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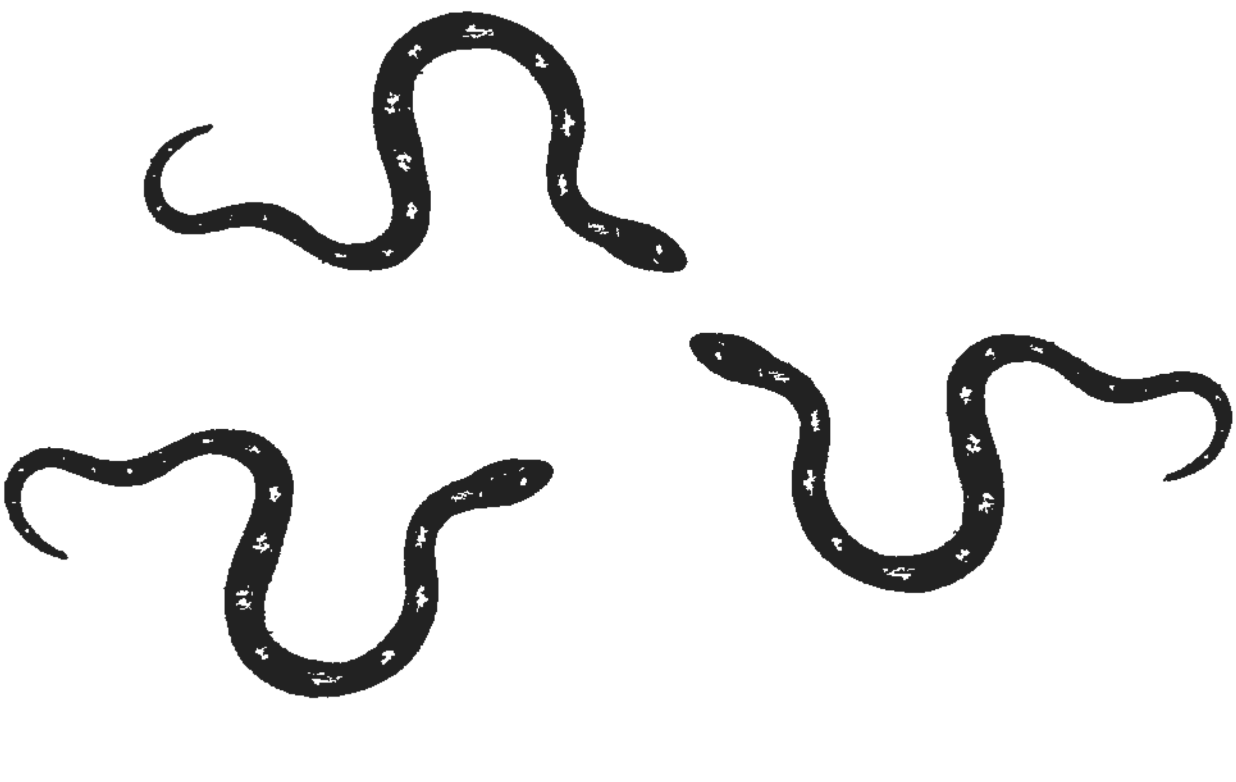

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SUMMARY

We used drift fences to trap reptiles near to and far from off road motorized vehicle (OHMV) trails in the Owyhee Front. We also assessed vegetation. We found that at the less intensively used OHMV site (Fossil Butte), there was a tendency for more reptiles to be found at 25 m from the trails than at 2 m from the trails. However, at the more intensively used site (Rabbit Creek), there was a tendency for more reptiles to be found at 2 m from the trail than at 25 m, but both were lower than at 100 m. Native shrubs, bunch grasses, and microbiotic crust were less prevalent closer to trails and at the more intensively used site. Cheatgrass and *Chrysothamnus* spp., both indicative of disturbance, were more prevalent closer to trails and at the more intensively used site. We largely ascribe the patterns in reptile density to the effects on vegetation. Dense cheatgrass prevents movement of reptiles, meaning that in disturbed areas, OHMV trails offer the only corridors available.

INTRODUCTION

On the Owyhee Front (near Murphy, ID), are located several trail-heads for off-highway motorized vehicle (OHMV) use. OHMVs include four wheel drive vehicles, ATVs, and motorcycles. The majority of trail usage is by motorcycles. The Bureau of Land Management (BLM) is concerned about the impacts of such trails on the natural resources of the area. This cost-share agreement was designed to assess the effects of these trails on the herpetofauna of the area. We also assess the effects of these trails on vegetation. Van-Horne and Sharpe (1998), and Watts (1998) examined the influence of military tank trails on the shrubsteppe habitat and demography of Townsend's ground squirrels in southeastern Idaho. However, little is known about the impacts of OHMV trails on desert communities in which these trails occur.

The Owyhee Front also contains the greatest reptile species diversity in Idaho, including nine lizard species and ten snake species (Table 1). Three of these species are considered to be sensitive by BLM and Idaho Department of Fish and Game (IDFG): *Sonora semiannulata* (western ground snake), *Rhinocheilus lecontei* (longnosed snake), and *Crotaphytus bicinctores* (Mojave black-collared lizard). *Hypsiglena torquata* (night snake) was recently removed from the sensitive species list but is treated with equal attention in this report. The herpetofauna of the area are dependent on the natural vegetation that occurs there for cover (escape locations and shade) and availability of prey. Terrestrial arthropods and rodents require vegetation and are important food sources for lizards and snakes in the area. Changes in the habitats of these animals can have strong impacts on the entire food web. For example, bunchgrasses are an important food source of the rodents in the Great Basin. Seed caching behavior in rodents has been shown by McMurray et al. (1998) to be beneficial to perennials and harmful to cheatgrass (*Bromus tectorum).*

Table 1. Reptiles that may potentially be found in the Owyhee Front area. Species marked with a "*" were captured during the present study and/or during the 1997 study.	
Lizards	**Snakes**
*Western Whiptail (*Cnemidophorus tigris*)	*Western Rattlesnake (*Crotalus viridis*)
*Longnose Leopard Lizard (*Gambelia wislizeni*)	*Striped Whipsnake (*Masticophis taeniatus*)
Mojave Black-collared Lizard (*Crotaphytus bicinctores*)	*Gopher Snake (*Pituophis catenifer*)
Short Horned Lizard (*Phrynosoma douglassi*)	*Night Snake (*Hypsiglena torquata*)
*Desert Horned Lizard (*Phrynosoma platyrhinos*)	W. Terrestrial Garter Snake (*Thamnophis elegans*)
Sagebrush Lizard (*Sceloporus graciosus*)	*Racer (*Coluber constrictor*)
*Western Fence Lizard (*Sceloporus occidentalis*)	Common Garter Snake (*Thamnophis sirtalis*)
*Side-blotched Lizard (*Uta stansburiana*)	*Longnose Snake (*Rhinocheilus lecontei*)
Western Skink (*Eumeces skiltonianus*)	*W. Ground Snake (*Sonora semiannulata*)
	Rubber Boa (*Charina bottae*)

Components of the vegetation of the Great Basin include: 1) native shrubs such as *Artemisia* (big sagebrush), *Ceratoides* (winterfat), and *Atriplex* (shadescale), 2) shrubs that are pervasive in disturbed areas such as *Chrysothamnus* (rabbitbrush), 3) exotic annuals or cheatgrasses (*Bromus tectorum, Draba verna, Lepidium perfoliatum*, etc.) which are also pervasive in disturbed areas, 4) perennial native grasses or bunchgrasses (*Poa, Sitanion*, and *Agropyron* [introduced]) and 5) Microbiotic crust.

Microbiotic crust contains a major part of the organic matter in desert ecosystems (Perez 1998) and is functional in trapping aeolian dust (Danin and Ganor 1997, Perez 1998), increasing water storage of the soil and resistance of raindrop erosion (Perez 1998), increasing nitrogen fixation, and immobilizing nitrogen in the tissues of microbial biomass. Zink and Allen (1998) deduced that when nitrogen level in the soil is reduced via immobilization in the crust, an environment is created that is more conducive to native perennial shrubs, allowing them to outcompete exotic annuals for water and nutrients.

Possible Impacts

There are several possible ways that OHMVs and their trails may impact the flora and fauna of the habitats they occur in. First, OHMVs can directly kill and/or damage native reptiles, shrubs, herbaceous perennials, and microbiotic crust. Second, trails may disturb the surrounding habitat enough to facilitate invasion by exotic annual grasses and shrubs thus decreasing covers of *Artemisia* and bunchgrasses. Exotic annual grasses can facilitate the spread of fire and lead to a monoculture. Trails can also increase the amount of bare ground and decrease the cover of microbiotic crust, negatively affecting nutrient cycling and the trapping of aeolian dust. Third, dust could have a role in decreasing covers of vegetation. Dust particles on leaves have been shown to significantly reduce rates of photosynthesis, leaf conductance, transpiration, and water-use efficiency in several species of desert shrubs (Sharifi et al. 1997) Other effects of dust are increased temperatures of leaves and stems and decreased leaf surface areas. Fourth, OHMVs may collapse rodent and reptile burrows which are required for escape, nesting, and thermoregulation. Lastly, the influx of cheatgrass caused by OHMV disturbance could also hinder movement, and many of the reptile species occurring in the Owyhee Front avoid areas with dense grasses (Stebbins 1985).

Our expectation is that if OHMV trails have a negative impact on the natural habitat-type of the study sites then it is expected that 1) frequencies and coverage of vegetation types that prefer disturbed areas, such as cheatgrasses and *Chrysothamnus*, will increase with closeness to the trails and increased abundance of trails, 2) frequencies and coverage of vegetation types such as bunchgrasses, native shrubs, and microbiotic crust will be lower closer to trails and with increased abundance of trails, and 3) frequencies of reptiles caught will be lowest in areas closer to trails and with increased abundance of trails.

METHODS

Study sites

The Rabbit Creek trailhead near Murphy, Idaho and the Fossil Butte trailhead ten miles south of Murphy were chosen as study sites. The Fossil Butte trails are few and lightly used, whereas at Rabbit Creek, there is an extensive and often-used system of trails (Figures 1 and 2). Rabbit Creek has a variety of lightly and heavily used trails, with many motocross races per year. Motorcyclists use these areas primarily during the spring and fall when weather is cool. Spring is the most intense part of the growing season due to nitrogen pulses and the availability of water. Both sites border the Snake River Birds of Prey National Conservation Area. Both sites are winter-grazed, have a dominant overstory of *Artemisia tridentata*, and contain a similar diversity of reptiles and vegetation. An initial study of the impacts of OHMVs and OHMV trails on the herpetofauna of the Fossil Butte study site was conducted in 1997 under this same agreement and data and results from 1997 and 1998 are combined in this report.

