SHORT-TERM EFFECTS OF HABITAT MANAGEMENT ON SMALL VERTEBRATES IN CHAPARRAL

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ABSTRACT

I report some short term effects of chaparral fuel management by disking, hand cutting, and prescribed fire on rodents, birds, reptiles and amphibians. Comparisons between treated and untreated areas showed that in the year following treatments (1980) in the disked area there were significantly fewer captures of rodents (10 vs 60) and lizards (5 vs 15), and species of birds observed (9 vs 18). Rodent captures remained significantly lower in the disked area (37 vs 104) in 1981. There were significantly fewer captures of rodents in the hand cut area than in the untreated area (36 vs 71) in 1980. Prescribed fire was also followed by significantly fewer captures of rodents in the burned area (41 vs 58) in 1981, and in the number of lizards and toads captured in 1980 (8 vs 29). The differences in capture frequencies of rodents between treated and untreated areas can be partly explained by the habitat preferences of the individual species. The rodent community was most sensitive to these habitat manipulations, followed by the herpetofauna. The avifauna was least sensitive to habitat manipulations. The reduction in the numbers of all three vertebrate groups after disking was related to the changes in the plant community, where 79 percent shrub cover was replaced by a sparse (16 percent) cover of grasses and forbs.

INTRODUCTION

The chaparral of California is frequently managed to lessen the risk of wildfire by reducing the quantity of vegetation available to burn. Fuel reduction can be accomplished by several methods (Roby and Green 1976). Type conversion, usually replacing shrubs with herbaceous vegetation, is one such method. Fuels can also be reduced with prescribed fire, which eliminates the large quantities of fuel in mature shrubs by burning. Fire by prescription is sometimes used over parts of entire watersheds, as has been the case on the Grindstone Project in northern California (White 1982). By contrast in the steep, partially urbanized chaparral of the southern California mountains prescribed fire must usually be applied on a smaller scale. In recent years the advent of the helitorch has made the burning of chaparral by prescription a more attractive management alternative for both large and small fires (Bungarz 1982). The effects of these relatively new management activities on wildlife, particularly with the expanded use of the helitorch by the United States Forest Service, California Department of Forestry, U.S. Bureau of Land Management and others, have not yet been fully assessed.

In 1974 the large and potentially catastrophic Soboba Wildfire occurred in the San Jacinto Mountains. The Soboba Project was undertaken after this fire. This project is a 4,850 ha (12,000 acre) demonstration area in the San Bernardino National Forest where various approaches to improving wildlife habitat have been combined with a fuel reduction and management program (Blong et al. 1978; Roberts 1980, 1981). The project is somewhat unusual in that the creation and improvement of wildlife habitat is one of its primary goals, and because attention has been given to non-game as well as game species.

In 1979 it was decided to study the effects of the fuel reduction program on selected wildlife populations at three study sites. Each of these sites was manipulated in a different way (disked, cut by hand, or burned with a helitorch). The objective of this paper is to describe the changes that took place at each site in the rodent, bird and herpetofaunal communities. The extent of the changes in these groups of animals was assessed by paired comparisons between the manipulated areas and adjacent, unmanipulated chaparral.

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METHODS

Study Sites

Two study sites were in six year old chaparral inside the boundaries of the Soboba Wildfire, and the third was in old chaparral that had not burned for 30 or more years. All three areas are located within the San Bernardino National Forest, Riverside County, California. The sites are within five km (three mi) of one another, less than three km (two mi) south and west of the Vista Grande Ranger Station, at elevations of 1280-1340 m (4200-4400 ft).

Manipulation of the Vegetation

1. Disking. In February of 1980 six year old chaparral was removed from a 35 meter (115 ft) wide strip on a ridgetop, using a Towner disk pulled by a Caterpillar D-7 crawler tractor. A Towner disk is a much larger, heavier model of the common farm implement. This machine uproots, chops, and buries the chapparal shrubs. After disking the area was seeded with *Dactylis glomerata* (orchardgrass).

