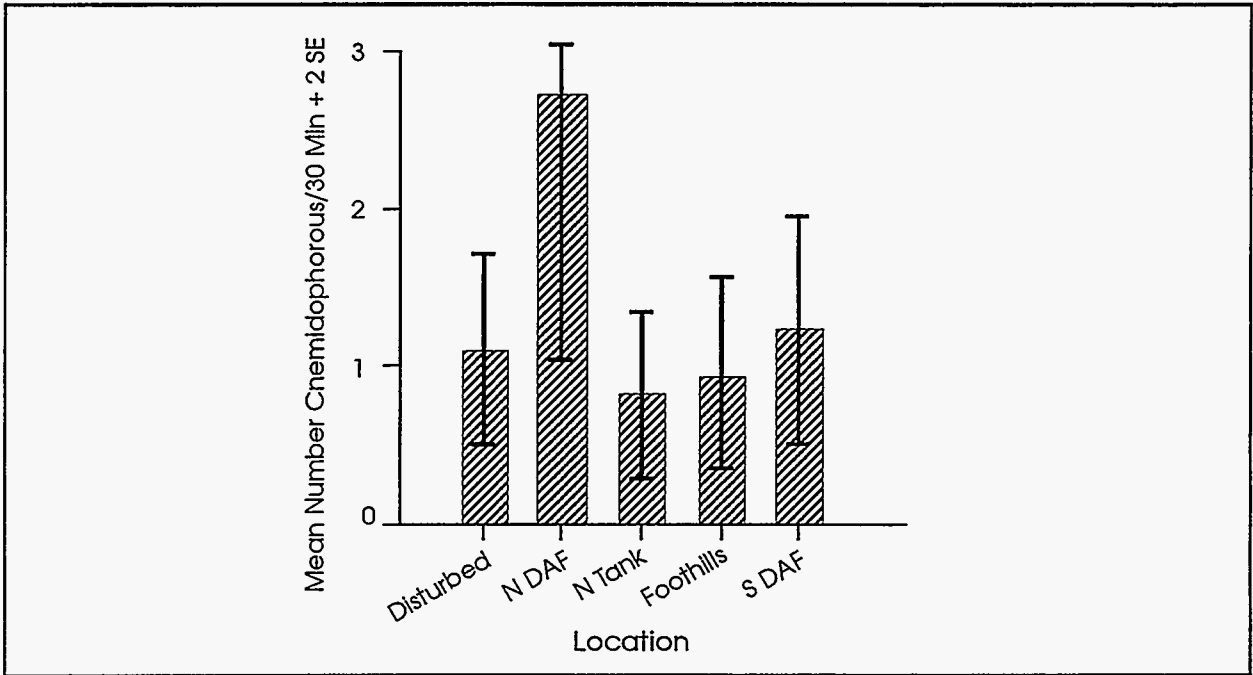


Figure 15 - Mean number of whiptail lizards seen per 30 minute search in five areas near the DAF in summer 1993.

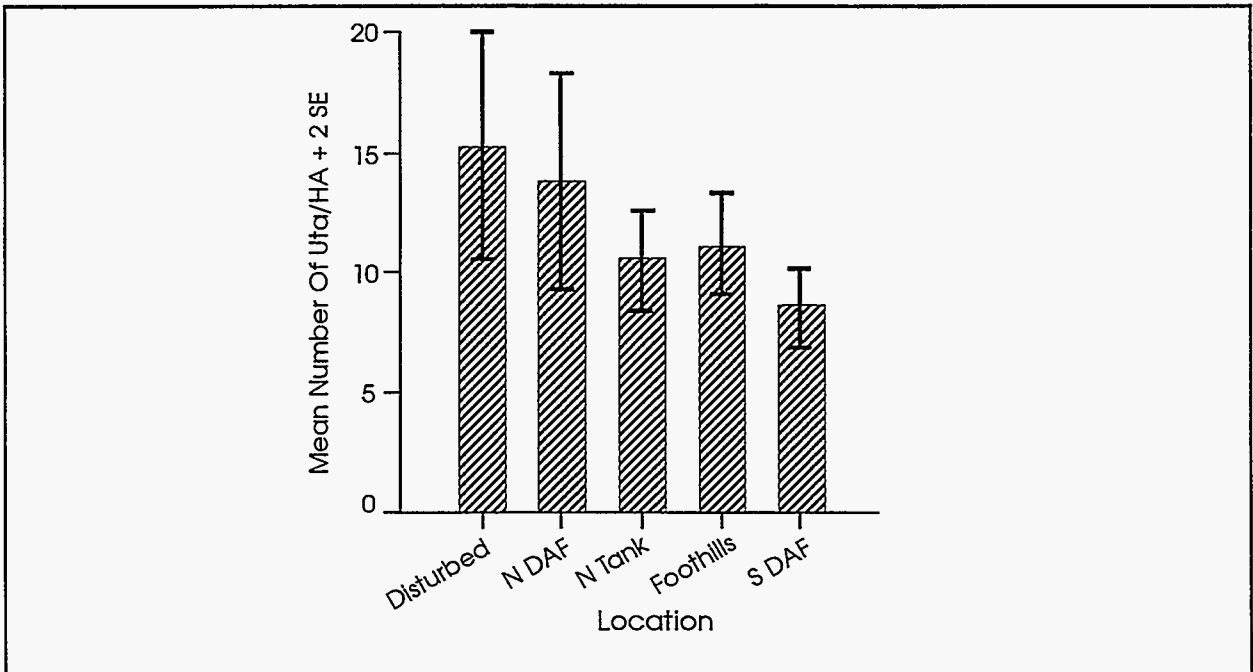


Figure 16 - Mean number of lizards (pooled across all species) seen per 30 minute search in five areas near the DAF in summer 1993.

## Reptile Species

Many reptile species were seen near the DAF (Table 18). The species list for lizards is relatively complete, whereas many snakes that are likely living there were not seen. Most species were widely distributed (Table 18), however, chuckwallas and collared lizards appear to be restricted to the rocky hillsides. One banded gecko (*Coleonyx variegatus*) was seen in an undisturbed area south of the DAF buildings. These lizards are not commonly seen, which may be a consequence of their secretive nature, and not a reflection of their relative scarcity. Several man-hours were put into rolling approximately 500 fallen Yucca trunks in an attempt to find the night lizard (*Xantusia vigilis*); none were seen.

Several man hours were spent looking for chuckwallas (*Sauromalus obesus*) in the foothills to the N and W of the DAF as the State of Nevada is becoming increasingly concerned over chuckwalla populations. One chuckwalla was seen in the foothills east of Mercury highway, approximately 4 km from the DAF buildings. Chuckwalla scat (of unknown age) was seen in several locations in the foothills north and west of the DAF buildings. Chuckwallas probably still occupy the surrounding foothills. Desert tortoises (*Gopherus agassizii*) or their remains were seen in all areas near the DAF except the disturbed DAF area. One live tortoise was marked and measured on 5 May 1993 approximately 300 m NW of the DAF ditch, and captured and measured again on 15 September approximately 100 m east of the DAF buildings on the paved access road. It had grown two mm in plastron length. All other sightings consisted of old tortoise remains (shells or scutes) and were concentrated to the north and west of the DAF buildings, however some were also present south of these buildings. Desert tortoise (federally threatened) and chuckwalla (state species of special concern and a federal candidate-category-2-species) were the only reptiles of special concern observed in the vicinity of the DAF.

## BIRDS

### Sewage Pond vs Natural Area

Bird usage of the DAF sewage ponds during spring (March-April) was low followed by heavy summer use. The three most abundant species observed during 1993 were mourning doves, house finches and black-throated sparrows. Usage varied significantly between the above three species during spring-summer

( $F_{2,20} = 61.0$ ,  $P < 0.0001$ ) but not across individual dates ( $F_{10,20} = 0.75$ ,  $P = 0.67$ , Table 19).

Mean air temperature ( $^{\circ}\text{C}$ ) at the pond ( $28.5 \pm 2.0$ ) did not differ from that in the natural habitat ( $29.3 \pm 2.3$ ) even though they were often sampled one hour apart ( $t = 0.88$ , 12 d.f.,  $P = 0.40$ ). Numbers of birds on the natural habitat area were quite low (Table 19). There were no differences in total number of the dominant three species counted across dates in spring-summer ( $F_{10,20} = 1.3$ ,  $P = 0.30$ ). However, counts of all three species differed from each other on the natural plot during spring-summer ( $F_{2,20} = 21.8$ ,  $P < 0.0001$ ; Tukey tests).

Mourning doves (*Zenaida macroura*) and house finches (*Carpodacus mexicanus*) arrived in high numbers in early May (Table 19). Counts (bird visits/hr) from outside the vehicle during two weeks from April 28-5 May ( $n = 4$ ), averaged  $69 \pm 34$  for doves (range = 30-100) and  $51 \pm 36$  for house finches (range 20-97). On 5 May 1993, dove counts from outside and inside the vehicle were compared: 97 verses 233 respectively: a large observer effect.

A second modification involved searching a natural habitat area (Plot 1) on foot ( $n = 8$ ) versus making counts from a fixed position ( $n = 3$ ). There appeared to be no difference between techniques in terms of birds observed per unit time ( $t = 0.6$ , 9 d.f.  $P = 0.56$ ).

Mean dove use of the pond was greater than house finches and black-throated sparrows (Tukey test,  $P = 0.0001$  for both comparisons) during the summer, reaching a peak in early June (Table 19). Doves declined gradually through July and were absent by September. House finches were numerous at the ponds but only from May-June. Finch numbers dropped to near zero by the middle of July but returned in moderate numbers by fall. The coefficient of variation for finches was highest (160%) for all species during the summer. Average use by house finches and black-throated sparrows did not differ (Tukey test,  $P = 0.99$ ), although they used the pond at different times of the year (Table 19).

Doves used the sewage pond more than a natural habitat on all dates ( $n = 10$ ) during spring-summer (Table 20, Figures 17, 18). House finches also used the pond at significantly greater rates than a control during mid-May through mid-June and again in the fall for one date (Table 20, Figures 19, 20). In May through June, black-throated sparrows used the control location in greater numbers than the sewage pond (Table 20). This species did not use the ponds until the end of June when mid-morning temperatures exceeded  $25^{\circ}\text{C}$ . Juveniles

comprised almost all of the sightings of black-throated sparrows seen in July (Table 19). Pond use was greater throughout July than natural habitat use (Table 20, Figures 21, 22).

**Table 19.** Total number of bird visits per hour of the dominant species at the DAF sewage pond and an undisturbed location during spring-fall of 1993. Mean  $\pm$  2 se and coefficient of variation %, = SD/Mean x 100 for summer, N = 11. Dashes = not sampled.

Date	Sewage Pond			Natural Plot		
	House finches	Mourning doves	Black-throated sparrows	House finches	Mourning doves	Black-throated sparrows
3-10-93	0	0	0	-	-	-
3-24-93	0	0	0	-	-	-
5-13-93	121	356	0	0	1	5
5-18-93	145	390	0	3	4	18
6-03-93	100	622	0	2	7	13
6-17-93	19	492	0	0	6	11
6-29-93	2	407	22	0	5	14
7-08-93	1	343	63	0	5	6
7-14-93	2	324	53	0	5	0
7-15-93	0	375	66	0	4	10
7-20-93	0	222	65	0	6	3
7-22-93	0	241	62	0	5	9
7-27-93	0	267	112	0	2	14
9-30-93	26	0	0	-	-	-
10-19-93	4	0	0	0	0	0
11-02-93	7	0	0	0	0	0
11-10-93	26	0	0	0	0	0
Mean+2se <sup>a</sup>	35+34	367+70	40+22	0.45+1.0	4.5+1.0	9.4+3.2
Coeff Var	160	31	94	228	39	58

<sup>a</sup> calculated for May-July only: Control not sampled on 30 September.

**Table 20.** Comparisons of bird counts (number/5 minutes) between sewage pond and control at DAF for various dates. P values in parentheses. T values in light print (22 d.f.); H values for Kruskal-Wallis test (1 d.f.) in bold; used for cases where species was absent on one plot. \* = species absent from both habitats. NS = not significant. NC = no comparison because sample sizes were too small.

Date	Mourning dove	House finch	Black-throated sparrow	Sage sparrow
5-18-93	3.2 (.008)	3.9 (.002)	15.2 (.0001)	*
6-03-93	9.7 (.00001)	5.7 (.0001)	NC	*
6-17-93	14.2 (.00001)	9.1 (.003)	7.5 (.006)	*
6-29-93	4.9 (.0005)	1.0 (.32) NS	NC	*
7-08-93	6.6 (.00001)	1.0 (.32) NS	3.5 (.0046)	*
7-14-93	9.4 (.00001)	NC	15.0 (.0001)	*
7-15-93	5.4 (.0002)	*	3.2 (.0066)	*
7-20-93	3.8 (.0029)	*	3.0 (.011)	*
7-22-93	3.4 (.0058)	*	2.1 (.053)	*
7-27-93	6.1 (.0001)	*	3.1 (.0074)	*
10-19-93	*	2.1 (.15) NS	*	0.3 (.79) NS
11-02-93	*	3.3 (.07) NS	*	11.0 (.001)
11-10-93	*	4.6 (.033)	*	9.1 (.003)

Sage sparrows (*Amphispiza belli*) were first observed at the DAF area in October. They used both pond and natural habitats equally at this time. However, in November, pond use exceeded use of the natural area (Table 20, Figures 23, 24). Sage sparrows usually breed at higher elevations in the northern part of the NTS, and are common migrants through Frenchman flat in winter (Hayward et al. 1963). Other sparrow usage was minimal and included white-crowned sparrows (fall), Brewer's sparrows (spring and fall) and song sparrows (spring).

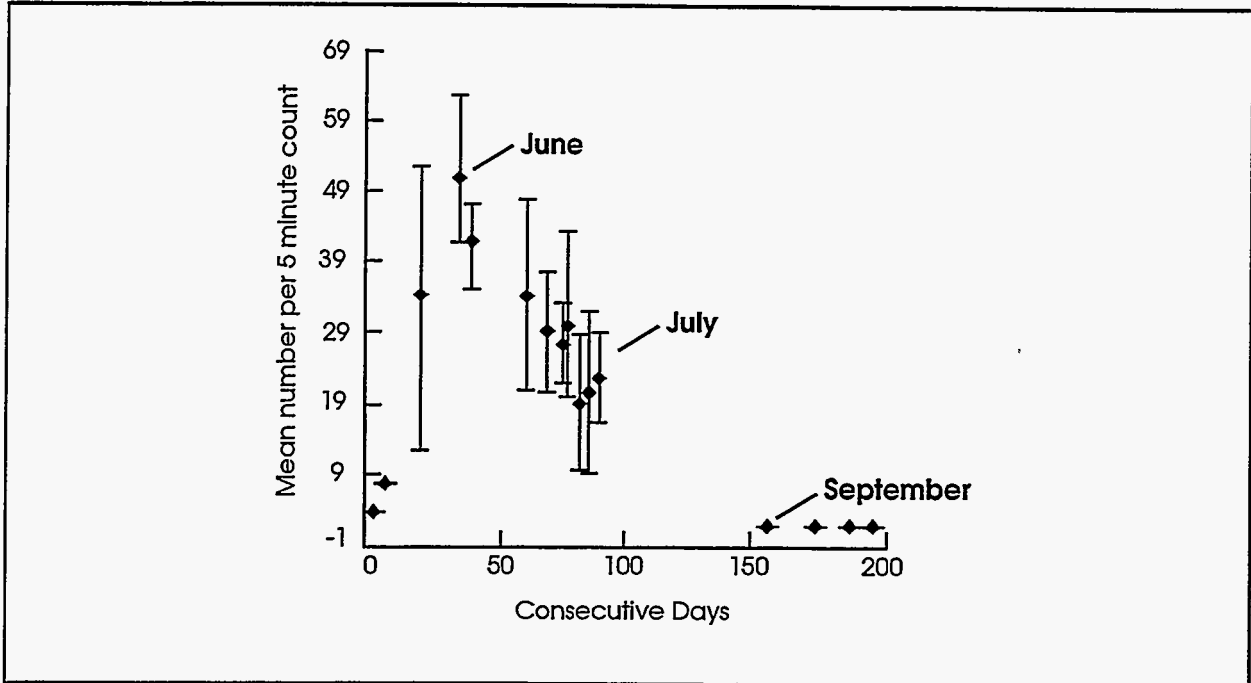


Figure 17 - Sewage pond use by mourning doves.

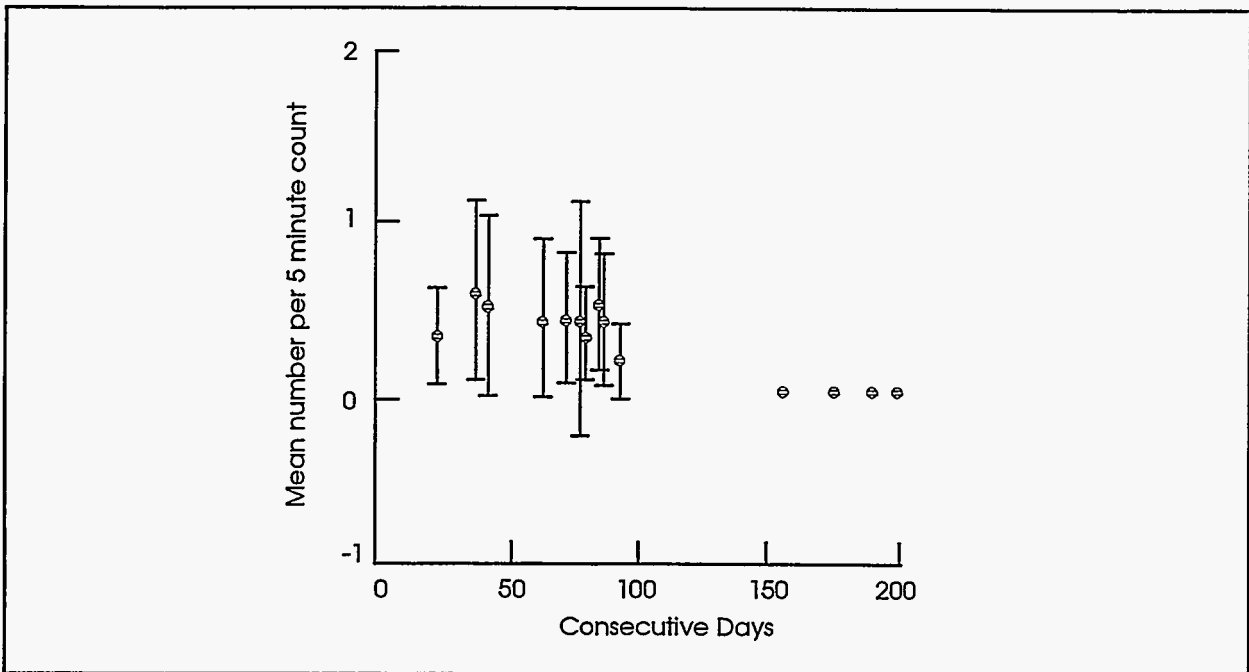


Figure 18 - Natural habitat use by mourning doves.

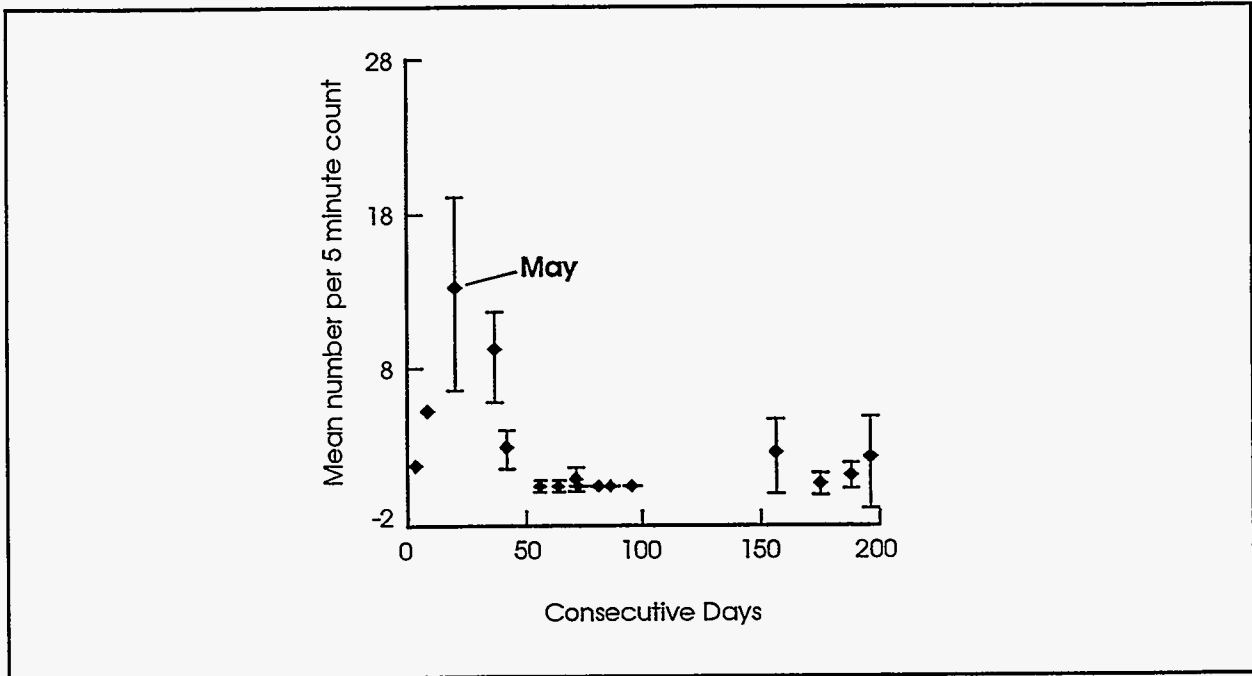


Figure 19 - Sewage pond use by house finches.

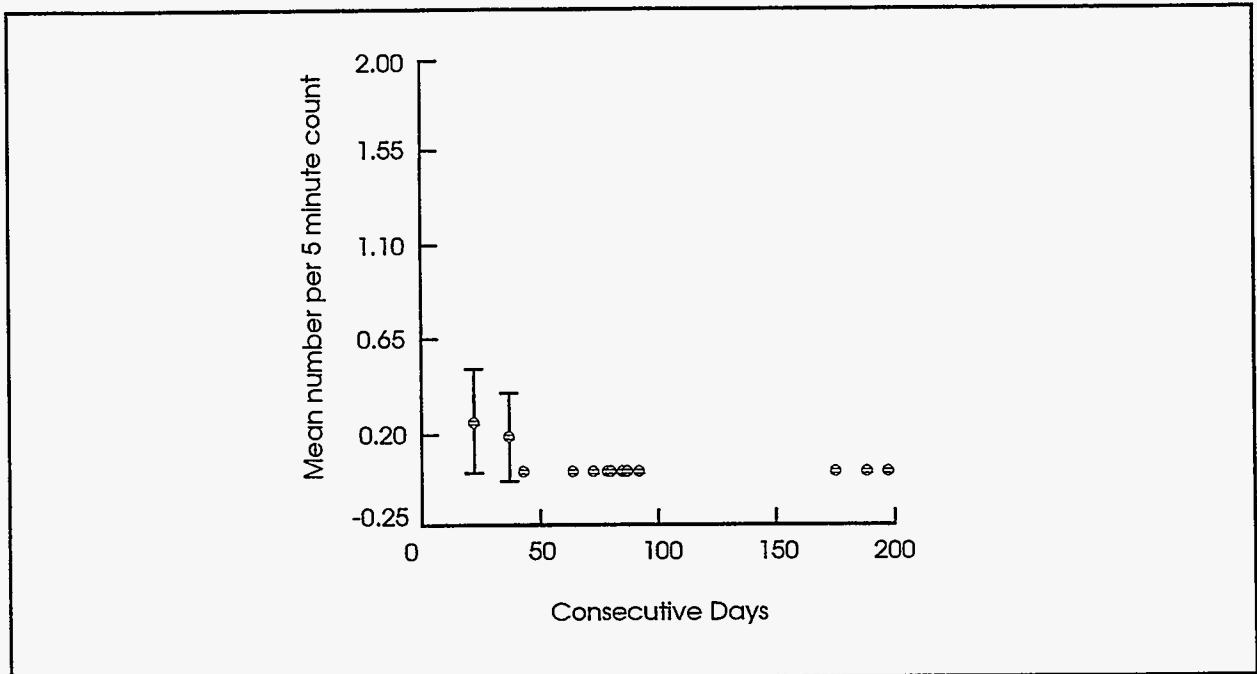


Figure 20 - Natural habitat use by house finches.