Reptiles

Nontraditional drift fences were used to capture the reptiles at both study sites (Figure 3). Each drift fence was constructed of a 2.5 meter long piece of 1/8" mesh hardware cloth (1 ft. wide) with an aluminum window screen funnel trap positioned at each end of the fence (Munger and Ames 1998). The fence was buried to 3.0" so that 9.0" extended from the ground, dirt was placed in each trap, and cheatgrass was used to shade the traps. This fence design allows stability of the array, camouflage from motorcyclists, and shade for the reptiles. This type of drift fence was proven effective in capturing most of the reptile species that occur in the sagebrush-bunchgrass habitat-type at these sites (Munger and Ames 1998). In 1998, 178 arrays were installed. Arrays were checked and reptiles captured were identified and noted every day from June 1 to July 15.

Trails

At Fossil Butte, each treatment plot consisted of two arrays, arranged parallel to and 2 m and 25 m from a trail. Each control plot consisted of two arrays, 23 m apart, arranged parallel to and approximately 175 m from the 2 m arrays. Fourteen treatment plots and 14 control plots, a total of 56 arrays, were used at Fossil Butte in 1998 in the same positions as those plots were in the 1997 study. Capture data from 1997 were combined with those from 1998 for analysis. We used paired t-tests to compare 2 m captures to 25 m captures and to compare combined 2 m and 25 m captures with combined 175 m and 200 m captures.

A similar design was employed at Rabbit Creek, the only difference being control plots at Rabbit Creek were approximately 100 m from the trails because the distance between trails there is smaller. Fourteen treatment plots and 7 control plots (arranged between treatment plots), for a total of 42 arrays, were used along the trails at Rabbit Creek. Twelve arrays were arranged along a transect in a stand of the same habitat-type approximately one mile south of the Rabbit Creek study site (Figure 1). This transect was placed in an area approximately 1 mi^2 without trails and serves as a universal control site. This design allows comparisons close to, and away from, OHMV trails within the study sites and comparisons of an area with no trails, an area with few trails, and an area with an extensive trail system. Capture data were analyzed using paired t-tests to compare 2 m captures to 25 m captures and to compare combined 2 m and 25 m captures to 100 m captures. Unpaired t-tests were used to compare the combined 2, 25, and 100 m captures to the plots in the unused area.

Washes

Washes are also used by OHMVs. Data collected in 1997 at Fossil Butte revealed washes to be important habitat for night snakes and ground snakes and therefore, washes were studied at Rabbit Creek in 1998. Thirty-two arrays were arranged approximately 100 m apart from each other in one wash and 200 m apart from each other in a second wash, both with used and unused portions. Used washes at Rabbit Creek were devoid of vegetation but unused washes had shrubs and grasses growing in them. Treatment arrays were placed on the inside edge of the wash and control arrays 25 m from the treatment and parallel to the wash. There was a total of eight treatment arrays and eight control arrays arranged along used washes and eight treatment arrays and eight control arrays arranged along unused washes (Figure 5). Analysis of variance was used to compare captures in control washes to captures in used washes, to compare in-wash arrays to arrays 20 m from washes, and to determine if there was an interaction between OHMV usage and distance from the wash.

Vegetation

Transects with a length of either 16 m or 17 m were aligned 2 m (treatment) and 100 m (control) away from, and parallel to, four different trails for a total of eight transects (four at 2 m and four at 100 m) at Rabbit Creek. A 0.1 m^2 plot frame (20 cm x 50 cm) was arranged every meter on each transect as the measurement unit (66 plots at 2 m and 66 plots at 100 m). The same design was used at Fossil Butte. This design allows for comparisons within trailheads and for comparisons among trailheads. Cover classes were estimated and frequencies determined for the various vegetation types, grouping them into categories of bunchgrasses (native and introduced), cheatgrass, microbiotic crust, and shrubs, which included *Artemisia* and *Chrysothamnus visidifloris*. Adequacy of sampling was assessed using a running mean calculated for each distance at each site. Differences between treatments were assessed using two-tailed t-tests for cover values and 2 x 2 contingency table analysis using G-tests for frequency of occurrence. Note that the way our sampling is structured results in a partial lack of independence among plots within a transect.

RESULTS

Reptiles

Neither night snakes nor ground snakes were captured at Rabbit Creek in 1998 and only a few were captured at Fossil Butte in 1997 (seven night snakes and five ground snakes). However, longnose snakes (the other sensitive species) were captured regularly at Fossil Butte and Rabbit Creek along with the other reptile species listed in Table 1.

Trails

At Rabbit Creek, there was not a significant effect of distance from trail on the number of longnose snakes caught: no difference between 2 m and 25 m, and no difference between 2 m and 25 m combined and 100 m (Figure 4). There was a trend, however, of fewer snakes at 25 m. This same trend occurred in striped whip snakes, gophersnakes, and all snakes together, with the 25 m traps having significantly fewer snakes than the other two, contrary to what would be expected if trails negatively affect snakes (Figures 5, 6, and 7).

Average numbers of all lizards captured per trap showed the same trend as was seen in snakes, with a decreased number caught at 25 m (Figure 8). Eighty percent of all lizards captured were western whiptails (*Cnemidophorus tigris*) (Appendix 1). Longnose leopard lizards (*Gambelia wislizenii*) were the only lizards to show a different trend, with a higher number of captures at 25 m than at 2 m (although this trend was not statistically significant; Figure 9). At Fossil Butte, combined 1997 -1998 data showed few significant trends (Figures 10, 11, 12, and 13). The only snake species at Fossil Butte to show the trend of more snakes at 2 m than at 25 m was the striped whip snake (Figure 13). Longnose snakes and gopher snakes show the opposite trend, with more captures at 25 m than at 2 m (Figures 12 and 13). Therefore, with the exception of striped whip snakes, captures of snakes at 25 m at Fossil Butte were not depressed (as was the case at Rabbit Creek). Because only a few night snakes were caught, no conclusions can be made regarding that species.

With the exception of desert horned lizards (*Phrynosoma platyrhinos*), lizards caught at Fossil Butte were caught more often at 25 m than at 2 m or 175 m (Figures 14, 15, 16, and 17). Numbers of side-blotched lizards (*Uta stansburiana*) captured were higher at the control plots (175 m and 200 m) than the trail plots (2 m and 25 m) and leopard lizards showed the same trend. Western whiptail lizards comprised the majority of lizards captured and were caught in greatest numbers at the 25 m arrays (Figure 17).

Washes

In control washes at Rabbit Creek, lizards and snakes were found at higher densities in the wash than 20 m from the wash, showing that washes are an important part of the habitat (Figures 18 and 19). The number of lizards caught per trap in portions of washes used by OHMVs was significantly lower than in unused portions (Figure 18). An even stronger trend was seen with snakes: not only were snakes fewer in used than in unused washes, they were fewer in used washes than in adjoining areas (contrary to what was seen in control areas). However, due to high variability among arrays, none of the tests on snakes was statistically significant. Longnose snakes showed the same trend (Figure 20); neither ground snakes nor night snakes were caught at Rabbit Creek.

Vegetation

At Fossil Butte, the coverages and frequencies of shrubs and microbiotic crust were significantly lower at 2 m from OHMV trails than at 100 m from trails (Figures 21 and 22). At Rabbit Creek, microbiotic crust had lower coverage at 2 m than at 100 m. Cheatgrass and *Chrysothamnus* had significantly higher coverage and frequency at 2 m than at 100 m. Coverage of bare ground was also higher at 2 m than at 100 m.

Figures 21 and 22 also allow comparison of averages and frequencies at Fossil Butte with those at Rabbit Creek. Rabbit Creek is much more heavily used by OHMVs than is Fossil Butte, and showed (at both the 2 m and 100 m distances) more cheatgrass and bare ground and less bunchgrass, native shrubs, and microbiotic crust. In addition, *Chrysothamnus* was found at Rabbit Creek but not at Fossil Butte.

DISCUSSION

At the more extensive trail system, Rabbit Creek, the overall trend was that fewer reptiles were captured at 25 m than at 100 m from trails, but more were captured at 2 m than at 25 m. This pattern was consistent among the snake and lizard species at this site (with the exception of leopard lizards), which suggests that the trails are having an influence on the herpetofauna that occur at that site. At the lesser used Fossil Butte trail system, numbers of captures were lower at 2 m than at 25 m (with the exception of horned lizards and striped whip snakes). There was substantial variation among species when comparing the treatment arrays (2 m and 25 m) to the control arrays (175 m and 200 m): some species increased in numbers away from the trails, some species decreased in numbers away from the trails, and some species exhibited no trends one way or the other. This variation among species suggests that any influence of the trails on the herpetofauna at Fossil Butte is localized to the 25 m nearest the trail.

Why did we capture more reptiles close to trails at the more heavily used site but fewer reptiles close to trails at the less used site? We believe that at the less used site (Fossil Butte), OHMV activity has a moderate negative influence on reptile densities. At the more heavily used site (Rabbit Creek), the effects of OHMV activity are primarily manifested via their effects on vegetation. Our results indicate that increased OHMV activity causes increased dense non-native vegetation and we suggest that increased densities of non-native vegetation (particularly cheatgrass) has a negative impact on reptiles.

Cheatgrass and *Chrysothamnus* spp. (species known to be favored in disturbed habitats) are most prevalent in close proximity to trails at the more heavily used Rabbit Creek site. At the lesser used Fossil Butte site, *Chrysothamnus* spp. is not present and cheatgrass is infrequent. In addition, densities of native shrubs and bunchgrasses are lower in areas close to OHMV activity.

We hypothesize that reptiles are negatively affected by the above-described vegetation changes in several ways. First, reptiles depend on native shrubs for cover to help them thermoregulate, for escape cover, and for cover from which to ambush prey. Second, a loss of native vegetation is likely to affect the availability of insect and rodent prey used by reptiles. Third, dense cheatgrass hinders movement of reptiles, making foraging and escape from predators more difficult. Dense cheatgrass also reduces the number of thermoregulatory basking sites.