2. Hand cutting. In the winter and spring of 1980 a 35 meter wide strip of six year old chaparral was removed from a ridgetop by chopping the shrubs down at ground level with hand tools, and stacking the cuttings in piles. The piles of cuttings were left in place to dry for several months, and then burned.

3. Prescribed fire. In June of 1980 approximately 19 ha (40 acres) of mature chaparral along a ridge was ignited from the air with a helitorch, under weather conditions that caused a fire of relatively low intensity. The experimental fire was patchy, removing 75 percent of the vegetative cover along the assessment line and 40-50 percent of the cover from the general fire area.

Vegetation Sampling

Vegetation was sampled in the treated and untreated portions of all three study sites by means, with one exception, of the line intercept method (Bauer 1943). Sampling was done in late 1979 in the areas to be treated, and repeated after treatment in 1981. Untreated areas were sampled in 1980-81. All sampling was done in the same places where animals were studied, using lines divided into 15-30 segments, each five m (16 ft) in length, in both treated and untreated vegetation. After disking it was not practical to repeat the line intercept method in the treated area, due to the small and numerous grasses and forbs that grew there. The sampling procedure in this area was therefore modified by using circular sample plots in place of the five meter segments of the line. These plots were one m (3.3 ft) in diameter, and were placed along the original sampling line at five m (16 ft) intervals.

Wildlife Assessment Lines

One wildlife assessment line was used to monitor the rodent, bird, and herpetofaunal communities at each of the three study sites. Lines were situated on ridge tops and hillsides, with the lines bending in conformity with the topography. Slopes along the lines varied from 0-15 percent, and all had a southerly aspect. Lines were arranged with 12-15 sampling stations within each treatment, and an equal number of sampling stations on extensions of the lines outside the treated areas. Sampling stations were 15 m (49 ft) apart in both treated and untreated areas, with a buffer zone of 30 m (100 ft) or more between the two. Each station contained a Sherman live trap for rodents, and was used as an observation point for birds. A 19 liter (5 gal) can was buried in the ground near each station as a pitfall trap for lizards and toads.

One Sherman live trap was placed within one m (3.3 ft) of each sampling stake. Each rodent captured was identified by species and sex and permanently marked by toe clipping. Traps were operated for 4-9 nights per season, until approximately 75 percent of all animals captured on the final night of trapping were recaptures.

Rodent trapping in the fall of 1979 preceded the manipulations of the vegetation, all of which occurred in the winter and/or spring of 1980. The 1980 trapping took place in the fall, after manipulation of the vegetation. The hand cut area was not trapped in 1980 because the treatment of the vegetation interfered with the trapping procedure. The 1981 trapping occurred in the spring.

Bird observations were made at each study site in the fall of 1979 and 1980, and in the spring of 1981. During each morning of observation all species of birds were observed and recorded in a manner similar to that of Emlen (1971), by walking slowly along an assessment line and stopping at every other sampling station for five minutes. All observations were made in clear weather in the early morning hours. Each line was observed 2-4 mornings in each year.

Pitfall traps for lizards and toads were buried with the tops at ground level. Traps were placed 2-3 m (6.5-10 ft) from each station, perpendicular to the assessment line, on alternating sides. The top of each trap was covered with a plywood square which was raised on pegs to rest 1-2 cm (0.4-0.8 in) above the ground. This left a crawl space beneath the lid, so that lizards and toads that ran beneath would fall in the trap. This device succeeded in catching all four species of lizards commonly observed in the area. Traps were inspected every two weeks. Each lizard and toad captured was identified to species and released. Lizards were marked by toe clipping in 1979, but this procedure was discontinued when it was found that almost no marked animals were recaptured. Traps were left open for 39-78 days in the fall of 1979, 14-36 days in 1980, and 37 days in the spring of 1981. In addition to the captures, other reptiles were recorded when observed on or near the assessment lines.

Analysis Procedures

Line intercept data from the vegetation sampling were used to calculate percent relative plant cover, counting bare ground as if it were a plant (Curtis and McIntosh 1951).