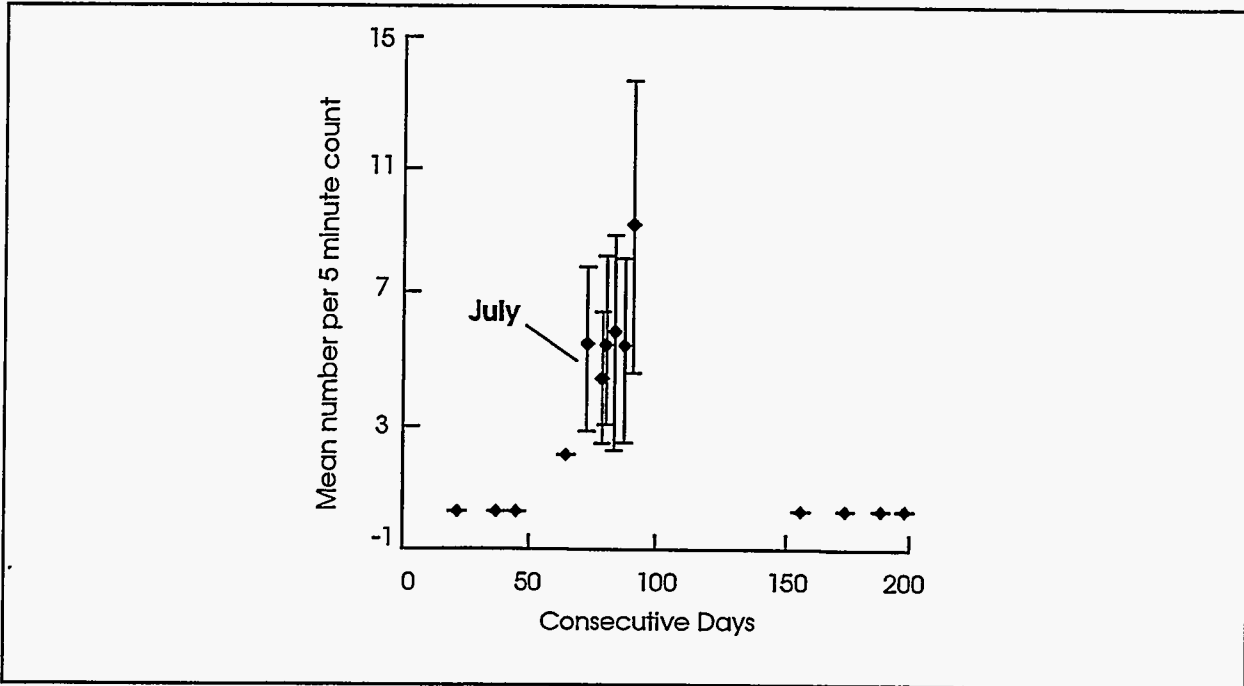


Figure 21 - Sewage pond use by black-throated sparrows.

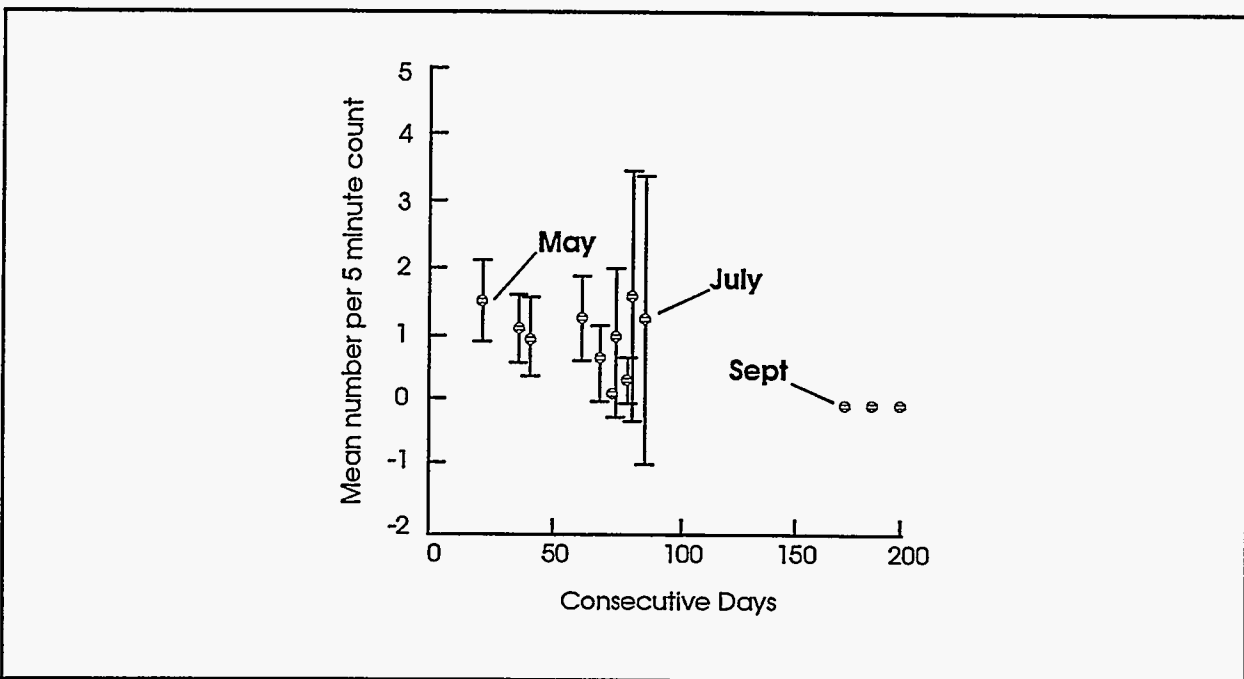


Figure 22 - Natural habitat use by black-throated sparrows.

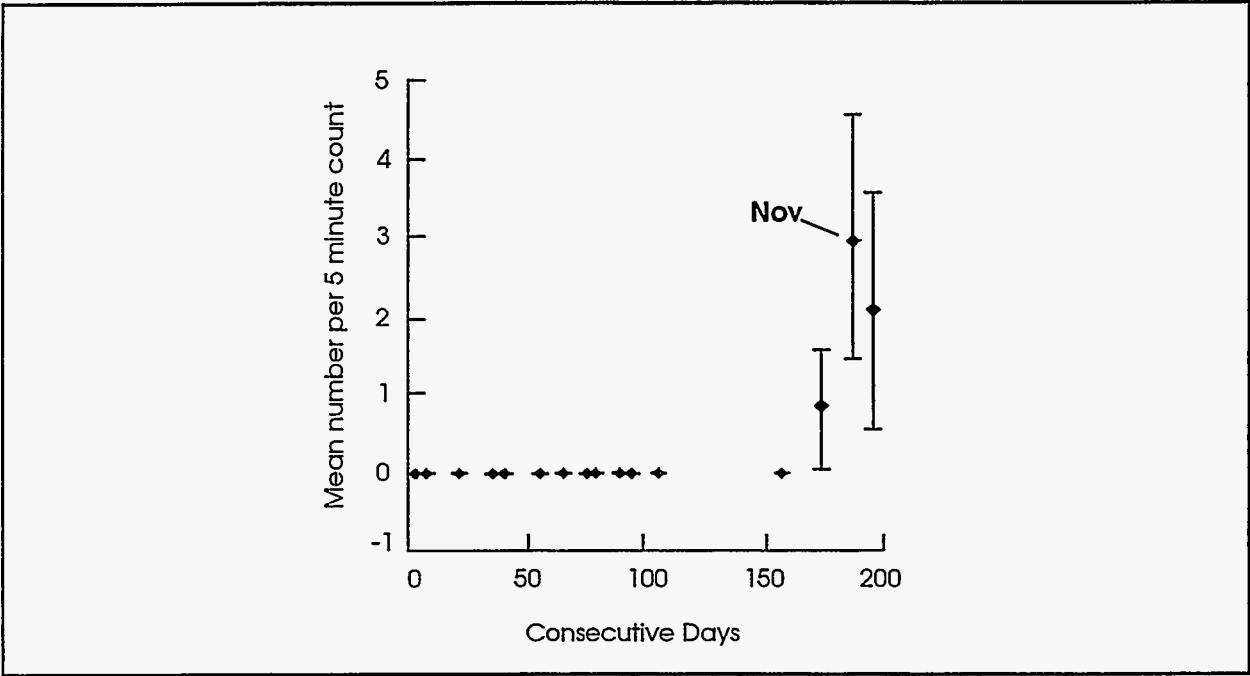


Figure 23 - Sewage pond use by sage sparrows.

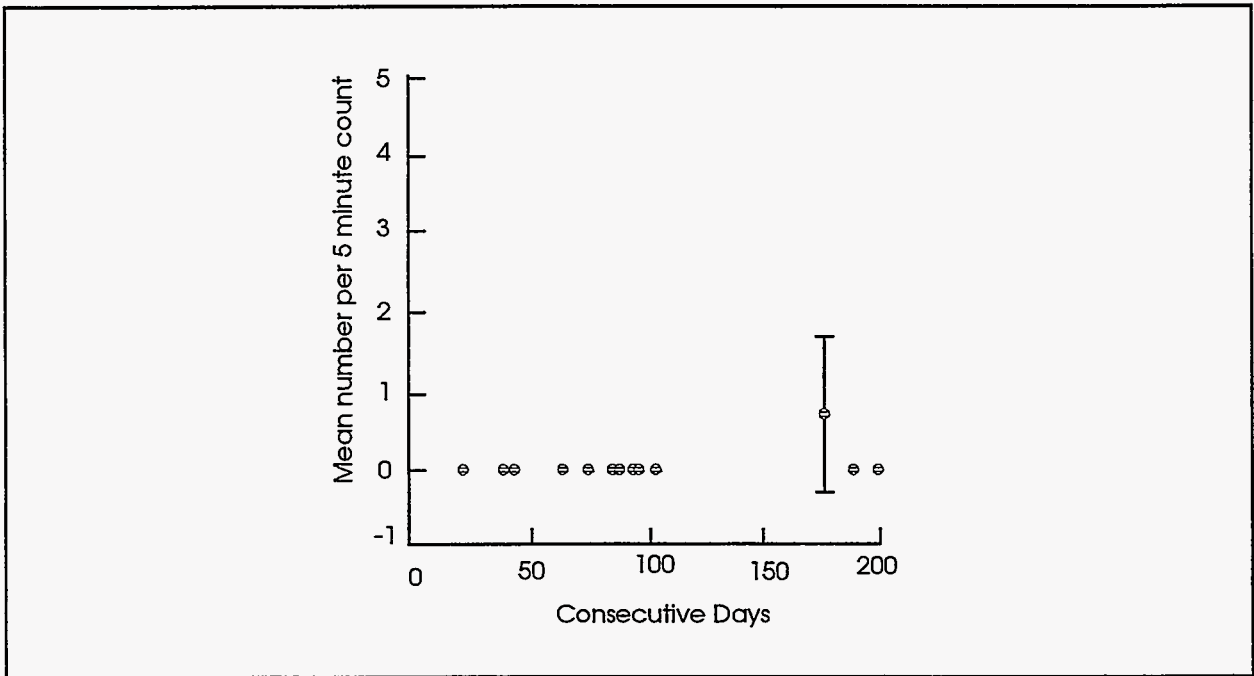


Figure 24 - Natural habitat use by sage sparrows.

## Other Migrant Use

During 1993, 39 species (25 were passerine species or perching birds) used the sewage ponds for resting, drinking or foraging (Appendix D). Thirteen of these were seen in natural habitats. Eleven species of shorebirds and ducks were seen at the sewage ponds but not in other habitats. These included spotted sandpiper, least and western sandpiper, American avocet, willet, snowy egret, bufflehead, and cinnamon and green-winged teal. Raptors observed were prairie falcon, red-tailed hawk and barn owl. Prairie falcons hunted doves and one was observed making a kill during mid-day. A red-tailed hawk was sighted drinking from the pond in mid July. Barn owls were also seen in one evening visit at the pond during July. Throughout the summer, remains of doves and regurgitated food pellets commonly littered the sewage pond area, suggesting heavy bird predation.

Species seen at sewage pond, roads, and buildings included common raven, American pipit, horned lark, barn owl, starling, and European house sparrow. Several barn owls (on two occasions) and an American kestrel were removed from inside the DAF building during August. Two barn owls died near the DAF building in July and August.

## Ravens

Ravens were not abundant at the sewage pond. They were seen on only 55% of visits throughout the year with an average sighting rate of  $1.25 \pm 0.7$  ravens per hour. Numbers sighted increased in fall (Figure 25) over spring and summer ( $F_{2,17} = 18.4$ ,  $P < 0.0001$ ) although totals were low. In addition, moderate numbers of ravens (4,4,1) were observed on plot 1 (3 one hour visits, respectively) in October–November while very few (2 total) were observed during the spring–summer ( $n = 16$  visits,  $>20$  hrs of observation) in natural habitats north of the DAF building. Therefore, raven numbers sighted from the control area appear consistent with numbers at the sewage pond within each season. Maximum number of ravens observed at the pond during a visit was twelve on 10 November. Most birds arrived in singular fashion over a 10–15 minute period as though they were being recruited by presence of other birds.

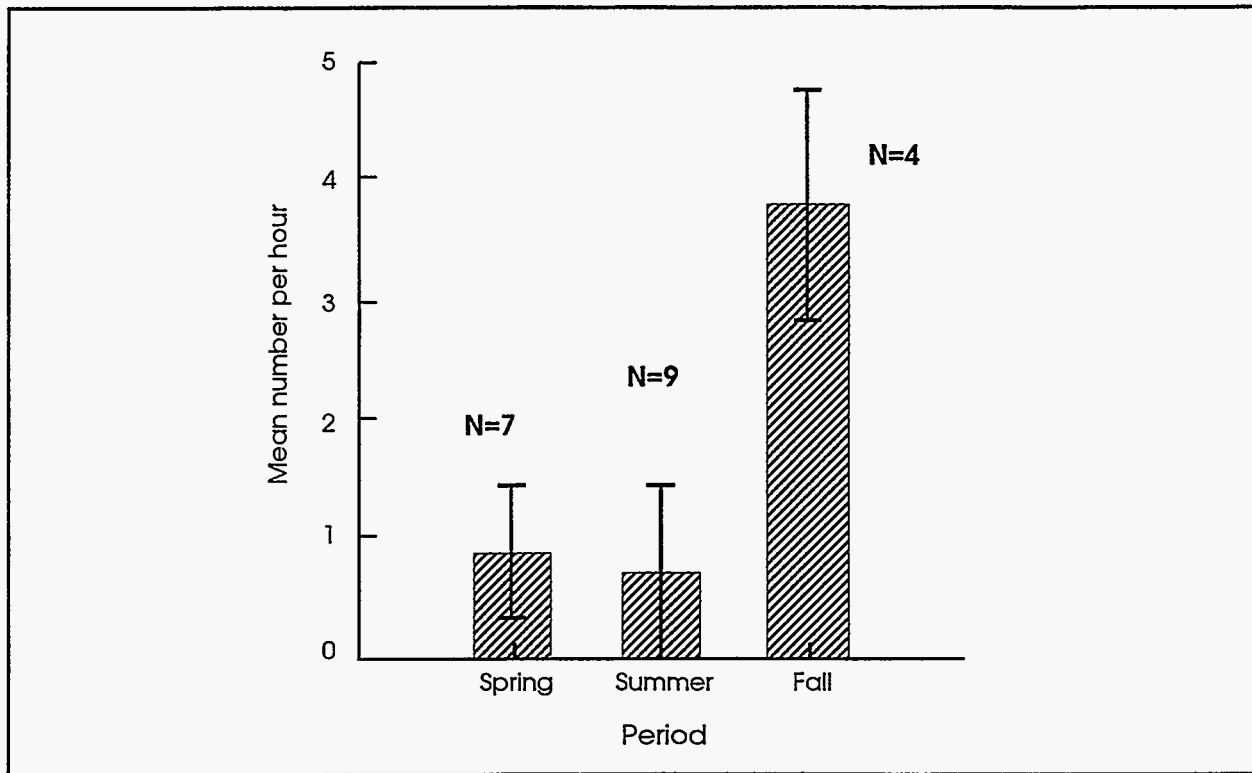


Figure 25 - Ravens observed at the DAF sewage pond 1993, N = number of visits.

### Bird Species on Undisturbed Habitats

We observed 31 bird species in natural habitats near the DAF in 1993. Eighteen of these were not seen at the sewage ponds. Raptors sighted were American kestrel, osprey, golden eagle, red-tailed hawk, and Swainson's hawk. Non-breeders in natural habitats included cactus wren, ladder-backed woodpecker, black-headed grosbeak, sage thrasher, mountain bluebird, pinyon jay and long-billed curlew. Breeding species detected at the DAF in 1993 were black-throated sparrow, mourning dove, house finch, northern mockingbird, Scott's oriole, and burrowing owl. Other probable breeders in the DAF vicinity as evidenced by the presence of juveniles during June-July were chukar, ash-throated flycatcher, Say's phoebe, loggerhead shrike, and western kingbird. Supplemental information of nesting is shown in Table 21.

Breeding activity for birds in the DAF region peaked in mid-May. Breeding periods for species were as follows: black-throated sparrow, early May to early June; house finch, late April to mid-May; mourning dove, early May to early July; northern mockingbird, early May to late May.

Table 21. Mean number ( $\pm 2$  se) of eggs and nestlings observed per nest for breeding species near the DAF.

Species	N	Eggs	Nestlings
Black-throated sparrow	7	3.43 $\pm$ 0.40	
Black-throated sparrow	6		3.0 $\pm$ 0.72
House finch	3		3.33 $\pm$ 1.32
Mourning dove	3	2.0 $\pm$ 0.0	
Mourning dove	2		1.5 $\pm$ 1.0
Northern mockingbird	1		5 <sup>a</sup>
Burrowing owl	1		5 <sup>b</sup>

<sup>a</sup>=Total number

<sup>b</sup>=Total number of fledglings observed at one burrow.

In the area north of the DAF building (Fig. 1), densities of black-throated sparrows did not vary significantly with respect to plot location ( $F_{4,12} = 1.6$ ,  $P = 0.25$ ) or sampling date ( $F_{3,12} = 1.2$ ,  $P = 0.36$ ). Furthermore, black-throated sparrow numbers did not differ across all plots, ( $F_{6,19} = 1.2$ ,  $P = 0.33$ ). In natural areas (Plots 1-7) there were no changes in black-throated sparrow numbers from late April through June ( $F_{5,19} = 2.2$ ,  $P = 0.10$ ). Combining all plots sampled ( $n = 7$ ), and using a radius of detectability of 60 m, density of black-throated sparrows was about  $1.87 \pm 0.46$  birds/ha (187 birds/km<sup>2</sup>). Mean number of black-throated sparrows estimated per ha was significantly greater than 0 for all plots ( $t = 8.13$ , 25 d.f.,  $P < 0.001$ ).

Northern mockingbird density was estimated at about  $0.09 \pm 0.04$  birds/hectare (9 birds/km<sup>2</sup>) with a radius of detectability of 150 m. Because of low numbers, densities of other species present could not be estimated.

### Sensitive Bird Species

Sensitive bird species that have recently been observed on Frenchman Flat include the American peregrine falcon, white-faced ibis, and loggerhead shrike. Peregrine falcons are uncommon to rare migrants in this region, but

could occur at the DAF. One was sighted in 1992 on north Frenchman Flat near a well pond: the first NTS record since 1976.

White-faced ibis are common migrants through the NTS region and are regularly sighted at well reservoirs throughout the NTS during spring and fall but are not abundant. This species will probably use the DAF sewage pond for short resting and foraging stops.

Loggerhead shrikes are common summer residents on the NTS and appear to breed near the DAF. They have been observed around the DAF regularly in summer, and may use the fence around the DAF compound for perching and impaling lizards.

It is possible that bald eagles may rarely migrate onto the NTS. Several sightings of bald eagles were made near Rock Valley in 1977 (Castetter and Hill 1979). At present, a small population of bald eagles winters at Pahrangat Lake National Wildlife Refuge, less than 100 km northeast of the NTS. Additional sensitive bird species that have been observed recently on the NTS include Swainson's hawk, with several sightings on Frenchman Flat and at the DAF and northern goshawk (Rainier Mesa). There are no other sensitive bird species expected in the vicinity of the DAF facility.

## MAMMALS

### Rodents Present

Several small mammal species were captured at each site during 1993 (Table 22). The three sites differed in only three species: *Perognathus longimembris*, *Peromyscus maniculatus*, and *Ammospermophilus leucurus*. *P. maniculatus* was captured in low numbers only on the roadside line and inside the building, while *P. longimembris* and *A. leucurus* (antelope ground squirrels), were not captured on the line north of the facility (FRF011). There were no species unique to line FRF011 or the building.

Table 22. Rodent species present (*) at the Device Assembly Facility. (See Figure 1 for plot locations.)				
Species	FRF008	FRF009	FRF011	Building
<i>Chaetodipus formosus</i>	*	*	*	*
<i>Dipodomys merriami</i>	*	*	*	

Table 22. continued.				
Species	FRF008	FRF009	FRF011	Building
<i>D. microps</i>	*	*	*	
<i>Perognathus longimembris</i>	*	*		
<i>Neotoma lepida</i>	*	*	*	*
<i>Onychomys torridus</i>	*	*	*	
<i>Peromyscus eremicus</i>	*	*	*	*
<i>P. maniculatus</i>	*			*
<i>Ammospermophilus leucurus</i>	*	*		

#### Other Mammal Species

In addition to rodents, coyotes (*Canis latrans*) were observed at the sewage lagoon and raided mesh traps on FRF008 and FRF009. Jackrabbits (*Lepus californicus*) were observed at all three locations. Coyotes reproduced in the vicinity of the sewage ponds. A lactating female was observed drinking at the sewage ponds on several occasions and several juveniles were also observed. Coyotes were seen on about 35% of visits and sighting rates were low ( $0.4 \pm 0.3/\text{hour}$ ,  $n = 20$ ). One dead juvenile coyote was found at the sewage pond.

Two Jackrabbits drank from the sewage pond on 22 July. Deer tracks were observed around the perimeter of the sewage pond in June, although they did not appear to enter the fenced area. Pronghorn antelope were reported on several occasions from west Frenchman flat in 1993, and are possible visitors to the area.

Jackrabbits were observed on natural habitats at an average sighting rate of  $0.65 \pm 0.30$  rabbits/hour ( $N = 40$ ), with 120 hours of effort. This frequency changed with season. More jackrabbits were seen in July per observer effort ( $F_{5,34} = 4.5$ ,  $P = 0.003$ ) than in March, April and May (Figure 26). Deer tracks and accompanying mountain lion tracks were observed on trails in the foothills west of DAF during two dates in mid-summer.

