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MORRO BAY KANGAROO RAT HABITAT EVALUATION STUDY

by Aryan I. Roest

Kangaroo rats are seed-eating rodents found only in the more arid regions of western North America; several species occur in California. They are usually pale in color, as is characteristic of many desert-inhabiting animals. The Morro Bay Kangaroo Rat (Dipodomys heermanni morroensis) is unique because it is the darkest of all kangaroo rats and is found in a limited area along the central California coast. A number of other technical differences distinguish it from its near relatives as well.

The Morro Bay Kangaroo Rat formerly occupied less than 5 square miles of old dune deposits along the south side of Morro Bay, in San Luis Obispo County (Stewart, 1958; Stewart and Roest, 1960). The area has been developed greatly during recent years, and Congdon (1971) found that they occupied less than 1.75 square miles of their original range. The earlier studies have shown that proper habitat is essential to the survival of the Morro Bay Kangaroo Rat. It is the habitat which is presently being destroyed as homes, streets, and shopping centers are constructed. Only about 10 acres of marginal kangaroo rat habitat are currently protected within the boundaries of Montana de Oro State Park, an area insufficient to insure survival of the animals. Since development in the area is continuing rapidly, the California Department of Fish and Game considers the Morro Bay Kangaroo Rat an endangered species (Dept. Fish & Game, 1972).

This study project was initiated by the Department of Fish and Game to determine the specific habitat requirements of the Morro Bay

Kangaroo Rat; to locate an area with a kangaroo rat population which might be suitable for acquisition as a protected reserve; and to make recommendations for habitat management of such a reserve, if appropriate. For convenience in administration and management, the area considered for acquisition was to be adjacent to Montana de Oro State Park, as indicated in Fig. 1. This study was conducted between 20 July and 1 September, 1973.

Maureen Carsel, William Cox, Carl Thelander, and Michael Ward assisted the author with the field work on the project. Plant identifications and other data on the flora were submitted by Barrett Anderson. The base map used in Fig. 2 was prepared by Linda Cox. The work of all these individuals is gratefully acknowledged. Financial support for the project was provided by the California Department of Fish and Game, under contract number W54R6-4.

METHODS

The study area was restricted to that portion of kangaroo rat range between Pecho Road and the sand dunes at the south end of Morro Bay. On the north a small dirt road Shark Inlet and the large eucalyptus grove formed the boundary (see Fig. 2), while on the south the study area was limited by the northern boundary of the State Park. This area involves roughly 350 acres.

Initial reconnaissance indicated the presence of three major subdivisions within the study area. Some portions were either heavily grown over with brush or with thick grass, and contained no evidence of kangaroo rats (no burrows or tracks). Other areas, with a low stand of scattered brush and other vegetation, were obviously occupied