Trapping results for rodents were analyzed for each study site by comparing the total number of captures of all species for each year between treated and untreated portions of the assessment line. Differences between treated and untreated areas were tested for significance using a 2 x 2 contingency table for Chi-square analysis, comparing the frequencies of captures and non-captures. A non-capture is one trap set for one night which fails to capture an animal.

Differences in the number of rodent captures of a particular species between the treated and untreated areas were tested for significance by use of a goodness-of-fit Chi-square test, with a null hypothesis of no significant differences in the number of captures between each. This test could only be used, however, in cases where the expected number of captures was five or more.

In two instances the patterns of change in captures between 1979 and 1980 were compared for significance between the treated and untreated areas. This was done with a 2 x 2 contingency table for Chi-square analysis, entering the 1979 and 1980 capture numbers for both treated and untreated areas.

Bird observations were analyzed for each study site by comparing the total number of species observed in the treated and untreated portions of the wildlife assessment line. Differences between treated and untreated areas were tested for significance with a goodness-of-fit Chi-square test, with a null hypothesis of no significant difference between the number of species in each. Lizard and amphibian data were analyzed in the same way, except that the total number of captures of all species rather than the total number of species were used.

Two additional bird species totals were made for comparisons between and within lines; treated plus untreated for each year and line, and all species for all three years on each line.

RESULTS AND DISCUSSION

Vegetation

Before treatment the plant community of all three study sites was dominated by *Arctostaphylos glauca-Adenostoma fasciculatum* (manzanita-chamise), with these two species covering 43-90 percent of the area, and bare ground accounting for most of the rest (Table 1). Prior to treatment the area to be manipulated and the untreated portion of each wildlife assessment line were similar, but not identical, in both species composition and the relative cover of each species.

Table 1. Percent relative plant cover on three wildlife assement lines.

A. DISKING

Species	UNTREATED	TREATED	
		Before	After
Bigberry Manzanita (*Arctostaphylos glauca*)	42.2	22.0	
Chamise (*Adenostoma fasciculatum*)	16.8	45.7	
Bare Ground	23.1	27.7	83.7
Ceanothus (*Ceanothus leucodermis*)	10.4	1.3	
Mountain Mahogany (*Cercocarpus betuloides*)	8.1		
Orchardgrass (*Dactylis glomerata*)			6.7
Others		3.3	9.6

B. HAND CUTTING

Species	UNTREATED	TREATED	
		Before	After
Bigberry Manzanita (*Arctostaphylos glauca*)	26.1	38.1	9.6
Chamise (*Adenostoma fasciculatum*)	17.2	26.7	
Bare Ground	28.1	27.8	76.5
Ceonathus (*Ceanothus leucodermis*)	25.1		
Others	3.5	7.3	13.9

C. PRESCRIBED FIRE

Species	UNTREATED	TREATED	
		Before	After
Bigberry Manzanita (*Arctostaphylos glauca*)	40.3	53.7	14.3
Chamise (*Adenostoma fasciculatum*)	36.0	37.1	8.6
Bare Ground	23.7	9.2	77.1

All three treatments resulted in a shift to about 3/4 bare ground and 1/4 plant cover (Table 1). Hand cutting and prescribed fire allowed for the rapid reestablishment of some shrub cover by resprouting during the following spring and summer. Disking, on the other hand, produced only sparse vegetation before the spring of 1981 when various forbs, grasses, and the seeded orchardgrass grew to cover 16 percent of the ground. The disking destroyed the root systems of the existing shrubs and thoroughly stirred the upper layer of the topsoil, thus preventing the growth of shrub resprouts and reducing the likelihood of germination of seeds on the site before treatment. The orchardgrass was the most common species of plant in 1981, and accounted for the most vegetative cover.

