Herpetofauna and Small Mammal Surveys on the Marine Corps Air Ground Combat Center, Twentynine Palms, CA March 1999-October 2001

Project End Report

Prepared for:

Marine Corps Air Ground Combat Center
Twentynine Palms, CA

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
WESTERN ECOLOGICAL RESEARCH CENTER

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By Robb Hirsch, Stacie Hathaway, and Robert Fisher

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Introduction and Background

Inventory and monitoring studies covering a wide range of taxa are being increasingly utilized to gauge current ecological conditions and long-term trends. They provide tangible scientific evidence that helps resource mangers understand the biological elements of the habitats under their jurisdiction and can aid in related decision-making. The inventory component consists of acquiring knowledge concerning the diversity, distribution and density of the species on site. Understanding the diversity of species present and their relative abundance is the most fundamental information, important for both short and long-term concerns. These data provide an immediate overview of the present biological communities, can help to address immediate ecological concerns, and provides the baseline information necessary for the monitoring component, if implemented. The baseline data, in conjunction with a standardized methodology, allows for follow-up studies to detect changes over longer periods of time.

In an effort to quantitatively study the herpetofauna on a portion of the Twentynine Palms Marine Base, the United States Geological Survey- Biological Resources Discipline (USGS-BRD) in conjunction with Marine Corps Air Ground Combat Center- Natural Resources and Environmental Affairs Division (MCAGCC-NREA), initiated an intensive, live capture and release project in March 1999. The data accumulated during this study provides biological insight on several levels. Immediate information gained includes data on overall species diversity and their relative abundance on site. These data are necessary to gauge changes spatially and temporally due to the various potential impacts present. In a broader context, these baseline data provide the starting point to examine long-term trends on the marine base. Additionally, the standardized methodology utilized here is also being used in many regions of southern California, including other areas of the Mojave Desert, allowing for broader comparisons (Fisher et al., 2002).

This project was primarily intended to investigate the herpetofauna in the study area and as a result, a pitfall trap design (described in detail in the Methods section and Stokes et al., in preparation) was chosen as the methodology. This technique is also proficient at sampling small mammals, so these data are included as well. Pitfall trapping is preferred over traditional walking transects for herpetological inventories of this nature for several reasons. There is an increased sampling time in pitfall trapping due to the continuous 24 hour captures while the traps are open. In contrast, there is a relatively short window of observation when walking transects. This is especially important in a desert ecosystem where different species of reptiles are active at very different times, from the middle of the night (e.g., sidewinders) to the middle of the day (e.g., coachwhips). Due to this wider sampling window, pitfall trapping has a greater ability to detect species that are in low abundance, or are cryptic. This increased detection, in terms of number of species and individuals within each species, provides a greater qualitative ecological understanding and a more robust, quantitative dataset for analysis. Pitfall trapping is also much less influenced by observer variability than walking transects. Differences in observers' experience, ability and eyesight create inherent biases when counting animals while walking transects. In pitfall trapping, observer bias is greatly reduced, as the traps perform much of the difficult work and the biologist simply records the data with animals in hand. Here we present the results from three years of sampling on MCAGCC.

Methods

Eleven pitfall traps were installed within the Sand Hill training area of MCAGCC, bordering the town of Twentynine Palms (Figure 1). Currently, this area is not heavily utilized for military training exercises. There were limited tank and truck tracks, with communication wire and small metal debris scattered through the area. The study site consisted of a relatively homogeneous habitat, dominated by creosotebush scrub (*Larrea tridentata*) and bursage (*Ambrosia dumosa*). A few Joshua trees (*Yucca brevifolia*) were present near one of the array locations. There were numerous small, ephemeral washes across the landscape that flow only after heavy rains. Overall, the habitat appeared relatively intact. A desert tortoise (*Gopherus agassizii*) "Special Use" area lies within the Sand Hill training area and is off limits for most military activities; two pitfall arrays were placed in this protected area.

Surveys were conducted using a pitfall trap and drift fence array design (Stokes et al., in preparation). Each array consisted of seven, 6-gallon buckets, buried as pitfall traps with their rims flush to the ground substrate. The buckets were connected by shade cloth drift-fences in the shape of a Y, each arm 15 meters long (Figure 1). A hardware cloth, double funnel trap was placed at each of the three arms for capturing large snakes and lizards. Below each of these "snake" traps, a six-gallon bucket was buried with a polyvinyl chloride (PVC) connection tube between the bucket and the trap, providing a thermal retreat if the ground temperatures became too extreme. A total of eleven arrays were installed and sampled in the Sand Hill training area of MCAGCC. GPS locations for all arrays are included in Table 1.

