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REPTILE POPULATION CHANGES WITH MANIPULATION OF SONORAN DESERT SHRUB

David J. Germano[1] and C. Roger Hungerford[1]

Abstract.— The diversity and abundance of reptiles were studied in three vegetation types on the Santa Rita Experimental Range, Arizona. Total reptile sightings were greatest in undisturbed mesquite and mesquite with irregularly shaped clearings. No zebra-tailed lizards (*Callisaurus draconoides*) or desert spiny lizards (*Sceloporus magister*) were seen, and significantly fewer western whiptails (*Cnemidophorus tigris*) were in the mesquite-free area. Only the Sonora spotted whiptail (*Cnemidophorus sonorae*) was significantly more abundant in the mesquite-free area than in the undisturbed mesquite. In an effort to increase grass production for cattle in mesquite grasslands, it is preferable to clear irregularly shaped areas rather than to attempt total mesquite removal, if reptiles are to be considered.

Desert grasslands of the southwestern United States have been invaded by stands of mesquite (*Prosopis juliflora*) during the last 100 years (Martin and Reynolds 1973, Martin 1975). As the mesquite increased, grass production decreased (Parker and Martin 1952, Caraher 1970). Traditional use of these lands has been for grazing domestic animals. To increase grass production for cattle on these ranges, much of the mesquite is being eliminated. This vegetation conversion to grass also occurs in other vegetation types such as sagebrush and pinyon-juniper. In past years the impact of vegetation manipulation on economically important wildlife species was studied. The current total ecosystem approach includes the investigation of the impact of these practices on all life forms. This paper presents one advantage of this approach.

Because of the smaller size and lower mobility of reptiles, their diversity is more closely tied to vegetation diversity than is that of large mammals and birds. Some reptiles are adapted to dense grass areas, some to life in trees, some to sandy substrates, etc. Environments can be stratified in a vertical direction and a horizontal direction, creating many habitats for a variety of reptile species. A uniform stand of grass may offer only a few habitats in a horizontal direction and none in the vertical direction. But a mesquite-grassland environment offers several strata vertically that can be exploited by several species. For example, the vegetation is more dispersed horizontally and may offer many habitats. Mesquite trees inhibit the growth of other vegetation under them, creating bare ground and litter areas. Sandy areas in adjacent washes may provide yet another habitat for reptiles. By clearing only patches in mesquite, it may be possible to increase grass growth and also maintain a greater variety of reptile species at the same time.

The purpose of this study was to monitor reptile responses to the creation of irregularly shaped clearings in mesquite on desert grassland range. Mammal and bird response is reported elsewhere.

Acknowledgments

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Study Area

The Santa Rita Experimental Range, 48 km south of Tucson, Arizona, is a 20,250 hectare area set aside for study since 1903

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(Martin and Reynolds 1973). Local ranchers have been allowed to graze their cattle on these ranges but only in conjunction with grazing systems designated by the U.S. Forest Service, which administers the Experimental Range. The Experimental Range does not receive the man use that other similar nonprotected areas receive. Hunting is restricted on the range and off-road vehicle use is prohibited. Many of the vegetation changes occurring on the range are well documented since the early 1900s, which, although incomplete, forms a basis for future ecosystem studies.

The climate of the range is typical of the semiarid Southwest, with low relative humidity and daily temperatures sometimes exceeding 38 C during the summer. Average annual precipitation in the study pastures ranges from 35 to 40 cm. About 60 percent of the annual moisture falls during the summer rainy season and produces most of the perennial grasses. Effective rainfall is unusual in April–June, the driest part of the year. The major shrubs are mesquite, cacti (*Opuntia spp.*), and burroweed (*Haplopappus tenuisectus*) (Martin and Reynolds 1973).

Observations were made in the three pastures from April to September 1977 and April to June 1978. The mesquite stand was undisturbed in one pasture (undisturbed mesquite); seven spot clearings ranging from 3 to 30 hectares were established in the second pasture (mesquite with clearings) by chaining in July 1976; mesquite in the third pasture (mesquite-free) was killed with diesel oil in 1955 (Fig. 1).

Cattle grazed the study pastures in a one-herd, three-pasture, three-year rotation. In each three-year cycle each pasture was grazed once November through February and once March through October, with 12 months of rest following each grazing period.