Rodents

1. Disking. Five species of rodents were captured, in varying numbers, in both the treated and untreated areas. Prior to disking there was no significant difference in the total number of captures between the treated and untreated areas (Table 2). *Dipodomys agilis* (Pacific kangaroo rat) was most common in both areas, with somewhat fewer numbers of the genus *Peromyscus* (white-footed mice). This pattern is typical of young chaparral communities (Quinn 1979). *D. agilis* uses openings between the shrubs (Bayless 1980), and such openings accounted for approximately 1/4 of the total ground area in this young chaparral (Table 1). *P. californicus* (California mouse), on the other hand, forages in chaparral shrubs (Quinn 1979, 1984; Meserve 1977) as does *P. boylii* (brush mouse) in chaparral and other plant communities (Bayless 1980; Matson 1974; Holbrook 1978).

After disking in 1980, which caused a loss of more than 3/4 of the total vegetative cover and eliminated all of the shrub cover (Table 1), most individuals disappeared from the treated area. There was a 79 percent reduction in the total number of captures, and the two species that require shrubs, *P. californicus* and *P. boylii*, disappeared altogether. At the same time *P. californicus* disappeared in the treated area its captures doubled in the untreated area. This difference in pattern was statistically significant by 2 x 2 contingency table analysis, using Yates' correction for small expected values ($X^2 = 4.19$, $p<0.05$). By 1981 all species present before disking had returned to the manipulated area, but the number of captures was still significantly reduced in comparison to the untreated area. The total number of captures increased in the untreated area in 1980 and 1981, due to the increase in *D. agilis* and *P. californicus* captures.

In both 1980 and 1981 there were significantly fewer *D. agilis* in the treated than in the untreated area. *D. agilis* survives chaparral habitat disturbances in the deepest parts of its burrow system (Quinn 1979), and can increase its population afterwards in the environment that has been created. These burrows can be 40 cm (16 in) or more deep (Quinn, unpublished data). Three of the seven individual *D. agilis* found in the disked area in 1980 were survivors of the manipulation, and the number of individuals further increased to 17 in 1981.

Peromyscus maniculatus (deer mouse), which became more common in the treated area by 1981, is associated with disturbed areas in chaparral. This species is known to forage on the ground in weedy, disturbed areas in several plant communities (Quinn 1979; Meserve 1977; Holbrook 1978) and has been reported by Carnes (1978) to become abundant after removal of mature chaparral by heavy equipment.

2. Hand cutting. There was no significant difference in the total number of captures between the treated and untreated areas prior to hand cutting (Table 2). One year following manipulation, however, the capture total for all species combined was significantly less in the treated than in the untreated area. By contrast the number of captures of *P. maniculatus* in the treated area was significantly greater than in the untreated area. Furthermore the number of captures of this species in the treated area increased significantly between 1979 and 1981 ($X^2 = 7.36$, $p<0.01$), while there was no such increase in the untreated area. These changes are consistent with the habitat preferences of *P. maniculatus* discussed in the previous section. Unlike the disked area, *D. agilis* captures sharply and significantly declined following hand cutting ($X^2 = 10.9$, $p<0.001$), while they did not in the untreated area. I have no explanation for this outcome.

Table 2. The number of captures of five species of rodents before and after treatment of the vegetation. No hand cutting data for 1980.

A. DISKING

Species	TREATED			UNTREATED		
	1979 (Disking ↓)	1980	1981	1979	1980	1981
Dipodomys agilis	35	7**	22**	23	24	47
Peromyscus californicus	4***	0	2***	16	32	53
Peromyscus maniculatus	2	3	7	0	4	1
Neotoma fuscipes	0	0	0	3	0	0
Peromyscus boylii	6	0	6	0	0	3
TOTALS	47	10**	37**	42	60	104

B. HAND CUTTING

Species	TREATED			UNTREATED		
	1979 (Hand Cutting ↓)	1980	1981	1979	1980	1981
Dipodomys agilis	16	-	2	11	-	8
Peromyscus californicus	4	-	3***	6	-	41
Peromyscus maniculatus	13	-	31***	11	-	13
Neotoma fuscipes	0	-	0	3	-	9
Peromyscus boylii	1	-	0	0	-	0
TOTALS	34		36*	31		71

C. PRESCRIBED FIRE

Species	TREATED			UNTREATED		
	1979 (Fire ↓)	1980	1981	1979	1980	1981
Dipodomys agilis	5	2	13	1	0	5
Peromyscus californicus	13*	8*	21*	3	20	36
Peromyscus maniculatus	0	2	5	0	0	3
Neotoma fuscipes	9	0	1**	8	6	11
Peromyscus boylii	0	7	1	0	0	3
TOTALS	27*	19	41*	12	26	58

*Significantly different than the untreated by Chi-square test, $p<0.05$.
**Significantly lower than the untreated, $p<0.01$.
*** Significantly different than the untreated, $p<0.001$.