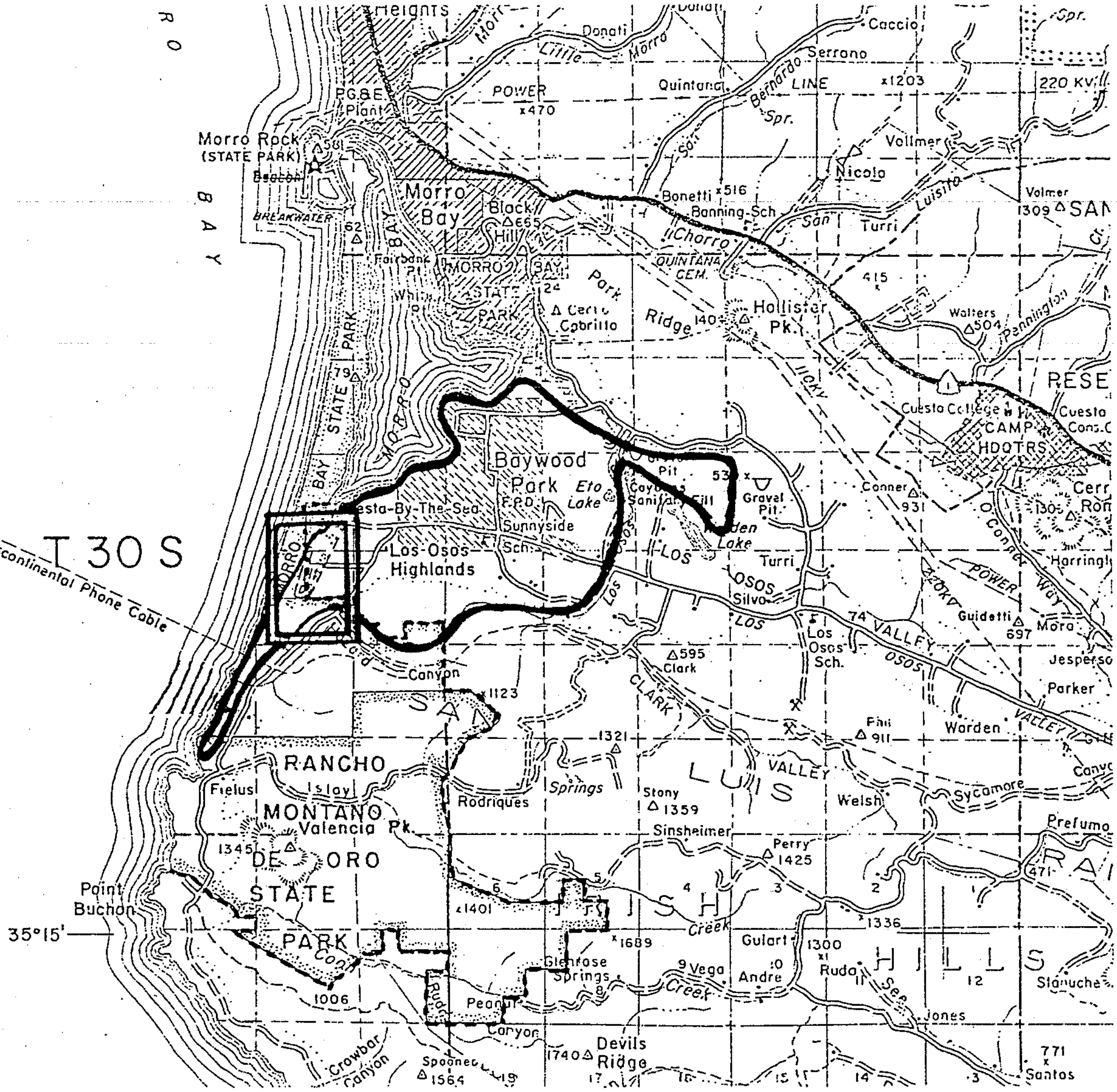

Fig. 1. Original range of Morro Bay Kangaroo Rat, and location of present study (rectangle). Rats are now completely absent from the shaded area of Baywood Park, and only part of the remaining range is suitable habitat.

by kangaroo rats -- burrows were easily found. The third subdivision included brush of varying height, as well as open areas, but showed very few burrows, if any. To determine whether kangaroo rats were present in the last vegetation type, a series of traplines were set out (Fig. 2). Standard Sherman live traps were used. Each trapline consisted of 10 stations, with 2 traps at each station. Stations