Initially, arrays were sampled for ten consecutive days, every six weeks, checking buckets for captures every morning. After efficiency versus effort analyses were performed, sample periods were reduced to four days (Atkinson et al., in prep). The four day period provided sufficient capture data and had the added benefit of returning to the site every three to four weeks, allowing us to collect more data on temporal variability. Data collected for reptiles included species identification, sex, age, weight, length (snout to vent). To collect recapture data, each individual was permanently marked, lizards by toe clipping and snakes by scale clipping (Stokes et al., in prep). All tissue, including incidental mortalities, was saved in an ethanol solution for potential future molecular systematic studies. Rattlesnakes were not handled, but were identified to species and their length estimated. Small mammals were identified to species when possible. Species were identified according to Jameson and Peeter's California Mammals (1988). Due to overlap in morphological characteristics and the resulting level of uncertainty, all individuals in the genus *Chaetodipus* were lumped together. All animals were released following data collection. For comparisons across years for reptiles and mammals, capture rates were calculated by dividing the number of captures by the number of sample days.

To complement the main focus of this study (primarily reptiles, secondarily small mammals) and in keeping with the standardization of the methodology, additional data concerning invertebrates, vegetation and weather were also compiled. Invertebrates were sampled at the end of every data collection period for future analysis. For each array, an individual of every species caught was collected and stored in an ethanol solution, and the remaining individuals were released. Vegetation transects were conducted at every array for future quantitative habitat association studies. These transects were conducted following a modified California Native Plant Society protocol, using a line intercept methodology at 0.5 meter intervals, recording dominant plants and understory. Basic weather data including temperature profiles, cloud cover, wind and recent rainfall was compiled for every sample period.

Results

A total of 15 sample periods, 135 pitfall trap days, were conducted between March 1999 and October 2001. We caught 702 reptiles from 16 species and 558 small mammals from 7 species, for a total of 1260 vertebrates. Among the reptiles, we captured 656 lizards (8 species) and 46 snakes (8 species). See Tables 2 and 3 for species captures by array comparisons. Western whiptails (*Cnemidophorus tigris*) were, by far, the most commonly captured lizard (509 captures), accounting for 72.5% of all lizards caught; they were found at every array, ranging from 31 to 65 captures per array. Other lizards caught in order of decreasing abundance were side-blotched lizards (*Uta stansburiana*- 55 captures from all 11 arrays), desert horned lizards (*Phrynosoma platyrhinos*- 35 from all 11 arrays), western banded geckos (*Coleonyx variegatus*- 31 from 9 arrays), desert iguanas (*Dipsosaurus dorsalis*- 10 from 8 arrays), desert spiny lizards (*Sceloporus magister*- 9 from 1 array), zebra-tailed lizards (*Callisaurus draconoides*- 4 from 2 arrays) and long-nosed leopard lizards (*Gambelia wislizenii*- 3 from 3 arrays).

Among the 46 snakes caught, the most common were western shovel-nosed snakes (*Chionactis occipitalis*- 19 captures from 7 arrays), followed by coachwhips (*Masticophis flagellum*- 14 from 7 arrays), spotted leaf-nosed snakes (*Phyllorhynchus decurtatus*- 5 from 3 arrays), glossy snakes (*Arizona elegans*- 2 from 2 arrays), Mojave rattlesnakes (*Crotalus scutulatus*- 2 from 2 arrays), gopher snakes (*Pituophis *melanoluecus*- 2 from 2 arrays), sidewinder (*Crotalus cerastes*- 1) and kingsnake (*Lampropeltis getula*- 1). No Desert Tortoises (*Gopherus agassizii*), a species listed as "Threatened" under the Endangered Species Act of 1973 (as amended), were captured or otherwise impacted.

Small mammal captures were dominated by little pocket mice (*Perognathus longimembris*), comprising 452 of the 558 total captures or 81%; and they were found at all 11 arrays. Southern grasshopper mice (*Onychomys torridus*- 71 captures from 10 arrays) were the next most common, followed by Merriam's kangaroo rats (*Dipodomys merriami*- 24 from 9 arrays), unidentified pocket mice (*Chaetodipus spp.*- 8 from 6 arrays), white-tailed antelope ground squirrel (*Amnospermophilus leucurus*-1), Botta's pocket gopher (*Thomomys bottae*- 1) and a ground squirrel

There was considerable year-to-year variability in captures over the course of the study. Capture rates for reptiles (number of captures/sample days) decreased from 7.12 in 1999 to 2.97 in 2000 and then increased to 6.58 in 2001. In addition to the variable capture rates, there was a substantial difference in diversity of snakes caught between years. While all 8 species of snakes were caught in 1999, only 4 species were caught in 2000 and 3 in 2001. Between year variability for small mammal captures was also considerable. The capture rate for small mammals decreased from 4.0 in 1999 to 2.34 in 2000 and increased to 8.46 in 2001. Captures by year data are summarized in Tables 4 and 5.