METHODS

We established four census lines, each 1200 m long, perpendicular to the drainage patterns in each pasture. Every reptile found was censused. Six species, zebra-tailed lizard (*Callisaurus draconoides*), desert spiny lizard (*Sceloporus magister*), lesser earless lizard (*Holbrookia maculata*), tree lizard (*Urosaurus inornata*), western whiptail (*Cnemidophorus*

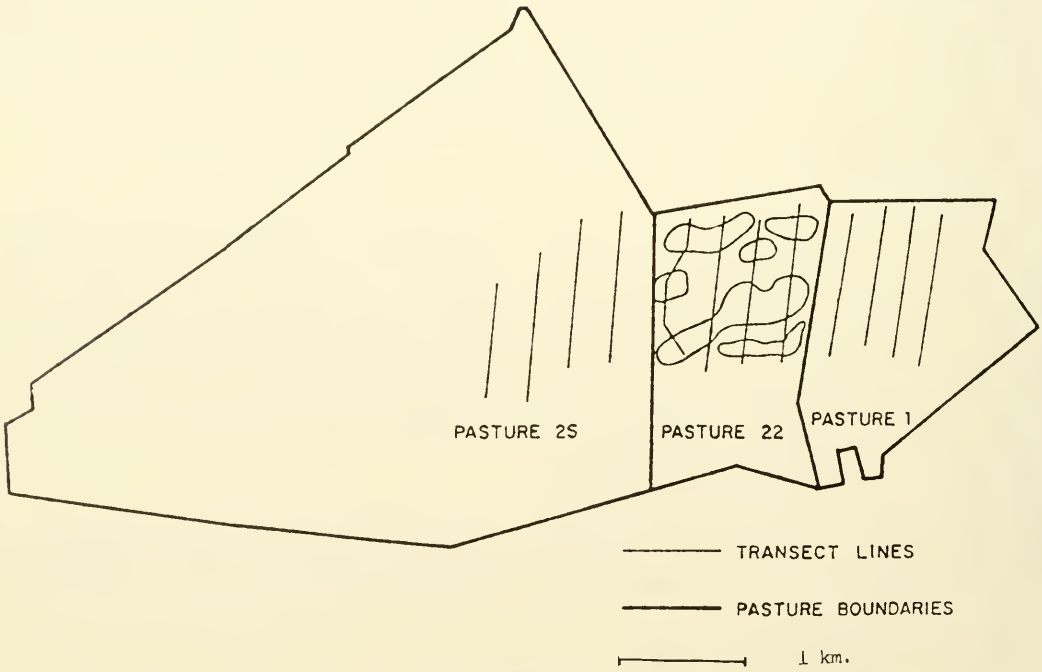

Fig. 1. The three pastures used in the study, showing placement of transect lines and size and shape of the seven clearings in pasture 22.

tigris), and Sonora spotted whiptail (*C. sonorae*), were found in sufficient numbers to analyze statistically. No effort was made to census nocturnal reptiles, a fact that accounts for the few snake sightings. Reptiles were censused by recording every reptile seen while walking the transect lines. Two transect lines were walked each morning, for six mornings, each month of the study. The actual morning starting time varied each month that we censused diurnal reptiles. Pianka (1970) notes that whiptails exhibit unimodal activity in the spring and bimodal activity in the summer, a habit directly related to soil temperatures. Milstead (1957) found whiptail activity began in the morning when soil temperatures reached 50–52 C. The same is true of other lizards; consequently, we began censusing earlier in the morning from June on, as compared to April and May. We therefore censused during peak lizard activity, using 7 × 35 binoculars to identify all reptiles seen.

Because the data were not normally distributed, we used a method (Bhapkar 1968) that categorizes the data into counts per transect to test for significant differences ($P<.05$). To test for significant differences between treatments, we used the "least significant difference" method ($P<.05$) (Steel and Torrie 1960). To test for differences between the number of reptiles visually censused in the mesquite and the number in the clearings of the second pasture, we used the nonparametric sign test ($P<.05$) (Steel and Torrie 1960).

RESULTS AND DISCUSSION

The number of desert spiny lizards, lesser earless lizards, and unidentified lizards seen showed no significant differences between treatment areas (Table 1).