Recall the general trend of reptile densities at Rabbit Creek: highest at 100 m from trails but second highest at only 2 m from trails. We suggest that this trend is indicative of a general trend of lower density near trails, but that the trails themselves provide some respite from the dense cheatgrass, leading to higher density of reptiles at 2 m than at 25 m. We emphasize, however, that there appears to be an overall negative effect of OHMV trails. The apparent positive effect of trails is merely a localized less-negative effect because any reptiles that remain close to trails can travel more easily on trails than near trails in the dense cheatgrass. The apparent negative effects of OHMV activity microbiotic crust is troubling. Reduction of microbiotic crust can facilitate erosion, reduce fixation of nitrogen, and lead to increased influx of exotic species.

Washes at the study site that were used by OHMVs were devoid of vegetation. We found fewer reptiles in used washes than in unused washes. We speculate that the lack of ground snakes and night snakes at Rabbit Creek may be a result of the extensive OHMV activity there. Both species were captured in washes at Fossil Butte where OHMV activity is substantially lower.

We end with two caveats. First, our study was a "natural experiment" in that it used pre-existing differences in OHMV activity as the basis for treatment differences. With all such studies, it is difficult to know if a OHMV activity caused a change in habitat or if a habitat difference led to a change in levels of OHMV activity. That is, trails might be started in places relatively devoid of shrubbery. Second, our sample size was modest. Therefore, any results in which we did not find an effect of OHMVs, cannot be taken as proof that no effect occurred. What can be said is only that no effect was detected.

CONCLUSIONS AND RECOMMENDATIONS

Our results are consistent with the conclusion that OHMVs have a modest negative effect on desert reptiles. This effect is most pronounced in washes, where OHMV activity is quite concentrated. The effect of OHMVs is somewhat an indirect one; it appears that OHMVs cause an increase in exotic vegetation and the exotic vegetation causes problems for reptiles.

We make the following recommendations:

1. We suggest that a study be conducted that makes use of either an experimental manipulation of OHMV activity or (more likely) a before and after study in a place where a large amount of OHMV activity is known to be occurring in the future. For example, reptiles could be surveyed extensively before a large-scale race, then resurveyed afterwards.

2. We suggest that a study be conducted that examines the habitat affinities of the reptiles in the Owyhee Front using a large number of drift fences over a wide range of habitats in a wide area. Although such a study would be a very large undertaking, the results would be very valuable in alerting managers to what habitats should be protected to protect reptiles.

3. In the present study, effects on reptiles in washes are most prevalent. We recommend that where possible, actions be taken to reduce the use of washes by OHMV riders. We also recommend that the results of the present study be bolstered with a study be undertaken that focuses on the effects of OHMVs on washes.

4. Many of the trails at extensive trail sites such as Rabbit Creek are cross-trails. Much of the potential damage of OHMV trails would be avoided if the formation of cross-trails could be prevented.

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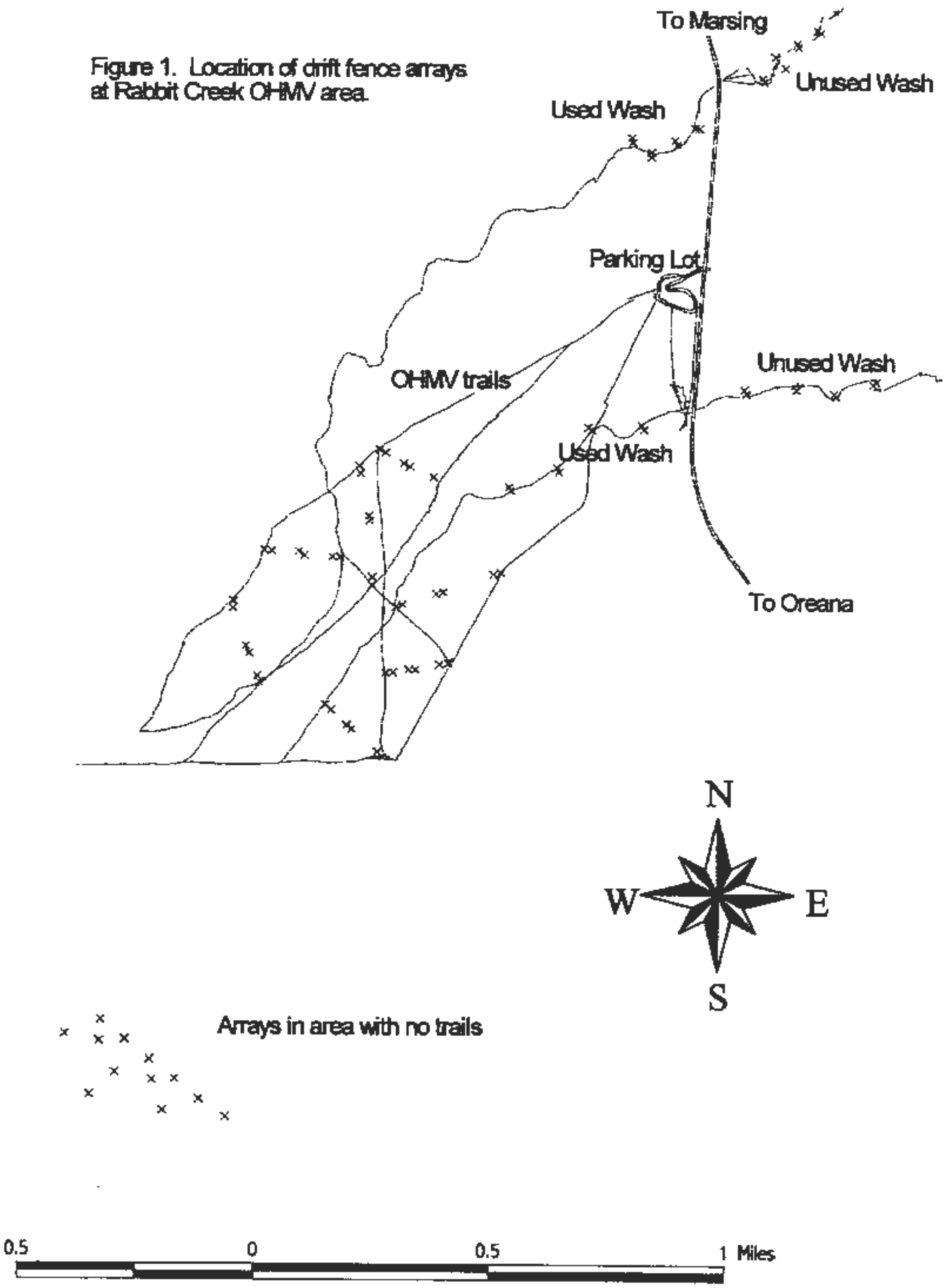


Figure 1. Location of drift fence arrays at Rabbit Creek OHMV area.

Figure 2. Layout of arrays at Fossil Butte area for the 1998 field season.

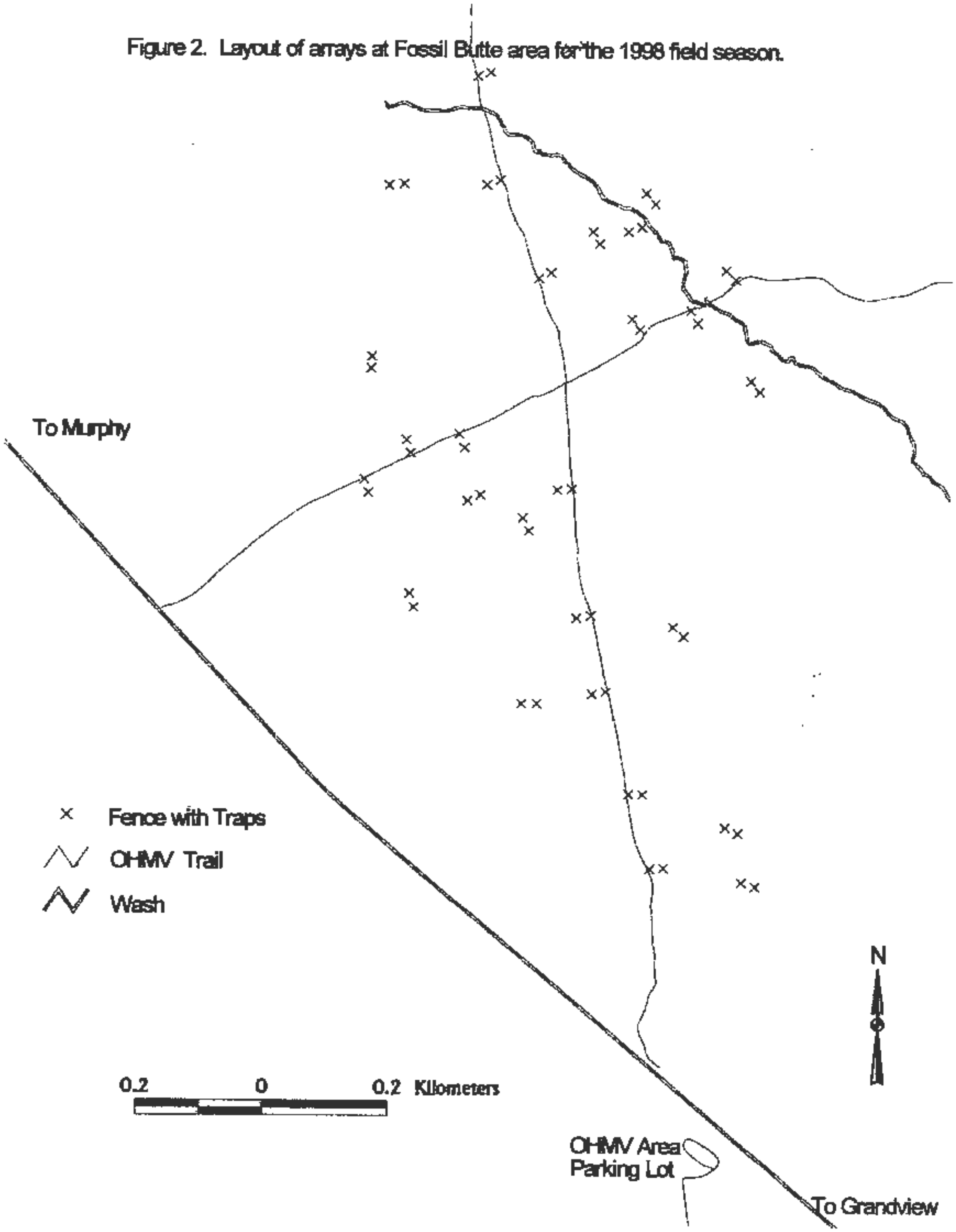


Figure 3. Placement of traps at end of fence.