Discussion

The reptile portion of this study provides an initial inventory of the diversity of snakes and lizards in the Sandhill training area of MCAGCC. Of nineteen species expected to occupy this habitat, sixteen were caught. The species not captured during sampling include long-tailed brush lizards (*Urosaurus graciosus*), long-nosed snakes (*Rhinocheilus lecontei*), and patch-nosed snakes (*Salvadora hexalepis*). Anecdotally, a single patch-nosed snake was observed dead on the road during a site visit. If present, these three species are probably not abundant, as they have been caught in sufficient numbers elsewhere using these methods, indicating that it is not a function of the methodology.

The relative abundance of diurnal lizards, the only group we regularly observed visually in the field, appeared consistent with the data, though there were a couple noteworthy exceptions. It appears that this pitfall trap technique does not accurately sample zebra-tailed lizards (*Callisaurus draconoides*). Through the course of the study 4 individuals were captured, though this was one of the most common lizards observed while driving between and walking out to the arrays. It is difficult to determine why this species has a lower detection, but it might be due to their rapid locomotion. This species was observed moving so quickly over the top of an open bucket that they reached the other side without falling in. Another species that appears to be under-represented in the dataset is the sidewinder (*Crotalus cerastes*). Observations of their very distinctive tracks lead us to believe they are more common than the data suggest; their sidewinding locomotion may make them less susceptible to capture.

The spatial distribution of captures is worth mentioning. All 9 desert spiny lizards (*Sceloporus magister*) were caught at array number 1. These lizards are known to be associated with vertical structure, usually trees or rocks. This array is in close proximity to several Joshua Trees (*Yucca brevifolia*) and is the only array with vertical structure nearby. Array 11 caught only four species and was the lowest for species diversity. This is the closest array to homes at the border of the base, where edge effects may be present including an increased impact of feral and domesticated predators.

Concurrent with this study, ten arrays were sampled in fragments of habitat owned by the Bureau of Land Management near the town of Twentynine Palms. This area was characterized by patches of creosote scrub habitat, very similar to that on the Marine Corps installation, though these fragments were surrounded by a network of dirt roads and low-density housing. These data might provide an interesting comparison of reptile and small mammal diversity and abundance between a low-density urbanized landscape (BLM) and relatively natural, intact habitat (MCAGCC). Preliminary analyses have shown a lower abundance of desert horned lizards (*Phrynosoma platyrhinos*), western banded geckos (*Coleonyx variegatus*), little pocket mice (*Perognathus longimembris*) and snakes overall, and an increase in desert iguanas (*Dipsosaurus dorsalis*) in the fragmented habitat (BLM) (Appendix 1). It is interesting that the lizards with lower capture rates on BLM lands are slow moving, possibly making them more susceptible to human activities, including feral and domestic animals, off-road vehicle use and collecting as pets. Snakes are also vulnerable to these pressures in addition to outright persecution by people in the area (personal observation). Higher numbers of desert iguanas (the only herbivorous reptile present) at the BLM site might be a result of supplemental food available in peoples' landscaped gardens.

The high degree of year-to-year variability in capture rates found in this study is consistent with data from our other sites. Capture rates for reptiles in 1999 and 2001 were over twice as high as the capture rate in 2000. Additionally, 1999 was the only year all species of snakes were observed. In other words, if sampling only took place in 2000 and/or 2001 several species of snakes would have been missed in the dataset. This supports previous conclusions that inventory and monitoring studies need a minimum of 3-5 years to compensate for this year-to-year variability. It is not known why these fluctuations are so common, but they are probably due to a variety of biotic and abiotic factors. The high capture rate in 1999 may be an artifact of the 1998 El Nino event that brought increased precipitation to southern California; a similar trend was observed at several other sites (Atkinson et al., in prep).