The zebra-tailed lizard was seen significantly more often in the undisturbed mesquite pasture than in either the mesquite with clearings or the mesquite-free pasture. The tree lizard was seen significantly more often in the mesquite with clearings than in either of the other pastures. Western whiptails were seen significantly more often in the pastures containing mesquite than in the mesquite-free pasture. Only the Sonora spotted whiptail was seen more often in the mesquite-free pasture than in the mesquite

TABLE 1. The number of reptiles sighted, number of counts per transect (mean score), and variance for each treatment and chi-square (X^2) value for each species using the method developed by Bhapkar (1968). Each treatment has two degrees of freedom. (Significant differences ($P<.05$) in numbers on the same line are indicated by suffixes that do not include a common letter.)

	Vegetative characteristics									
	Mesquite with clearings			Undisturbed mesquite			Mesquite-free			
Species	Number sighted	Mean score	Variance	Number sighted	Mean score	Variance	Number sighted	Mean score	Variance	X^2
Zebra-tailed lizard	20[b]	0.278	0.023	61[a]	1.694	0.038	0[b]	0	0	32.869*
Desert spiny lizard	5	0.139	0.003	12	0.333	0.031	0	0	0	1.107
Lesser earless lizard	31	0.861	0.023	18	0.500	0.021	22	0.611	0.016	3.101
Tree lizard	42[a]	1.167	0.073	16[b]	0.444	0.012	22[b]	0.611	0.031	6.232*
Western whiptail	210[a]	5.833	0.970	303[a]	8.417	1.670	3	0.083	0.002	73.454*
Sonora spotted whiptail	53[a]	1.472	0.081	8[b]	0.222	0.005	70[a]	1.944	0.148	35.984*
Leopard lizard	1			1			0			
Eastern fence lizard	0			0			1			
Regal horned lizard	0			1			0			
Sceloporus spp.	2			3			1			
Cnemidophorus spp.	17			7			9			
Unidentified lizard	41	1.139	0.057	30	0.833	0.033	55	1.528	0.073	4.657
Western diamondback rattlesnake	0			0			1			
Unidentified snake	0			0			1			
Western box turtle	0			0			2			
Western spadefoot	0			0			1			
All reptiles	422[a]	11.722	2.293	460[a]	12.056	2.444	188[b]	5.194	0.674	10.597*

*Significant difference ($P<.05$)

pastures, and these differences were statistically significant only as compared to the undisturbed mesquite pasture. The Sonora spotted whiptail was also seen significantly more often in the mesquite with clearings than in the undisturbed mesquite (Table 1).

When comparing the spot clearings with the mesquite areas of the mesquite with clearings pasture, there were significantly more tree lizards in clearings and significantly more zebra-tailed lizards in the mesquite (Table 2). We believe this unexpected result was due to specific microhabitat preferences for each species. These are discussed more fully below in each species account.

The graph showing the total sightings of all reptiles by month (Fig. 2) illustrates lizard preferences for areas with mesquite. Except in April and June 1977, every month we saw at least twice the number of reptiles in the pastures with mesquite as the mesquite-free pasture. May of each year showed high numbers not only for total reptile sightings but also for individual species (Figs. 2–7). May is the first month on the range where temperatures are consistently high and most reptiles have emerged from winter torpor to resume feeding. June of both years brought a drop in numbers for total reptile sightings (Fig. 2). Western whiptails and lesser earless lizards also showed this reaction (Figs. 4 and 6). June is the hottest, driest month of the year. Zebra-tailed lizards in the undisturbed mesquite showed little fluctuation throughout their active period (Fig. 3). The spring of 1978 showed increased numbers in all species and total sightings of all reptiles, possibly due to the very wet winter experienced in 1977–78 (Figs. 2–7).

Zebra-tailed lizard

The undisturbed mesquite range contained significantly more zebra-tailed lizards than the mesquite-free range. In fact, there were none in the mesquite-free range. They utilize a wide variety of habitats in the arid Southwest, including washes, flood plains of rivers, sand dunes, and flat land deserts (Vitt and Ohmart 1977a). They are particularly associated with open space where they can run between shrubs (Pianka and Parker 1972, Tanner and Krogh 1975). These conditions are met by the mesquite areas where large sandy washes are found and the vegetation around the mesquite is sparse with many open areas. On the mesquite-free range, the drainages were not sandy but were covered with grasses and forbes. Also, there were no open spaces between shrubs because of the dense grass growth. In the mesquite with clearings the zebra-tailed lizards were only seen in the mesquite areas, usually in the sandy washes. It is insectivorous (Kay et al. 1970), often feeding on insects found on either overhanging annual vegetation or overhanging perennials such as catclaw and mesquite (Vitt and Ohmart 1977a). A mesquite-free range in which grasses dominate would eliminate zebra-tailed lizard populations.