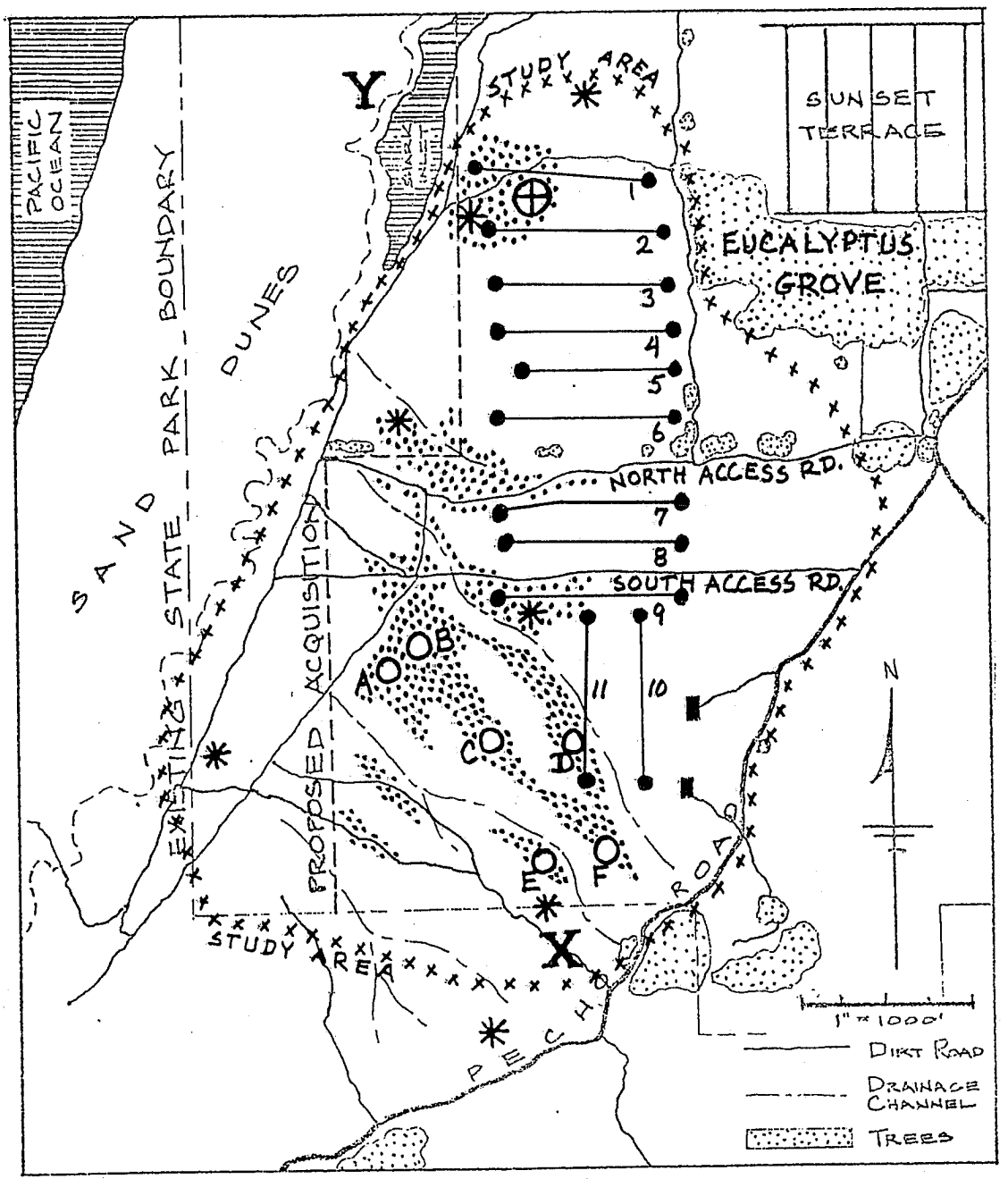

Fig. 2. Location map. ●——● = trapline; ○ = burrow trapping area; ⊕ = area trapped by Stewart (1958); ✱ = locations of traplines run by Congdon (1971); ×××× = approximate limit of study area; stippled areas indicate where burrows were found; X and Y indicate camera locations for Plates 1 and 2, respectively.

were set about 50 paces apart (90-110 feet), so each trapline was nearly 1000 feet long. Eleven such traplines were run for 3 nights each. Traps were baited with a generous pinch of rolled oats, which have proved to be a successful bait for capturing good numbers of animals in traps of this type.