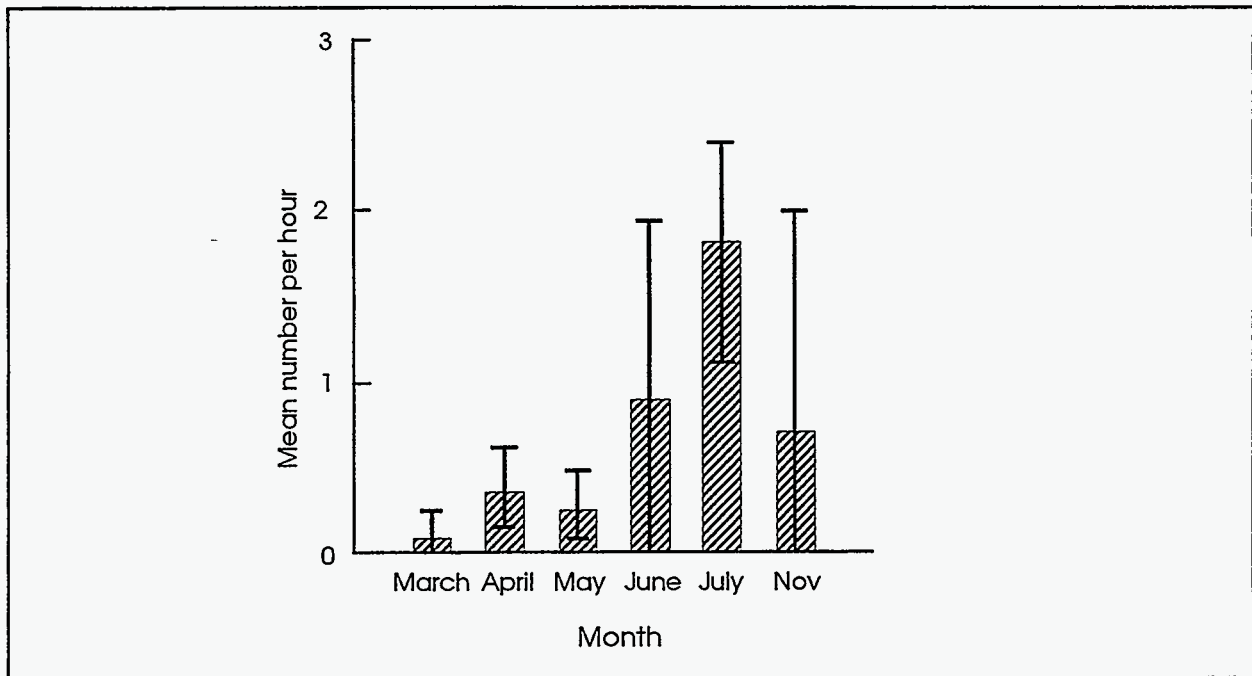


Figure 26 - Mean number of jackrabbits observed in natural habitats at the DAF.

### Abundance and Roadside Effects

Small mammal trap success at all three sites in early June was high: 38.2, 41.9 and 51.0% at lines 8, 9 and 11 respectively. Tripped and moved or missing traps were included in the total number of captures since it was assumed an animal had been inside the trap but was released and/or eaten by a predator.

The most abundant rodent at the two southern lines was *Dipodomys merriami*. This was not the case north of the DAF where *Chaetodipus formosus* was most common (Table 23). A twoway ANOVA revealed that plot location influenced trap success per 10-stakes ( $F_{2,60} = 8.73, P = 0.00047$ ) but that trap type did not ( $F_{1,60} = 2.68, P = 0.107$ ). There was also no interaction between the two terms ( $F_{2,60} = 0.74, P = 0.481$ ). The greater abundance at FRF011 might be attributed to the vegetation and topographic difference: 11 had more Joshua trees and washes while 8 and 9 were quite similar in plant type.

While not significant, two 10-stake sections on FRF008 with the lowest average captures ( $5.3 \pm 0.6$  and  $6.3 \pm 2.1$ ) coincided with areas of disturbance related to culverts and the associated runoff diversion. The highest average captures



per 10-stakes on FRF008 was  $10.0 \pm 1.7$  and was the section closest to the DAF. The range of average captures on FRF009 was  $6.7 \pm 1.5$  to  $10.3 \pm 3.1$ . Although areas nearest the sewage lagoon were expected to have lower abundance due to predation by birds and coyotes, there was no correlation nor pattern observed.

Mean capture per 10-stakes (Figure 27) was significantly higher on FRF011 ( $10.0 \pm 0.5$ ) than either FRF008 ( $7.8 \pm 0.8$ ) or FRF009 ( $8.3 \pm 0.5$ ,  $F_{2,10} = 14.08$ ,  $P = 0.0012$ ). Also, mean capture per 10-stake unit on FRF011 was not uniform ( $F_{10,22} = 2.67$ ,  $P = 0.026$ ) where two of eleven 10-stake samples averaged captures ( $8.0 \pm 0.0$  and  $7.7 \pm 1.5$ ) significantly lower than the highest average capture ( $12.3 \pm 1.5$ ; Newman-Keuls Multiple Range Test,  $q_{20,10} = 5.520$  and  $q_{20,11} = 5.945$ ). These could not be associated with any habitat differences.

Animal abundance on lines 8 and 9 in late June was similar to that in early June (Tables 23, 24). Since line 11 was not trapped in late June it was not included in any further comparisons but is included in some figures for completeness.

Although half as many traps were set in late June, the same number of individuals was captured on FRF008 as in early June and only 20 fewer individuals were captured in late June on FRF009. The distribution of species captured at both sites also did not change appreciably from early to late June. However, three species captured in low numbers earlier at FRF008 were not captured in late June. Percent trap success was 61.1% on FRF008 and 65.3% on FRF009.

Trap success per 10-stakes (= per 10-traps) increased significantly from early June levels at both plots when captures on 8-10 June were adjusted to per 10-stakes by trap-type ( $F_{3,80} = 22.99$ ,  $P < 0.0001$ , Figure 28). Mean trap success in late June was not significantly different between the two lines (Figure 28, Newman Keuls,  $q_{80,2} = 0.606$ ,  $P > 0.05$ ).

**Table 23.** Species captured, numbers of individuals (N), percent of total rodents captured (%T), sex ratio ( $\sigma/\rho$ ), and species diversity ( $H'$ ) at the DAF traplines on 8-10 June 1993.

Species	FRF008			FRF009			FRF011		
	N	%T	$\sigma/\rho$	N	%T	$\sigma/\rho$	N	%T	$\sigma/\rho$
<i>Chaetodipus formosus</i>	46	31.5	19/27	61	34.7	22/39	129	54.2	62/66 <sup>a</sup>
<i>Dipodomys merriami</i>	82	56.2	48/34	83	47.2	40/43	81	34.0	43/38
<i>D. microps</i>	1	0.7	0/1	1	0.6	1/0	1	0.4	1/0
<i>Perognathus</i>	2	1.4	0/2	8	4.5	4/4	0	0.0	---
<i>Neotoma lepida</i>	10	6.8	5/5	6	3.4	5/1	20	8.4	13/7
<i>Onychomys torridus</i>	1	0.7	1/0	5	2.8	4/1	3	1.3	2/1
<i>Peromyscus eremicus</i>	2	1.4	2/0	6	3.4	2/4	4	1.7	2/2
<i>P. maniculatus</i>	1	0.7	0/1	0	0.0	---	0	0.0	---
<i>Ammospermophilus</i>	0	0.0	---	1	0.6	1/0	0	0.0	---
Tripped/Missing	1	0.7	---	5	2.8	---	0	0.0	---
Total	146	100.1	75/70	176	100.0	79/92	238	100.0	123/114
Number of species	8			8			6		
$H'$	0.4743			0.5473			0.4576		
<sup>a</sup> One animal of undetermined sex.									

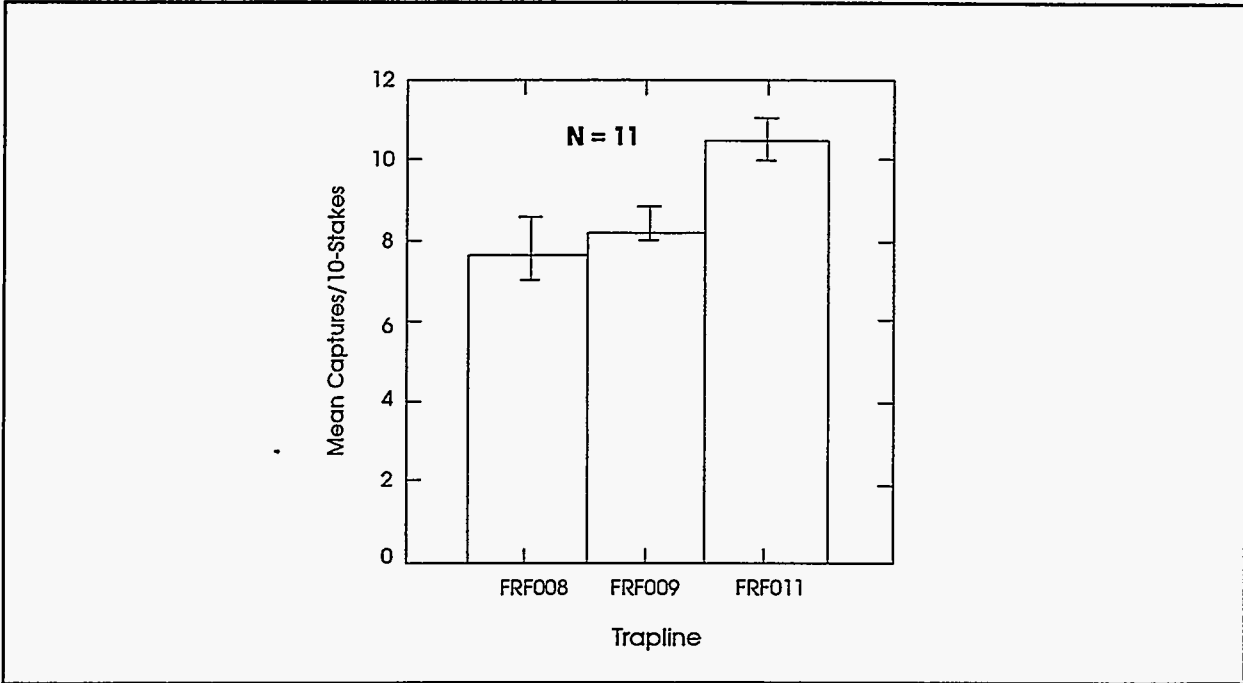


Figure 27 - Mean captures  $\pm$  2 sem per 10-stakes in early June.

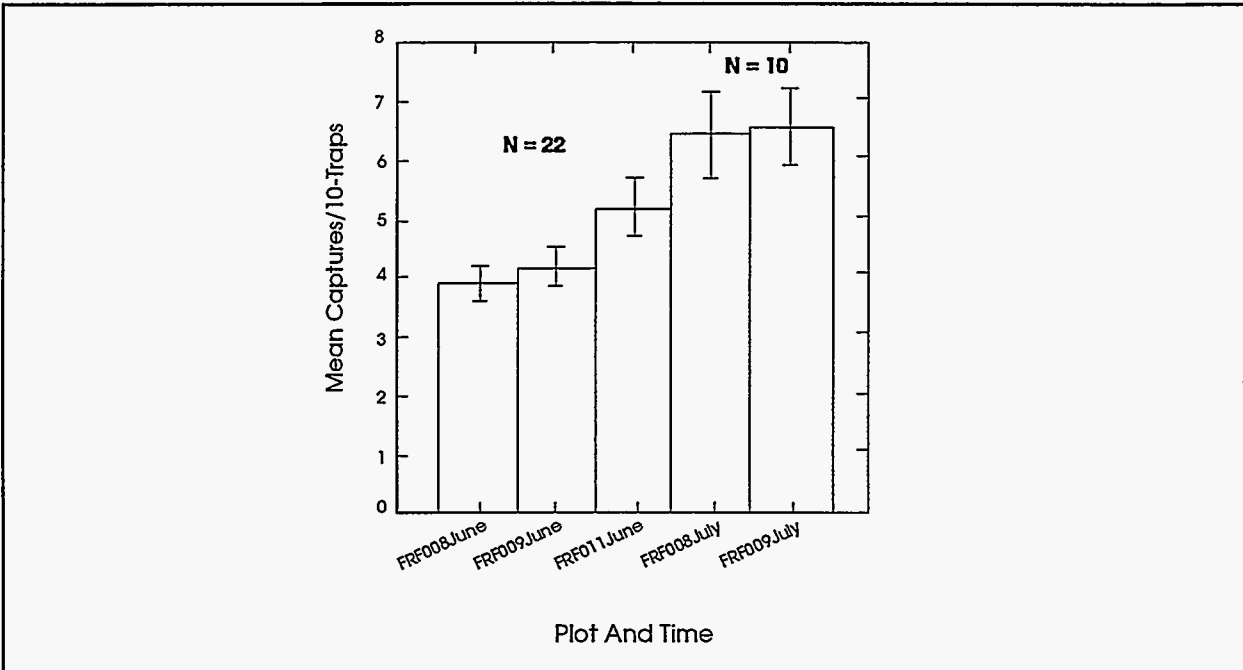


Figure 28 - Mean captures per 10-stake unit for each plot and trapping date. JUNE = early June, JULY = late June.

Table 24. Species, individuals (N), % of total captures (%T), sex ratio ( $\sigma/\text{♀}$ ), and species diversity ( $H'$ ) at the DAF in late June.

Species	ERF008			ERF009		
	N	%T	$\sigma/\text{♀}$	N	%T	$\sigma/\text{♀}$
<i>Chaetodipus formosus</i>	39	27.7	20/19	52	33.3	30/22
<i>Dipodomys merriami</i>	85	60.3	42/43	67	42.9	31/36
<i>D. microps</i>	0	0.0	---	1	0.6	1/0
<i>Peroqñathus longimembris</i>	0	0.0	---	9	5.8	3/6
<i>Neotoma lepida</i>	6	4.3	3/3	4	2.6	3/1
<i>Onychomys torridus</i>	3	2.1	0/3	2	1.3	1/1
<i>Peromyscus eremicus</i>	3	2.1	1/2	1	0.6	0/1
<i>P. maniculatus</i>	0	0.0	---	0	0.0	---
<i>Ammospermophilus leucurus</i>	4	2.8	1/3	18	11.5	5/12
Tripped/Missing	1	0.7	---	2	1.3	---
Total	141	100.0	67/73	156	99.9	74/79
Number of species	6			8		
$H'$	0.4604			0.5916		

### Trap Type

Given a choice of either a Sherman or mesh trap, rodents did not appear to frequent one trap more than the other ( $F_{1,64} = 2.17$ ,  $P = 0.145$ ). However, *D. merriami* were captured more often in the mesh traps on 2 of 3 lines while *Chaetodipus formosus* were captured more frequently in the Sherman traps on 3 of 3 lines (Table 25). In late June, there was no effect of trap type ( $X^2_c = 0.0081$ ,  $df = 1$ ,  $P = 0.0717$ ) or order of trap presentation ( $X^2_c = 0.0076$ ,  $df = 1$ ,  $P = 0.0695$ ) on trap success. Mesh traps did have a slight nonsignificantly higher average of new captures (mesh =  $2.2 \pm 0.4$ , Sherman =  $2.0 \pm 0.4$ ;  $t = 0.694$ ,  $df = 29$ ,  $P = 0.493$ ).

Table 25. Total 3 day captures in mesh (M) and Sherman (S) traps at the three DAF traplines on 8-10 June 1993.

Species	FRF008		FRF009		FRF011		Total	
	M	S	M	S	M	S	M	S
<i>Chaetodipus formosus</i>	15	38	29	41	62	89	106	168
<i>Dipodomys merriami</i>	65	53	59	60	65	40	189	153
<i>D. microps</i>	1	0	1	1	0	1	2	2
<i>Perognathus longimembris</i>	0	2	3	5	0	0	3	7
<i>Neotoma lepida</i>	4	7	2	4	12	12	18	23
<i>Onychomys torridus</i>	0	1	0	5	1	2	1	8
<i>Peromyscus eremicus</i>	1	1	4	3	2	3	7	7
<i>P. maniculatus</i>	0	1	0	0	0	0	0	1
<i>Ammospermophilus leucurus</i>	0	0	0	1	0	0	0	1
Tripped/Missing	1	0	5	0	0	0	6	0
TOTAL	87	103	103	120	142	147	332	370
H'	0.3311	0.4795	0.4472	0.5488	0.4444	0.4492	0.4725	0.5166

One significant difference between trap types was the number of torpid/dead animals. Pooling plots and dates ( $N_{\text{mesh}} = 15$ ,  $N_{\text{Sherman}} = 15$ ), significantly more animals ( $F_{1,28} = 14.63$ ,  $P = 0.00067$ ) were torpid or dead per day in the mesh ( $8.1 \pm 3.3$ , total = 122) than the Sherman ( $1.5 \pm 0.8$ , 23 animals). Since season may have an effect on torpidity, time of trapping was partitioned out to directly compare early and late June, FRF011 was excluded (Figure 29). A twoway ANOVA showed that trap type ( $F_{1,20} = 26.16$ ,  $P = 0.00005$ ) but not season ( $F_{1,20} = 2.91$ ,  $P = 0.104$ ) had an effect, with no significant interaction term ( $F_{1,20} = 0.39$ ,  $P = 0.537$ ).

An added deleterious trait of the mesh trap was that they were easily picked up by coyotes and crushed open. Six mangled and bloody traps (Figure 30) were retrieved more than 30 meters from a stake and an additional three could not be located. While a few Sherman traps were also moved, animals were usually still inside the trap. Only one Sherman trap was found bloody and empty.

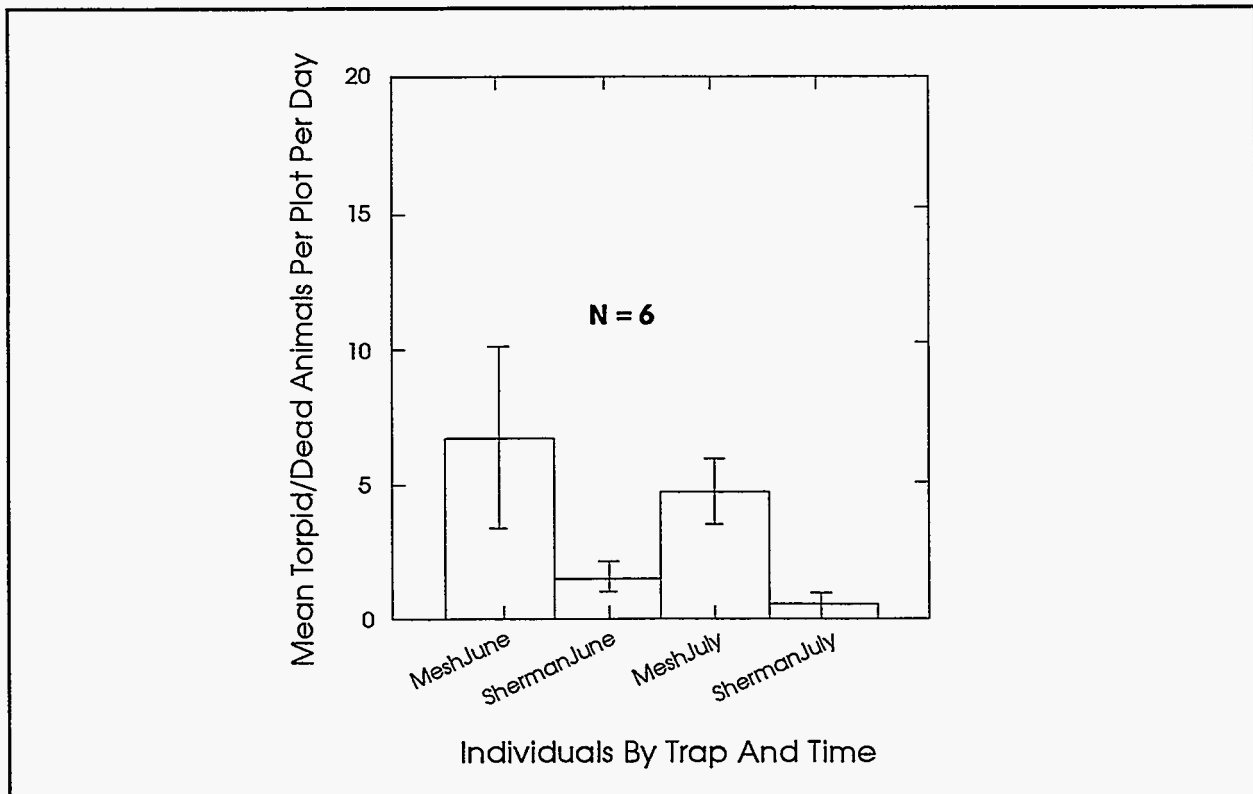
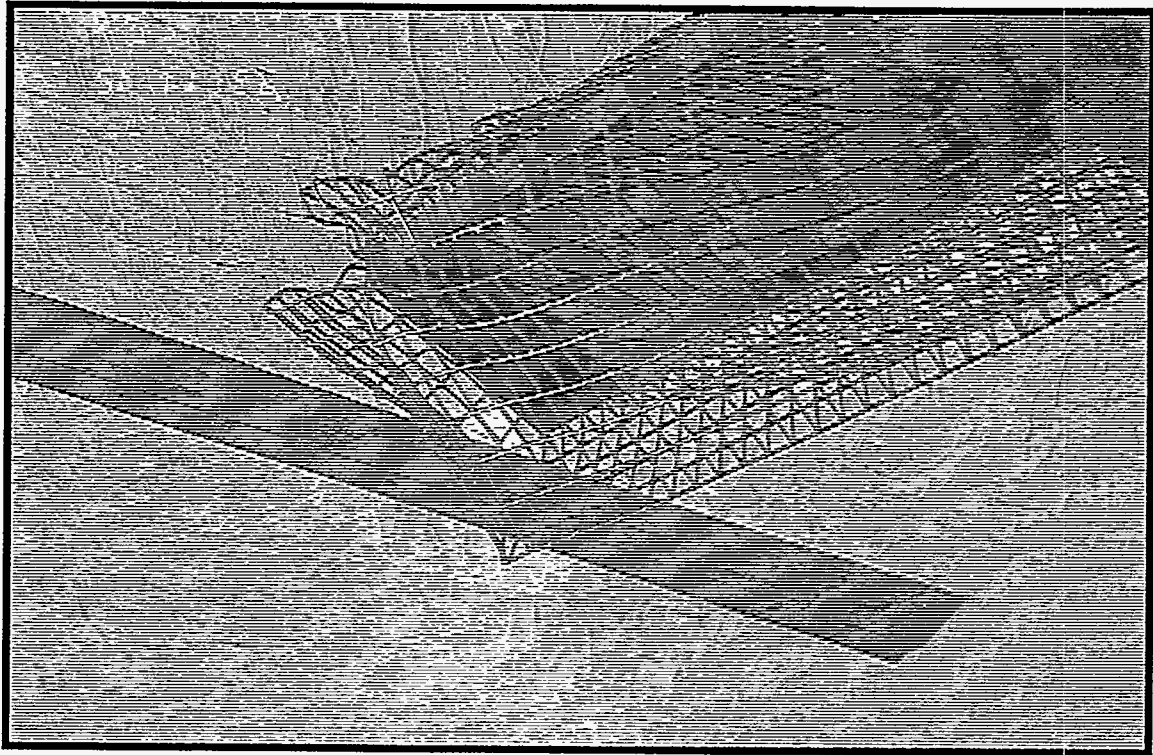


Figure 29 - Mean number of torpid/dead animals captured by trap type at plots 8 and 9 in early (JUNE) and late (JULY) June.