The unknown ground squirrel was probably *Spermophilus tereticaudus* (roundtailed), however there is a slight chance that it is either a Mojave ground squirrel (*Spermophilus mojavensis*), an endangered species whose range is not known to extend this far south or a hybrid of those two species. Four individuals with similar characteristics were caught in the BLM fragmented landscape nearby. These were not antelope ground squirrels (*Ammospermophilus leucurus*) as they lacked the obvious white side stripe. Photos of one of the animals in question caught in the BLM fragmented habitats were circulated among biologists with intimate knowledge of this group (this correspondence is included in Appendix 2). No definitive identification could be made..

Management Recommendations

This study provides a good overview of the diversity and relative abundance of reptiles and small mammals present in the Sand Hill training area. The diversity of reptiles found here is relatively high for a desert site. The low level of human/vehicular activity in this area might have contributed to the protection of the flora and fauna. To determine any long-term trends, we recommend resurveying this site over time.

Sand Hill is only one small portion of the entire landscape covered by MCAGCC. Many other habitats exist throughout the installation that might support different species of reptiles and small mammals not observed in this study. These habitats include desert washes, boulder outcrops and sand dunes. An interesting area lies on the northern edge of the base near Amboy crater where the geologic and topographic variables have created a very unique landscape. To gain a greater understanding and inventory of the reptiles and small mammals base-wide, the techniques utilized in this study could be employed in the diverse habitats on other portions of the installation.

The unidentified species of ground squirrel (both on base and in habitats nearby), prompt us to recommend further investigation. Identification of these unknown ground squirrels could not be made solely by photographs given to professional biologists familiar with these animals. Focused surveys by qualified mammalogists are warranted to examine whether Mojave ground squirrels and/or hybrids are present.

Literature Cited

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Fisher, R.N., Suarez, A.V. and T.J. Case. 2002. Spatial patterns in the abundance of the coastal horned lizard. Conservation Biology 16:205-215.

Jameson, E. W. and H. J. Peeters. 1988. California Mammals. University of California Press, Berkeley, California

Stokes, D., C. Rochester, R. Fisher, and T. Case. In preparation. Herpetological Monitoring Using a Pitfall Trapping Design in Southern California.

Table 1- Locations of pitfall trap arrays in the Sand Hill training area of MCAGCC. All locations in map datum WGS84.

Array	Lat. (N) dec.	Lon. (W) dec.	Elevation (m)
1	34.2698141	116.3003796	821
2	34.2834883	116.2998770	804
3	34.3033335	116.3000485	773
4	34.3029118	116.2978616	772
5	34.3244889	116.2875795	764
6	34.3233708	116.2875932	765
7	34.3177053	116.2668881	764
8	34.3052416	116.2445010	751
9	34.2994415	116.2306701	714
10	34.2826463	116.2414258	760
11	34.2621589	116.2646470	824

<u>Table 2</u> – Reptile captures by array summed for all sample periods.

		Array Number											
Common Name	**Scientific Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Total**
Zebra-tailed Lizard	*Callisaurus draconoides*									1	3		4
Western Whiptail	*Cnemidophorus tigris*	43	56	42	65	57	65	42	40	31	31	37	509
Western Banded Gecko	*Coleonyx variegatus*	3	2	4	7	3	7		1	2	2		31
Desert Iguana	*Dipsosaurus dorsalis*	1		1		2	1	1	1	1	2		10
Long-nosed Leopard Lizard	*Gambelia wislizenii*			1		1					1		3
Desert Horned Lizard	*Phrynosoma platyrhinos*	1	1	4	2	5	6	6	2	3	4	1	35
Desert Spiny Lizard	*Sceloporus magister*	9											9
Side-Blotched Lizard	*Uta stansburiana*	3	2	10	1	2	6	7	5	4	4	11	55
Glossy Snake	*Arizona elegans*	1						1					2
Western Shovel-nosed Snake	*Chionactis occipitalis*		6			4	1	2	3	2	1		19
Sidewinder	*Crotalus cerastes*							1					1
Mojave Rattlesnake	*Crotalus scutulatus*		1	1									2
Desert Kingsnake	*Lampropeltis getulus*		1										1
Coachwhip/Red Racer	*Masticophis flagellum*			3		1	1	4		3	1	1	14
Spotted Leaf-nosed Snake	*Phyllorhynchus decurtatus*				1				3	1			5
Gopher Snake	*Pituophis melanoleucus*						1				1		2
	Total Individuals	61	69	66	76	75	88	64	55	48	50	50	702
	Total Species	7	7	8	5	8	8	8	7	9	10	4	16

Table 3 – Mammal captures by array summed for all sample periods.