The study area was also surveyed for active burrows. This involved walking over the area and observing where kangaroo rat burrows were located. Burrows were easily recognizable by their size and shape. They are usually from 1½ to 3 inches in diameter, go into the ground at an angle, and have an inverted U shape, flat at the bottom. Some burrows may be plugged with sand, but most are open. If the burrow is in active use, no spider webs will be present across the opening. Areas where burrows were found are indicated by stippling in Fig. 2. Walking for burrows had the added advantage of permitting subjective analysis of the vegetation and of burrow locations in relation to the terrain.

Traps were set in irregular patterns in several areas where kangaroo rat burrows were abundant. The number of traps set in a burrow area varied from 7 to 26; usually two traps were set near a burrow entrance, as suggested by Stewart (1958). Four burrow areas were trapped for 3 nights each, and two for 2 nights. Traps were baited with a mixture of rolled oats and a commercial 'horse mix', which contained several grains, pellets, and a small amount of molasses. The locations of burrow trapping areas are indicated in Fig. 2. Totalling all the traps set each night, 928 trap-nights were involved in this study.

The vegetation in the area was studied by Barrett Anderson; a list of the bird life was developed by Michael Ward. Photographs were taken to illustrate the area, the appearance of burrows, and their relationship to nearby vegetation. A review of the previous literature on Morro Bay Kangaroo Rats permitted comparisons of value to the present study as well.

RESULTS AND DISCUSSION

Trapping: Trapping results are presented in Tables I and II. The traplines captured very few animals of any kind, even though as many as 120 traps were out each night. A heavy overcast occurred every night that traplines were run, but cleared off during the day between about 11 AM and 6 PM. Temperatures at night varied from 55° to 65° F. The moon was nearly full, but waning, and came up early each evening. Due to the heavy overcast it had little affect on visibility during the night. There was considerable dew, and the vegetation was thoroughly wet every morning.

Trapping in burrow areas was relatively more successful. Again nights were overcast, but not cold. The moon was still waning until 7 August; it was waxing on 21 and 22 August, and rose late at night. In spite of placing live traps near active burrows, few kangaroo rats were captured. There was little evidence of rat activity, such as the characteristic tail marks in the sand.

Two of the kangaroo rats captured were adult females (adult pelage and tufted tail), 1 was an immature female (grayish pelage and untufted tail), and 1 female and 2 males were subadults (grayish pelage with tufted tail). The young animals were born earlier in the year and were beginning to leave their natal burrows as they matured. The

Table I. Results of trapline survey. Traplines were numbered as shown in Fig. 2. Abbreviations used: D = deer mouse, H = harvest mouse, J = jackrabbit, K = kangaroo rat, P = pocket mouse.

Date in July 1973	Line number: 1	2	3	4	5	6	7	8	9	10	11
25	--	K,H	D,D	--	--	--					
26	--	--	--	D	D,H	D					
27	--	--	--	D	--	P					
28							--	--	K	D,D	H
29							J	--	D	--	--
30							D	D	D	--	D

Totals: Trap nights - 660

Catch - 2 kangaroo rats
13 deer mice
3 harvest mice
1 pocket mouse
1 jack rabbit (juvenile)

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immature female was captured in heavy brush at the east end of line 9, and had probably left its home burrow very recently.

A comparison with trapping success during previous studies in the area indicates the strong possibility of an actual decline in the total

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Table II. Results of trapping in burrow areas. Abbreviations are the same as those in Table I; r indicates a retrapped animal.

Date in August 1973	Burrow Area: A	B	C	D	E	F
5			--	K	H	--
6			D, H	--	--	--
7			--	D	D	--
21	D, K	K,K,K				
22	K-r	D				

Totals: Trap nights - 268

Catch - 5 kangaroo rats
5 deer mice
2 harvest mice

population. Table III illustrates this by listing the number of trap nights necessary to capture one kangaroo rat in favorable habitat. The number of trap nights necessary has increased from slightly over 7 TN/KR in 1958 to over 50 TN/KR in 1973. Although not exactly comparable, trapping success has obviously decreased in the past 15 years.