Figure 30 - Mesh trap destroyed by predator.



## Reproduction

For sites 8 (roadside) and 9 (control) in early and late June there was a significant difference between mean weights of adult *Dipodomys merriami* for the four samples ( $F_{3,199} = 4.45$ ,  $P = 0.005$ ) but not sex ( $F_{1,199} = 0.53$ ,  $P = 0.468$ ). There was also evidence of an interaction ( $F_{3,199} = 3.13$ ,  $P = 0.027$ ). Adult females are the real test of reproduction: in general females weigh less than males during hiatus from reproduction and increase in weight approaching that of males during bouts of reproduction (Kenagy 1973). The above results indicate that females were indeed close to males in mean weight (Table 26).

Table 26. Mean weight (g $\pm$ 1 sd) of adult <i>D. merriami</i> at FRF008 (roadside) and FRF009 (control) in early and late June. Numbers in parentheses are number of individuals weighed.				
	FRF008		FRF009	
Sex	Early	Late	Early	Late
Male	41.6 $\pm$ 4.6 (34)	41.1 $\pm$ 4.7 (29)	42.7 $\pm$ 3.2 (29)	41.0 $\pm$ 3.7 (20)
Female	43.2 $\pm$ 4.6 (26)	43.6 $\pm$ 4.0 (22)	42.8 $\pm$ 4.4 (24)	38.6 $\pm$ 5.0 (23)
Male + Female	42.3 $\pm$ 4.6 (60)	42.1 $\pm$ 4.5 (51)	42.8 $\pm$ 3.7 (53)	39.7 $\pm$ 4.5 (43)

Female *D. merriami* at FRF009 in late June had a significantly lower mean weight than females at 8 and 9 in early June and at 8 in late June ( $F_{3,91} = 6.14$ ,  $P = 0.001$ ). This was not true for the males ( $F_{3,108} = 1.00$ ,  $P = 0.394$ ) and might indicate females were no longer reproductive along line 9.

The distribution of weights at the DAF sites appeared to be bimodal with peaks between 25 to 30 and 40 to 45 grams. This was not true for FRF009 in late June (Figures 31 - 35), which had a significantly different distribution ( $\chi^2 = 70.651$ , 32 d.f.,  $P = 0.0001$ ). There is the possibility of a greater dispersal or mortality of adults from the area around FRF009 since a greater proportion of the *D. merriami* at this site in late June were in the 30 to 40 gram weight class (Figure 34).



It is more likely that on the roadside this species experienced a lag or extra bout in reproduction as shown by the distribution of female reproductive status (e.g. pregnant or lactating, nonreproductive, or immature juvenile). Since males (except very immature juveniles) may exhibit scrotal testes during most of the year (Bradley and Mauer 1971; Reichman and Van De Graaff 1973) and therefore may not be accurately designated as reproductive or not, only females were tested.

The percentage of reproductive females on plot 8 in early June was two times as high as on plot 9 (Figure 36). The opposite was true for the females ranked as juvenile, with line 11 falling in the middle. In late June the same percentage of females were judged to be reproductive on each plot with a slightly greater proportion of juveniles present on line 8. The distribution of females was significantly different on plot 8 in early June from the other three samples ( $\chi^2 = 12.913$ , 6 d.f.,  $P = 0.044$ ). The ratio of new juveniles to new adults at FRF008 in late June (22/8) was significantly greater than that from FRF009 in late June (11/9);  $\chi^2 = 4.089$ , 1 d.f.,  $P = 0.045$ .

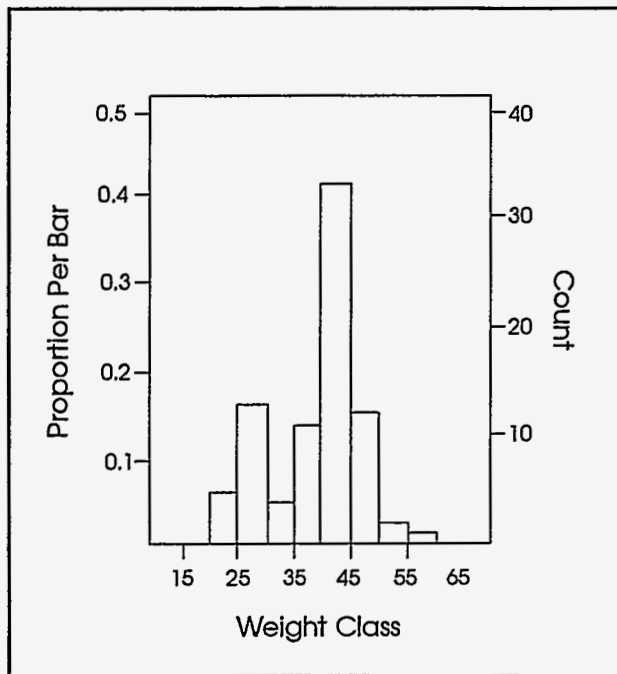


Figure 31 - Distribution of *D. merriami* weights at FRF008 in early June.

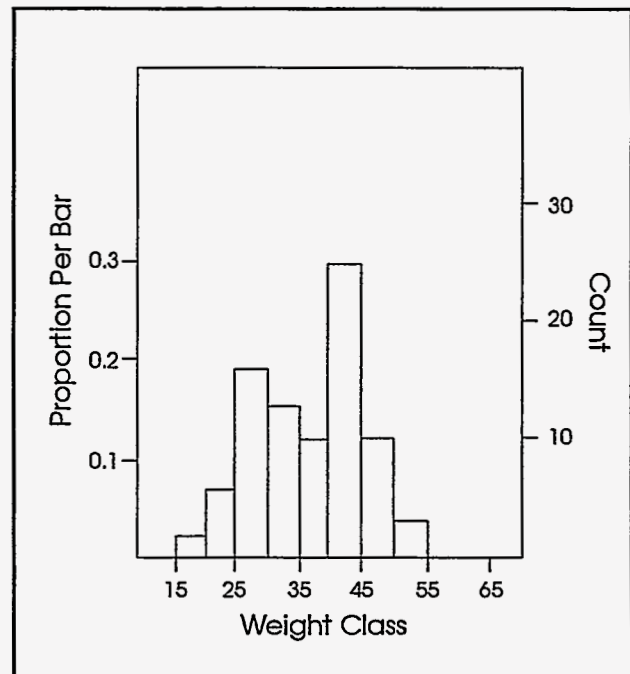


Figure 32 - Distribution of *D. merriami* weights at FRF008 in late June.

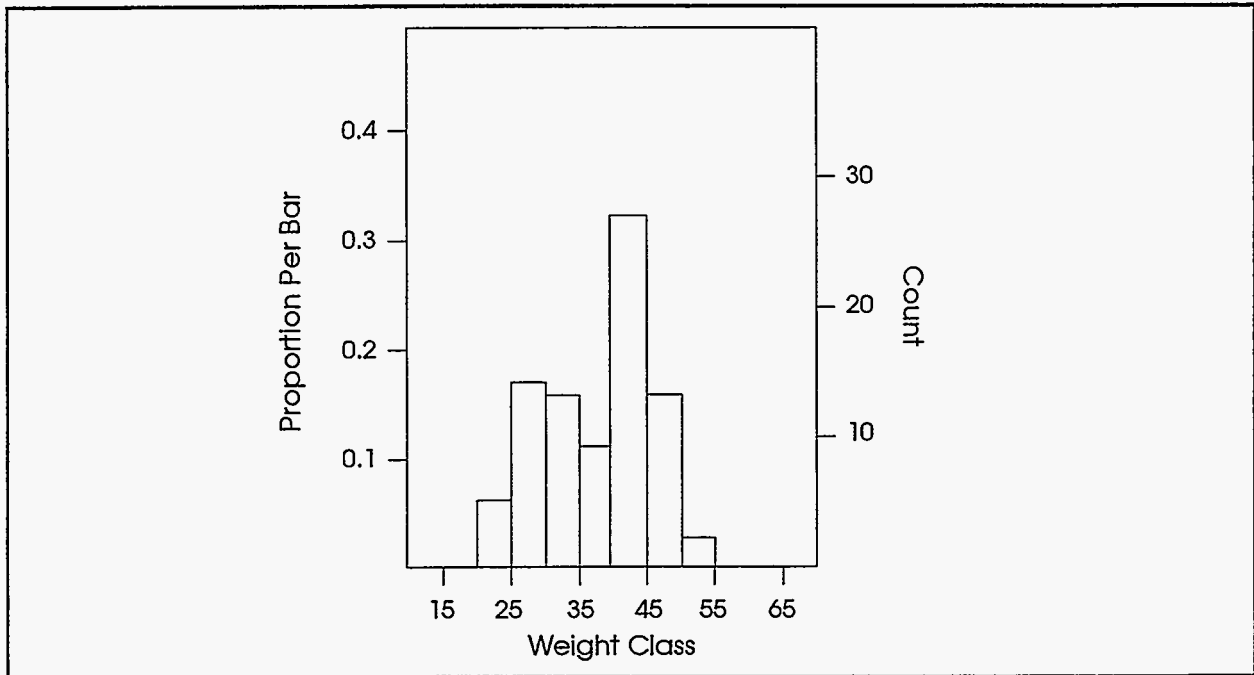


Figure 33 - Distribution of *D. merriami* weights at FRF009 in early June.

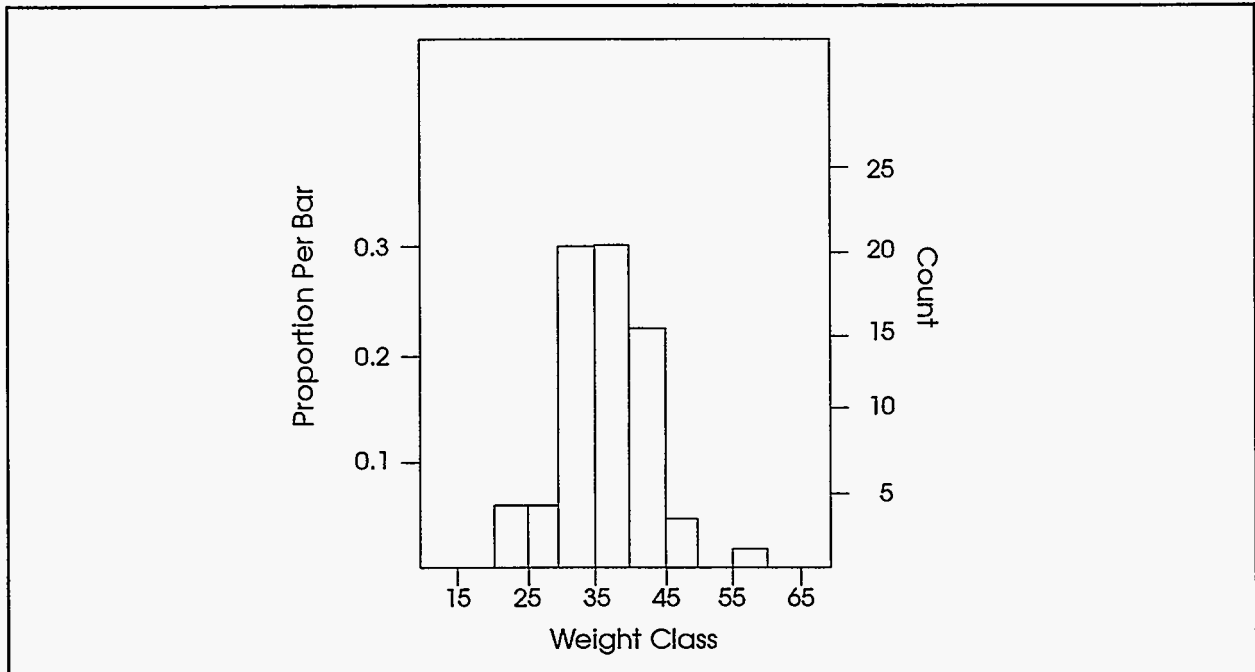


Figure 34 - Distribution of *D. merriami* weights at FRF009 in late June

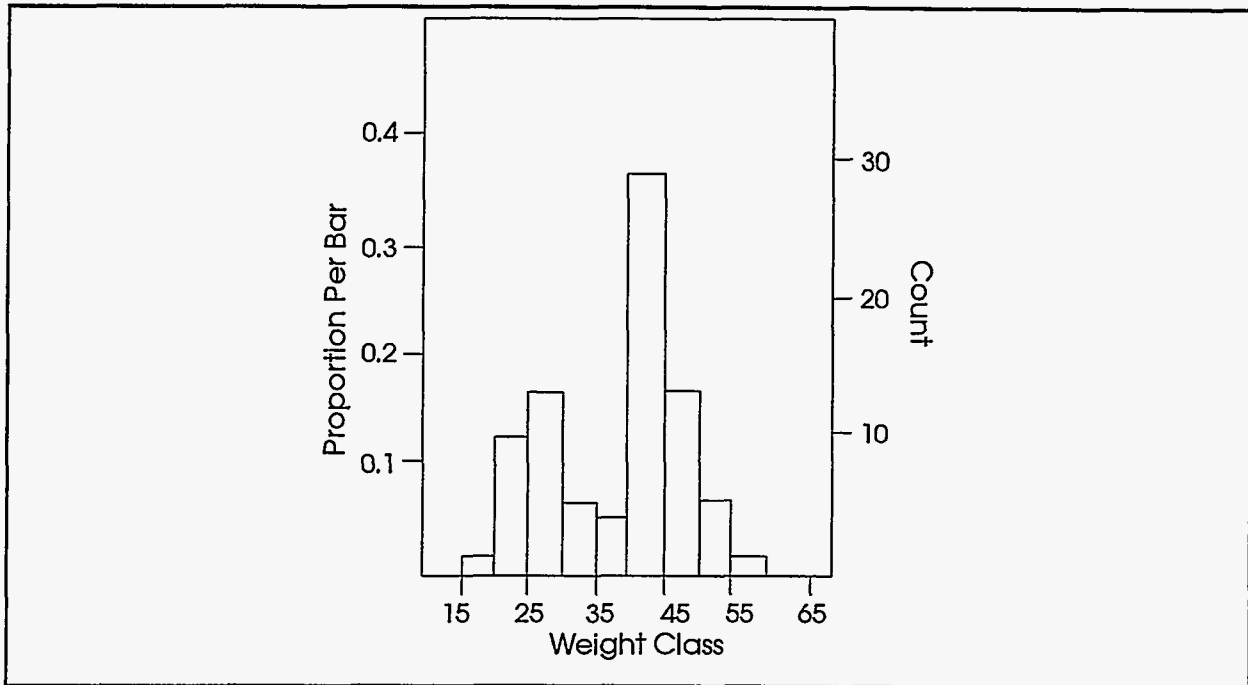


Figure 35 - Distribution of *D. merriami* weights at FRF011 in early June.

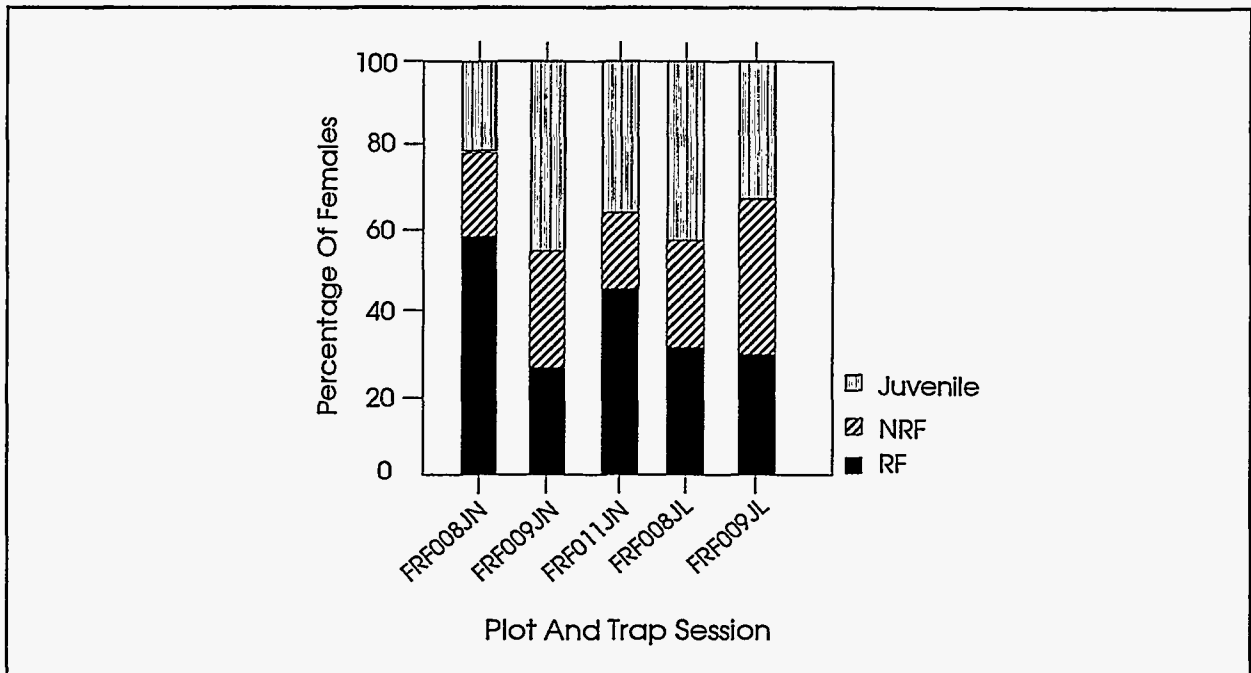


Figure 36 - Reproductive status of female *D. merriami* captured at the DAF in early (JN) and late (JL) June. R=reproductive, NR=nonreproductive, J=juvenile.

While it appears that there is some significant impact of the road on the *D. merriami* population, it is unclear whether these results indicate a benefit or detriment. Had FRF011 been trapped in late June for a comparison to another undisturbed area, the results may have been clearer. More intense and regular trapping is needed to determine the cause as well as the direction of the effect.

Looking at the second most abundant rodent at these two sites, *Chaetodipus formosus*, a different pattern emerged. Mean weight of all rodents differed across samples ( $F_{3,189} = 4.05$ ,  $P = 0.008$ ), but not across sexes ( $F_{1,189} = 0.64$ ,  $P = 0.424$ ) there also was no interaction,  $F_{3,189} = 0.62$ ,  $P = 0.602$ ). The late June mean weights of 8 and 9 were significantly greater than the early June weights at 8 and 9. When juveniles were excluded there were no significant comparisons (sample:  $F_{3,146} = 0.58$ ,  $P = 0.627$ ; sex:  $F_{1,146} = 0.29$ ,  $P = 0.589$ ; interaction:  $F_{3,146} = 0.59$ ,  $P = 0.625$ ).

In all cases, a unimodal distribution of weights was observed. However, the distribution of weights for plots 8 and 9 appeared to increase slightly from early to late June (Figures 37 - 41). This clearly indicates that the reproduction of *C. formosus* was synchronous at the roadside and control lines.

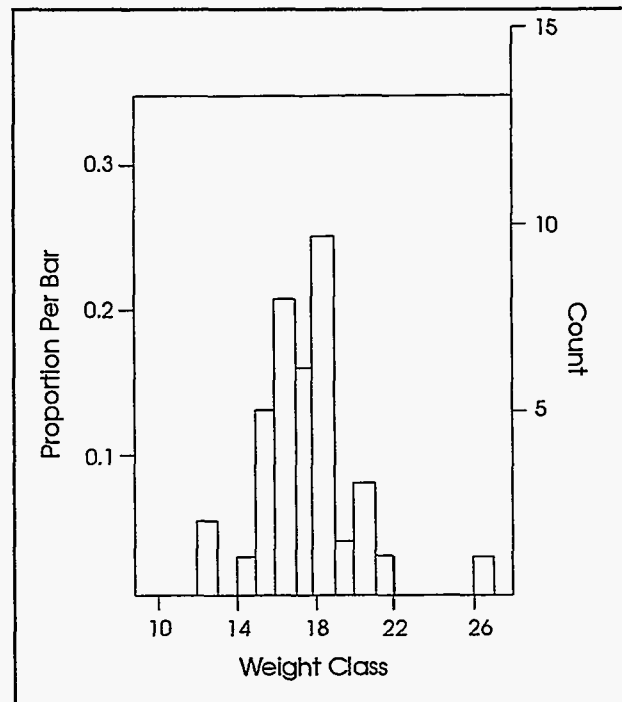
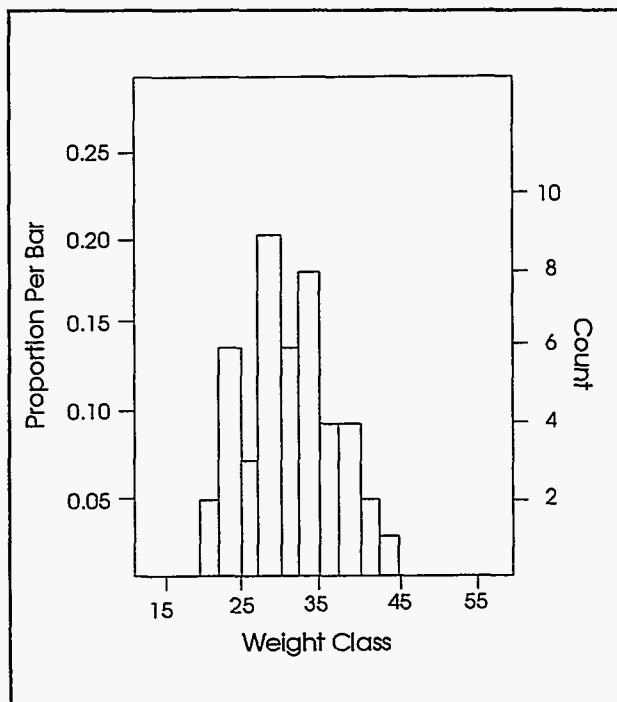


Figure 37 - Distribution of *C. formosus* weights at FRF008 in early June.

Figure 38 - Distribution of *C. formosus* weights at FRF008 in late June.

## Bat Species

The only bat captured at the sewage lagoon was the western pipistrelle (*Pipistrellus hesperus*). Several larger pale bats, possibly *Antrozous pallidus* or *Plecotus townsendii*, were observed but never caught. High winds had a negative impact on the effectiveness of the nets.

Mammal trapping and mist netting revealed no species of special concern within the DAF study area. Two federal candidate species that may occur on the NTS are the Pygmy rabbit (*Sylvilagus idahoensis*) and the spotted bat (*Euderma maculatum*). The preferred habitat for the pygmy rabbit is tall sagebrush, which does not occur near the DAF and therefore it is highly unlikely that this species would be encountered here. Little is known about the habitat requirements for the spotted bat and it is possible that this species may utilize the DAF area, particularly for foraging moths attracted to the building lights.

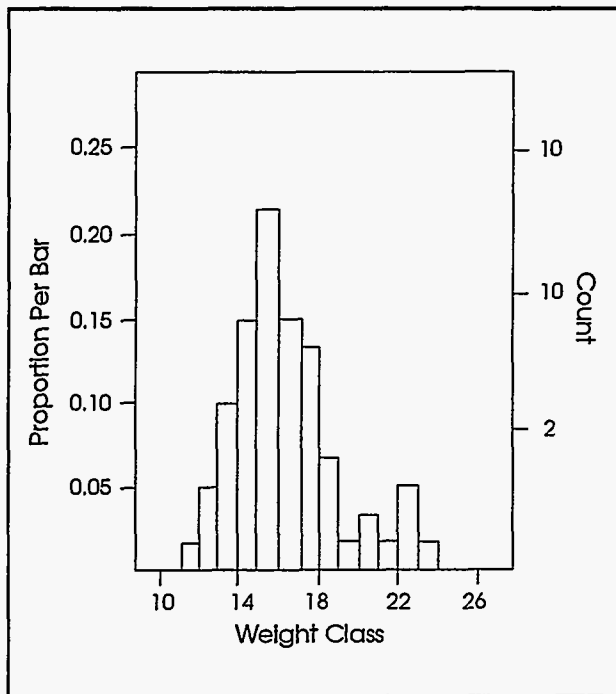


Figure 39 - Distribution of *C. formosus* weights at FRF009 in early June.