		Array Number											
Common Name	**Scientific Name**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**Total**
Southern grasshopper mouse	*Onychomys torridus*	17	7	1	3	5	7	11	11	4	5		71
Merriam's kangaroo rat	*Dipodomys merriami*	1	4	1	1		4		6	2	2	3	24
Unknown pocket mouse	*Chaetodipus sp.*		1	1			1	2	1			2	8
Little pocket mouse	*Perognathus longimembris*	45	13	57	48	33	54	61	36	23	26	56	452
White-tail antelope ground squirrel	*Amnospermophilus leucurus*				1								1
Unknown ground squirrel	*Spermophilus sp.*				1								1
Botta's pocket gopher	*Thomomys bottae*	1											1
	Total Individuals	64	25	60	54	38	66	74	54	29	33	61	558
	Total Genera	4	4	4	5	2	4	3	4	3	3	3	7

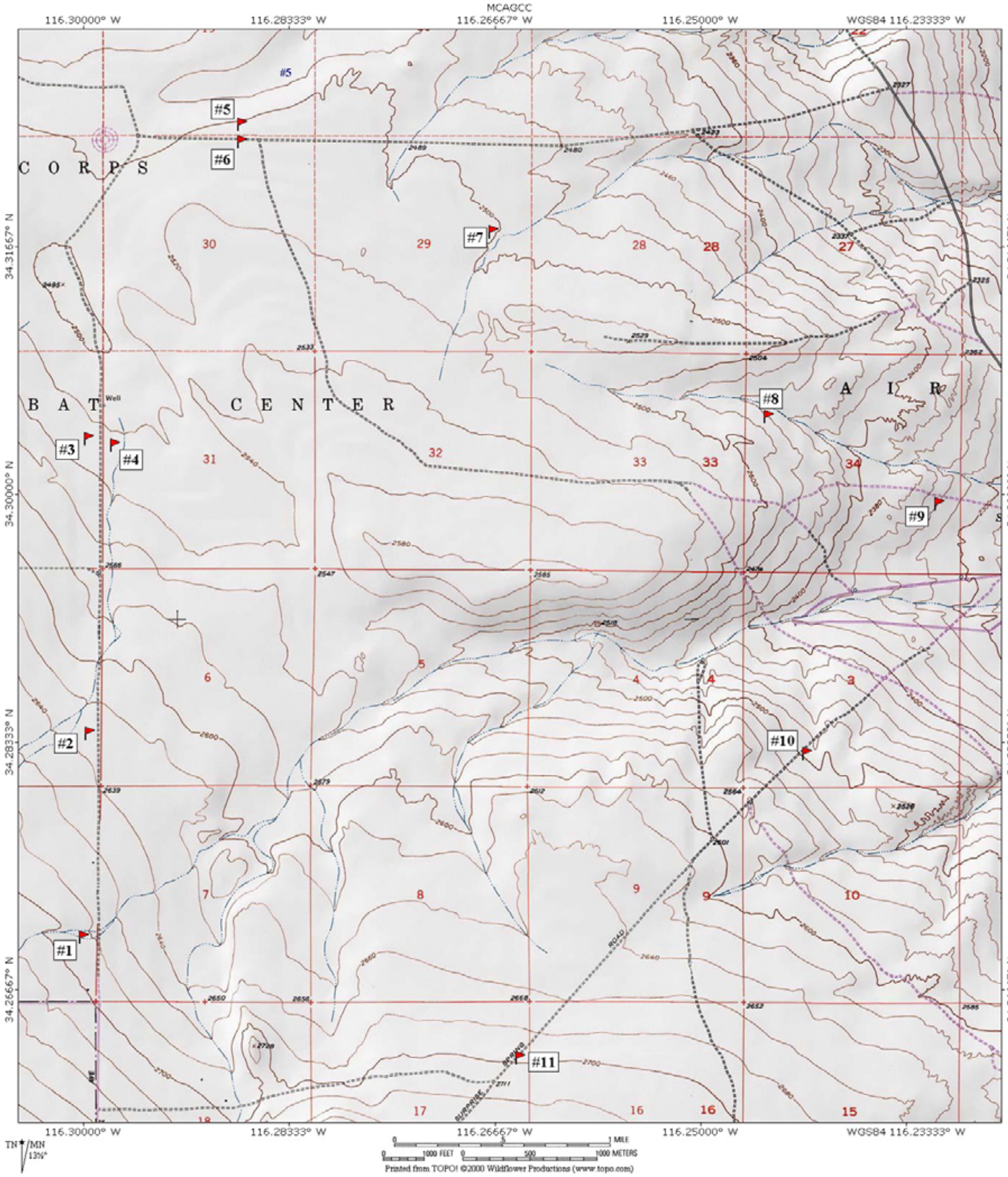
Table 4 – Reptile captures by year for all arrays.