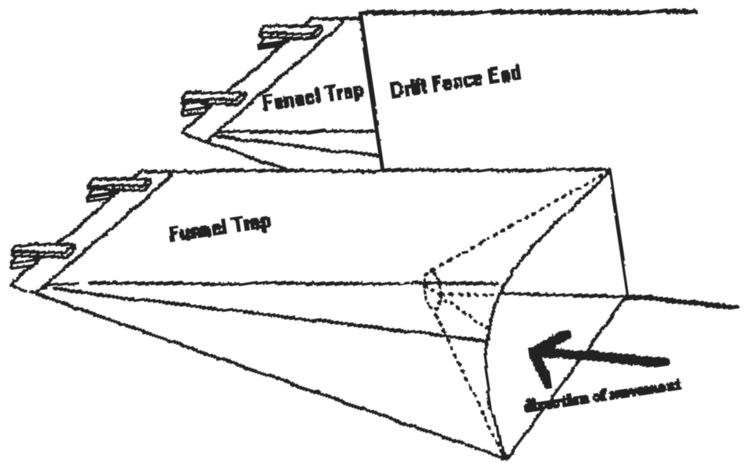


Figure 4. Longnosed Snakes at Rabbit Creek OHMV trails.

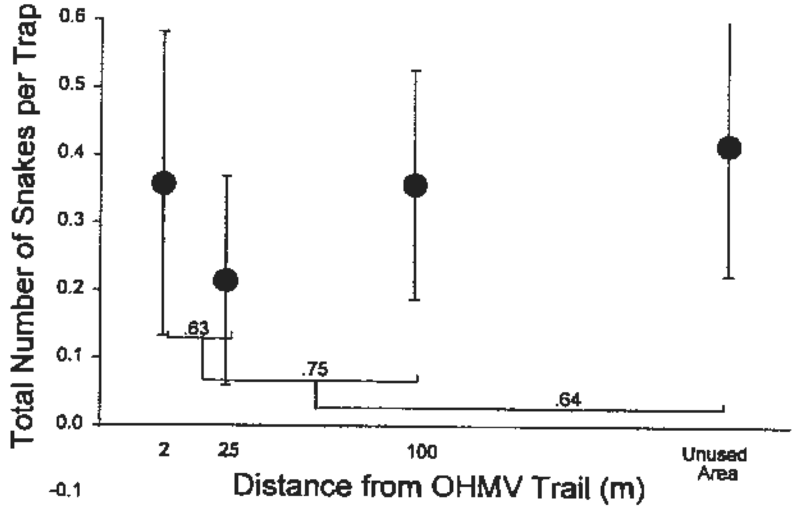


Figure 5. Striped Whipsnakes at Rabbit Creek OHMV trails.

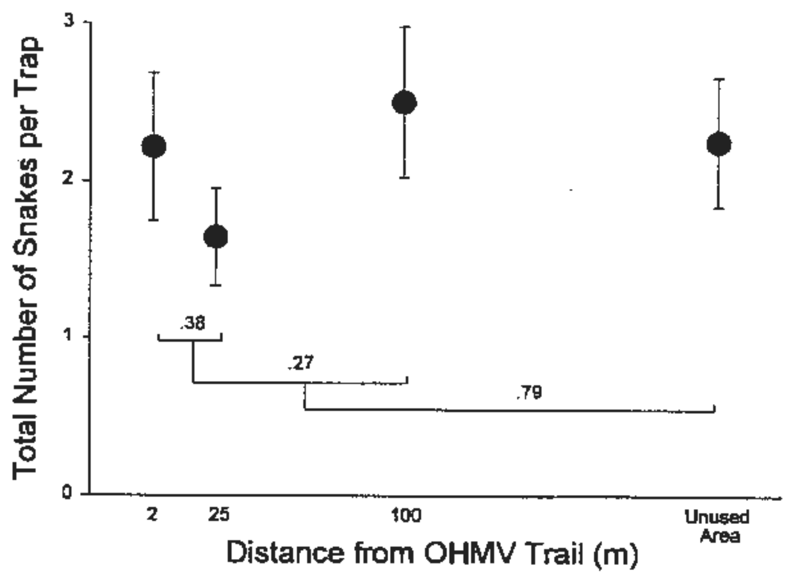


Figure 6. Gopher Snakes at Rabbit Creek OHMV trails.

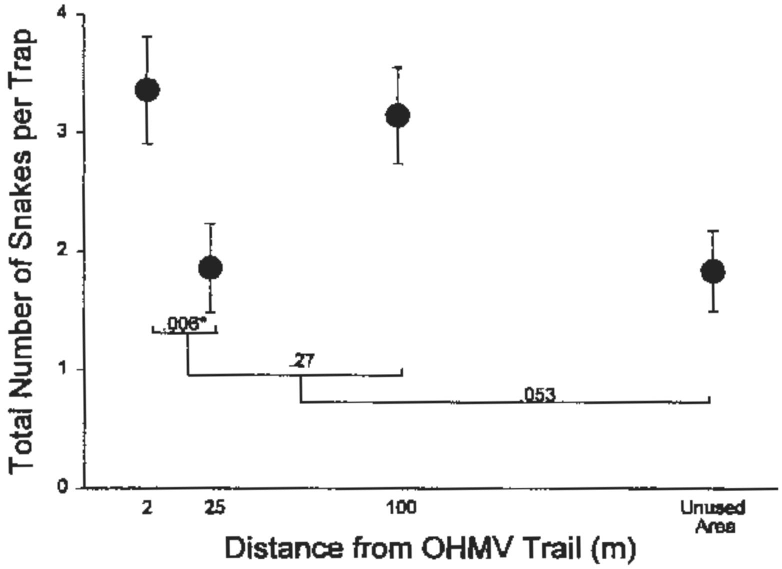


Figure 7. All Snakes at Rabbit Creek OHMV trails.

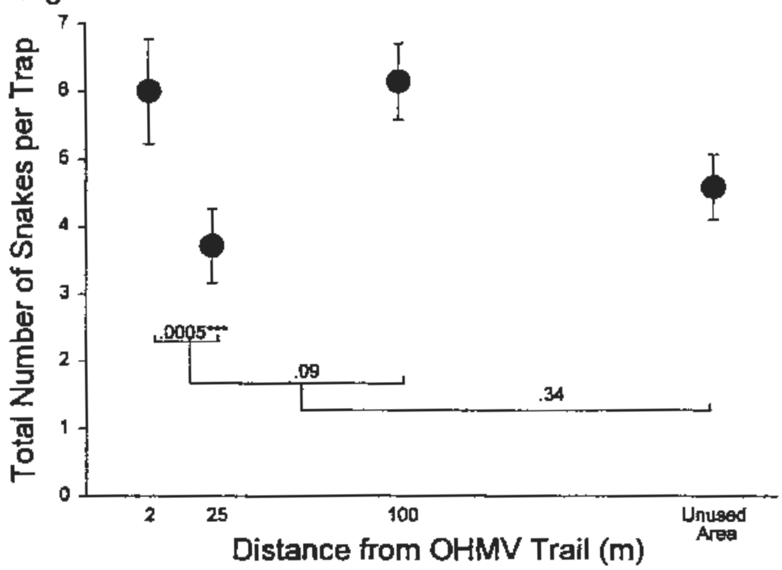


Figure 8. All lizards at Rabbit Creek OHMV trails.

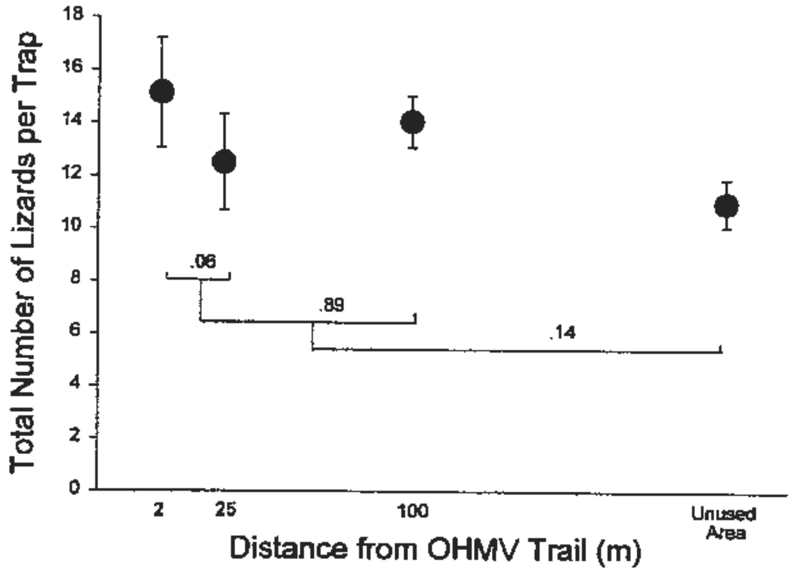


Figure 9. Leopard Lizards at Rabbit Creek OHMV trails.