P. californicus captures increased significantly in the untreated area between 1979 and 1981 ($X^2 = 26.1$, $p<0.001$). There is no obvious explanation for this increase, but similar results from the untreated portions of the other two wildlife assessment lines suggest an area-wide increase of this species in undisturbed chaparral, both young (6 years old) and mature (>30 years old). Increases in captures of *P. californicus* between 1979 and 1981 were highly significant in separate analyses of the untreated portions of the other lines; disking ($X^2 = 27.7$, $p<0.001$), prescribed fire ($X^2 = 27.7$, $p<0.001$).

3. Prescribed fire. The number of captures of all species combined declined in the treated area between 1979 and 1980, even though capture numbers increased in the untreated area during the same period (Table 2). The difference between these two patterns was significant by 2 x 2 contingency table analysis ($X^2 = 6.15$, $p<0.025$). By 1981 total number of captures was significantly lower in the fire area. In the year following the fire N. fuscipes was absent from the treated area. This happened because its flammable stick nests were destroyed by the fire, and because it requires the dense and continuous cover of mature chaparral (Quinn 1979; Horton and Wright 1944). After an initial decrease in the year after the fire D. agilis, which can flourish in the first 2-4 years after chaparral fires (Wirtz 1977, 1982; Quinn 1979, 1984), had significantly increased in numbers between 1980 and 1981 ($X^2 = 8.06$, $p<0.005$). P. californicus was the most abundant species in both treated and untreated areas, except in the untreated area in 1979. This species can use areas with mixed shrubs and open areas, and the treated area retained its mixed manzanita-chamis character even though the amount of bare ground increased from 9 to 77 percent (Table 1). The number of captures of P. californicus, which was significantly greater in 1979 in the treated than in the untreated area, was significantly less in the treated area in both 1980 and 1981. A recovery of P. californicus in the burned area is suggested, however, since the number of captures increased significantly in the treated area between 1980 and 1981 ($X^2 = 5.82$, $p<0.025$).

Birds

A total of 59 species of birds was observed on the three wildlife assessment lines over the three years. The total number of species in one year (T & U) was quite similar for all three areas, and for each area in all three years combined (Table 3). Since individual birds can move freely in and out of the relatively small treated areas, these were observations of habitat selection in the behavior of individual birds.

Table 3. Number of bird species sighted on three wildlife assessment lines. T = treated, U = untreated. No data for handcutting in fall 1980.

	Fall 1979	Fall 1980			Spring 1981			1979-81
Treament	T & U	T	U	T & U	T	U	T & U	Total
Disking	21	9*	18	20	13	12	21	39
Hand Cutting	24	-	-	-	15	16	21	35
Prescribed Fire	19	11	13	17	11	17	23	35

* Significantly lower than the untreated by Chi-square test, $p<0.01$.

Neither prescribed fire nor hand cutting significantly affected the number of species observed using those two manipulated habitats. Disking was followed by significantly fewer species of birds using the treated than untreated area in 1980, but by 1981 there were nearly equal numbers of species using both areas (Table 3). This temporary reduction in the number of bird species was probably due to the extent of the impact of disking on the plant community, which after treatment had only sparse vegetation until the spring of 1981, when orchardgrass became established (Table 1).

The 13 most frequently observed species of birds are listed in Table 4. All are often seen in chaparral (Cody 1975; Wirtz 1973) and are conspicuous due to their calls, flocking, flying, or some other aspect of their behavior. By contrast 11 species of birds were sighted only once. The mean number of observations for all 59 species combined was 3.42.