Common Name	Scientific Name	Year 1999	2000	2001	Total
Zebra-tailed Lizard	*Callisaurus draconoides*	3	1		4
Western Whiptail	*Cnemidophorus tigris*	266	124	119	509
Western Banded Gecko	*Coleonyx variegatus*	14	7	10	31
Desert Iguana	*Dipsosaurus dorsalis*	7		3	10
Long-nosed Leopard Lizard	*Gambelia wislizenii*	1		2	3
Desert Horned Lizard	*Phrynosoma platyrhinos*	12	12	11	35
Desert Spiny Lizard	*Sceloporus magister*	5	2	2	9
Side-Blotched Lizard	*Uta stansburiana*	20	19	16	55
Glossy Snake	*Arizona elegans*	1	1		2
Western Shovel-nosed Snake	*Chionactis occipitalis*	9	6	4	19
Sidewinder	*Crotalus cerastes*	1			1
Mojave Rattlesnake	*Crotalus scutulatus*	1	1		2
Desert Kingsnake	*Lampropeltis getulus*	1			1
Coachwhip/Red Racer	*Masticophis flagellum*	10	2	2	14
Spotted Leaf-nosed Snake	*Phyllorhynchus decurtatus*	3		2	5
Gopher Snake	*Pituophis melanoleucus*	2			2
	Total Individuals	356	175	171	702
	Total Species	16	10	10	16
	Sample Days	50	59	26	135
	Capture Rate (captures/sample days)	**7.12**	**2.97**	**6.58**	**5.2**

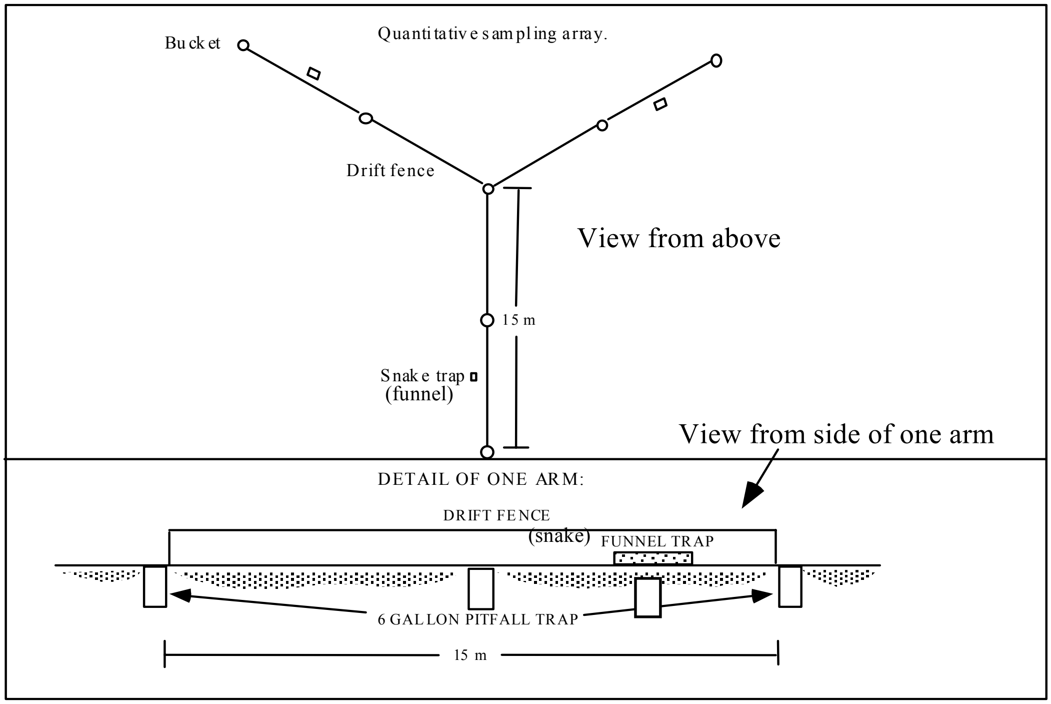
Table 5 – Mammal captures by year for all arrays.