Desert Spiny Lizard

The authors found no significant difference between pastures for this lizard, possibly due to the nature of the test used. There were none in the mesquite-free range. Desert spiny lizards are primarily arboreal on cottonwoods, mesquite, and willows. Parker and

TABLE 2. The number of reptiles sighted in the two habitat types of the mesquite with clearings pasture, the mean ($\bar{X}$), standard deviation (S), and Z score using the nonparametric sign test. (Significant differences ($P<.05$) in numbers on the same line are indicated by suffixes that do not include a common letter.)

	Vegetative characteristics				
Species	Mesquite	Clearings	$\bar{X}$	S	Z
Zebra-tailed lizard	18[a]	2[b]	5.5	1.658	3.016*
Desert spiny lizard	4	1	2.5	1.118	0.894
Lesser earless lizard	15	16	8.5	2.062	0
Tree lizard	9[a]	33[b]	9.0	2.121	2.122*
Western whiptail	102	108	14	2.646	0.945
Sonora spotted whiptail	34	19	8.5	2.062	0.485

*Significant difference ($P<.05$).

Pianka (1973) often found them in trees that had pack rat nests at their bases. We also observed this on the pastures with mesquite. These lizards were quite wary and often would jump out of a mesquite tree, as high as 5–6 feet from the ground, and run down a hole in a pack rat nest. As with the zebra-tailed lizard, a mesquite-free environment would not provide the habitat needed by desert spiny lizards. Mesquite remaining from spot clearing will provide the necessary habitat for desert spiny lizards.