Table III. Comparison of trapping results obtained during different studies. All figures in terms of trap nights per kangaroo rat (TN/KR).

Authority	Season	Study Area	Sunnyside School	Total*
Stewart, 1958	August	18.0	13.5	7.0
	November	7.7	18.0	9.0
Helsel, 1962	April-May		28.5	
Congdon, 1971	May-June	70.0	25.0	47.0
Roest, this study, burrow areas only.	August	53.6		132.5

* Total is total trapping in all areas of kangaroo rat range during the study cited.

Burrow cruising: Burrow cruising was successful in locating areas with burrow concentrations. The entire area was traversed over slightly different routes on several occasions, and some of the adjoining State Park land was surveyed as well. Active burrows were abundant around trapping localities A, B, C, and D (Fig. 2). Burrows were scarce in the area west of lines 1 and 2, near Shark Inlet, and in the area west of lines 6 and 7. They were also scarce in the small patches south of trapping areas A and B, near the southwest corner of the study area.

Burrows were most abundant in open areas where brush was low and scattered. This situation was found primarily along the low ridges which run through the area from southeast to northwest. In such

locations the prevailing winds from the ocean have blown away most smaller sand particles. The larger sand grains which remain appear to become compacted, probably assisted by moisture from dew and rain. Roots of herbaceous plants spread through much of the surface layer as well. The result is a firmer soil surface than that found in the broad drainage channels, or swales, between the ridges. The swales, sheltered from wind by both the ridges and the dense growth of brush which grows in them, have a surface of loose sand. Kangaroo rat burrows are nearly always located in areas with compacted soil, not in loose sand. In loose sand burrows would of course immediately cave in. See Fig. 4.

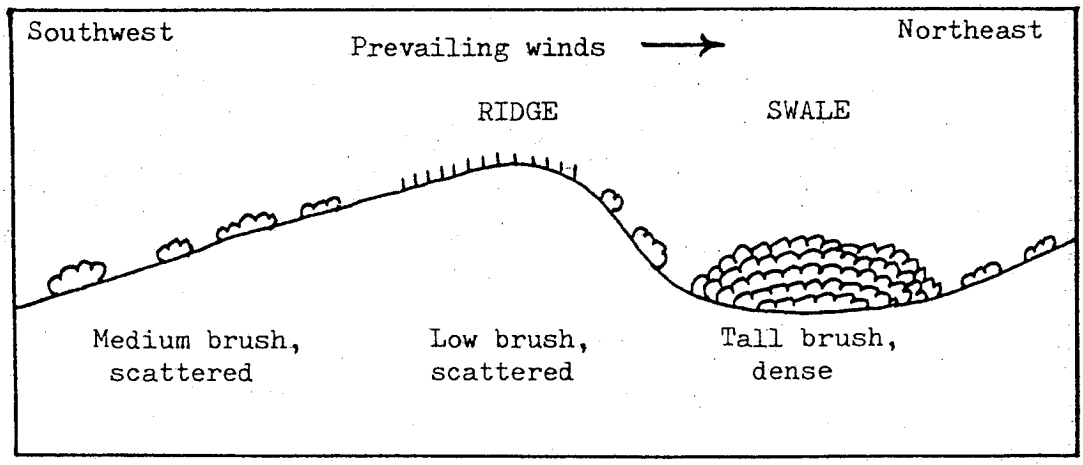

Fig. 4. Exagerrated profile of a section of terrain near Area D in Fig. 2. Over most of the study area mixed brush and herbaceous plants grow in fairly loose sand on gentle slopes. In the swales grows dense brush nearly 6 feet high; sur- is loose sand. On the wind-exposed ridges the surface is compacted and vegetation consists of low brushy and herbaceous plants rarely more than 18 inches high. The southwestern slope of each ridge is less steep than the northeastern slope, due to the action of prevailing winds on the sand. Kangaroo rat burrows are most abundant along the ridge crests and down from them on the southwestern slopes.