Common Name	Scientific Name	Year 1999	2000	2001	Total
Southern grasshopper mouse	*Onychomys torridus*	36	24	11	71
Merriam's kangaroo rat	*Dipodomys merriami*	16	2	6	24
Unknown pocket mouse	*Chaetodipus sp.*			8	8
Little pocket mouse	*Perognathus longimembris*	146	111	195	452
White-tail antelope ground squirrel	*Ammospermophilus leucurus*	1			1
Unknown ground squirrel	*Spermophilus sp.*	1			1
Botta's pocket gopher	*Thomomys bottae*		1		1
	Total Individuals	200	138	220	558
	Total Genera	5	4	4	7
	Sample Days	50	59	26	135
	Capture Rate (captures/sample days)	**4**	**2.34**	**8.46**	**4.13**

Figure 1- Map of MCAGCC array locations.



<u>Figure 2</u>. Terrestrial survey protocol and designs for arrangement of pitfall and funnel traps with drift fences. Figures are not drawn to scale.



Appendix 1- Preliminary analysis of BLM-MCAGCC data for differences between the sites and sample size analysis. Analysis completed by Andrea Atkinson, USGS.

A preliminary analysis of the BLM-MCAGCC site data was performed to assist with determining the recommended number of arrays to place at Jawbone Canyon, Kern County in FY03.

The data were collected by Robb Hirsch under the supervision of Robert Fisher over a 2 year period at two adjacent sites: 1) MCAGCC site had relatively few roads, whereas 2) a nearby BLM site was crossed by many dirt roads. The data were collected using Robert Fisher's pitfall arrays during 13 sampling periods (total of 116 sampling days). Only data that was collected concurrently at both sites was used. Data collected during 3 sampling periods at the MCAGCC site but not simultaneously at the BLM site were dropped. The data presented in tables 1 and 2 were summed across the entire 2 years of data collection and divided by the number of arrays (11 at MCAGCC site; 10 at BLM site). Recaptures were not eliminated from the data.

Tests for differences between the sites involved analysis of individual species capture rates, total herpetofauna capture rates, total snake captures rates, herpetofauna species richness, and snake species richness. Results for herpetofauna and small mammals are presented in Table 1.

Three analyses were conducted to test for differences between the MCAGCC and BLM sites.

1) T-tests were conducted to test for differences between average capture rate per array between the two sites
2) F-tests for homogeneity of variance were used to test for differences between the variance in the capture rate between the two sites
3) Z-test for difference in proportions were used to test for differences in the percentage of arrays with a given species present (individual species only)

Variables that were significant at the 5% significance level are shaded.

Sample size calculations on the average capture rate per array over 2 years were conducted only on the herpetofauna data to determine the number of arrays per site recommended to detect differences that ranged from 30-80% of the mean, with a significance level (α) of 5% and a power ($1-\beta$) of 80%. These calculations were conducted on 5 of the more abundant species as well as herpetofauna capture rates, snake capture rates, herpetofauna species richness and snake species richness. Results are given in Table 1.

<u>Preliminary Results</u>

The MCAGCC site (few roads) was associated with higher desert horned lizard captures rates. The MCAGCC site also had snakes present at 100% of the arrays compared with 70% at the BLM site. The BLM site (many dirt roads) was associated with higher capture rates of desert iguana.

No fewer than 12 arrays per site were recommended to test for differences in herpetofauna species capture rates and species richness at new sites over a two year period. This will still only allow detection of extreme differences, i.e., 80% or greater difference in species capture rates and a 35% difference in species richness.

Table 1. Use of herpetofauna monitoring over two years at MCC (MCAGCC) and BLM sites (many dirt roads versus few respectively) to identify important variables and number of arrays per group for Jawbone Canyon study. Tests for equality of means, homogeneity of variance and differences in percent of arrays with species present were performed between the two sites. Variables for which there are significant differences between sites at the 5% significance level are shaded.