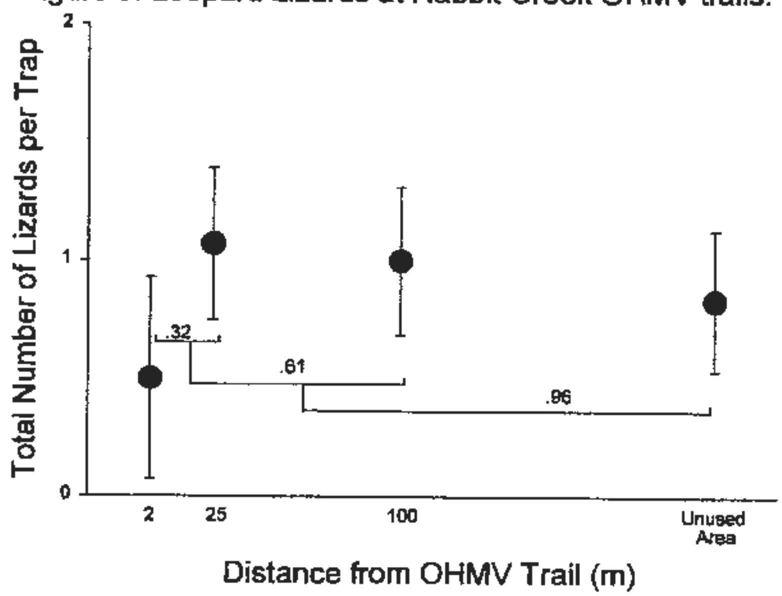


Figure 10. Snakes: All Species

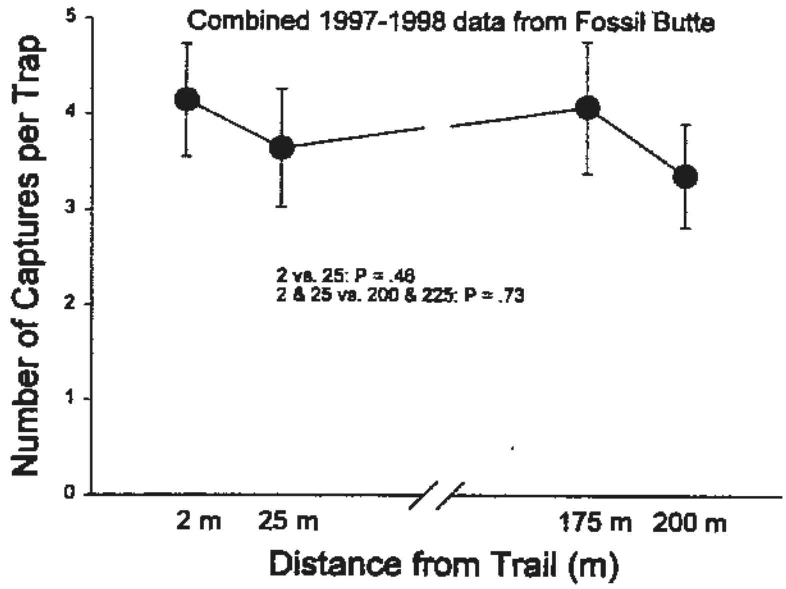


Figure 11. Snakes: Sensitive Species

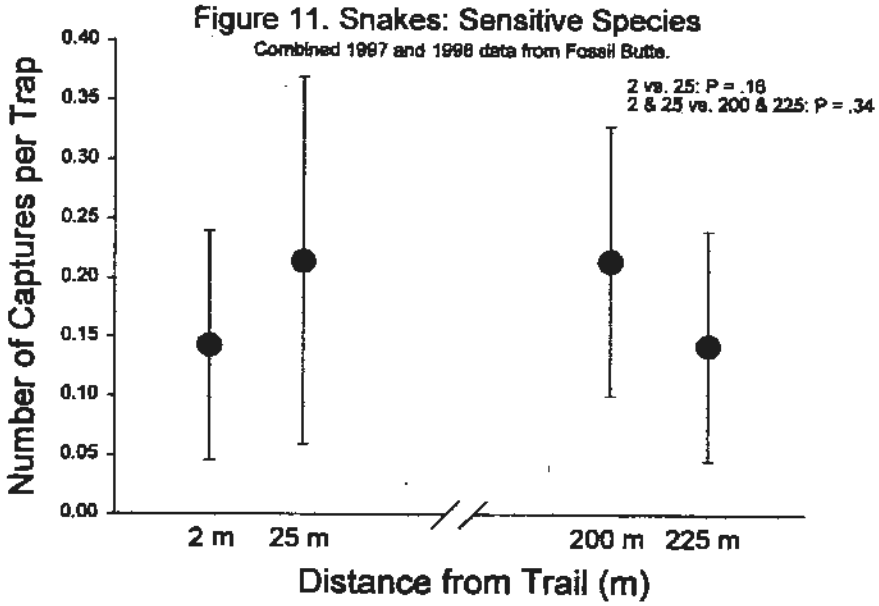


Figure 12. Snakes: Sensitive Species

Combined 1997 and 1998 data from Fossil Butte.