Some burrows may be found in brushy areas through which a road has been cut, as along trapline 9 and near the intersections at the west end of South Access Road. The road creates open space in an otherwise densely vegetated area. Even near the road, where occasional vehicles have gone through the brush, breaking it down, some burrows were found. In one or two locations burrows were noted in the open space created by a small wash not yet grown over by brush. Open space is clearly important in the environment of these kangaroo rats.

Vegetation: Most of the study area is covered with vegetation which is usually described as Coastal Sage Scrub (Munz and Keck, 1959), or as Coastal Sand-plains and Stabilized Dunes (Hoover, 1970). The characteristic plants of this association are Artemisia, Corethrogyne, Ericameria, Eriogonum, Lupinus, and Salvia (for species epithets of the local species, see Table IV). The dominant of the entire area is probably Ericameria, the mock heather. Toward the east and south of the study area species more typical of true chaparral appear, such as Arctostaphylos, Ceanothus, and Prunus. Where vegetation is less dense, along the western side of the area, Chorizanthe, Cirsium, Corethrogyne, Croton, Horkelia, Lotus and the grasses are abundant. Astragalus, Lupinus, and Eriastrum are scattered throughout the more open areas. In areas where kangaroo rat burrows are most abundant, the commonest plants appear to be Cardionema, Cirsium, Croton, Eriogonum, Lotus, and the grasses. The tall brush species (Artemisia, Baccharis, Ericameria, Lupinus, Prunus, and Rhus) occur as dense thickets in the bottoms of the swales which transect the study area. Table IV indicates a number of species which are of importance as food sources for kangaroo rats.

Table IV. Plants of the study area. The first group includes species known to be used as food by kangaroo rats. An asterisk (*) indicates important, common members of the plant community.

Arctostaphylos morroensis - manzanita
* Artemisia californica - sagebrush
Bromus rubens - red brome
Chorizanthe californica
* Cirsium occidentale - thistle
Corethrogyne filaginifolia - cudweed aster
* Croton californicus - croton
Cryptantha clevelandei - popcorn plant
* Dudleya - (succulent)
* Ericameria (= Haplopappus) ericoides - mock heather
* Eriogonum parvifolium - buckwheat
* Eriophyllum confertiflorum
Eschscholzia californica - California poppy
* Lupinus arboreus - bush lupine
* Lupinus chamissonis - dune lupine
* Lotus scoparius - deer weed
Plantago sp. - plantain
* Salvia mellifera - black sage
Solanum xantii - nightshade

Abronia umbellata - sand verbena
Achillea millefolium - yarrow
Astragalus sp. - loco weed
Baccharis pilularis - coyote brush
Bromus rigidus - ripgut grass
* Cardionema ramosissimum - sand mat (burrows often beneath mats)
Carpobrotus (= Mesembryanthemum) edulis - ice plant
Eriastrum densifolium - phlox
Ehrharta calycina - grass
Ceanothus cuneatus - buck brush
Erigeron blochmaniae - daisy
* Helianthemum scoparium - rushrose
Hemizonia sp. - tarweed
Heterotheca grandiflora - telegraph weed
Horkelia cuneata - silverweed
Koeleria cristata - june grass
Marah fabaceus - wild cucumber
Mimulus aurantiacus - sticky monkey flower
Orthocarpus purpurascens - pink paintbrush
Phacelia distans
Pholisma arenarium - (parasitic on Ericameria)
Prunus fasciculata - chokecherry
Prunus ilicifolia - holly-leaf cherry
Rhus diversiloba - poison oak
Senecio californicus - groundsel
* Silene laciniata - indian pink
Stephanomeria virgata

Some of the other plants listed in the lower portion of the table may also contribute to their food supply.