	MCC site (few roads); 11 arrays				BLM site (many dirt roads); 10 arrays				# arrays per group to detect given difference between groups					
	Average per array	SE	variance	% arrays present	Average per array	SE	variance	% arrays present	30%	40%	50%	60%	70%	80%
Desert Horned Lizard** *Phrynosoma platyrhinos*	2.36	0.53	3.05	82%	0.30	0.21	0.46	20%	77	44	28	20	15	12
Desert Iguana** *Dipsosaurus dorsalis*	0.73	0.19	0.42	64%	5.30	1.22	14.90	100%	74	42	28	20	15	12
Desert Spiny Lizard *Sceloporus magister*	0.82	0.82	7.36	9%	--	--	--	--						
Long-nosed Leopard Lizard *Gambelia wislizenii*	0.09	0.09	0.09	9%	--	--	--	--						
Side-Blotched Lizard** *Uta stansburiana*	4.36	0.89	8.65	100%	5.70	1.05	11.12	100%	55	32	21	15	11	9
Western Banded Gecko** *Coleonyx variegatus*	2.27	0.62	4.22	73%	1.10	0.31	0.99	70%	127	72	47	33	25	19
Western Whiptail** *Cnemidophorus tigris*	39.00	3.21	113.20	100%	42.30	3.83	146.90	100%	12	8	6	4	4	3
Zebra-tailed Lizard *Callisaurus draconoides*	0.27	0.27	0.82	9%	0.60	0.40	1.60	20%						
California Kingsnake *Lampropeltis getulus*	0.09	0.09	0.09	9%	--	--	--	--						
Coachwhip/Red Racer *Masticophis flagellum*	1.00	0.36	1.40	55%	0.30	0.15	0.23	30%						
Glossy Snake *Arizona elegans*	0.18	0.12	0.16	18%	0.40	0.22	0.49	30%						
Long-nosed Snake *Rhinocheilus lecontei*	--	--	--	0%	0.30	0.15	0.23	30%						
Mojave Rattlesnake *Crotalus scutulatus*	0.09	0.09	0.09	9%	--	--	--	--						
San Diego Gopher Snake *Pituophis melanoleucas*	0.18	0.12	0.16	18%	0.20	0.20	0.40	10%						
Sidewinder *Crotalus cerastes*	0.09	0.09	0.09	9%	0.30	0.15	0.23	30%						
Spotted Leaf-nosed Snake *Phyllorhynchus decurtatus*	0.36	0.20	0.45	27%	0.10	0.10	0.10	10%						
Western Shovel-nosed Snake *Chionactis occipitalis*	1.55	0.55	3.27	64%	0.50	0.17	0.28	50%						
Total herpetofauna captures / array**	53.45	3.47	132.27		57.40	5.13	262.71		10	7	5	4	3	3
species richness / array**	6.55	0.49	2.67		6.00	0.63	4.00		13	8	6	5	4	3
Total snake captures / array**	3.55	0.74	6.07	100%	2.10	0.57	3.21	70%	81	46	30	21	16	13
Snake species richness /array**	2.09	0.34	1.29		1.90	0.48	2.32		63	36	23	17	13	10

Appendix 2- E-mail correspondence regarding unknown ground squirrel caught on MCAGCC

>----- Original Message ----- From: <cbrown@sunstroke.sdsu.edu> To: Matt

Brooks <mbrooks@lightspeed.net> Sent: Tuesday, May 09, 2000 7:29 AM

Subject: Mojave Ground Squirrel??
Matt, here is a jpeg of one of the squirrells cought in the bucket by Robb Hirsch out at 29 Palms. > > Let me know if it comes through and what you think it is. > > Chris

> ----- Original Message ----- From: Matt Brooks

Robert I was unsure about the identification of your MCAGCC ground squirrel, so I sent the picture to Phil Leitner. As you can see from his response, he is unsure as well. The historical range of the MGS extends south to the lucerne valley area, so MCAGCC would be a long way out of the range. Also, the sandy substrate you found it in is more consistent with RTGS than MGS. The animal could be a hybrid, since MGS and RTGS are known to hybridize. If you capture any others in this area, I suggest that you collect a voucher specimin and let one of the MGS experts check it out. I would suggest Phil Leitner or Tony Recht, each of whom I can put you in contact with. A detailed analysis of the skull and other body parts may be only way to settle this identification definitively. Matt

>Matt Brooks wrote:

>Phil Check out this ground squirrel caught at MCAGCC. Whatcha think?

>Matt

> ----- Original Message ----- From: Phil Leitner To:

mailto:mbrooks@lightspeed.net title=mbrooks@lightspeed.net>Matt Brooks

Sent: Tuesday, June 06, 2000 4:43 PM Subject: Re: Fw: Mojave Ground Squirrel??

Hi Matt,

Sorry to be so tardy in getting back to you regarding this animal from 29 Palms. 've studied it and studied it and looked for good photos of the two species. I haven't been able to get really detailed photos of the tail of the RTGS, but my impression is that it's relatively long and round in cross-section like a pencil. The mystery animal is probably a RTGS, but the tail is not exactly as it should be. The tail is relatively long as it should be for a RTGS and the proximal 1/3 looks round in x.s., but the distal 2/3 has lateral hairs
sticking out, giving an MGS look. I would be very surprised to find MGS at 29 Palms, but maybe we're dealing with hybrids???

>Sorry I can't come up with anything more definite!!

>Phil L.