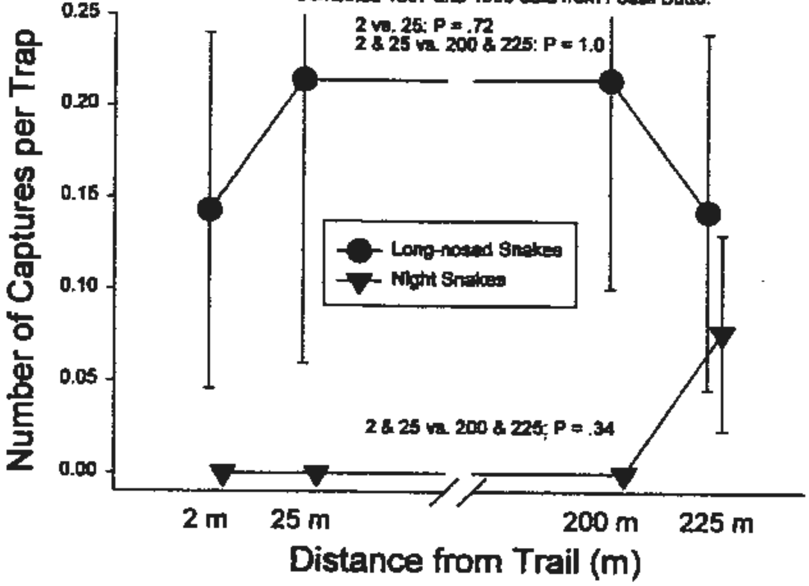


Figure 13. Combined 1997-1998 data from Fossil Butte

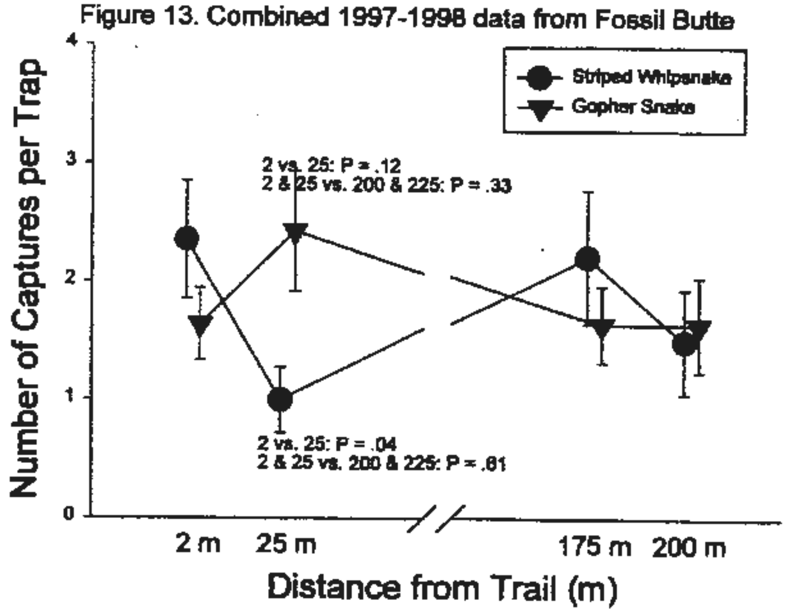


Figure 14. Lizards: All Species

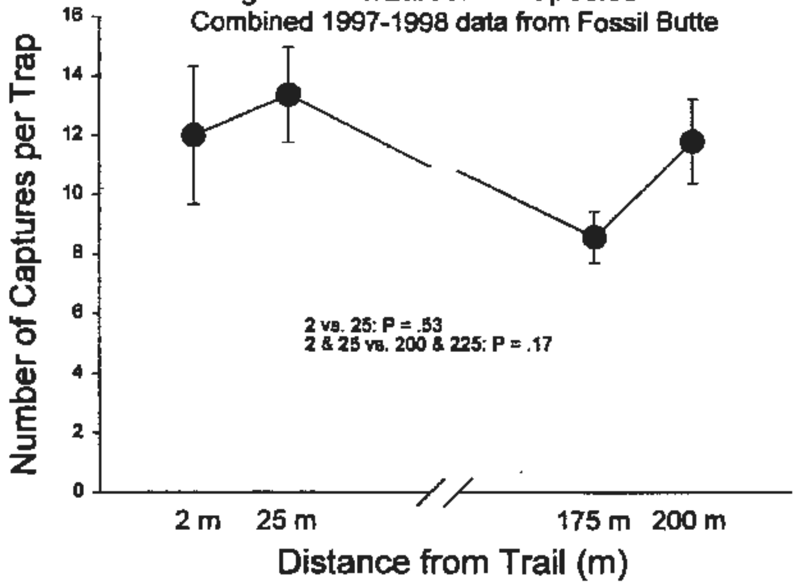


Figure 15. Combined 1997-1998 data from Fossil Butte

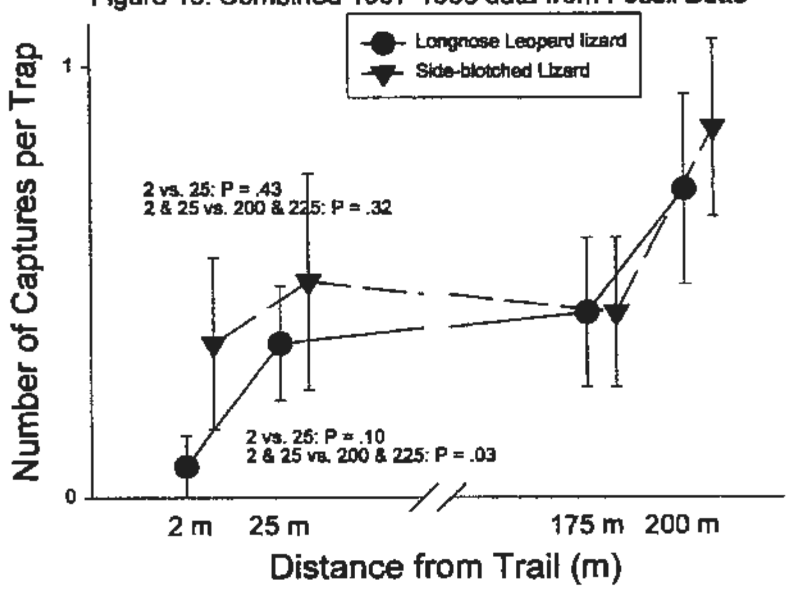


Figure 16. Combined 1997-1996 data from Fossil Butte

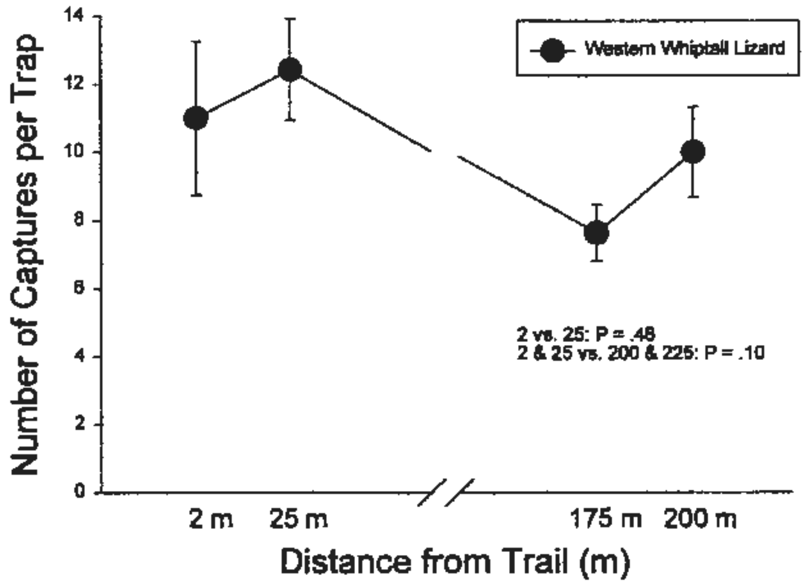


Figure 17. Combined 1997-1996 data from Fossil Butte

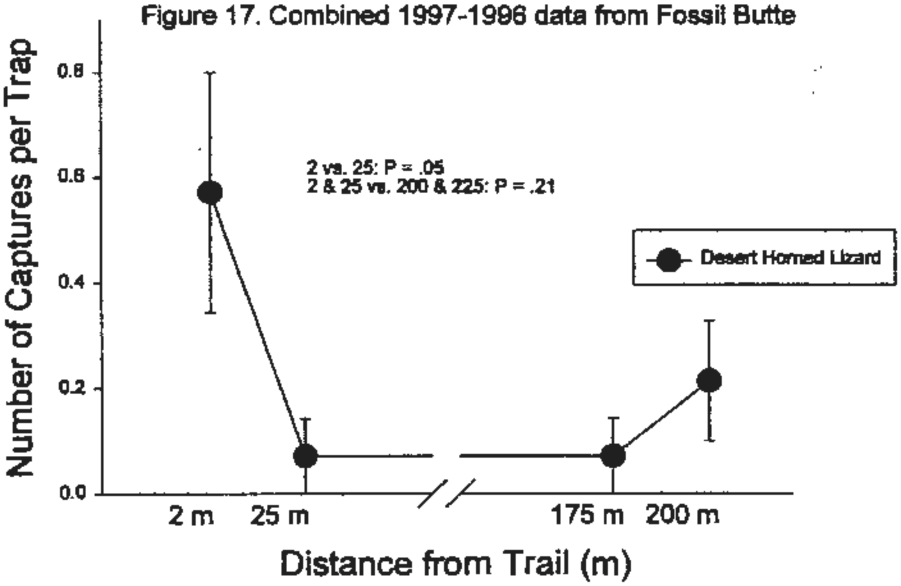


Figure 18. Number of Lizards in and out of washes used by and not used by OHMV's at Rabbit Creek

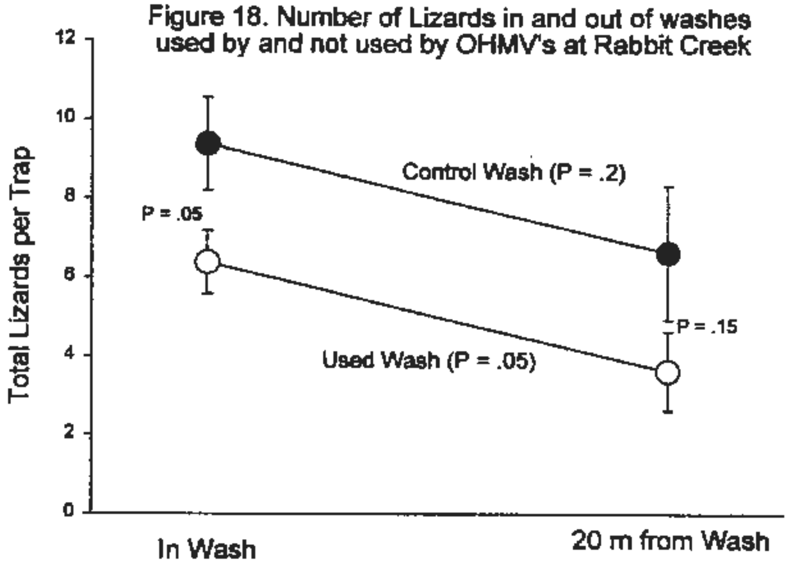


Figure 19. Number of Snakes in and out of washes used by and not used by OHMV's at Rabbit Creek.

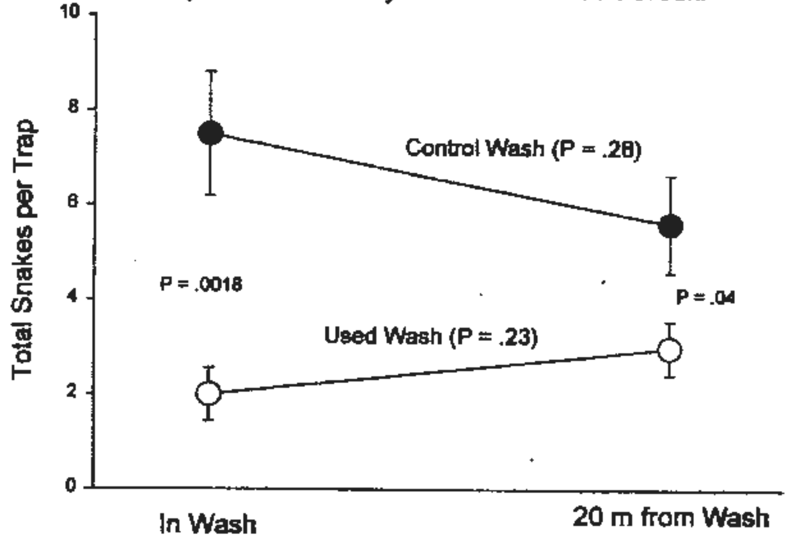


Figure 20. Number of Longnosed Snakes in and out of washes used by and not used by OHMV's at Rabbit Creek.

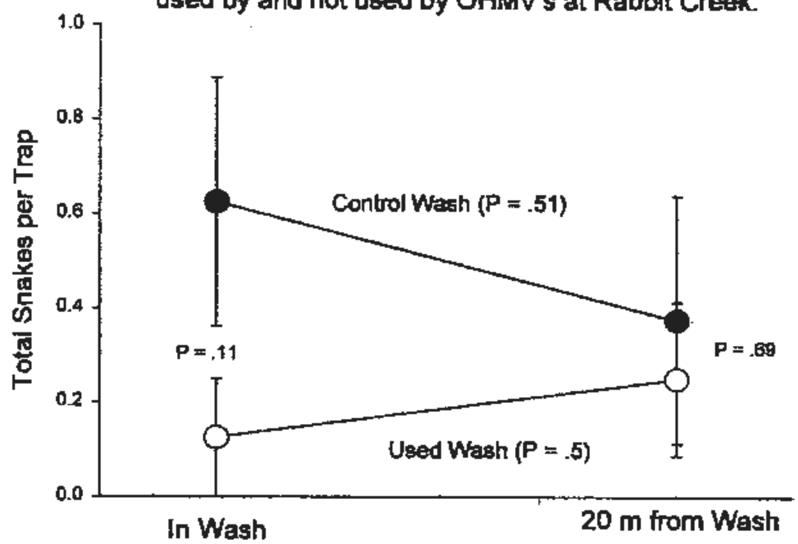
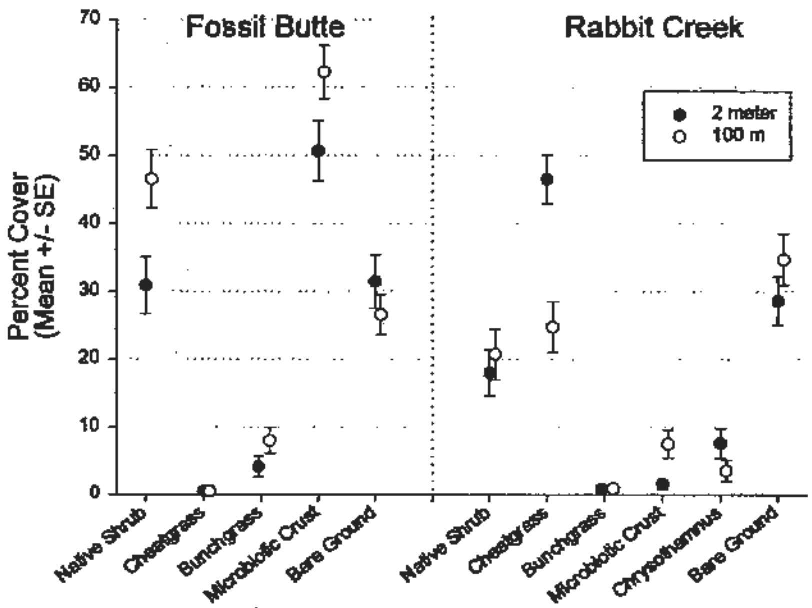
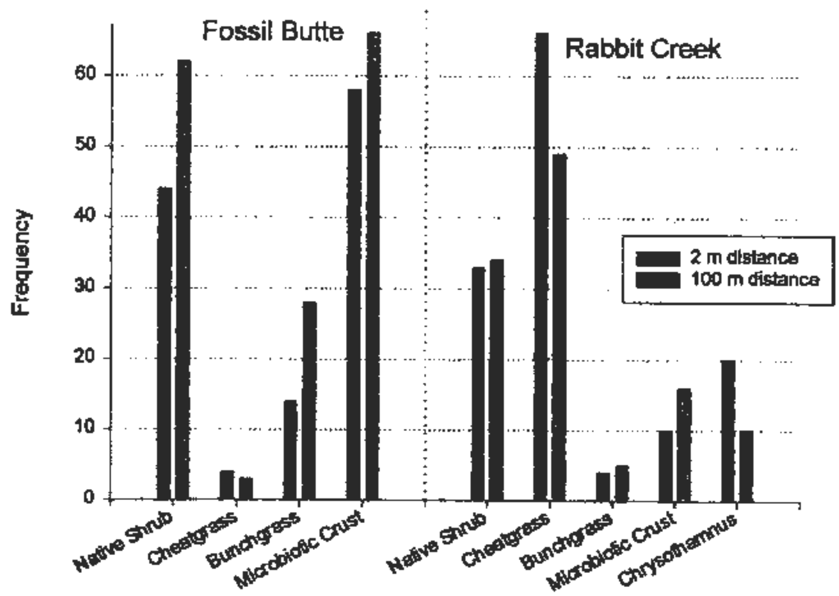


Figure 21. Percent cover of various plots 2 m from OHMV trails and 100 m from OHMV trails at two sites, Rabbit Creek and Fossil Butte. Sixty six plots were assessed at each of the two sites. Depicted are the means +/- one standard error. Statistics refer to comparisons between plots within sites and between sites.