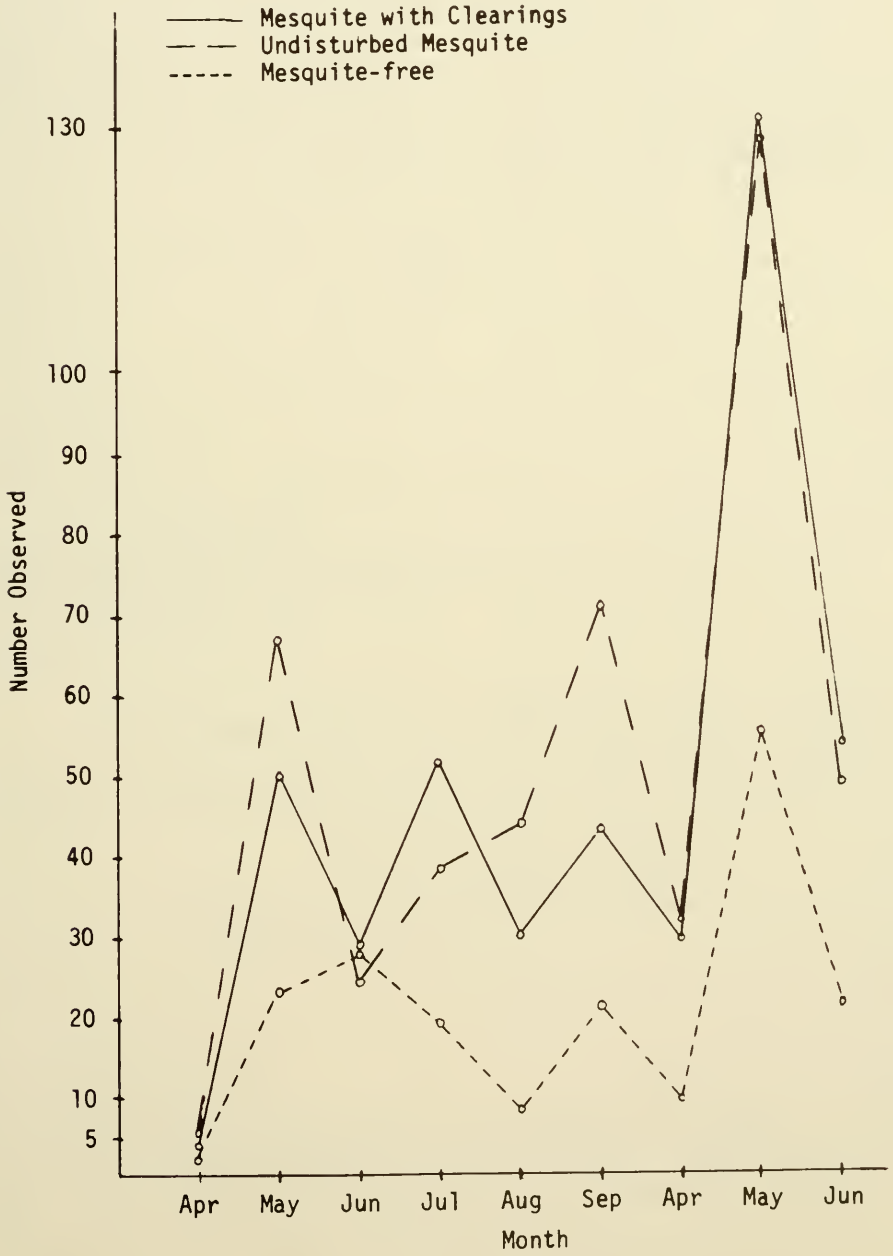

Fig. 2. Sightings of all reptiles by month, April–September 1977 and April–June 1978.

Lesser Earless Lizard

We found no significant differences between pastures in the number of lesser earless lizards seen. We also saw no significant difference in their sightings between the mesquite and the clearings of pasture 22. A slight trend of higher numbers can be seen in the graph for 1978 for the mesquite with clearings, but numbers and length of time observed are not enough to be conclusive. Further study of this trend may show a preference for the mesquite habitat with clearings. Gennaro (1972) found that the lesser earless lizard fed in open areas with sparse vegetation. Degenhardt (1966), working in the Big Bend National Park in Texas, found that the lesser earless lizard seemed to prefer flat areas with sparse vegetation. This did not occur in our study area. The lesser earless lizard was seen approximately as often in the dense grass areas as in the areas with sparse vegetation. Stebbins (1966) shows that the lesser earless lizard occupies a wide range of habitats, including washes, sandy stream banks, sand dunes, short grass prairies, mesquite woodlands, and farmlands. The lesser earless lizard apparently would not decrease significantly in numbers if mesquite were totally removed.

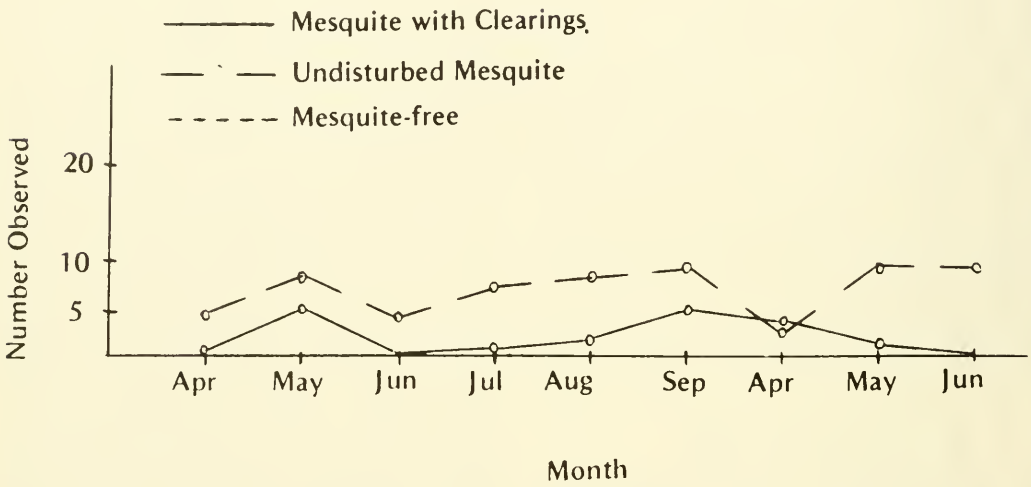

Fig. 3. Sightings of zebra-tailed lizards by month, April–September 1977 and April–June 1978.