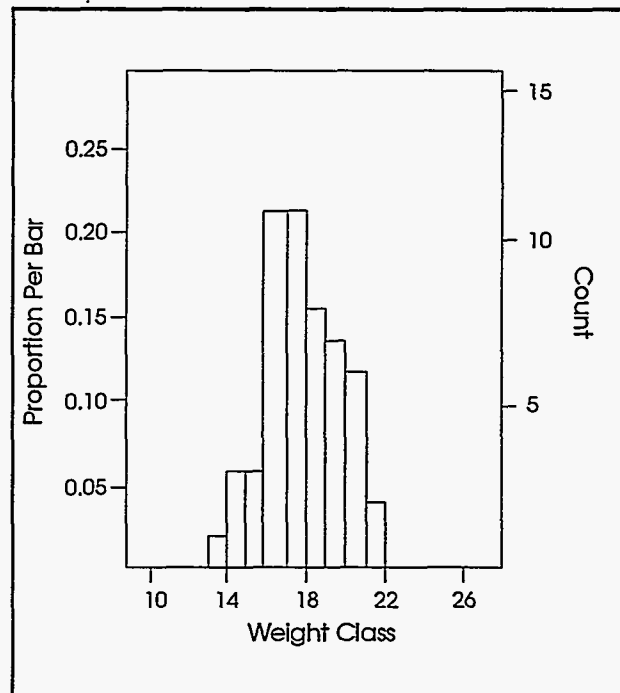


Figure 40 - Distribution of *C. formosus* weights at FRF009 in late June.

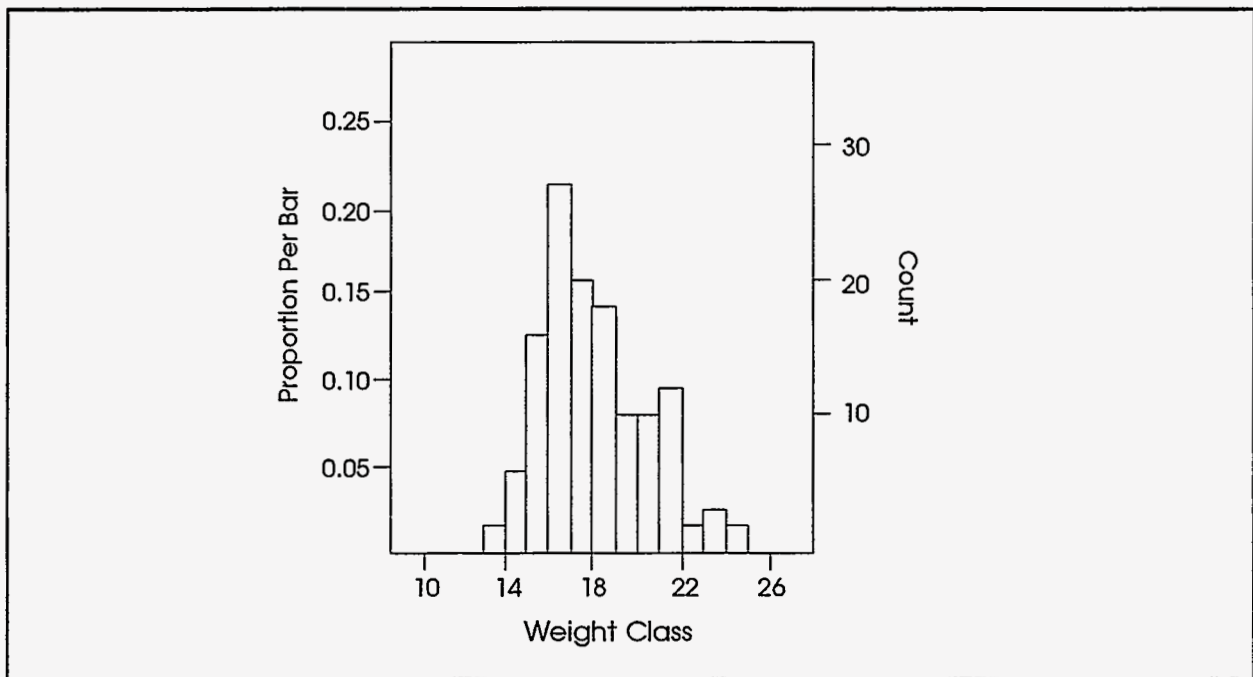


Figure 41 - Distribution of *C. Formosus* weights at FRF011 in early June.

## DISCUSSION

### EPHEMERALS

#### Ephemeral Techniques

One of the main goals of the DAF ephemeral sampling was to assess techniques. All ephemeral sampling techniques used were inadequate in some respects. The standard BECAMP technique (20 quadrats, nested to 1000 m<sup>2</sup>) provided detailed information on the most common species, but the results were applicable only to the 1000-m<sup>2</sup>-areas actually sampled. It was too time-consuming to do multiple sites, and it gave little data (presence/absence only) on most species. Use of a second technique (ten quadrats nested to 100 m<sup>2</sup>) saved a small amount of time, but the three sites monitored took 1½ days to census, preventing its use at many replicate locations. It suffers from the same problems as the standard technique, in that results were applicable only to the sites studied, and statistical inferences could be made only for the most common species.

The log<sub>10</sub> observations (Figures 4 - 8; Table 5) provided coarse density information for common species near the paved road. It was rapid enough to

sample random spots along the whole length of the paved road, and the information is therefore applicable to the road and its use and maintenance, not just to the particular site studied. No information was collected on mean plant size, biomass, or reproduction, which limits suggestions as to causes of road-engendered effects on ephemerals. This technique also did not distinguish between densities of rare (density  $<5/m^2$ ) and absent (density = 0) plant species.

The  $\log_2$  technique of estimating density was inadequate on several grounds. Unlike the standard technique it provided a density estimate for each species (Table 6), but those density estimates lacked statistical error estimates. Location of the first encountered plants of a species largely determined the density estimates. Absence of replicates prevented averaging across many samples, which would reduce the calculated density from that first occurrence. Expected time savings were unrealized. The method took 6 hours for two sites, as long as standard techniques.

These observations are important because DAF monitoring is somewhat different from that on most other NTS areas. It is a central location from which influences may spread radially outward, in contrast to blasted or burned areas, subsidence craters, or waste dumps, whose primary influences may be limited to the disturbed areas or extend only short distances from them (e.g., roads). It would be preferable to have numerous plots set up randomly at many different distances and directions from the DAF, as was done for perennial plants. Techniques need further modification before that can be accomplished in the short time available for sampling ephemerals.

### Ephemeral Populations in 1993

Ephemeral populations measured near the DAF in 1993 were unusually rich in species, had good growth, and exhibited mixed dominance, depending on location. The number of species was high both in undisturbed and disturbed habitats (Table 27). The difference in mean species numbers on DAF and BECAMP plots was significant ( $t = 3.14$ , d.f. = 6,  $P = 0.020$ ) but the data were not strictly comparable because of technique differences among the DAF plots. The wide dispersal of the  $1\ m^2$  quadrats with the  $\log_{10}$  technique may have increased the numbers of species seen. Nevertheless, seeing 51 species on the scraped and graveled area, and 48 on the dirt road to the water tank was surprising.

Table 27. Comparison of number of ephemeral plant species seen at DAF and general Nevada Test Site locations in spring 1993.

Location	Area searched (m <sup>2</sup> )	Number of Species
DAF paved road - modified BECAMP plots	300	31
DAF paved road - log <sub>10</sub> quadrats	200	71
DAF scraped/graveled area	1000	51
DAF undisturbed N of Dike	1000	37
DAF Water Tank Road - log <sub>2</sub> plot	400	48
DAF Water Tank - undisturbed log <sub>2</sub> plot	400	49
DAF plot mean + 2 se		47.8 + 11.2
Yucca Flat Baseline Plot	1000	33
Jackass Flats Baseline Plot	1000	26
Frenchman Flat Baseline Plot	1000	29
Pahute Mesa Baseline Plot	1000	28
Rainier Mesa Baseline Plot	1000	13
Rock Valley Historical Trend Plot	1000	39
Mid Valley Burned Plot	1000	36
Mid Valley Control Plot	1000	39
Red Rock Valley Burned Plot	1000	20
Red Rock Valley Control Plot	1000	24
Yucca Flat Burned Plot	1000	25
Yucca Flat Control Plot	1000	26
Frenchman Flat Roadside	1500	32
Frenchman Flat Roadside Control	1500	37
BECAMP Plot mean + 2 se		29.2 + 4.0



There are several possible reasons for the high species richness near the DAF. First, the DAF is situated near the boundary between two shrub "communities", one dominated by *Larrea tridentata* (creosotebush) and *Ambrosia dumosa* (white bursage) and the other by *Coleogyne ramosissima* (blackbrush) and *Yucca brevifolia* (Joshua tree). These communities are mixed together in the vicinity of the DAF, and it is possible the ephemeral plant community is responding to the mixed perennial populations. Alternatively, there might be more habitat variation near the DAF, perhaps associated with the slopes and drainage channels. Another possibility is that *Bromus rubens*, an introduced grass now dominant over many NTS areas, grew to dominance more slowly in the vicinity of the DAF, and thus has had less effect on native populations. None of these hypotheses is particularly plausible, and none explains the high number of species on some of the disturbed areas sampled near the DAF.

Rainfall in the 1992-1993 ephemeral season was unusually high, and ephemeral plants all over the NTS grew well. It is not plausible that weather near the DAF was more favorable to germination than in other areas. However, many species seen in 1993 may not be seen again for many years because 1993 was an unusually good year.

Biomass production by ephemerals on undisturbed sites (DAF1, DAF3) was  $40 \pm 26$  g/m<sup>2</sup> and  $52 \pm 21$  g/m<sup>2</sup> ( $\bar{x} \pm 2$  se). Data of Turner and Randall (1989) for Rock Valley during the early 1970's suggest that the 288 mm of rain which fell (at Cane Springs, 7 miles from the DAF) should have produced 107 g/m<sup>2</sup>. It is difficult to explain the difference between their predictive equation, which is based on September to March rainfall ranging from 43 to 220 mm, and the DAF results. In Rock Valley, Turner and Randall's equation predicted 1988-1991 ephemeral production somewhat below actual production, but always within 10 g/m<sup>2</sup> (Hunter 1994a). Some variables which might relate to the difference are soil fertility, rainfall timing, shrub competition, surface aspect, and reduction in seed reserves during the 1989-90 drought.

The significant differences in weight per plant found among the roadside plots (Table 4) and between the scraped and undisturbed areas (Table 3) are explainable as effects of plant density, soil compaction, and species differences.

## Effects of Disturbances on Ephemeral Populations

Disturbances examined near the DAF included the scraped/graveled area west of the DAF, the verge of the paved road, and the dirt road leading to the DAF water tank. These construction/operation disturbances can be expected to have major influences on ephemeral populations where they occur, and to an unknown extent may affect populations off the disturbed area. The technique which best demonstrated such effects was the  $\log_{10}$  density estimation used near the paved road. Results suggest road construction, maintenance, and use are responsible for dense concentrations of *Eriogonum deflexum* found there, and by implication construction disturbances are probably responsible for the dense *E. deflexum* populations common near the DAF. This is not unique, as *E. deflexum* has recently been increasing on NTS disturbed areas. In 1992 it was the most common species on a scraped/compacted area in Mid Valley and also on a shrub-removal plot in Mercury (Hunter 1994b). All that appears required for increase in *E. deflexum* is removal of shrubs, as that was the only disturbance to the Mercury plot.

The road also appears to be a site of increase for *Schismus arabicus*, an introduced grass which has not become dominant on the NTS, although it is dominant at lower elevations in the Mojave Desert (Hunter et al. 1987). It has been present on the NTS at least since 1959, as indicated by specimen #558 in the NTS herbarium. Near Daggett, California it occurs widely in the desert at densities high enough to compete significantly with native species. Its presence along the DAF roadside probably indicates a combination of favorable factors, including the absence of shrubs caused by scraping the roadside, import of seeds by vehicle traffic, runoff from the pavement adding extra water from light rains, and increased winter temperatures related to the south-facing slope on the road shoulder. It was the densest species on the Mercury shrub-removal plot in 1993, at  $2040 \pm 976/\text{m}^2$  ( $\bar{x} \pm 2 \text{ se}$ ). Its absence from the vicinity of the DAF except for the roadside suggests either that it cannot persist in undisturbed desert, or that it has only been recently introduced and has not spread far near the DAF.

Another introduced species found along the DAF paved road in small numbers was *Halogeton glomeratus*. This is a toxic weed found in recent years on scraped areas on Pahute Mesa, where it appears to be spreading significantly into undisturbed sites. It has also in recent years increased in abundance along the Mercury Highway.

*Halogeton* is related to another weed common on disturbed areas all over the NTS, *Salsola australis* (Russian thistle). *Salsola* was present ( $8 \pm 7$  per  $m^2$ ;  $\bar{x} \pm 2$  se) on the scraped/graveled area (DAF6) west of the DAF, where it can be expected to be dominant in future years. It is well adapted to growing on disturbed areas, in contrast to the native species.

## PERENNIAL PLANTS

Perennial vegetation on the NTS has been in a state of constant change since the current monitoring program began in 1987 (Hunter and Medica 1989; Hunter 1992b, Hunter 1994c, d). Severe drought in 1989 and 1990 resulted in death of most of the perennial grasses and herbaceous perennials and many of the smaller shrubs in the Mojave and Transition deserts (Hunter 1994c). Partial recovery occurred in 1992 and 1993, with regrowth of some of the drought-hardy perennials and germination of a few shrubs and many grasses (Hunter 1994d). Beatley (1979) reported only minimal changes in shrub populations between 1963 and 1975. Her study period straddled a drought in 1971 and 1972 which apparently did not result in significant shrub death. Beatley did not report data on herbaceous perennials and grasses.

Around the DAF there were no studies prior to 1993 except at one of Beatley's plots (#27; Nevada Grid Coordinates N780123, E681009). She reported 16.8% cover by shrubs in 1963, and 18.9% in 1975, but species composition was lumped with that of six other plots with similar vegetation (*Larrea-Lycium-Grayia*), and actual conditions near the DAF cannot be determined from her report. Total live cover on the 100 BECAMP plots around the DAF was 14.1% (Table 3), but that number is based on different techniques from Beatley's and is not strictly comparable to her cover values. On the seven lumped plots, Beatley found averages of 7 of 91 shrubs dead in 1963 (8%) and 8 of 106 (8%) in 1975. In 1993 640 of 1087 shrubs were dead (59%). The difference in percent dead across the three years was significant ( $\chi^2 = 175$ , 2 d.f.,  $P < 0.001$ ).

Shrubs which died in the recent drought were not random, but were concentrated among particular species (Table 28). (The proportions of live and dead shrubs differed across 8 non-herbaceous species examined,  $\chi^2 = 177$ , 7 d.f.,  $P < 0.001$ .) Only a few dead *Larrea tridentata* and *Krameria parvifolia* were found, but most *Coleogyne ramosissima*, *Grayia spinosa*, and *Ephedra nevadensis* were dead. Surviving *Ephedra* occurred in small washes and at the edges of disturbed areas. Only two plots NE of the DAF were in locations previously dominated by *Coleogyne ramosissima*, but in those areas the *Larrea* and *Ambrosia*

survived while most of the *Coleogyne* died. These data are evidence of recent change in the perennial plant communities around the DAF towards a more drought-hardy composition, as Mojave Desert species became more dominant, and transition desert species less so.

**Table 28.** Live and dead shrubs censused in 1993, by species, on 1000 m<sup>2</sup> of plant transect within 1500 m of the DAF.

Species	number alive	number dead	percent dead
<i>Ambrosia dumosa</i>	159	79	33
<i>Atriplex confertifolia</i>	39	11	22
<i>Coleogyne ramosissima</i>	1	5	83
<i>Ephedra nevadensis</i>	8	36	82
<i>Grayia spinosa</i>	7	43	86
<i>Krameria parvifolia</i>	84	7	8
<i>Larrea tridentata</i>	77	11	12
<i>Lycium andersonii</i>	27	15	36
<i>Menodora spinescens</i>	16	37	70
<i>Yucca brevifolia</i>	5	2	29

The herbaceous species, including the grasses *Erioneuron pulchellum*, *Oryzopsis hymenoides*, and *Stipa speciosa*, and the herbs *Sphaeralcea ambigua*, *Xylorhiza tortifolia*, and *Dyssodia cooperi* probably germinated and grew largely in 1992 and 1993. They were killed by drought elsewhere on the NTS during 1989 and 1990 except on disturbed areas. Near the DAF the older disturbances were dominated in 1993 by the summer annual *Eriogonum deflexum*, and had not yet been invaded by the local herbaceous perennial species.

Continuing change can be expected in perennial vegetation near the DAF, as recovery from construction disturbance proceeds. Rates of recovery of perennial vegetation elsewhere on the NTS are very slow. Only bunchgrasses and a rare shrub were present on ground zeroes from above-ground nuclear weapons tests thirty years after cessation of testing (Hunter 1994c, d). North-facing slopes of subsidence craters contained only recently germinated shrubs (*Atriplex canescens*) 23 and 24 years after they were created (Hunter in press c, d), although the south-facing slopes did not.

If construction disturbances surrounding the DAF are not disturbed again during operation, gradual increases in grass and shrub populations can be expected. Perennial plants already rooted within about 10 m of these disturbances can be expected to grow to increased cover and volume, as they use water from the disturbed areas. Some new species can be expected in these more mesic areas, as was seen along the 5-05 road in Frenchman Flat in 1990 (Hunter 1994c). One species not seen on the 100 plots which should be expected is *Hymenoclea salsola* (white burrobrush). It is the primary shrub invading ground zeroes in Yucca Flat, and is also common on roadsides in Frenchman Flat. Germination of many shrub species appeared to be rare.

Predictable effects of DAF operations on perennial vegetation will be largely related to the disturbance regime. Scraping of roadsides and clearing of parking lots, clearing of vegetation growing on and around the DAF, traffic along dirt roads for maintenance of water and sewage facilities, and possibly for security purposes, will maintain certain areas in a constant state of disturbance. Plants adjacent to these disturbances will grow larger, as along Mojave Desert roadsides in other areas (Johnson et al. 1975; Lightfoot and Whitford 1991).

### SENSITIVE PLANTS

A few sensitive plant species occur within several miles of the DAF. *Camissonia megalantha* occurs in significant numbers at Cane Springs, on French Peak, and on the scraped roadside entering Area 11 (Plutonium Valley). *Phacelia beatleyae* has been seen on loose, eroded volcanic soils on Skull Mountain and at the base of French Peak (Rhoads and Williams 1977). *Cymopterus ripleyi saniculoides* occurs occasionally in sandy soils in the center of Frenchman Flat. *Arctomecon merriamii* occurs in washes along the base of limestone hills forming the southern margin of Frenchman Flat (Spotted Range, Mercury Ridge). Habitats of these species are not found near the DAF, although some could colonize repeatedly disturbed areas such as roadsides, or subsoils bared by construction activity. The DAF is not expected to affect extant populations of these species in any way.

### REPTILES

DAF reptile studies dealt with four topics: effect of the main DAF access road; differences between disturbed areas around DAF buildings and other local nondisturbed areas; effect of the diversion ditch around the DAF; and

investigations of reptile species of special concern. The main consequence for lizards of human disturbances at the DAF appears to be vegetational changes associated with site construction. The main vegetational change is removal of perennials as a consequence of grading for roads, building sites, or parking lots. Effects of vegetation on lizard distributions or abundances are well known (see Pianka 1986, Vitt 1991 for a review). Vegetational characteristics can influence insect abundance and thus the lizard's prey base (Polis and Yamashita 1991; Dunham 1980), or perch availability or temperature regimes available, and thus duration and effectiveness of prey capture or predator avoidance. Given this background, DAF construction activities were expected to influence lizards.

The main DAF road had no effects on weight, SVL, or age composition of side-blotched lizards, the most commonly encountered reptile on the NTS. The higher spring to summer recapture rate for side-blotched lizards on control plots relative to the roadside suggests either survival is higher or dispersal off the plot reduced, on the control relative to the roadside plots. The reduced number of perennials along the road could increase lizard mortality via increasing predation and thereby lower survival, or dispersal could be greater off roadside plots for this or some other factor. Transect or plot results did reveal sizeable road effects on lizard numbers. In spring, there were more side-blotched lizards in the control area than along the road (Fig. 9). By summer, sample numbers did not differ between roadside and control areas, implying road effects were seasonal (Fig. 9). A closer examination of roadside plots in spring (Fig. 10), reveals no side-blotched lizards near the road, but equivalent densities in the berm and control areas. By summer, graded or paved areas were still unoccupied by side-blotched lizards, but, their densities on the berm had doubled, while those on the control area were unchanged from spring. The net effect was that by summer, berm areas had side-blotched lizard densities twice those of nearby control areas. The most likely explanation for this shift is that the greater number of females on the berm in the spring (150% of control levels) lead to greater reproduction there. Medina et al. (1994) showed a very strong correlation across the NTS between number of females in spring and number of hatchlings in the summer. An alternative explanation is differential dispersal into the berm area. Only movement studies would allow us to eliminate this potential explanation. A final alternative is that the berm area may have contained more insects (see Lightfoot and Whitford 1991 for evidence) and that this lead to greater survival in this area.

During the spring, whiptails had similar densities in the berm and control areas, but densities only 15 to 20 percent of those levels along the roadside. Distributions of whiptail and side-blotched lizards suggest effects within 10 m of the road arise from vegetation removal due to paving or grading roadsides, as shrubs were considerably more abundant in the control area, or the second 10 m away from the road relative to the first 10 m away from the road. By summer the female biased sex ratio along the road had disappeared. Whether this change reflects a male biased clutch sex ratio or differential dispersal is not clear. BECAMP's roadside studies suggest the road had negative effects on side-blotched lizards and whiptails, two of the most prevalent lizards in western deserts (Pianka 1986).

Lizard populations in the DAF ditch also differed a great deal from nearby controls (Figures 10, 11). Control areas were dominated by side-blotched lizards (10 to 15 times ditch densities), while the ditch was dominated by zebra-tailed lizards (6 to 15 times control densities). Whiptail lizards were also more abundant (7 to 39 times ditch densities) in the control area relative to the ditch. Pooling across species, control areas contained more lizards relative to the ditch. These differences are likely due to shrub removal and elimination of small mammal holes at the soil surface. Both of these activities remove cover for the lizards. Shrub removal also eliminates a resource base for insects, the lizards' primary prey base. Zebra-tailed lizards are known to favor open habitats (Pianka 1986), and thus have probably increased in the cleared ditch. Number of lizards per species, total number of lizard species, or total number of lizard individuals per plot differed between the DAF ditch and either the flat or the arroyo control areas, however, flat or arroyo control areas never differed. These results imply that either flat or arroyo areas may be used interchangeably as controls when testing for DAF effects on lizards.