	Comparison of 2 m plots to 100 m plots. Paired t-tests; all df=66.		Compare Fossil Butte plots to Rabbit Creek plots. Unpaired two-sample t-tests with df corrected as necessary for unequal variances (SAS)	
	Fossil Butte	Rabbit Creek	2 m only	100 m only
Native Shrubs	t = 2.87; P = .0055**	t = .57; P = .57	t = 2.41 df = 130.0 P = 0.0175*	t = 4.52 df = 130.0 P<.0001***
Cheatgrass	t = .085; P = .93	t = 4.10; P = .0001***	t = 12.78 df = 66.0 P = .0001***	t = 6.47 df = 66.0 P = .0001***
Bunchgrass	t = 1.67; P = .10	t = .10; P = .92	t = 1.96 df = 84.3 P = 0.0529	t = 3.59 df = 72.0 P = .0006***
Microbiotic Crust	t = 2.04; P = .045	t = 2.69; P = .009**	t = 11.06 df = 68.4 P = .0001***	t = 12.32 df = 98.7 P = .0001***
Chrysothamnus		t = 1.94 P = .056		
Bare Ground	t = .94; p = .35	t = 1.34 P = .18	t = 7.42 df = 69.2 P = .0001***	t = 5.25 df = 116.3 P = .0001***

Figure 22. Frequencies of various vegetation types at plots 2 m from OHMV trails and 100 m from OHMV trails at two sites, Rabbit Creek and Fossil Butte. Sixty-six plots were assessed at each of the two sites; the frequency is the number out of 66 that had the specified plant present.



G-values and P-values from G-tests of contingency table analysis	Comparison of 2 m plots to 100 m plots.		Compare Fossil Butte plots to Rabbit Creek plots.		
	Fossil Butte	Rabbit Creek	2 m and 100 m combined	2 m only	100 m only
Native Shrubs	G = 19.7; P = .001***	G = 0.03 P = .862	G = 26.1; P = .001***	G = 3.8; P = .052*	G = 33.1; P = .001***
Cheatgrass	G = 0.0 P = 1.0	G = 26.1; P = .001***	G = 208.3; P = .001***	G = 152.3; P = .001***	G = 77.3; P = .001***
Bunchgrass	G = 6.9; P = .015*	G = 0.1; P = .73	G = 28.3; P = .001***	G = 6.8; P = .009**	G = 23.1; P = .001***
Microbiotic Crust	G = 11.6; P = .001***	G = 1.7; P = .19	G = 169.7; P = .001***	G = 81.9; P = .001***	G = 102.1; P = .001***
Chrysothamnus		G = 4.38 P = .036*			

Appendix 1. Locations, treatment types, and captures at each array at Rabbit Creek during Summer of 1998

UTM Easting	UTM Northing	Elevation (m)	Trap #	Treatment	days up	Intensity of OHMV Usage	Total Captures by Species Ct	Cv	Gw	Mt	Pc	Pp	Rl	Si	Us	tota
534949.67	4785786.4	889.132	r1a	2m single trail	43	L	30	0	0	2	2	1	0	0	0	35
534928.98	4785789.7	891.682	r1b	25m single trail	43	L	23	0	0	1	1	0	0	0	1	26
534849.26	4785827.2	889.477	r1c	within trails control	43	HLL	12	0	0	0	4	0	0	0	0	16
534829.13	4785838	887.934	r1d	within trails control	43	HLL	8	1	0	1	4	0	1	0	0	15
534768.38	4785876	885.494	r1e	25m X trail	43	HL	1	0	0	0	3	0	0	0	1	5
534746.77	4785886	884.809	r1f	2m X trail	43	HL	4	0	0	6	3	0	3	0	0	16
534676.98	4785827.8	885.402	r2a	2m single trail	43	H	11	0	0	3	3	0	0	0	0	17
534681.37	4785803	890.058	r2b	25m single trail	43	H	7	0	0	2	3	0	1	0	0	13
534710.84	4785654.8	899.46	r2c	within trails control	43	HHL	12	0	0	1	1	0	0	0	0	14
534713.63	4785639.2	894.232	r2d	within trails control	43	HHL	7	0	1	2	5	0	0	0	0	15
534722.37	4785413.9	901.068	r2e	25m X trail	43	HL	2	0	0	3	3	0	0	0	0	8
534982.7	4785143	909.487	r2f	2m X trail	43	HL	12	0	0	0	2	0	0	0	0	14
534351.87	4785536.8	899.365	r3a	2m single trail	43	L	17	0	0	4	3	0	1	0	1	26
534377.84	4785633.1	902.636	r3b	25m single trail	43	L	13	0	3	1	0	0	0	0	1	18
534470.96	4785530.5	885.264	r3c	within trails control	43	HLL	16	1	1	0	5	0	0	0	0	23
534490.32	4785517	897.708	r3d	within trails control	43	HLL	14	0	2	2	5	0	1	0	0	24
534585.97	4785513.4	901.745	r3e	25m X trail	43	HL	22	0	0	1	2	1	0	0	0	26
534613.05	4785510.7	899.01	r3f	2m X trail	43	HL	23	0	0	2	7	0	0	0	0	32
534248.38	4785358	911.589	r4a	2m single trail	43	L	9	0	0	3	4	1	0	0	5	22
534246.92	4785332.8	911.041	r4b	25m single trail	43	L	13	0	1	2	4	0	0	0	1	21
534291.23	4785201.5	912.364	r4c	within trails control	43	LLL	18	0	2	2	1	0	2	0	1	24
534302.14	4785176.9	913.969	r4d	within trails control	43	LLL	11	0	4	3	1	0	0	0	0	19
534329.92	4785098.4	917.875	r4e	25m X trail	43	LL	12	0	2	2	1	0	0	0	2	19
534336.97	4785078.5	918.043	r4f	2m X trail	43	LL	16	0	0	1	3	1	0	0	0	21
534564.54	4785000.2	918.264	r5a	2m single trail	43	H	13	0	1	0	6	0	0	0	2	22
534583.77	4784981.5	918.816	r5b	25m single trail	43	H	13	0	1	2	4	0	0	0	0	20
534638.34	4784927.2	920.226	r5c	within trails control	43	HHH	10	0	2	5	2	1	0	0	0	20
534653.97	4784912.7	921.759	r5d	within trails control	43	HHH	16	0	0	2	2	0	0	0	2	22
534744.07	4784633	938.614	r5e	25m X trail	43	HH	3	0	1	1	0	0	0	0	0	5
534761.95	4784615.7	944.193	r5f	2m X trail	43	HH	3	0	0	2	0	0	0	0	1	6
534771.47	4785110.1	909.297	r6a	2m single trail	43	H	21	1	6	4	4	0	0	0	0	38
534796.24	4785111.4	910.155	r6b	25m single trail	43	H	11	0	1	3	0	1	0	0	0	18
534849.37	4785120.5	912.055	r6c	within trails control	43	HHL	16	0	0	4	4	0	0	0	0	24
534871.17	4785121.3	917.302	r6d	within trails control	43	HHL	12	0	1	3	4	0	0	0	0	20
534953.44	4785139.4	906.762	r6e	25m X trail	43	HL	9	0	4	4	1	0	2	0	0	20
534723.49	4785441	899.076	r6f	2m X trail	43	HL	9	0	0	1	3	1	0	0	0	14
535169.84	4785460.4	900.86	r7a	2m single trail	43	H	7	0	0	0	3	4	1	0	0	15
535136.31	4785452.2	899.309	r7b	25m single trail	43	H	11	0	1	0	2	1	0	0	0	15
534964.67	4785389.6	895.937	r7c	within trails control	43	HHL	11	0	0	4	3	0	0	0	0	18
534941.03	4785383.7	897.277	r7d	within trails control	43	HHL	17	0	1	6	3	1	1	0	0	29
534826.61	4785347.5	899.252	r7e	25m X trail	43	HL	11	0	1	1	2	0	0	0	0	15
534804.38	4785338.2	899.549	r7f	2m X trail	43	HL	13	0	0	3	4	0	0	0	0	20
534228.29	4783589.8	918.899	rc1	control	43	none	13	0	1	3	0	0	0	0	0	17
533798.43	4783829.8	927.369	rc10	control	43	none	8	0	1	0	2	0	0	0	0	11
533678.78	4783854.8	934.072	rc11	control	43	none	6	0	0	0	3	2	0	0	0	11
533763.91	4783844.7	926.879	rc12	control	43	none	5	1	0	2	0	2	0	0	3	13
534137.45	4783830.6	923.128	rc2	control	43	none	14	0	1	4	0	0	2	1	1	23
534054.06	4783700.1	925.779	rc3	control	43	none	11	0	2	4	3	0	0	0	0	20
533969.75	4783786.8	928.91	rc4	control	43	none	5	0	0	3	2	1	1	1	0	13
533885.34	4783836	932.019	rc5	control	43	none	11	0	3	1	2	1	1	0	1	20
533801.85	4783804.4	934.179	rc6	control	43	none	9	0	0	2	2	1	0	0	0	14
534012.87	4783592.3	920.154	rc7	control	43	none	9	0	2	2	3	0	0	0	0	16
533978.91	4783698.4	923.852	rc8	control	43	none	5	0	0	4	3	2	0	0	1	15
533851.06	4783722.3	924.536	rc9	control	43	none	10	0	0	2	2	0	1	0	1	16
535994.58	4786083.9	846.878	w1a	control wash	43	none	11	0	0	6	0	0	1	0	0	18
535988.65	4786099.3	858.335	w1aa	20m control wash	43	none	16	0	1	6	3	0	2	0	0	28
536162.49	4786116.2	842.197	w1b	control wash	43	none	10	0	1	8	6	0	2	1	0	28
536166.2	4786099.6	847.034	w1bb	20m control wash	43	none	6	0	1	3	2	0	1	0	0	13
536303.43	4786078.6	833.782	w1c	control wash	43	none	11	0	3	4	3	0	0	0	0	21
536296.42	4786066.9	821.563	w1cc	20m control wash	43	none	5	0	2	3	2	0	0	0	0	12
536442.16	4786129	826.138	w1d	control wash	43	none	6	0	1	3	2	0	1	0	0	13
536431.11	4786119.8	834.302	w1dd	20m control wash	43	none	7	0	1	0	1	0	0	0	0	9
535640.35	4785972.6	856.966	w1e	used wash	43	H	8	0	0	2	0	0	0	0	0	10
535649.3	4785959.1	862.649	w1ee	20m used wash	41	H	7	0	0	0	0	0	0	0	0	7