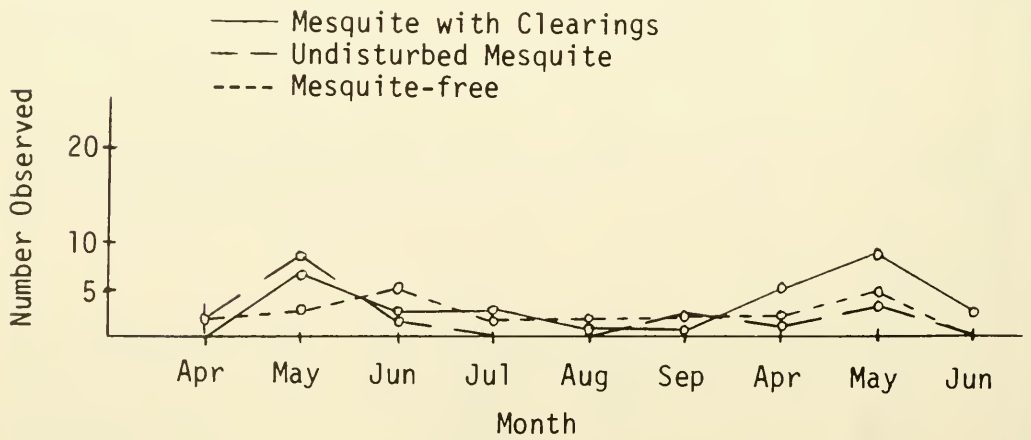

Fig. 4. Sightings of lesser earless lizards by month, April–September 1977 and April–June 1978.

Tree Lizard

Tree lizards were significantly more abundant in the mesquite with clearings pasture than the undisturbed mesquite pasture. They are found in a variety of habitats but are mostly arboreal (Aspland 1964). They are rarely found in areas where trees are absent and then usually in rocky terrain (Aspland 1964, Milstead 1970). We found about the same number in the mesquite-free pasture as the undisturbed mesquite pasture. This may have been partially due to our inability to see the tree lizards on mesquite trees as often as they occurred. Tree lizards are cryptically colored and patterned and, without movement on their part, they are difficult to detect. On the mesquite-free range, we saw them often on stumps of dead mesquite. We saw significantly more tree lizards in the clearings than in the mesquite of pasture 22, and almost always on the fallen dead mesquite. In winter, tree lizards often aggregate in large numbers under the loose bark of dead mesquite (Vitt 1974). Also, the termite *Kalotermes minor* is often a prey item commonly found in standing or fallen dry wood (Aspland 1964). The dry mesquite in pasture 22 is a source of both food and hibernating sites for tree lizards and probably is the reason we found significantly more tree lizards in this pasture.

Western Whiptail

The authors saw significantly more western whiptails in the mesquite pastures than in the mesquite-free pasture. Of 516 western whiptails seen, only three were in the mesquite-free pasture. Western whiptails inhabit xeric habitats (Medica 1967), often with sparse vegetation and open areas (Burkholder and Walker 1973, Schall 1977). They forage in shrubs and run swiftly between these shrubs (Vitt and Ohmart 1977b). Their food consists largely of termites (Echternacht 1967, Pianka 1970). The dense grasses of mesquite-free pasture hinders both movements and foraging behavior of the western whiptail. A significant difference was not found between the number of western whiptails seen in the clearings and in the mesquite of pasture 22. Overall, however, western whiptails should be found in good numbers in the mesquite left from spot clearing.

Sonora Spotted Whiptail

The other whiptail species we found is probably the Sonora spotted whiptail as defined by Lowe and Wright (1964), but some nonwestern whiptails seen may be hybrids of the bisexual western whiptail and the parthenogenic Sonora spotted whiptail (Lowe et al. 1970). The name Sonora spotted whiptail designates the whiptails seen that were not western whiptails.

Both the mesquite-free and the mesquite with clearings pastures contained significantly more Sonora spotted whiptails than the undisturbed mesquite pasture. The Sonora spotted whiptail is found in the southeast corner of Arizona, with the Chihuahua whiptail (*Cnemidophorus exsanguis*) occurring in

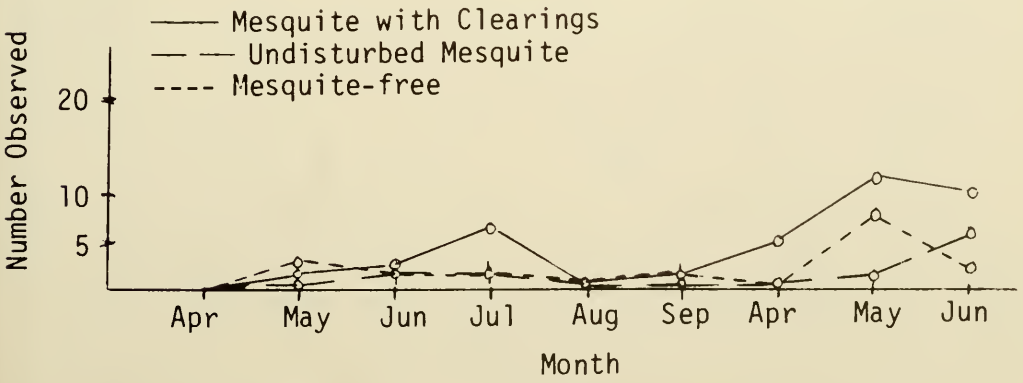

Fig. 5. Sightings of tree lizards by month, April–September 1977 and April–June 1978.