The limited effect of prescribed fire on the avifauna may have been partly due to the patchiness of the fire. Burned areas were small, so that unburned chaparral shrubs were always nearby. After a prescribed fire in chaparral that only partially removed the vegetation, Dutton (1981) found no significant change in the structure of the avifauna that was atributable to the fire. The 33 ha site was studied over an 18 month period that included two breeding seasons. A prescribed chaparral fire in the foothills of the Sierra Nevada Mountains was followed by an increase the following spring in the number of breeding pairs of birds (Lawrence 1966). Even after a 1600 ha chaparral wildfire that removed all vegetative cover, Wirtz (1977, 1979, 1984) reported that in the year following the fire as many species of birds were present in the burned census areas as in nearby unburned areas.

Table 4. Bird species observed 5 or more times in three years on three wildlife assessment lines

Species	Number of Observations
Wrentit (Chamaea fasciata)	29
Scrub jay (Aphelocoma coerulescens)	20
Rufous-sided towhee (Pipilo erythrophthalmus)	19
California thrasher (Toxostoma redivivum)	13
Bushtit (Psaltriparus minimus)	10
Red-tailed hawk (Buteo jamaicensis)	9
Lesser goldfinch (Carduelis psaltria)	8
Black-chinned sparrow (Spizella atrogularis)	7
Common raven (Corvus corax)	7
Bewick's wren (Thryomanes bewickii)	7
Dark-eyed junco (Junco hyemalis)	5
Northern flicker (Colaptes auratus)	5
Brown towhee (Pipilo fuscus)	5

Herpetofauna

Five species of lizards commonly found in chaparral communities (Fuentes 1977; Schoenheer 1976) were captured in the pitfall traps: Uta stansburiana (side-blotched lizard), Sceloporus occidentalis (western fence lizard), Sceloporus graciosus (sagebrush lizard), Cnemidophorus tigris (western whiptail), and Phrynosoma coronatum (coast horned lizard). Two other species of lizards, Anniella pulchra (California legless lizard) and Xantusia henshawi (granite night lizard) were observed. The latter species is at the northern limit of its distribution in the San Jacinto Mountains.

Four species of snakes, all common in chaparral, were observed but not captured: Crotalus viridus (southern pacific rattlesnake), Crotalus ruber (red diamond rattlesnake), Masticophis lateralis (striped racer), and Pituophis melanoleucus (gopher snake).

After disking in 1980 there were significantly fewer captures of lizards in the treated area, both as compared to the untreated area and as compared to the season prior to manipulation (Table 5). The small number of captures in the treated area was probably due to the lack of vegetative cover, and perhaps the lack of shallow underground refugia after the thorough stirring of the upper layers of the soil during disking. By 1981 the number of captures in both treated and untreated areas was the same, but four rather than two species were found in the untreated area.

In 1979 the area to be treated by hand cutting had significantly more lizard captures than the untreated area (Table 5). In 1980 there was no significant difference between the number of captures in the treated and untreated areas, and in 1981 the number of captures was almost identical in the two areas. Furthermore, in all three years the same species were caught, and in similar proportions, in both treated and untreated areas. These results suggest that hand cutting had a relatively small effect on the community of lizards.

Before the prescribed fire, for unknown reasons the area to be burned had a significantly higher number of lizard captures than did the untreated area (Table 5). In 1980, after the fire, the difference was reversed; the treated area had significantly fewer captures than the untreated area. The 1980 pattern is consistent with the findings of Lillywhite (1977a, 1977b), who reported that the lack of vegetative cover shortly after a chaparral fire was associated with low population densities of lizards. Similarly, Simovich (1979) found small numbers of lizards in the first year after a chaparral wildfire. In 1981 there were very few captures in either the treated or untreated areas.

Table 5. The number of captures of six species of lizards and amphibians before and after treatment of the vegetation.