UTM	UTM	Elevation				Intensity of	Total Captures by Species									
Easting	Northing	(m)	Trap #	Treatment	days up	OHMV Usage	Ct	Cv	Gw	Mt	Pc	Pp	Rl	Sl	Us	tota
535469.15	4785957.1	873.16	w1f	used wash	40	H	3	0	0	0	1	0	0	0	0	4
535456.77	4785966.2	866.246	w1ff	20m used wash	41	H	3	0	0	1	3	0	0	0	0	7
535350.23	4785826.7	870.775	w1g	used wash	41	H	4	0	0	0	0	0	0	0	0	4
535357.01	4785810.7	872.558	w1gg	20m used wash	43	H	8	0	0	0	2	0	0	0	0	10
535192.16	4785745.5	879.07	w1h	used wash	41	H	3	0	1	1	0	0	0	0	1	6
535186.66	4785757	885.025	w1hh	20m used wash	43	H	5	0	0	4	1	0	0	0	0	10
536051.64	4787164.9	833.022	w2a	control wash	43	none	5	0	0	7	0	0	0	0	0	12
536046.11	4787175.6	836.313	w2aa	20m control wash	43	none	4	0	0	5	2	0	0	0	0	11
536088.55	4787252.3	811.554	w2b	control wash	43	none	9	0	1	4	2	0	1	0	0	17
536122.57	4787214.4	865.764	w2bb	20m control wash	43	none	3	0	0	2	4	0	0	0	0	9
536169.31	4787287.4	824.434	w2c	control wash	43	none	12	0	0	4	3	0	0	0	0	19
536163.22	4787299.3	828.297	w2cc	20m control wash	43	none	6	0	0	1	5	0	0	0	0	12
536234.17	4787344.7	833.457	w2d	control wash	43	none	3	0	2	1	2	0	0	0	0	8
536244.73	4787338.3	832.664	w2dd	20m control wash	43	none	1	0	0	1	2	0	0	0	0	4
535816.87	4787000.7	839.054	w2e	used wash	43	H	9	0	0	2	1	0	0	0	0	12
535831.18	4787000.6	834.968	w2ee	20m used wash	43	H	2	0	0	3	1	0	0	1	0	7
535756.6	4786944.7	835.713	w2f	used wash	43	H	9	0	0	1	0	0	0	0	0	10
535747.56	4786958.6	837.888	w2ff	20m used wash	43	H	1	0	0	0	2	0	1	0	0	4
535669.77	4786918.5	837.499	w2g	used wash	43	H	6	0	0	2	1	0	0	0	0	9
535669.43	4786900.9	840.58	w2gg	20m used wash	43	H	0	0	0	0	3	0	1	0	0	4
535604.93	4786952.2	841.107	w2h	used wash	43	H	7	0	0	3	1	0	1	0	0	12
535602.14	4786968.8	843.107	w2hh	20m used wash	41	H	3	0	0	1	1	0	0	0	0	5
				Ct = Western Whiptail (*Cnemidophorus tigris*)												
				Cv = Western Rattlesnake (*Crotalus viridis*)												
				Gw = Longnose Leopard Lizard (*Gambelia wislizenii*)												
				Mt = Striped Whipsnake (*Masticophis taeniatus*)												
				Pp = Desert Horned Lizard (*Phrynosoma platyrhinos*)												
				Pc = Gopher Snake (*Pituophis catenifer*)												
				Rl = Longnose Snake (*Rhinocheilus lecontei*)												
				Sl = Great Basin Spadefoot Toad (*Spea intermontanus*)												
				Us = Side-blotched Lizard (*Uta stansburiana*)												

Appendix 2. Locations, treatments, and captures of reptiles and amphibians at arrays at Fossil Butte during 1996													
UTM	UTM	Elevation			Total Captures by Species								
Easting	Northing	(m)	Trap #	Treatment	Ct	Gw	Mt	Pc	Pp	Rl	Sl	Us	total
544642	4772533	965	00C	***A***	4	0	0	0	0	0	0	0	4
544661	4772542	966	00D	***B***	6	1	0	3	0	0	0	0	10
544783	4772808	958	00E	***C***	7	0	2	0	0	0	0	0	9
544803	4772816	956	00F	***D***	6	1	0	0	0	0	0	0	7
544580	4772689	963	00G	***A***	9	0	1	0	0	1	0	0	11
544558	4772682	964	00H	***B***	6	0	2	0	1	0	0	0	9
544428	4772683	967	01A	***C***	3	0	1	0	0	0	0	0	4
544404	4772681	967	01B	***D***	2	0	1	0	0	0	0	0	3
544543	4772856	967	01C	***A***	12	0	2	2	2	0	0	0	18
544563	4772862	966	01D	***B***	11	0	0	4	0	0	0	0	15
544687	4772902	972	01E	***C***	5	0	2	2	0	0	0	0	9
544710	4772907	973	01F	***D***	6	1	2	0	0	0	0	0	9
544696	4772195	964	02A	***A***	5	0	2	2	0	0	0	0	9
544673	4772193	968	02B	***B***	3	1	0	0	0	0	0	0	4
544551	4772185	971	02C	***C***	0	0	0	1	0	0	0	0	1
544532	4772174	971	02D	***D***	4	0	0	0	0	0	0	0	4
544727	4771991	961	02E	***A***	5	0	1	1	0	0	0	0	7
544705	4771988	961	02F	***B***	6	0	1	1	0	0	0	0	8
544857	4771973	955	02G	***C***	2	0	6	1	0	0	0	0	9
544874	4771958	958	02H	***D***	3	1	0	4	0	0	0	0	8
544750	4771869	962	03A	***A***	2	1	1	0	0	0	0	0	4
544729	4771864	961	03B	***B***	4	0	0	1	0	0	0	0	5
544642	4771849	961	03C	***C***	4	1	0	0	0	0	0	2	7
544618	4771848	966	03D	***D***	5	1	2	3	0	0	0	1	12
544788	4771704	964	03F	***A***	2	0	0	1	0	0	0	0	3
544810	4771704	963	03G	***B***	3	1	0	4	0	0	0	0	8
544822	4771585	966	03H	***A***	6	0	5	1	0	0	0	0	12
544844	4771586	966	03I	***B***	7	0	1	5	0	0	1	2	16
544941	4771652	965	13A	***C***	4	0	1	2	0	0	0	1	8
544982	4771642	964	13B	***D***	1	0	0	2	0	1	0	0	4
544968	4771563	968	13C	***C***	6	0	2	0	0	0	0	0	8
544990	4771556	967	13D	***D***	9	0	3	1	1	0	1	0	15
544367	4772209	981	1A	***A***	3	0	0	1	0	0	0	0	4
544374	4772187	979	1B	***B***	11	0	0	1	0	0	0	0	12
544440	4772025	972	1C	***C***	4	0	1	3	0	0	0	0	8
544447	4772004	972	1D	***D***	3	0	1	2	0	0	0	0	6
544441	4772251	981	2A	***A***	4	0	0	1	0	0	0	0	5
544434	4772273	980	2B	***B***	3	0	0	1	0	0	0	0	4
544377	4772387	977	2C	***C***	5	0	0	0	0	0	0	0	5
544376	4772406	976	2D	***D***	8	0	0	1	0	0	0	1	10
544526	4772260	975	3A	***A***	5	0	2	1	2	0	0	0	10
544516	4772282	977	3B	***B***	6	1	1	1	0	0	0	0	9
544818	4772148	971	3C	***C***	3	0	2	1	0	0	0	0	6
544828	4772126	969	3D	***D***	11	1	0	1	0	0	0	1	14
544801	4772451	955	4A	***A***	3	0	3	4	0	0	0	0	10
544769	4772468	955	4B	***B***	5	1	1	2	0	0	0	2	11
544737	4772589	959	4C	***C***	3	1	0	3	0	0	0	0	7
544727	4772608	958	4D	***D***	2	0	1	4	0	0	0	0	7
544883	4772482	955	5A	***A***	22	0	3	1	0	0	0	0	26
544893	4772462	953	5B	***B***	7	0	0	0	0	2	0	0	9
544978	4772370	952	5C	***C***	9	0	0	3	0	0	0	0	12

UTM	UTM	Elevation			Total Captures by Species								
Easting	Northing	(m)	Trap #	Treatment	Ct	Gw	Mt	Pc	Pp	Rl	Si	Us	total
544992	4772353	954	5D	***D***	12	0	4	0	0	0	0	0	16
544954	4772532	955	6A	***A***	16	0	1	2	0	0	0	0	19
544938	4772547	956	6B	***B***	16	0	1	5	0	1	0	1	24
544825	4772653	959	6C	***C***	2	0	4	2	0	0	0	0	1
544811	4772670	957	6D	***D***	7	0	4	1	0	0	0	0	1

A	2 m from trail
B	25 m from trail
C	175 m from trail
D	200 m from trail

Ct = Western Whiptail (*Cnemidophorus tigris*)
Cv = Western Rattlesnake (*Crotalus viridis*)
Mt = Striped Whipsnake (*Masticophis taeniatus*)
Pp = Desert Horned Lizard (*Phrynosoma platyrhinos*)
Pc = Gopher Snake (*Pituophis catenifer*)
Rl = Longnose Snake (*Rhinocheilus lecontei*)
Si = Great Basin Spadefoot Toad (*Spea intermontanus*
Us = Side-blotched Lizard (*Uta stansburiana*)

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