As indicated above, a critical factor in the kangaroo rat's environment appears to be open space. Stewart (1958) and Congdon (1971) both comment on the importance of open space. Bartholomew and Caswell (1951) relate it to the jumping which enables kangaroo rats to escape their predators. Rosenzweig (1973) found that the density of Dipodomys merriami populations was inversely proportional to the amount of foliage in the vegetation layer between 8 and 45 cm (3 to 18 inches). A similar conclusion seems warranted for D. heermanni morroensis, since burrow areas occur abundantly only where the vegetation is sparse and less than 18 inches high.

About 1956 the U.S. Army, which had used the study area as a mortar range during World War II, came in with heavy equipment to plow up and remove unexploded shells and other military debris. At that time the vegetation and soil surface were considerably chewed up, but a good kangaroo rat population was observed soon afterward (Stewart, 1958).

Stewart and Congdon have both indicated to the author (pers. comm.) that over much of the study area the brush has grown up considerably over what it was at the time of their investigations. Kangaroo rat densities are also lower than they were when previously studied, as confirmed by the data in Table III. It seems clear that since the nearly complete destruction of vegetation by the Army, the area has been developing toward a chaparral-like climax condition. As this situation is achieved, the area becomes less suitable for kangaroo rats.

Other animals: Stewart (1958) and Congdon (1971) have both commented on the other animal species in the area, particularly with regard to predators. A list of herptiles, birds, and mammals known to occur in the area is presented in Table V. It appears unlikely that any of the natural predators would have a significant effect on kangaroo rat populations. There are a number of other rodent species in the area which

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Table V. Wildlife of the study area. Species which prey on kangaroo rats are indicated with an asterisk (*).

Mammals:	Broad-footed Mole	Botta Pocket Gopher
	Raccoon	California Pocket Mouse
	* Long-tailed Weasel	Morro Bay Kangaroo Rat
	Striped Skunk	Western Harvest Mouse
	* Badger	Deer Mouse
	* Gray Fox	Black-tailed Jack Rabbit
	* House Cat	Brush Rabbit
	* Bobcat	Black-tailed Mule Deer

Birds: Species known to nest in the area are indicated with an N after the name.

Turkey Vulture	Common Crow
Cooper's Hawk	Chestnut-backed Chickadee
Red-tailed Hawk	Common Bushtit-N
Sparrow Hawk	Wrentit-N
California Quail-N	Bewick Wren-N
Mourning Dove-N	California Thrasher-N
Barn Owl	Loggerhead Shrike-N
Great Horned Owl	Hutton Vireo
Anna Hummingbird-N	Bullock Oriole
Red-shafted Flicker	House Finch-N
Hairy Woodpecker	American Goldfinch
Downy Woodpecker	Lesser Goldfinch
Nuttall Woodpecker	Rufous-sided Towhee-N
Black Phoebe	Brown Towhee-N
Western Flycatcher	Sage Sparrow-N
Western Wood Peewee	Oregon Junco
Olive-sided Flycatcher	White-crowned Sparrow-N
Scrub Jay-N	Barn Swallow

Herptiles:

Pacific Treefrog	California Legless Lizard
Western Fence Lizard	* Gopher Snake
Coast Horned Lizard	* Western Rattlesnake

are also preyed upon by the predators, and as one species population is depleted the predators turn to another. The domestic cat is an exception. Pet cats often hunt small animals as an exercise rather than for any need of food. As development has taken place elsewhere in the south Morro Bay area, the kangaroo rats in adjacent habitat have been subjected to increased predation from pet cats. This is somewhat less true for feral cats, which occupy a more natural position as predators in the wildlife community. Their presence does, however, add an additional predator to those already in the area.