Timed surveys were performed in 5 areas near the DAF (disturbed areas near DAF, area out to 1 km S of DAF, N of DAF [about 1 km] to the water tank, water tank to foothills, 0.2 km into foothills). Five investigators of various experience levels, ages, and physical abilities participated in these surveys. In spite of their differing abilities, counts/30 minutes did not vary across investigators, suggesting that investigators were largely interchangeable and that this variable had no effect on our number estimates. In contrast, there were sizeable differences in lizard numbers across areas (Figures 13 - 16). Zebra-tailed lizards were 6 to 18 times more abundant in graded areas around the DAF relative to all other areas. While no quantitative data were



collected on densities in the ditch versus around the building, these lizards appeared dense in the ditch and essentially absent from other graded areas around the building. This may be because of the high soil compaction in most non-ditch areas or due to the gravel added to the surface of many of these areas. Side-blotched lizards were 8 to 10 times as abundant in the three sample areas north of the DAF relative to the disturbed area around the DAF buildings. Side-blotched lizard densities south of the DAF were indistinguishable from DAF densities. Whiptail densities were higher just north of the DAF relative to the area from the foothills back to the water tank, all other areas were indistinguishable. There were no differences across areas in number of species, however, the DAF area had more individual lizards (pooled across all lizard species) than the area south of the DAF. Again all other areas were indistinguishable. These results suggest lizard densities are not uniform near the DAF. The disturbed areas around the DAF buildings and the road edges were largely devoid of lizards. In contrast, the DAF ditch appeared to contain high densities of zebra-tailed lizards. Superimposed on this pattern, the area to the north of the DAF contained more individual lizards, while the area south of the DAF contained few lizards relative to other areas near the DAF.

### **Potential Effects of the DAF on Reptiles**

With one field season now complete, the ecological consequences of DAF operation are becoming clear. DAF operation as an assembly facility is likely to release no or extremely small quantities of radioactive material during normal operations. Release would likely be windborne and occur in quantities too small to have measurable ecological impacts. Accidents could in principle release significant quantities of radioactive material with potentially deleterious ecological consequences. Physical operation and maintenance of the DAF facility is the most likely avenue for the DAF to effect plants and animals (Table 1). These effects are potentially major, long lasting, and may reach considerable distances from the DAF. Also, because these factors emanate from the DAF buildings, their effects can potentially be confused with effects of an accident at the DAF. This has important ramifications for monitoring designs as it will influence abilities to separate nonnuclear (largely unregulated) and nuclear (regulated) effects of DAF operation. The potential ecological consequences of DAF operation are discussed in further detail under "Proposed Monitoring Efforts".



## BIRDS

Fifty-seven species of birds were recorded on habitats at or near the DAF in 1993. More than half of these (31) were migrants and the remainder were classified as summer or permanent residents (Appendix-D). Thirty-nine of these 57 species (68%) were seen at the sewage pond: 18 species (32%), were seen only on natural habitats. Three species (5%) were seen around strictly disturbed habitats. Thirteen of 31 species (42%) found in natural habitats were drawn to the pond. Some migratory birds typically attracted to water (e.g. long-billed curlew, killdeer) will also occupy other habitats for short periods. Therefore different habitats support or attract different species. A complete species area list requires sampling multiple habitats or micro-habitats.

Bird usage of the sewage pond was considerable during summer months. Use changed over time with peak usage exceeding 700 bird visits per hour in early June. The most numerous species, mourning doves and house finches raised broods during the summer, when drinking was common at the ponds. These species probably benefited from having access to water when water would normally be lacking. Many species that migrate seasonally also benefited from the ponds. For instance, sage sparrows drank heavily in the fall using habitats at the DAF for winter range. Other common groups of birds such as ducks, sandpipers and avocets regularly stop to rest and forage during migration. Juvenile black-throated sparrows drank heavily from the ponds during July possibly increasing survival of many local fledglings.

Comparisons of density of adult black-throated sparrows on plots away from to those near the pond showed no difference. It suggests increased avian activity near the pond may not have displaced adult songbirds from natural habitats nearby. This is stated with caution because limited sampling occurred on plots near the pond. However, large numbers of birds surrounding the pond in May-June could have reduced local breeding attempts by adult songbirds because of constant interference. Similarly, breeding success could have been reduced by increased predation. This was not investigated in 1993.

While densities could not be estimated for all species, counts on Plot 1 in spring-summer (Table 19) suggested differences in relative bird abundances in natural habitat (house finch < mourning doves < black-throated sparrows). Actual densities between species may vary as relative abundance shown above. However, lower densities of doves and finches near the DAF area as compared to

black-throated sparrows may be a reflection of greater daily dispersal distances. Furthermore, both doves and finches drank from the pond during the breeding season, requiring daily movements, while black-throated sparrows did not. Doves are known to migrate distances up to 1-8 km daily (Losito and Mirarchi 1991). Consistent with this, observations with binoculars at the DAF sewage pond indicated doves as well as finches appeared to fly moderate distances away (>1 km) after pond visits. Breeding birds dependant on summer water may disperse from a heavily used water source to avoid large numbers of birds (drawing predators) or other negative impacts on nesting success.

Birds are particularly difficult to study because of their general mobility, migratory habits, and low densities. Effects of the sewage pond are complex because perceived benefits to some species (leading to population increase) could potentially cause negative impacts on others. This could occur through competition for limited food resources or space.

Disturbed (bladed) areas at the DAF may reduce area for most native species but may also create habitat for those preferring open areas (e.g. horned lark, water pipit). Annual plants growing abundantly on roadsides and bladed areas may bear considerable seed for bird species to consume conferring a benefit. For example, house finches and sage sparrows consumed seeds of *Salsola australis* and *Eriogonum deflexum* growing along denuded areas on dirt roads and near the sewage pond. Detailed work on bladed areas near the DAF buildings or on roadsides was not performed in 1993.

Birds seen only at the sewage ponds and the DAF building included ravens, barn owls, European starlings and house sparrows (the latter two introduced). Starlings and house sparrows are aggressive cavity nesters that form large flocks when abundant and have been implicated in the demise of cavity nesting species such as eastern bluebirds, northern flickers, and swallows. (Ehrlich et al. 1988, Ryser 1985). They usually become common in desert areas after buildings are constructed, in part from the creation of additional nesting habitat. When abundant these species may have negative impacts on resident cavity nesters such as Say's phoebe and ash-throated flycatcher.

Brown-headed cowbirds were also observed at the sewage ponds. This species is an obligate nest parasite which ejects eggs of other species replacing them with its own. It has been implicated in the demise of North American songbirds (Bohning-Gaese et al. 1993). This species would be of concern if it were to become abundant.

Large numbers of doves at the sewage pond attracted predators such as coyote, owls, hawks, falcons, and ravens, all of which could benefit from increased abundance of food. Increased numbers of predator/scavengers such as coyotes and ravens could potentially impact tortoise populations by feeding on young (Luckenbach 1982, Berry 1986). Raptors may be attracted to the DAF buildings because they offer perch sites, insects or other prey, and potential nest sites. Windows on guard towers and light poles, may be hazardous to migrating raptors because of collisions causing mortality. Indirect affects of litter from human activity (dumpsters) can provide food for many species. Raptors or ravens can be drawn to prey attracted to buildings, roadsides, or cleared areas, resulting in collisions with vehicles or structures.

While many of the potential effects of DAF activities on birds are subtle, they should not be considered unimportant. The greatest potential impact is from the sewage pond because many different species may be affected although on a scale of only a few miles distant. Clearing of shrubs is severe for all biota because it removes habitat and changes species distributions. Mitigations should favor minimizing total area cleared during future operations.

## MAMMALS

Species number and abundance on the DAF traplines most resembled that in the Mojave Desert mosaic of the NTS (see Hunter and Medica 1989; Saethre and Medica 1992; Saethre 1994). This is based mainly on the near absence of *Dipodomys microps* at the three sites. The low number of *Perognathus longimembris* was not usual for a site in Frenchman Flat, as sites trapped in this area have shown reduced numbers during the last 5 years. The large proportion of *Chaetodipus formosus* does deviate from the normal trapping results in Frenchman Flat. This species was previously captured in high numbers only on the southern end of the NTS in Mercury and Rock Valleys (French et al. 1966, 1967; Turner 1973, 1975; Turner and McBrayer 1974; Saethre and Medica 1992; Saethre 1994).

In the Mojave Desert, available ephemeral plant material generally depends on adequate amounts of winter rainfall for germination and spring rain for growth (Beatley 1974b, 1976; Bowers 1987). Most rodents are herbivores or granivores and depend on adequate quantities of plant biomass (most importantly from annual plants) for reproduction and growth (Kenagy 1972, 1973; Van de Graaff and Balda 1973; Reichman and Van de Graaff 1973, 1975; Kenagy and Bartholomew

1981). Consequently 1993, a year of ample rainfall, was a year of high rodent abundance. The copious number of rodents in 1993 may explain why DAF monitoring did not show any anomalies in rodent abundance or diversity between sites. No real conclusions should be made on mean weight differences between sites sampled over time with so few samples, although some effect of the road was evident.

### **Trap Type**

The effectiveness of the mesh traps is questionable. O'Farrell et al. (1992) captured over twice as many individuals of three species in mesh traps when sequentially trapping with mesh and Sherman live traps. At the DAF site only one species was captured more often in the mesh traps, suggesting that it may not be worth the added hassle of baiting the extra-sensitive traps. The high number of torpid rodents and potential mortality was also not acceptable. Using cotton batting would reduce the number of hypothermic rodents, but also requires more effort and causes a pollution problem.

Animal abundance at the DAF sites appeared to be high relative to historical norms at the NTS. This may have negated any benefit from the mesh traps due to saturating traps with captures. Both traps at a station contained animals on 168 occasions in early June. Species diversity was slightly higher for Sherman traps (Table 25), and, overall, the results were not compelling enough to switch exclusively to mesh traps.

### **PROPOSED MONITORING EFFORTS**

BECAMP's monitoring program is intended to assess both nuclear and nonnuclear (Table 1) consequences of DAF operation. Preoperational sampling in 1993 revealed several gradients in species abundances in the DAF vicinity which were incorporated into the monitoring program. Monitoring programs are discussed with respect to each group of study organisms.

### **EXPECTED DAF EFFECTS AND FUTURE MONITORING OF EPHEMERALS**

Construction disturbance currently surrounds the DAF, and is already having major effects on the ephemeral plant populations. In the absence of further disturbance, one would expect an increase in weedy and introduced species on and near present disturbances, and a very gradual recovery over a period of many decades. (The ground zeroes and subsidence craters in Yucca Flat show

only the beginnings of normal plant populations some 30 to 35 years after disturbance - Hunter 1994a, b).

Continuing disturbance can be expected near the DAF for road maintenance, clearing of parking and traffic areas, runoff events reestablishing blocked drainage channels and new ones created by the dike, and clearing of vegetation to maintain visibility for security purposes. These conditions favor the maintenance and spread of weedy introduced species, which are causing significant ecological changes worldwide (e.g., Holzapfel et al. 1992; Pavlik et al. 1993; Tyser and Worley 1992).

Besides effects of DAF operation and recovery from the construction disturbance, ephemeral populations on the NTS are faced with effects of the many introduced species now present, with changes in soil fertility associated with air pollution, and with human-caused and natural climate change. Given these threats, ephemeral species diversity is expected to decrease, especially among those species already present in low numbers or in small disjunct patches.

Future monitoring of ephemeral plants near the DAF should allow an assessment of how DAF operations affect the balance between rare native and weedy introduced species. The extent of continuing disturbance should be monitored, as well as the distance from disturbance to which introduced/weedy species spread. The presence and densities of rare species in undisturbed habitat near the DAF should be monitored, as should the association of the weedy species with various DAF-related disturbances. These monitoring efforts will require further method development.

There are several possible ways to organize future monitoring of ephemerals. The first would be to monitor random locations around the DAF to detect changes generally associated with the DAF. Another would be to focus on particular disturbances and design monitoring to detect particular variables, such as distance of spread of weedy plants away from the roadside or disturbed areas, to monitor plant populations on particular kinds of disturbance, and to monitor plant growth, reproduction, and species composition at significant distances from disturbance. The latter would do a better job of determining expected effects, while the former might have a better chance of detecting unexpected effects. The latter would also provide precise information on specific questions, while the former would provide general information for many questions. We believe that for ephemeral plants more specific monitoring

would be of greater value per effort expended. Current methods for monitoring ephemerals are too time consuming and statistically inadequate to detect unanticipated or subtle changes.

Our recommendation is to use BECAMP's standard technique to determine ephemeral plant population parameters on the paved roadside, a scraped and graveled area, a scraped/compacted area, and two or three control areas. The control areas should be several hundred meters from the nearest disturbance, which would require sites at least a kilometer from the DAF. In addition, the  $\log_{10}$  technique should be used to monitor the spread of weedy species away from an example of each of the three disturbance types studied. Finally, the extent of continuing disturbance should be monitored to help distinguish operational from construction effects and allow management to exercise some control over the disturbance/recovery processes near the DAF.

Data collection for the proposed monitoring would take two to four man weeks between April 1 and May 1. Analysis and reporting would take considerably longer. If time or funding is not adequate, the effort should be reduced by cutting out disturbance and control sites proportionately.

## PERENNIAL PLANTS

Perennial plant parameters amenable to monitoring include germination and establishment of seedlings (population changes), growth and dieback of established plants, and reproduction and grazing of established plants. Different species exhibit different habits, and differ somewhat in speed of response to disturbance. The herbaceous perennials, for example, reproduce quickly and are generally short-lived, while the long-lived dominant species generally grow and die back with few changes in number. In general, however, perennial plants change rapidly by growth and dieback, and more slowly and erratically by germination, establishment, and death of whole plants.

Predictable effects of DAF construction on perennial plant populations include increased growth of plants near disturbances (an effect of reduced competition for water), increases in weedy herbaceous perennials on and adjacent to disturbed areas, and increases in grazing damage associated with rabbits (which preferentially graze on the moister vegetation on disturbed areas, (Hunter 1987). Changes over wide areas or changes in species composition, such as might occur with plants, are unlikely. Because expected changes are minor, and there are no predicted effects of DAF operations, we believe

perennial sampling should be aimed at detecting unpredicted changes and perhaps changes in radionuclide contents.

Plant transects set up in 1993 should be monitored each year both near and far from the DAF. Because relatively few perennial plants are present in each plot, we recommend sampling all 100 plots each year. Censusing these plots provides information on the full range of species present at the DAF, and would allow determination of year-to-year changes in size, populations of herbaceous species, reproduction, and grazing patterns. It would put monitoring personnel in all areas surrounding the DAF, and thus provide opportunities to observe unexpected patches of dying plants or other unusual occurrences.

Monitoring involves observing a site and reporting unfavorable trends or occurrences to management, who then modify procedures and/or goals accordingly. To satisfy this need to warn management, it is important to monitor perennial plants on an annual basis, even in the desert where change is sometimes slow. Monitoring desert biota on a multi-year frequency does not provide timely warnings. It also would miss data on when changes occur, which would allow determination of causes of unpredicted change. Monitoring more frequently than annually would lead to tracking changes associated with reproductive and growing seasons, which would greatly complicate data collection and interpretation.

We recommend sampling the marked *Ephedra nevadensis*, *Yucca brevifolia*, and *Larrea tridentata* nearest the 100 plots on a three-year frequency. These species are long-lived and slow-growing, they are mostly large and therefore not fragile, and they tolerate weather extremes better than most species. These stable species are less likely to respond rapidly to changes associated with DAF operations, and their monitoring is therefore less urgent.

Certain operations are expected, such as roadside maintenance and clearing of vegetation in parking and vehicle access areas. Most DAF-related damage to the perennial plant ecology of the surrounding area is caused by clearing that occurred during construction. We recommend that these disturbed areas be monitored for continuing disturbance, to document interference with recovery processes. A number of plant transects are already in these cleared areas, but additional plots specially placed to document recovery processes may be desirable. A decision on monitoring efforts for these areas should be made after construction activities are completed.

Monitoring at the suggested levels (Table 29) would require approximately two man-months of field work during summer, mostly by college students, plus an equivalent time spent analyzing and reporting data by senior personnel. An additional man-month would be necessary every third year when remeasuring the marked individuals of the dominant species.

### **SENSITIVE PLANTS**

No endangered, threatened, or candidate plant species was seen during baseline characterization studies, nor was any habitat suitable for those species seen. Therefore, no activities are planned specifically to characterize sensitive plant species. If such species are seen during future monitoring efforts, their presence will be noted and monitoring plans may be revised accordingly.

### **REPTILES**

Reptile abundances were greater in nondisturbed areas away from the DAF relative to the disturbed areas near it, implying negative consequences for reptiles of nonnuclear human activities associated with the DAF. The main access road also appeared to negatively affect lizards. Finally, there was evidence that nondisturbed areas north of the DAF contained more lizards than nondisturbed areas to the south, suggesting the lizard fauna may not have been homogeneous in this area prior to DAF construction. This means designation of an appropriate control area for the DAF building complex is problematic.

Given these preliminary findings, three types of reptile monitoring are proposed (Table 29). The first is a series of transects in the disturbed area around the DAF, and radiating away from it. This protocol is designed to assess effects of operation of the DAF buildings. Transects consist of 100 x 15 m wide sections isolated from one another by 100 m. These transects are located on four sides (the cardinal directions) of the DAF disturbed area. Each quadrant contains 2 transect sections in the disturbed area, and four radiating out from it. Lizard counts within each 100 m section will be made following standard BECAMP techniques (Medica et al. 1994; REECO lizard study procedure AABAF.D.05.00 revision 1, revised 28 Aug. 1991). Each transect will be walked four times. Two analyses will be performed on these counts. A three-way analysis of variance test, with direction (north, south, east, west) day sampled, and location (in disturbed areas vs nearest two vs farthest two sections in undisturbed habitat) will be used to contrast lizard numbers in the area of immediate DAF operations to more distant areas. This analysis is



**Table 29.** Field manpower needs for proposed DAF monitoring plan. Data entry, analysis and report writing are estimated to take 100 % of field time, and should be added to the field time to get total manpower needs.

Taxon/task	Manpower staff (students)	Days needed for task	Total man-days per year	Repeat interval of task
Reptiles/ Walking transects radiating from DAF	1 (2)	4 days x two seasons = 8	24	every year
Reptiles/ Walking plots in disturbed and undisturbed areas near the DAF	1 (3)	5 days x two seasons = 10	40	once every 3 years
Reptiles/ Walking plots in roadside and control area	1 (3)	5 days x two seasons = 10	40	once every 5 years
Reptiles/ General survey for chuckwalla and desert tortoise	1 (2)	5 days	15	every year
Ephemeral plant censusing	1 (0)	6 days	6	every year
Perennial plant plots	0 (2)	20 days	40	every year
Marked perennials	1 (2)	5 days	15	every 3 years
Raven count at sewage pond	1 (0)	8 days	8	every year
Birds/ Census circular plots	1 (0)	5 days	5	alternate years
Birds/ Nest searches	1 (1)	15 days	30	alternate years
Birds/ Disturbed areas	1 (0)	5 days x two seasons	10	once every 3 years

Table 29. continued.

Taxon/task	Manpower staff (students)	Days needed for task	Total man-days per year	Repeat interval of task
Rodents/ Trapping lines in roadside and control	1 (1)	2 days x 5 months = 10	20	once
Rodents/ Trapping lines in	2 days x 2 seasons =	every 3 years		
Rodents/ Assessment lines radiating from ditch to north	1 (3)	2 days x 2 seasons = 4	16	once
Random samples around DAF	1 (1)	2 days x 10 locations = 20	40	once every 5 years
Bat surveys - net	1 (1)	3 nights x 3 seasons = 9	18	once every 3 years
Jackrabbits	1 (0)	5 days	5	alternate years

designed to assess overall effects (both nuclear and nonnuclear) of DAF operation on lizards. The other analysis is a regression examining variation in lizard numbers as a function of distance from the DAF disturbed areas. This analysis is designed to assess long distance effects of the DAF which we suspect would be mainly nuclear, should a mishap occur. Both sampling protocols incorporate directional faunal differences into the analysis. The field work for this monitoring program requires three people for four days and should be performed annually, as these data would be essential for interpreting the consequences of a nuclear mishap on lizards.

The second monitoring program involves a modified mark-recapture program (Medica et al. in press). This approach yields a better estimate of side-blotched-lizard numbers than the transect technique discussed above. The technique is, however, much more labor intensive (four people for five days to sample a much smaller area), and will be used only every three years. Sampling in the undisturbed area will be restricted to two arms (north and south or east and west in alternating sampling periods) of the transect array in any sample year. Lizard numbers will be estimated in the eight transect sections in undisturbed habitat and compared to the eight transect sections in the disturbed area with an analysis of variance. This study enables us to examine DAF effects on side-blotched lizards more closely, and will be used to calibrate transect-study-results.

The final lizard monitoring program will be to repeat the roadside studies protocol discussed in this report, once every five years. This will allow us to examine continuing effects of the road on lizard numbers.

Two species of special concern, the desert tortoise and the chuckwalla, occurred near the DAF. The status of these species will be assessed with general opportunistic surveys over 15 man days in each year. These surveys will be modeled after the timed surveys discussed in this report.

## **BIRDS**

Recommended future work (Table 29) includes counting ravens at the sewage pond with current methods (1 hour counts) yearly to assess potential long term increases. From February to December all bird species present at the sewage pond will be recorded to continue development of a species list for the DAF. Circular bird plots will be resampled to obtain baseline density estimates on

natural areas and near the sewage pond in the second year and every other year thereafter using variable circular plot techniques.

Nest site searches will be performed near the sewage pond and compared to natural areas to assess pond impacts on local breeding success. Two plots (10-15 ha) near the sewage pond and two about 600-800 meters away will be marked with stakes at 50 m intervals. Plots will be searched for nests from April-June. Individual nests will be examined for eggs and nestlings, and comparisons made across plots to examine treatment effects.

Relative abundance of birds on bladed areas near DAF or roadsides may be compared to those in a natural habitat using 9 minute counts at various stations (2 minute rest period) along a transect. Transect length (300-700 m) and number of stations (3-6) placed about 100 m apart could vary depending on shape or length of disturbed area. Birds will be counted within a 20 m wide band perpendicular to the transect and within 40 m along the transect (McGarical and McComb 1992). Breeding activity of birds associated with the buildings and bladed areas will be recorded. Finally, DAF lights will be examined at night to determine bird attraction, and to record presence of any dead or injured birds.

General observations and records of loggerhead shrikes and other sensitive species will be made at the DAF and in the immediate vicinity as part of the monitoring effort.

## **MAMMALS**

To determine the precise timing of reproduction in rodents around the DAF, trapping at shorter intervals is needed. Since reproduction in rodents is clearly related to weather patterns (i.e., rainfall producing vegetation for forage) this question can probably not be answered by trapping at three year intervals. As such, one year of trapping on a monthly basis will be done to corroborate 1993 results. Future effort will emphasize abundance and diversity of disturbed areas in comparison to relatively natural areas (Table 29).

Fine tuning of species distribution and abundance will be accomplished by trapping shorter lines or grids at several distances from the DAF. Snap traps or pitfalls may also be used in selected areas. Approximately 20 such

locations can be set up with a minimum effort and sampled on a five year basis.

Assessment lines from the disturbed area near the drainage dike and crossing FRF011 may help determine to what extent the ditch is a barrier to dispersal and how it may affect rodent abundance (Table 1). Other specific disturbances to be assayed in the future may include the attraction of the lights to bat species, the spotted bat in particular. This may entail using nets and possibly digital audio tape recorders. The other disturbances listed in Table 1 are less likely to have any ongoing impact on the small mammal population. The mobile rodents will have no trouble passing through the chain-link fence to the cleared area. However, this area is so depauperate in vegetation that foraging is not likely and any feeding or dispersing rodent would be exposed to an increased risk of predation.