A. DISKING

Species	TREATED 1979	Disking ↓ 1980	1981	UNTREATED 1979	1980	1981
Uta stansburiana	30		10	17	1	3
Sceloporus occidentalis					2	3
Sceloporus graciosus		5	4		12	2
Sceloporus sp.	10			8		
Cnemidophorus tigris						6
TOTALS:	40	5*	14	25	15	14

B. HAND CUTTING

Species	TREATED 1979	Hand Cutting ↓ 1980	1981	UNTREATED 1979	1980	1981
Uta stansburiana	36	13	10	20	6	5
Sceloporus occidentalis			6			10
Sceloporus graciosus			5			4
Sceloporus sp.	23	12		15	9	
Cnemidophorus tigris			12			12
TOTALS:	59**	25	33	35	15	31

C. PRESCRIBED FIRE

Species	TREATED 1979	Fire ↓ 1980	1981	UNTREATED 1979	1980	1981
Uta stansburiana	17	6		2	10	1
Sceloporus occidentalis						3
Sceloporus sp.	4	2		1	16	
Cnemidophorus tigris			4		1	2
Phrynosoma coronatum					1	
Bufo boreas					1	
TOTALS:	21***	8***	4	3	29	6

*Significantly lower than the untreated, by Chi-square test, $p<0.05$.
**Significantly different than the untreated, $p<0.02$.
***Significantly different than the untreated, $p<0.001$.

SUMMARY AND CONCLUSIONS

Of the three groups of vertebrates studied, rodents were the most sensitive to the habitat modifications. All three manipulations significantly reduced the number of rodent captures in the treated areas. Captures were still significantly lower in all three treated areas at the conclusion of the study, 12-16 months after manipulations. Captures were increasing at the time, however, in the disked and burned areas. Rodent populations have been observed to sharply increase in the second through fourth years after chaparral fire (Quinn 1979; Wirtz 1981). I would therefore predict a continued increase here in the rodent population in the prescribed fire area.

The differences in capture frequencies of rodents between treated and untreated areas can be partly explained by the habitat preferences of the individual species. For example *P. californicus*, which prefers shrubs, had consistently more captures in the untreated than in the treated areas. Similarly *N. fuscipes*, which is found almost exclusively where there is extensive shrub cover, was common only in the mature, untreated chaparral. Conversely *P. maniculatus*, which is often numerous in disturbed habitats, was captured more frequently in the treated than in the untreated areas in four out of five cases.

The herpetofauna was somewhat less sensitive to habitat modifications than the rodents, showing significant declines in captures only in the first season after manipulation, and only in response to disking and prescribed fire. These declines were somewhat obscured by the variability in capture rates between and within assessment lines. This variability apparently had nothing to do with the manipulations.

Bird behavior was least affected by the three manipulations, with a significant reduction in the number of species sighted only after disking and only in the first season after the manipulation.

The reductions in numbers of all three vertebrate groups studied after disking is consistent with the changes in the plant community. The disking was designed to replace chaparral shrubs with forbs and grasses that would persist for many years. This plant community is less capable than one with some chaparral shrubs of supporting a wide variety of smaller vertebrates (Bell and Studinski 1972; Lillywhite 1977a, b; Longhurst 1978), although some species adapted to grasslands such as *D. agilis*, *Spizella atrogularis* (black-chinned sparrow), and *U. stansburiana* could become quite abundant. Prescribed fire and hand cutting, on the other hand, produce a mix of herbaceous vegetation, subshrubs, and rapidly growing shrubs (Hanes 1971). This type of plant community will support a greater variety and abundance of wildlife than either unbroken chaparral or grassland, particularly if it is closely associated with other age classes of chaparral and other plant communities (Longhurst 1978; Lillywhite 1977a, b; Bell and Studinski 1972). Postfire habitats in many plant communities tend to support a slightly greater number of species of mammals and birds than do otherwise comparable, unburned habitats (Bendell 1974).

As fuel management is practiced on an ever growing scale throughout the chaparral of California, greater impacts on wildlife resources can be expected. Better information on animal communities and their responses to management activities is needed for properly evaluating these impacts and for managing wildlife resources.

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