Arizona only near the Arizona-New Mexico border (Wright and Lowe 1968). Echternacht (1967), working on the Santa Rita Experimental Range, found what he called the Chihuahua whiptail (more likely the Sonora spotted lizard) at higher elevations but not in the grasslands. He thought their numbers diminished as the elevation lowered. Wright and Lowe (1968) indicate the Sonora spotted whiptail's habitat as essentially woodlands, with local populations occurring in desert-grassland and desert scrub. This lizard is found between 1065 and 2130 m (Lowe and Wright 1964), but we found more of them as the elevation increased. We also found no significant difference in the number seen between the mesquite and the openings of the mesquite with clearings pasture, a fact indicating no habitat preference. At elevations where Sonora spotted whiptails do occur,

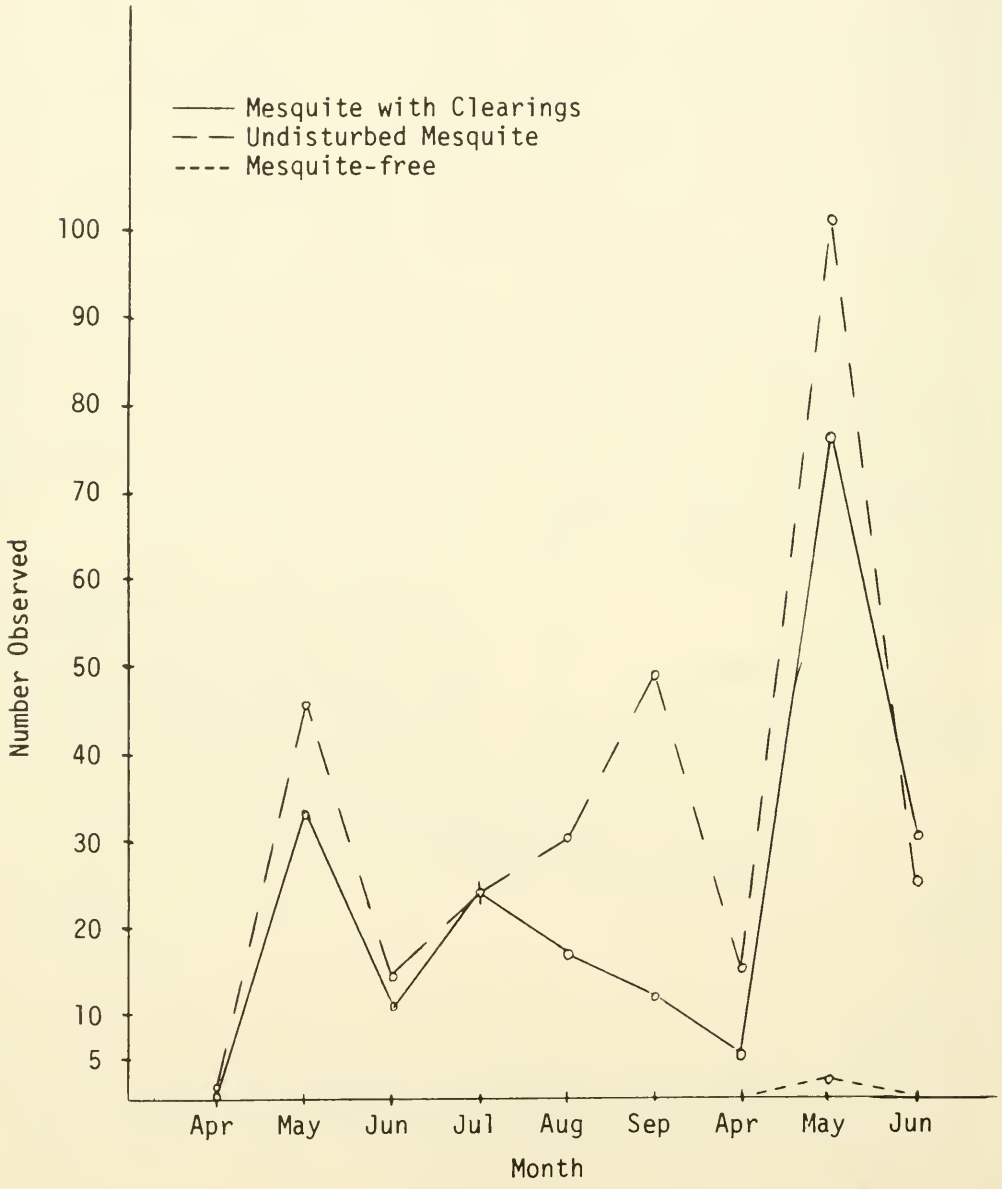

Fig. 6. Sightings of western whiptails by month, April–September 1977 and April–June 1978.

clearings in mesquite would not be harmful to their populations.

SUMMARY

Partial clearing of mesquite was less detrimental to the lizards observed than was complete clearing. For the tree lizard there was a definite benefit in having spot clearings with the dead mesquite left in the clearings. Although the mesquite-free pasture contained a few species not seen in the other two pastures, they were seen in such low numbers that no conclusions could be made.