Use of two traps will be continued based on the high trap success at this site. The two different trap types will continue to be used on a trial basis in case poorer quality years show differences in trap preference. Trapping sessions will be limited to two days and performed once a month in 1994 during peak rodent activity (April through September). New captures decreased markedly after the second morning in 1993, suggesting a third day would only deliver marginally better data for the added effort in future years (Table 29). This would considerably reduce the manpower needs and facilitate trapping at more locations around the DAF.

After one more year of intense study, monitoring on a smaller scale (one session each in spring and summer) will continue on a three-year cycle, possibly with even shorter assays in the other two years. Future monitoring will require less effort once all plots are set up (Table 29). Concentrating on abundance and diversity will yield relatively clear results at low manpower cost. Relative abundance of jackrabbits can be monitored for several days each month. An observer will count rabbits per hour in undisturbed habitat recording number of juveniles and adults, and noting condition and presence of any dead animals away from the roads.

## REFERENCES

- Allred, D.M. and DE. Beck. 1963. Ecological distribution of some rodents at the Nevada Atomic Test Site. *Ecology* 44:211-214.
- Allred, D.M., DE. Beck, and C.D. Jorgensen. 1963. Biotic communities of the Nevada Test Site. *Brigham Young University Science Bulletin Biological Series* 2:1-52.
- Banks, R.C., R.W. McDiarmid and A.L. Gardner. 1987. Checklist of Vertebrates of the United States, the U.S. Territories and Canada. U.S. Fish Wildlife Serv., Resour. Publ. 166. 79 pp.
- Beatley, J.C. 1974a. Effects of rainfall and temperature on the distribution and behavior of *Larrea tridentata* (creosote bush) in the Mojave Desert of Nevada. *Ecology* 55:245-261.
- Beatley, J.C. 1974b. Phenological events and their environmental triggers in Mojave Desert ecosystems. *Ecology* 55:856-863.
- Beatley, J.C. 1975. Climates and vegetation pattern across the Mojave/Great Basin Desert transition of Southern Nevada. *Amer. Midl. Natur.* 93:53-70.
- Beatley, J.C. 1976. Vascular plants of the Nevada Test Site and Central-Southern Nevada: ecologic and geographic distributions. Report TID-26881, NTIS, U. S. Department of Commerce, Springfield, VA 22161. 308 pp.
- Beatley, J.C. 1979. Shrub and tree data for plant associations across the Mojave/Great Basin transition of the Nevada Test Site, 1963-1975. Report DOE/EV/2307-15, NTIS, U. S. Dept. of Commerce, 5285Port Royal Rd., Springfield, VA 22161. 52 pp.
- Berry, K.H. 1986. Desert tortoise (*Gopherus agassizii*) research in California 1976-1985. *Herpetologica* 42:62-67.
- Bohning-Gaese, K., M.L. Taper and J.H. Brown. 1993. Are declines in North American insectivorous songbirds due to causes on the breeding range? *Conservation Biology* 7:76-86.
- Bowers, M.A. 1987. Precipitation and the relative abundance of desert winter annuals: a 6-year study in the northern Mohave Desert. *J. Arid Environ.* 12:141-150.



- Bradley, W.G. and R.H. Mauer. 1971. Reproduction and food habits of Merriam's kangaroo rat, *Dipodomys merriami*. J. Mammal. 52:497-507.
- Bradley, W.G. and K.S. Moor. 1975. Ecological studies of small vertebrates in Pu-contaminated study areas of NTS and TTR. pp. 151-185 *In*: The Radioecology of Plutonium and Other Transuranics in Desert Environments. Nevada Applied Ecology Group Progress Report as of January 1975. M.G. White and P.B. Dunaway, eds. NAEG/ERDA Report NVO-153, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. 503 pp.
- Bradley, W.G. and K.S. Moor. 1976. Ecological studies of small vertebrates in Pu-contaminated study areas of Nevada Test Site and Tonopah Test Range. pp. 53-65 *In*: Studies of Environmental Plutonium and Other Transuranics in Desert Ecosystems. M.G. White and P.B. Dunaway, eds. NAEG/ERDA Report NVO-159, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. 189 pp.
- Bradley, W.G. and K.S. Moor. 1978. Ecological studies of small mammals in a nuclear site on the Nevada Test Site. pp. 1-13 *In*: Selected Environmental Plutonium Research Reports of the NAEG. M.G. White and P.B. Dunaway, eds. NAEG/DOE Report NVO-192, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. 318 pp.
- Bradley, W.G., K.S. Moor, and S.R. Naegle. 1977a. Plutonium and other transuranics in small vertebrates: a review. pp. 385-405 *In*: Transuranics in Natural Environments. M.G. White and P.B. Dunaway, eds. NAEG/ERDA Report NVO-178, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. 710 pp.
- Bradley, W.G., K.S. Moor, and S.R. Naegle. 1977b. Plutonium concentrations and Pu/Am ratios in small vertebrates from NAEG study areas of NTS. pp. 207-219 *In*: Transuranics in Desert Ecosystems. M.G. White, P.B. Dunaway, and D.L. Wireman, eds. NAEG/DOE Report NVO-181, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. 469 pp.
- Campbell, H.W. and S.P. Christman 1982. The herpetological components of Florida sandhill and sand pine scrub associations. pp. 163-172 *In*: Herpetological Communities, N.J. Scott, Jr. ed., U.S. Dept. of the Interior, Fish and Wildlife Service, Wildlife Research Report 13. Washington, D.C. 239 pp.

- Casteller, R.C. and H.O. Hill. 1979. Additions to the birds of the Nevada Test Site. *Western Birds* 10:221-223.
- Chew, R.M. 1975. Effects of density on the population dynamics of *Perognathus formosus* and its relationships within a desert ecosystem. U.S./International Biological Program (IBP) Desert Biome Research Memo RM 75-18. Utah State Univ., Logan, UT. pp. 19-26.
- Dingman, R.E. 1975. Interaction between a fossorial rodent (the pocket gopher, *Thomomys bottae*) and a desert plant community. U.S./IBP Desert Biome Research Memo RM 75-23. Utah State Univ., Logan, UT. pp. 50-57.
- Dunham, A. 1980. An experimental study of interspecific competition between the iguanid lizards *Sceloporus merriami* and *Urosaurus ornatus*. *Ecol. Monogr.* 50:309-330.
- EG&G/EM (EG&G Energy Measurements, Inc.). 1992. Yucca Mountain Biological Resources Monitoring Program Annual Report FY 91. EG&G/EM Santa Barbara Operations Report No. 10617-2127, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. 68 pp.
- EG&G/EM. 1993. Yucca Mountain Biological Resources Monitoring Program Annual Report FY 92. EG&G/EM Santa Barbara Operations Report No. 10617-2195, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. 77 pp.
- Ehrlich, P.R., D.S. Dodkin, and D. Wheye. 1988. *The Birders Handbook: A field guide to the natural history of North American birds*. Simon and Schuster Inc., New York. 785 pp.
- French, N.R. 1964. Description of a study of ecological effects on a desert area from chronic exposure to low level ionizing radiation. U.S. Atomic Energy Commission Report UCLA 12-532. 27 pp. + figures.
- French, N.R., B.G. Maza, and A.P. Aschwanden. 1966. Periodicity of desert rodent activity. *Science* 154:1194-1195.
- French, N.R., B.G. Maza, and A.P. Aschwanden. 1967. Life spans of *Dipodomys* and *Perognathus* in the Mojave Desert. *J. Mammal.* 52:497-507.
- French, N.R., B.G. Maza, H.O. Hill, A.P. Aschwanden, and H.W. Kaaz. 1974. A population study of irradiated rodents. *Ecol. Monographs* 44:45-72.



- French, N.R., T.Y. Tagami, and P. Hayden. 1968. Dispersal in a population of desert rodents. *J. Mammal.* 49:272-280.
- Hall, E.R. 1981. *The Mammals of North America*. New York, NY: John Wiley and Sons. Second Edition. 1181 pp. + Indices.
- Hayward, C.L., M.L. Killpack and G.L. Richards. 1963. Birds of the Nevada Test Site. Brigham Young University, *Sci. Bull., Biol. Ser.* 1:1-27.
- Holzappel, C., W. Schmidt, and A. Shmida. 1992. Effects of Human-Caused Disturbances on the Flora Along a Mediterranean-Desert Gradient. *Flora* 186:261-270.
- Hunter, R.B. 1987. Jackrabbit-shrub interactions in the Mojave Desert. Proceedings, Symposium on Plant-Herbivore Interactions. USDA Forest Service Gen. Tech. Rep. INT-222:88-92.
- Hunter, R.B. 1991. *Bromus* invasions on the Nevada Test Site: present status of *B. rubens* and *B. tectorum* with notes on their relationship to disturbance and altitude. *Great Basin Naturalist* 51:176-182.
- Hunter, R.B. Compiler. 1992a. Status of the Flora and Fauna of the Nevada Test Site, 1988. Report DOE/NV/10630-29. NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. 229 pp.
- Hunter, R.B. 1992b. Status of perennial plants on the Nevada Test Site in 1988. Pp. 183-228 *In: Status of the Flora and Fauna on the Nevada Test Site, 1988*. R. Hunter, compiler, Report DOE/NV/10630-29, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. 229 pp.
- Hunter, R.B. 1994a. Trends in ephemeral plant populations on the Nevada Test Site, 1989 - 1991. pp. 334 - 377 + app. *In: Status of the Flora and Fauna on the Nevada Test Site, 1989 - 1991*. R. Hunter, compiler, Report DOE/NV/14432-57, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. 377 pp. + apps.

- Hunter, R.B. 1994b. Status of ephemeral plants on the Nevada Test Site, 1992. pp. 1 - 30 + apps. *In: Status of the Flora and Fauna on the Nevada Test Site, 1992.* R. Hunter, compiler, Report DOE/NV/11432-58, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. 207 pp. + appendices.
- Hunter, R.B. 1994c. Trends in perennial plant populations on the Nevada Test Site - 1989-1991. pp. 236 - 333 + apps. *In: Status of the Flora and Fauna on the Nevada Test Site, 1989 - 1991.* R. Hunter, compiler, Report DOE/NV/14432-57, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. 377 pp. + apps.
- Hunter, R.B. 1994d. Status of perennial plants on the Nevada Test Site, 1992. pp. 176 - 207 + apps. *In: Status of the Flora and Fauna on the Nevada Test Site, 1992.* R. Hunter, compiler, Report DOE/NV/14432-58, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. 207 pp. + apps.
- Hunter, R.B., F.B. Turner, R.G. Lindberg, and K. B. Hunter. 1987. Effects of land clearing on bordering winter annual populations in the Mohave Desert. *Great Basin Naturalist* 47:234-238.
- Hunter, R.B. and P.A. Medica. 1989. Status of the Flora and Fauna of the Nevada Test Site: Results of Continuing Basic Environmental Research January through December 1987. Report DOE/NV/10630-2, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. 103 pp.
- Inouye, R.S. 1991. Population biology of desert annual plants. Pp. 27-54 *In: The Ecology of Desert Communities.* G. Polis, ed. Univ. of
- Johnson, H.B., F.C. Vasek, and T. Yonkers. 1975. Productivity, diversity and stability relationships in Mojave Desert roadside vegetation. *Bulletin of the Torrey Botanical Club* 102:106-115.
- Jorgensen, C.D. and C.L. Hayward. 1965. Mammals of the Nevada Test Site. *BYU Sci. Bull. Biol. Ser.* 6:1-81.
- Kartesz, J.T. and R. Kartesz. 1980. A Synonymized Checklist of the Vascular Flora of the United States, Canada, and Greenland. Univ. of North Carolina Press, Chapel Hill, NC. 500 pp.

- Kenagy, G.J. 1972. Saltbush leaves: excision of hypersaline tissue by a kangaroo rat. *Science* 178:1094-1096.
- Kenagy, G.J. 1973. Daily and seasonal patterns of activity and energetics in a heteromyid rodent community. *Ecology* 53:1201-1219.
- Kenagy, G.J. and G.A. Bartholomew. 1981. Effects of day length, temperature, and green food on testicular development on a desert pocket mouse, *Perognathus formosus*. *Physiol. Zool.* 54:62-73.
- Lightfoot, D.C. and W.G. Whitford. 1991. Productivity of creosotebush foliage and associated canopy arthropods along a desert roadside. *Amer. Midl. Natur.* 125:310-322.
- Losito, M.P., R.E. Mirarchi. 1991. Summertime habitat use and movements of hatchling-year mourning doves in northern Alabama. *J. Wildl. Manage.* 55:137-146.
- Luckenbach, R.A. 1982. Ecology and management of the desert tortoise (*Gopherus agassizii*) in California. Pp. 1-37 *In: North American Tortoises: Conservation and Ecology*, R.B. Bury, ed. U.S. Dept. of Interior, Fish and Wildlife Service Wildlife Research Report 12. Washington, D.C.
- Maza, B.G., N.R. French, and A.P. Aschwanden. 1973. Home range dynamics in a population of heteromyid rodents. *J. Mammal.* 54:405-425.
- McAuliffe, J.R. 1990. A rapid survey method for the estimation of density and cover in desert plant communities. *J. Vegetation Science* 1:653-656.
- McGarigal, K., and W.C. McComb. 1992. Streamside versus upslope breeding bird communities in central Oregon coast range. *J. Wildl. Manage.* 56:10-23.
- Medica, P.A. 1990. Noteworthy mammal distribution records for the Nevada Test Site. *Great Basin Nat.* 50:83-84.
- Medica, P.A., M.B. Saethre, R.B. Hunter and J.D. Drumm. 1994. Trends in reptile populations on the Nevada Test Site. pp. 1 - 49 + apps. *In: Status of the Flora and Fauna on the Nevada Test Site, 1989-1991*. R. Hunter, compiler, Report DOE/NV/14432-57, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. 377 pp. + apps.

- Moor, K.S. and W.G. Bradley. 1974. Ecological studies of vertebrates in plutonium contaminated areas of the Nevada Test Site. pp. 187-212 *In: The Dynamics of Plutonium in Desert Environments*. P.B. Dunaway and M.G. White, eds. NAEG/ERDA Report NVO-142, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. 369 pp.
- Moor, K.S. and W.G. Bradley. 1987. Radioecology of small animal populations inhabiting nuclear-event site at Nevada Test Site. pp. 321-344 *In: The Dynamics of Transuranics and Other Radionuclides in Natural Environments*. W.A. Howard and R.G. Fuller, eds. NVO-272, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161 565 pp.
- Moor, K.S., W.G. Bradley, J.S. Miller, and S.R. Naegle. 1976. Standard Nevada Applied Ecology Group procedures for collection of small vertebrates from intensive study areas of NTS. pp. 139-148 *In: Nevada Applied Ecology Group Procedures Handbook for Environmental Transuranics*. M.G. White and P.B. Dunaway, eds. NAEG/ERDA Report NVO-166 (Volume 1 of 2), NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161 322 pp.
- Moor, W.G., S.R. Naegle, and W.G. Bradley. 1977.  $^{239}\text{Pu}$  and  $^{241}\text{Am}$  contamination of small vertebrates in NAEG study areas of NTS and TTR. pp. 193-217 *In: Environmental Plutonium on the Nevada Test Site and Environs*. M.G. White, P.B. Dunaway, and W.A. Howard, eds. NAEG/ERDA Report NVO-171, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161 322 pp.
- Moorefield, J. D. and T. A. Knight. 1991. Endangered, threatened, and sensitive vascular plants of Nevada. Nevada State Office of U. S. Bureau of Land Management, Reno, NV. 46 pp.
- Munz, P.A. 1974. A flora of southern California. Univ. of California Press, Berkeley, CA. 1086 pp.
- O'Farrell, M.J., W.A. Clark, F.H. Emerson, F.R. Kay, T.M. O'Farrell, and T. Okamoto. 1992. The use of mesh live traps for small mammals: are Sherman live traps deceptive? Poster presented at the 72nd Annual Meeting of the American Society of Mammalogists. 14-18 June 1992, University of Utah, Salt Lake City, UT.

- O'Farrell, T.P. and L.A. Emery. 1976. Ecology of the Nevada Test Site: A Narrative Summary and Annotated Bibliography. USERDA Report NVO-169, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. 246 pp.
- O'Farrell, T.P. and M. Sauls. 1987. Small mammals inhabiting nuclear event sites: population characteristics and radionuclide body burden. pp. 279-304 *In: The Dynamics of Transuranics and Other Radionuclides in Natural Environments*. W.A. Howard and R.G. Fuller, eds. NVO-272, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. 565 pp.
- Pavlik, B.M., D.I. Nickrent, and A.M. Howald. 1993. The recovery of an endangered plant. I. Creating a new population of *Amsinckia grandiflora*. *Conservation Biology* 7:510-526.
- Pianka, E.R. 1986. Ecology and natural history of desert lizards. Analyses of the ecological niche and community structure. Princeton Univ. Press, Princeton, New Jersey, US. 208 pp.
- Polis, G.A. and T. Yamashita. 1991. The ecology and importance of predaceous arthropods in desert communities. Pp. 180-222 *In: The ecology of desert communities*. G.A. Polis, editor. The Univ. of Arizona Press, Tucson, Arizona US. 456 pp.
- Reichman, O.J. 1991. Desert mammal communities. Pp. 311-347 *In: The ecology of desert communities*. G.A. Polis, editor. The Univ. of Arizona Press, Tucson, Arizona US. 456 pp.
- Reichman, O.J. and K.M. Van De Graaff. 1973. Seasonal activity and reproduction patterns of five species of Sonoran Desert rodents. *Am. Midl. Nat.* 90:118-126.
- Reichman, O.J. and K.M. Van De Graaff. 1975. Association between ingestion of green vegetation and desert rodent reproduction. *J. Mammal* 56:503-506.
- Reynolds, R.T., J.M. Scott and R.A. Nussbaum. 1980. A variable circular-plot method for estimating bird numbers. *Condor* 82:309-313.
- Rhoads, W. A. and M. P. Williams. 1977. Status of endangered and threatened plant species on Nevada Test Site - a survey. Part 1: endangered species. Report EGG 1183-2356. Available from NTIS, 5285 Port Royal Road, Springfield, VA 22161. 102 pp.

- Ryser, F.A. 1985. Birds of the Great Basin. University of Nevada Press. Reno, NV. 604 pp.
- Saethre, M.B. 1994. Trends in small mammals on the Nevada Test Site: 1989 through 1991. pp. 50 - 140 + appe. *In*: Status of the Flora and Fauna on the Nevada Test Site, 1989 - 1991. R. Hunter, compiler, Report DOE/NV/14432-57, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. 337 pp. + apps.
- Saethre, M.B. and P.A. Medica. 1992. Status of small mammals on the Nevada Test Site in 1988. pp. 97-160 *In*: Status of the Flora and Fauna on the Nevada Test Site: 1988. R.B. Hunter, compiler, Report DOE/NV/10630-29, NTIS, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, VA 22161. 229 pp.
- Scott, T.G. and C.H. Wasser. 1980. Checklist of North American plants for wildlife biologists. The Wildlife Society, 7101 Wisconsin Ave, Washington, D.C. 20014. 58 pp.
- Szaro, R.C., and M.D. Jakle. 1985. Avian use of a desert riparian island and its adjacent scrub habitat. *Condor* 87:511-519.
- Tanner, W.W. and C.D. Jorgensen. 1963. Reptiles of the Nevada Test Site. *BYU Science Bull., Biol. Ser* 3:1-31.
- Tueller, P.T. and V. Bostick. Joshua tree (*Yucca brevifolia*) biomass determinations. Unpublished manuscript in the BECAMP library. 23 pp.
- Turner, F.B. (Coordinator). 1973. Rock Valley validation site report. U.S./IBP Desert Biome Reports of 1972 Progress, 'Vertebrates'. US/IBP Desert Biome Research Memo RM 73-2. Utah State Univ., Logan, UT. pp. 168-200.
- Turner, F.B. (Coordinator). 1975. Rock Valley validation site report. Reports of 1974 Progress Volume 2: Validation Site Studies. US/IBP Desert Biome Research Memo RM 75-2. Utah State Univ., Logan, UT. 53 pp.
- Turner, F.B. and McBrayer (eds.). 1974. Rock Valley validation site. U.S./IBP Desert Biome Research Memorandum 74-2. Utah State Univ., Logan, UT. 64 pp.

- Turner, F.B. and P.A. Medica. 1977. Sterility among female lizards (*Uta stansburiana*) exposed to continuous gamma radiation. *Radiation Research* 70:154-163.
- Turner, F.B. and D.C. Randall. 1989. Net production by shrubs and winter annuals in Southern Nevada. *J. Arid Environ.* 17:23-26.
- Tyser, R.W. and C.A. Worley. 1992. Alien flora in grasslands adjacent to road and trail corridors in Glacier National Park, Montana (U.S.A.). *Conservation Biology* 6:253-262.
- Van De Graaff, K.M. and R.P. Balda. 1973. Importance of green vegetation for reproduction in the kangaroo rat, *Dipodomys merriami merriami*. *J. Mammal.* 54:509-512.
- Vitt, L. 1991. Desert reptile communities. pp. 249-277 *In: The ecology of desert communities.* G.A. Polis, editor. The Univ. of Arizona Press, Tucson, Arizona, US. 346 pp.
- Wilson, D.E. and D.M. Reeder, eds. 1993. *Mammal Species of the World: A taxonomic and Geographic Reference.* Washington, DC: Smithsonian Institution Press in association with the American Society of Mammalogists. Second Ed. 1206 pp.
- Zar, J.H. 1984. *Biostatistical Analysis.* Second Edition. Prentice-Hall, Inc. Englewood Cliffs, N.J. 718 pp.

**APPENDIX A**  
**MAMMALS OF THE NEVADA TEST SITE<sup>(1)</sup>**

Order **INSECTIVORA**: Insectivores

		DAF <sup>(2)</sup>
		<u>Present/Absent</u>
Family Soricidae: Shrews		
<i>Notiosorex crawfordii</i>	Desert shrew	?
<i>Sorex merriami</i>	Merriam's shrew	A
<i>Sorex tenellus</i>	Inyo shrew	A

Order **CHIROPTERA**: Bats

Family Vespertilionidae: Vespertilionid bats		
<i>Antrozous pallidus</i>	Pallid bat	p
<i>Eptesicus fuscus</i>	Big brown bat	?
<i>Euderma maculatum</i> <sup>(3)</sup>	Spotted bat	?
<i>Lasionycteris noctivagans</i>	Silver-haired bat	p
<i>Lasiurus cinereus</i>	Hoary bat	?
<i>Myotis californicus</i>	California myotis	?
<i>Myotis evotis</i>	Long-eared myotis	?
<i>Myotis thysanonodes</i>	Fringed myotis	?
<i>Myotis volans</i>	Long-legged myotis	?
<i>Pipistrellus hesperus</i>	Western pipistrelle	P
<i>Plecotus townsendii</i>	Townsend's big-eared bat	p
Family Molossidae: Free-tailed bats		
<i>Tadarida brasiliensis</i>	Mexican free-tail bat	?

Order **CARNIVORA**: Carnivores

Family Canidae: Coyotes and foxes		
<i>Canis latrans</i>	Coyote	P
<i>Urocyon cinereoargenteus</i>	Gray fox	?
<i>Vulpes velox [=macrotis]</i>	Kit fox	P

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<sup>(1)</sup>Nomenclature from Wilson and Reeder 1993, List is compiled from O'Farrell and Emery 1976, Jorgensen and Hayward 1965, Medica 1990, and EG&G/EM 1992, 1993.

<sup>(2)</sup>P = present by trapping or sign (tracks, scats or burrows), p = present by habitat type, A = absent by habitat, ? = status unknown.

<sup>(3)</sup>Vocalization evidence only (EG&G/EM 1993).



Family Procyonidae: Procyonids			
<i>Bassariscus astutus</i>	Ringtail		p
Family Mustelidae: Mustelids			
<i>Mustela frenata</i>	Long-tailed weasel		?
<i>Taxidea taxus</i>	Badger		p
<i>Spilogale putorius [=gracilis]</i>	Western spotted skunk		A
Family Felidae: Cats			
<i>Felis concolor</i>	Cougar		p
<i>Lynx rufus</i>	Bobcat		p
Order PERISSODACTYLA: Odd-toed ungulates			
Family Equidae: Horses			
<i>Equus asinus</i>	Burro		A
<i>Equus caballus</i>	Horse		A
Order ARTIODACTYLA: Even-toed ungulates			
Family Cervidae: Deer and Elk			
<i>Odocoileus hemionus</i>	Mule deer		P
<i>Cervus elaphus</i> <sup>(4)</sup>	Wapiti (Elk)		A
Family Antilocapridae: Pronghorns			
<i>Antilocapra americana</i>	Pronghorn		p
Family Bovidae: Bovids			
<i>Bos taurus</i>	Cattle		A
<i>Ovis canadensis</i> <sup>4</sup>	Bighorn sheep		A
Order RODENTIA: Rodents			
Family Sciuridae: Squirrels			
<i>Ammospermophilus leucurus</i>	White-tailed antelope squirrel		P
<i>Spermophilus tereticaudus</i>	Round-tailed ground squirrel		p
<i>Spermophilus townsendii</i>	Townsend's ground squirrel		A
<i>Spermophilus variegatus</i>	Rock Squirrel		A
<i>Tamias [=Eutamias] dorsalis</i>	Cliff chipmunk		A

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<sup>(4)</sup>Resident populations near NTS boundaries.

Family Geomyidae: Pocket gophers		
<i>Thomomys bottae</i>	Botta's pocket gopher	P
Family Heteromyidae: Heteromyid rodents		
<i>Chaetodipus formosus</i>	Long-tailed pocket mouse	P
<i>Dipodomys deserti</i>	Desert kangaroo rat	p
<i>Dipodomys merriami</i>	Merriam's kangaroo rat	P
<i>Dipodomys microps</i>	Chisel-toothed kangaroo rat	P
<i>Dipodomys ordii</i>	Ord's kangaroo rat	P
<i>Microdipodops megacephalus</i>	Dark kangaroo mouse	A
<i>Perognathus longimembris</i>	Little pocket mouse	P
<i>Perognathus parvus</i>	Great Basin pocket mouse	p
Family Muridae: Rats, mice, and voles		
<i>Lemmyscus [=Lagurus] curtatus</i>	Sagebrush vole	A
<i>Neotoma lepida</i>	Desert woodrat	P
<i>Onychomys torridus</i>	Southern grasshopper mouse	P
<i>Peromyscus crinitus</i>	Canyon mouse	A
<i>Peromyscus eremicus</i>	Cactus mouse	P
<i>Peromyscus maniculatus</i>	Deer mouse	P
<i>Peromyscus truei</i>	Pinyon mouse	A
<i>Reithrodontomys megalotis</i>	Western harvest mouse	p
Family Erethizontidae: New World porcupines		
<i>Erethizon dorsatum</i>	Porcupine	A
Order LAGOMORPHA: Lagomorphs		
Family Leporidae: Hares and rabbits		
<i>Lepus californicus</i>	Black-tailed jackrabbit	P
<i>Sylvilagus audubonii</i>	Desert cottontail	P
<i>Sylvilagus nuttallii</i>	Nuttall's cottontail	A

## APPENDIX B

### EPHEMERAL PLANT SPECIES IN AREAS SURROUNDING

#### THE DEVICE ASSEMBLY FACILITY

(Letters following each name indicate the study sites a species was found at; A = vicinity of the paved access road; B = bladed, graveled area west of the DAF; C = undisturbed area north of the dike; D = area near water tank.) <sup>i</sup> = introduced species.

	Location
<i>Amsinckia tessellata</i>	ABCD
<i>Antirrhinum filipes</i>	A
<i>Astragalus acutirostris</i>	ACD
<i>Astragalus lentiginosus fremontii</i>	ABCD
<i>Bromus rubens</i> <sup>i</sup>	ABCD
<i>Bromus tectorum</i> <sup>i</sup>	ABD
<i>Camissonia boothii</i>	A
<i>Camissonia brevipes</i>	ABCD
<i>Camissonia claviformis</i>	AD
<i>Camissonia kernensis</i>	BD
<i>Camissonia munzii</i>	A
<i>Camissonia pterosperma</i>	D
<i>Camissonia refracta</i>	D
<i>Caulanthus cooperi</i>	AD
<i>Caulanthus lasiophyllus</i>	ABCD
<i>Chaenactis carphoclinia</i>	ABCD
<i>Chaenactis fremontii</i>	AB
<i>Chaenactis macrantha</i>	B
<i>Chaenactis stevioides</i>	ABCD
<i>Chenopodium incanum</i>	D
<i>Chorizanthe brevicornu</i>	ABD
<i>Chorizanthe rigida</i>	A
<i>Chorizanthe thurberi</i>	A
<i>Cryptantha circumscissa</i>	ABCD
<i>Cryptantha dumetorum</i>	BD
<i>Cryptantha gracilis</i>	AD
<i>Cryptantha micrantha</i>	AD
<i>Cryptantha nevadensis</i>	ABCD
<i>Cryptantha pterocarya</i>	ABCD
<i>Cryptantha recurvata</i>	AD
<i>Delphinium parishii</i>	AC
<i>Descurainia pinnata</i>	ABCD
<i>Descurainia sophia</i> <sup>i</sup>	ACD

<i>Eriogonum deflexum</i>	ABCD
<i>Eriogonum inflatum</i>	ABCD
<i>Eriogonum maculatum</i>	ABD
<i>Eriogonum nidularium</i>	ABCD
<i>Eriogonum reniforme</i>	B
<i>Eriogonum trichopes</i>	ABCD
<i>Eriophyllum wallacei</i>	B
<i>Erodium cicutarium</i> <sup>1</sup>	ABD
<i>Eschscholzia glyptosperma</i>	ABCD
<i>Eschscholzia minutiflora</i>	D
<i>Eucrypta micrantha</i>	AB
<i>Euphorbia albomarginata</i>	C
<i>Gilia cana</i>	D
<i>Gilia filiformis</i>	D
<i>Gilia sinuata</i>	ABD
<i>Gilia transmontana</i>	ABCD
<i>Halogeton glomeratus</i> <sup>1</sup>	AB
<i>Ipomopsis polycladon</i>	ABCD
<i>Langloisia schottii</i>	A
<i>Langloisia setosissima</i>	A
<i>Lepidium lasiocarpum</i>	ABCD
<i>Linanthus arenicola</i>	D
<i>Linanthus demissus</i>	ABD
<i>Linanthus dichotomus</i>	ABD
<i>Linanthus jonesii</i>	A
<i>Lotus humistratus</i>	CD
<i>Lupinus flavoculatus</i>	CD
<i>Lupinus shockleyi</i>	ABCD
<i>Machaeranthera canescens</i>	AD
<i>Malacothrix glabrata</i>	ABCD
<i>Malacothrix sonchoides</i>	AD
<i>Mentzelia albicaulis</i>	ABCD
<i>Mimulus bigelovii</i>	B
<i>Mirabilis bigelovii</i>	C
<i>Monoptilon belliodes</i>	AD
<i>Nama aretoides</i>	A
<i>Nama demissum</i>	ABCD
<i>Nama pusillum</i>	ABD
<i>Nemacladus glanduliferus</i>	ABCD
<i>Oxytheca perfoliata</i>	A
<i>Pectocarya heterocarpa</i>	AD
<i>Pectocarya platycarpa</i>	ABCD
<i>Pectocarya setosa</i>	A
<i>Phacelia crenulata</i>	A

<i>Phacelia fremontii</i>	ABCD
<i>Phacelia parishii</i>	B
<i>Phacelia vallis-mortae</i>	ABCD
<i>Prenanthes exigu</i>	AB
<i>Rafinesquia neomexicana</i>	ABC
<i>Salsola australis*</i>	ABD
<i>Schismus arabicus*</i>	ABD
<i>Sisymbrium altissimum*</i>	AC
<i>Stephanomeria exigu</i>	A
<i>Stephanomeria pauciflora</i>	A
<i>Streptanthes longirostris</i>	AB
<i>Ustilago bullata*</i>	
(smut on <i>B. rubens</i> )	ABD
<i>Vulpia octoflora</i>	ABCD

Total = 89 plant species plus one fungus. Several may live more than one year, (e.g., *Astragalus lentiginosus fremontii*, *Stephanomeria pauciflora*, *Mimulus bigelovii*, *Delphinium parishii*).

Notable missing species include *Eriophyllum pringlei*, *Mirabilis pudica*, *Anisocoma acaulis*, *Astragalus didymocarpus*, *Eriastrum eremicum*.

## APPENDIX C

### EPHEMERAL PLANTS

Tables below show properties of ephemeral plant plots determined with 10 (DAF3) or 20, 0.025 m<sup>2</sup> quadrats. Plot locations are in text Table 2. Species found outside the 20 quadrats are listed in Appendix B. Abbreviations are the first three letters of the genus and species combined, and may be determined from Appendix B.

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<u>DAF1 PLOT SUMMARY</u>		<u>SPECIES PROPERTIES (+ 2 se)</u>				
		<u>SPECIES</u>	<u>n/m<sup>2</sup></u>	<u>g/m<sup>2</sup></u>	<u>mg/plant</u>	<u>% reproductive</u>
Date	5/6/93	BRORUB	280 ± 167	34 ± 16	152 ± 66	100 ± 0
%Rock	57 ± 15	CAMBRE	4 ± 6	0.19 ± 0.27	48 ± 10	50 ± 100
%Litter	9.9 ± 8.3	CHASTE	8 ± 12	0.16 ± 0.28	18 ± 11	100 ± 0
%Cover	20 ± 15	CRYCIR	4 ± 6	0.05 ± 0.08	13 ± 7	100 ± 0
%Mound	0.5 ± 1.0	CRYNEV	2 ± 4	0.7 ± 1.4	369	100
Pellets/m <sup>2</sup>	12 ± 8	ERIDEF	8 ± 9	0.09 ± 0.10	12 ± 3	0 ± 0
Total Plants n/m <sup>2</sup>	694 ± 327	ERINID	4 ± 6	0.03 ± 0.05	8 ± 7	0 ± 0
Total Plants g/m <sup>2</sup>	52 ± 21	ERITRI	4 ± 6	0.04 ± 0.06	10 ± 12	50 ± 100
$\bar{x}$ Wt/plant/mg	114 ± 50	ESGLY	24 ± 26	0.32 ± 0.34	16 ± 8	100 ± 0
$\bar{x}$ Plant Spp/Quad	3.2 ± 0.7	GILTRA	4 ± 6	0.6 ± 1.1	156 ± 261	100 ± 0
		LUPFLA	22 ± 24	8 ± 8	567 ± 527	67 ± 39
		LUPSHO	4 ± 6	0.05 ± 0.10	25	50 ± 100
		MALGLA	2 ± 4	0.26 ± 0.53	132	100
		MENALB	14 ± 10	1.1 ± 1.0	79 ± 61	100 ± 0
		MIRBIG	2 ± 4	0.27 ± 0.54	135	100
		NEMGLA	6 ± 9	0.02 ± 0.03	4 ± 6	75 ± 50
		PHAFRE	302 ± 242	7.3 ± 4.1	48 ± 32	97 ± 7

DAF2 PLOT SUMMARYSPECIES PROPERTIES (+ 2 se)

		<u>SPECIES</u>	<u>n/m<sup>2</sup></u>	<u>g/m<sup>2</sup></u>	<u>mg/plant</u>	<u>%</u>
<u>reproductive</u>						
Date	5/6/93	BRORUB	4 ± 6	0.35 ± 0.66	88 ± 153	100 ± 0
%Rock	99.8 ± 0.4	CHASTE	2 ± 4	0.42 ± 0.83	208	100
%Litter	0.15 ± 0.22	PHAFRE	8 ± 7	5.3 ± 9.6	665 ± 1158	100 ± 0
%Cover	0 ± 0	SAL AUS	8 ± 7	0.87 ± 1.21	109 ± 129	25 ± 50
%Mound	0 ± 0					
Pellets/m <sup>2</sup>	0 ± 0					
Total Plants n/m <sup>2</sup>	22 ± 15					
Total Plants g/m <sup>2</sup>	7 ± 10					
$\bar{x}$ Wt Plant/mg	316 ± 420					
$\bar{x}$ Plant SPP/Quad	0.55 ± 0.37					

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DAF3: SCRAPED AREA

		<u>SPECIES</u>	<u>n/m<sup>2</sup></u>	<u>g/m<sup>2</sup></u>	<u>mg/plant</u>	<u>% reproductive</u>
Date	4/20/93	BRORUB	16 ± 13	0.34 ± 0.34	21 ± 14	100 ± 0
%Rock	62 ± 6	ERIDEF	1952 ± 728	9.0 ± 3.0	5.0 ± 1.5	0 ± 0
%Litter	2.7 ± 1.3					
%Cover	0 ± 0					
%Mound	0 ± 0					
Pellets/m <sup>2</sup>	4 ± 8					
Total Plants n/m <sup>2</sup>	1968 ± 732					
Total Plants g/m <sup>2</sup>	9.3 ± 3.1					
$\bar{x}$ Wt Plants/mg	9.6 ± 5.5					
$\bar{x}$ Plant Spp/Quad	1.4 ± 0.3					

DAF3: ONE M FROM SCRAPED AREA

SPECIES PROPERTIES (+ 2 se)

		<u>SPECIES</u>	<u>n/m<sup>2</sup></u>	<u>g/m<sup>2</sup></u>	<u>mg/plant</u>	<u>%</u>
<u>reproductive</u>		BRORUB	336 ± 496	9.7 ± 10.2	46 ± 34	94 ± 13
Date	4/20/93	CAMCLA	4 ± 8	0.03 ± 0.06	7	100
%Rock	46 ± 13	CHOBRE	4 ± 8	0.016 ± 0.033	4	100
%Litter	22 ± 16	CRYNEV	4 ± 8	0.03 ± 0.06	8	100
%Cover	15 ± 20	ERIDEF	1260 ± 372	14 ± 7	13 ± 7	0 ± 0
%Mound	1.3 ± 2.6	GILTRA	4 ± 8	0.23 ± 0.46	58	100
Pellets/m <sup>2</sup>	28 ± 48	IPOPOL	4 ± 8	0.05 ± 0.10	12	100
		PHAFRE	20 ± 32	0.22 ± 0.35	10 ± 1	100 ± 0
		VULUCT	16 ± 24	0.15 ± 0.20	13 ± 14	100 ± 0
Total Plants n/m <sup>2</sup>	1652 ± 768					
Total Plants g/m <sup>2</sup>	25 ± 11					
$\bar{x}$ Wt Plant/mg	24 ± 12					
$\bar{x}$ Plant Spp/Quad	2.7 ± 0.7					



DAF3: 50 M FROM PAVEMENT EDGESPECIES PROPERTIES (+ 2 se)

		<u>SPECIES</u>	<u>n/m<sup>2</sup></u>	<u>g/m<sup>2</sup></u>	<u>mg/plant</u>	<u>% reproductive</u>
		BRORUB	468 ± 373	32 ± 25	67 ± 21	100 ± 0
Date	4/21/93	CHACAR	12 ± 17	0.35 ± 0.58	26 ± 20	50 ± 100
%Rock	54 ± 16	CRYNEV	8 ± 16	0.22 ± 0.44	27	100
%Litter	19 ± 13	ERIDEF	8 ± 16	0.15 ± 0.30	19	0
%Cover	48 ± 30	ERINID	8 ± 11	0.12 ± 0.16	14 ± 7	0 ± 0
%Mound	11 ± 18	ERIPRI	4 ± 8	0.06 ± 0.12	15	0
Pellets/m <sup>2</sup>	0 ± 0	ERIPUL	8 ± 16	0.4 ± 0.8	50	100
		GILTRA	12 ± 12	0.55 ± 0.57	46 ± 10	100 ± 0
Total Plants n/m <sup>2</sup>	560 ± 395	LUPFLA	4 ± 8	3.6 ± 7.3	900	100
Total Plants g/m <sup>2</sup>	40 ± 26	LUPSHO	4 ± 8	0.8 ± 1.6	195	100
$\bar{x}$ Wt Plant/mg	89 ± 67	PHAFRE	20 ± 18	1.7 ± 1.8	76 ± 35	100 ± 0
$\bar{x}$ Plant Spp/Quad	2.6 ± 1.0	VULOCT	4 ± 8	0.22 ± 0.43	54	

APPENDIX - D

BIRD LIST FOR THE DEVICE ASSEMBLY FACILITY AREA 6 1993<sup>(5)</sup>

CLASS AVES: BIRDS

	<u>Status</u> <sup>(6)</sup>
Order Ciconiformes: Herons, Ibises, and Storks	
Family Ardeidae: Herons, Egrets, and Bitterns	
<i>Egretta thula</i> .....Snowy Egret	M, S
Order Anseriformes: Waterfowl	
Family Anatidae: Swans, Geese, and Ducks	
<i>Anas crecca</i> .....Green-winged Teal	M, S
<i>Anas cyanoptera</i> .....Cinnamon Teal	M, S
Order Falconiformes: Diurnal Birds of Prey	
Family Accipitridae: Hawks, Kites, and Eagles	
Subfamily Pandioninae: Ospreys	
<i>Pandion haliaetus</i> .....Osprey	M
Subfamily Accipitrinae: Kites, Hawks, Eagles, and Harriers	
<i>Aquila chrysaetos</i> .....Golden Eagle	PR
<i>Buteo jamaicensis</i> .....Red-tailed Hawk	PR, S
<i>Buteo swainsoni</i> .....Swainson's Hawk	M
Family Falconidae: Falcons and Caracaras	
<i>Falco mexicanus</i> .....Prairie Falcon	PR, S
<i>Falco sparverius</i> .....American Kestrel	PR,

---

<sup>(5)</sup>Nomenclature follows Banks et al. (1987)

<sup>(6)</sup>Status: S = observed at DAF sewage pond; B = breeds near DAF; SR = Summer resident near DAF; PR = Permanent resident in or near DAF region; M = Spring-fall migrant.

Order Galliformes: Gallinaceous Birds

Family Phasianidae: Pheasants, Grouse, and Quail

Subfamily Phasianinae: Partridges, Francolins, and Pheasants

*Alectoris chukar*.....Chukar PR,B

Order Charadriiformes: Shorebirds, Gulls, and Alcids

Family Charadriidae: Plovers

*Charadrius vociferus*.....Killdeer M,S

Family Recurvirostridae: Avocets and Stilts

*Recurvirostra americana*.....American Avocet M,S

Family Scolopacidae: Sandpipers and Allies

Subfamily Scolopacinae: Sandpipers, Turnstones, Surfbirds and Snipes

*Actitis macularia*.....Spotted Sandpiper M,S

*Calidris mauri*.....Western Sandpiper M,S

*Calidris minutilla*.....Least Sandpiper M,S

*Catoptrophorus semipalmatus*.....Willet M,S

*Gallinago gallinago*.....Common Snipe M,S

*Numenius americanus*.....Long-billed Curlew M

Order Columbiformes: Pigeons and Allies

Family Columbidae: Pigeons and Doves

*Zenaida macroura*.....Mourning Dove SR,B,S

Order Strigiformes: Owls

Family Tytonidae: Barn-owls

*Tyto alba*.....Common Barn-Owl PR,S

Family Strigidae: Typical Owls

*Athene cunicularia*.....Burrowing Owl PR,B

Order Caprimulgiformes: Goatsuckers and Allies

Family Caprimulgidae: Nightjars	
<i>Chordeiles acutipennis</i> .....	Lesser Nighthawk SR
Order Apodiformes: Swifts and Hummingbirds	
Family Trochilidae: Hummingbirds	
.....	.Unid. Hummingbird M
Order Piciformes: Woodpeckers and Allies	
Family Picidae: Woodpeckers and Wrynecks	
<i>Picoides scalaris</i> .....	Ladder-backed Woodpecker SR
Order Passeriformes: Perching Birds	
Family Tyrannidae: Tyrant Flycatchers	
Subfamily Fluvicolinae: Fluvicoline Flycatchers	
<i>Sayornis saya</i> .....	Say's Phoebe SR,B,S
Subfamily Tyranninae: Kingbirds and Allies	
<i>Myiarchus cinerascens</i> .....	Ash-throated Flycatcher SR B,S
<i>Tyrannus verticalis</i> .....	Western Kingbird SR,B,S
Family Alaudidae: Larks	
<i>Eremophila alpestris</i> .....	Horned Lark PR,S
Family Hirundinidae: Swallows	
<i>Hirundo pyrrhonota</i> .....	Cliff Swallow M,S
<i>Hirundo rustica</i> .....	Barn Swallow M,S
<i>Stelgidopteryx serripennis</i> .....	Northern Rough-winged Swallow M,S
<i>Tachycineta thalassina</i> .....	Violet-green Swallow M,S
Family Corvidae: Jays, Magpies, and Crows	
<i>Corvus corax</i> .....	Common Raven PR,S
<i>Gymnorhinus cyanocephalus</i> .....	Pinyon Jay M
Family Troglodytidae	
<i>Campylorhynchus brunneicapillus</i> ..	Cactus Wren SR

Order Passeriformes: (cont.)

Family Muscicapidae: Old World Flycatchers and Allies

Subfamily Turdinae: Thrushes

*Sialia currucoides*.....Mountain Bluebird M

Family Mimidae: Mockingbirds and Thrashers

*Mimus polyglottos*.....Northern Mockingbird SR,B

*Oreoscoptes montanus*.....Sage Thrasher M

Family Motacillidae: Wagtails and Pipits

*Anthus rubescens*.....American Pipit M,S

Family Laniidae: Shrikes

*Lanius ludovicianus*.....Loggerhead Shrike SR,B

Family Sturnidae: Starlings

Subfamily: Sturninae

*Sturnus vulgaris*.....European Starling PR,S

Family Emberizidae: Emberizid Finches and Allies

Subfamily Parulinae: Wood-Warblers

*Dendroica coronata*.....Yellow-rumped Warbler M,S

Subfamily Cardinalinae: Cardinal-Grosbeaks

*Pheucticus melanocephalus*.....Black-headed Grosbeak M

Subfamily Emberizinae: American Sparrows and Towhees

*Amphispiza belli*.....Sage Sparrow M,S

*Amphispiza bilineata*.....Black-throated Sparrow SR,B,S

*Melospiza melodia*.....Song Sparrow M,S

*Spizella breweri*.....Brewer's Sparrow SR,B,S

*Zonotrichia leucophrys*.....White-crowned Sparrow M,S

Subfamily Icterinae: American Blackbirds and Orioles

*Agelaius phoeniceus*.....Red-winged Blackbird M,S

*Icterus parisorum*.....Scott's Oriole SR,B

*Molothrus ater*.....Brown-headed Cowbird SR,S

Order Passeriformes: (cont.)

<i>Quiscalus mexicanus</i> .....	Great-tailed Grackle	SR,S
<i>Sturnella neglecta</i> .....	Western Meadowlark	M,S

Family Fringillidae: Old World Finches and Allies

Subfamily Carduelinae: Cardueline Finches

<i>Carduelis psaltria</i> .....	Lesser Goldfinch	M,S
<i>Carduelis tristis</i> .....	American Goldfinch	M,S
<i>Carpodacus mexicanus</i> .....	House Finch	PR,B,S

Family Passeridae: Old World Sparrows

<i>Passer domesticus</i> .....	House Sparrow	PR,B,S
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