Even in an area that is mostly grass there will probably remain horizontal stratification. This can occur and did occur on our study area where hillsides were rocky and where patches of bare ground were evident. Grasslands, though, lack the vertical stratification necessary for arboreal species. We did see an eastern fence lizard and an unidentified *Sceloporus*, but these were on remnant mesquite at the border of the pasture and would not be expected to occur if vast areas of mesquite were converted back to grasslands. The mesquite-free areas contained few to no zebra-tailed lizards, desert spiny lizards, or western whiptails, all of which were found in partially cleared mesquite.

Spot clearing in mesquite resulted in greater diversity of habitat, less visual impact than did total clearing of mesquite, was less detrimental to reptiles, and still increased forage production for livestock. More lizard species should be found as the environment becomes more complex. Proper location of clearings could accomplish the range management objectives while causing the least amount of disturbance to existing reptile populations. There is even the potential of an increased diversity of lizard species as clearings in mesquite are opened to allow for the dense growth of grass while retaining the habitats found in mesquite woodlands.

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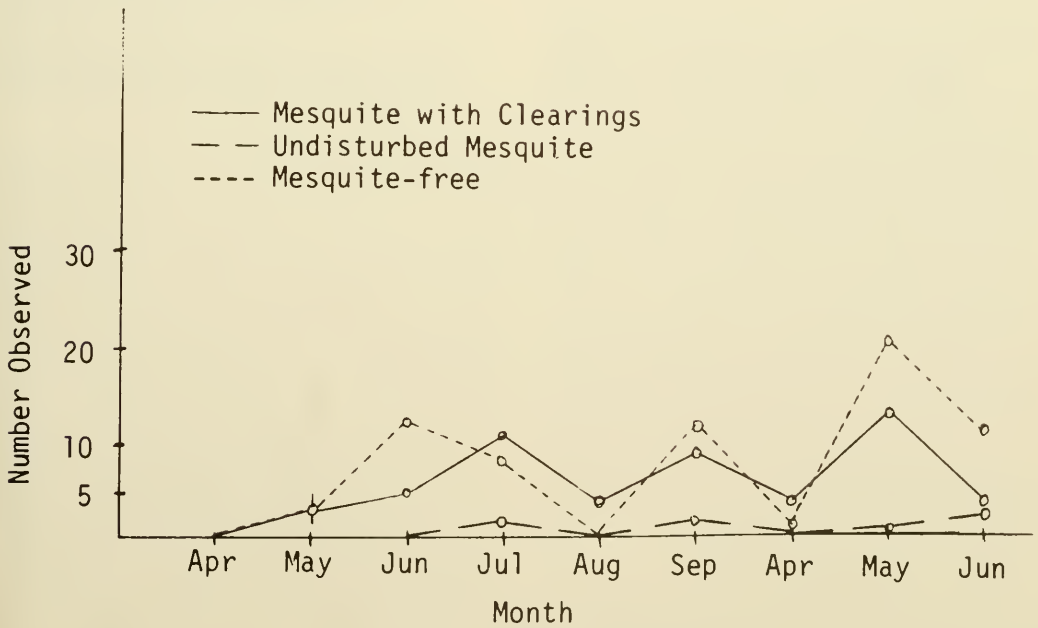

Fig. 7.—Sightings of Sonora spotted whiptails by month, April–September 1977 and April–June 1978.

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