PROPOSED LAND ACQUISITION

The map (Fig. 2) shows a 'Proposed Acquisition' to the existing Montana de Oro State Park. The State Department of Beaches and Parks hopes to acquire this land, which would provide them with complete control of access to the sand dunes at the south end of Morro Bay. The present study consequently dealt primarily with the land lying to the east of the State Park 'Proposed Acquisition'.

San Luis Obispo County plot map 74-022 shows that most of the study area is located in Units 2 and 6. The 50 or 60 acres in the southeast corner of Unit 2, corresponding to the northern portion of the study area, have very few burrows and a considerable amount of brush. In their present condition they are not particularly suitable for kangaroo rats. This area is not recommended for acquisition.

The 40 acre parcel in the center of the north half of Unit 6 includes most of the area with an abundance of burrows -- the area lying between burrow trapping areas A, B, C, and D, as shown on Fig. 2. An 80 acre parcel, involving the center of both north and south

halves of Unit 6, would include burrow trapping area E and the small isolated areas south of A and B as well. This 80 acres would include the largest number of active burrows, and would easily be managed to maintain a low brush level. As much as possible of Unit 6 should be acquired.

Stewart (1958) indicated that populations of kangaroo rats in this area ranged between 14 and 16 per acre. An average population of 15 rats per acre on 50 acres of suitable habitat should be expected to support 750 kangaroo rats. This is probably the minimum population which might be expected to survive in the face of a normally varying mortality. Since heavily brushed swales occur across the area, it might be necessary to acquire more than 50 acres of land to make certain that at least 50 acres of suitable habitat were included in a reserve.

MANAGEMENT RECOMMENDATIONS

The continuing growth and spread of the larger shrub species, especially mock heather (Ericameria) and sagebrush (Artemisia), threatens the open space essential to the Morro Bay Kangaroo Rat. Although these and the other brush species are a source of food to the rats, as the brush grows taller and spreads farther over the area the resulting habitat is no longer suitable for kangaroo rats. A brush control program is consequently essential on any land acquired as a kangaroo rat reserve.

Brush control could be achieved quickly and easily by driving large-wheeled vehicles through the brush in order to break down the plants. As most broken plants die within a short time, the debris

resulting from such mechanical destruction could be gathered into piles or windrows to decompose or be burned. The remaining herbaceous vegetation would recover quickly, to the benefit of the kangaroo rat population.

Other brush control techniques are also possible. Hand labor could remove the larger plants selectively, and would be less disturbing to the soil surface. A controlled burn would also destroy brush; the burned area would be quickly reseeded from plants in adjacent, unburned areas. Chemical brush control should not be attempted, since its action is not sufficiently selective to eliminate only brush species. Further, residues left on the vegetation could be poisonous to the kangaroo rats.

Whatever means are employed to remove the brush, the result will be a more open area. Wind action will carry away the finer sand particles, and the remaining, coarser sand will become compacted; burrows are more easily constructed in compact sand. Most of the important food plant species should become re-established in a short time. An area managed in this manner should be colonized by kangaroo rats from adjacent areas, without any necessity for artificially introducing them.

If a density of about 15 rats per acre could be maintained by proper brush control efforts, it is unlikely that any predator problems would develop. In the future, as adjacent lands become developed, it might be necessary to control the activities of pet or feral cats.

SUMMARY

The Morro Bay Kangaroo Rat requires an environment which is relatively open, with low-growing plants and considerable bare ground. Between Pecho Road and the Morro Bay sand dunes a good population of kangaroo rats still exists, as evidenced by abundant burrows in certain locations. The population is lower than it was in previous years, as shown by comparisons of trapping results obtained during earlier studies with those obtained recently. This appears to be a direct result of the growth and spread of large brushy plants over the area.

Acquisition of a minimum of 50 acres of land in this area, which should be managed for brush control, would be an important step in the preservation of this endangered species.

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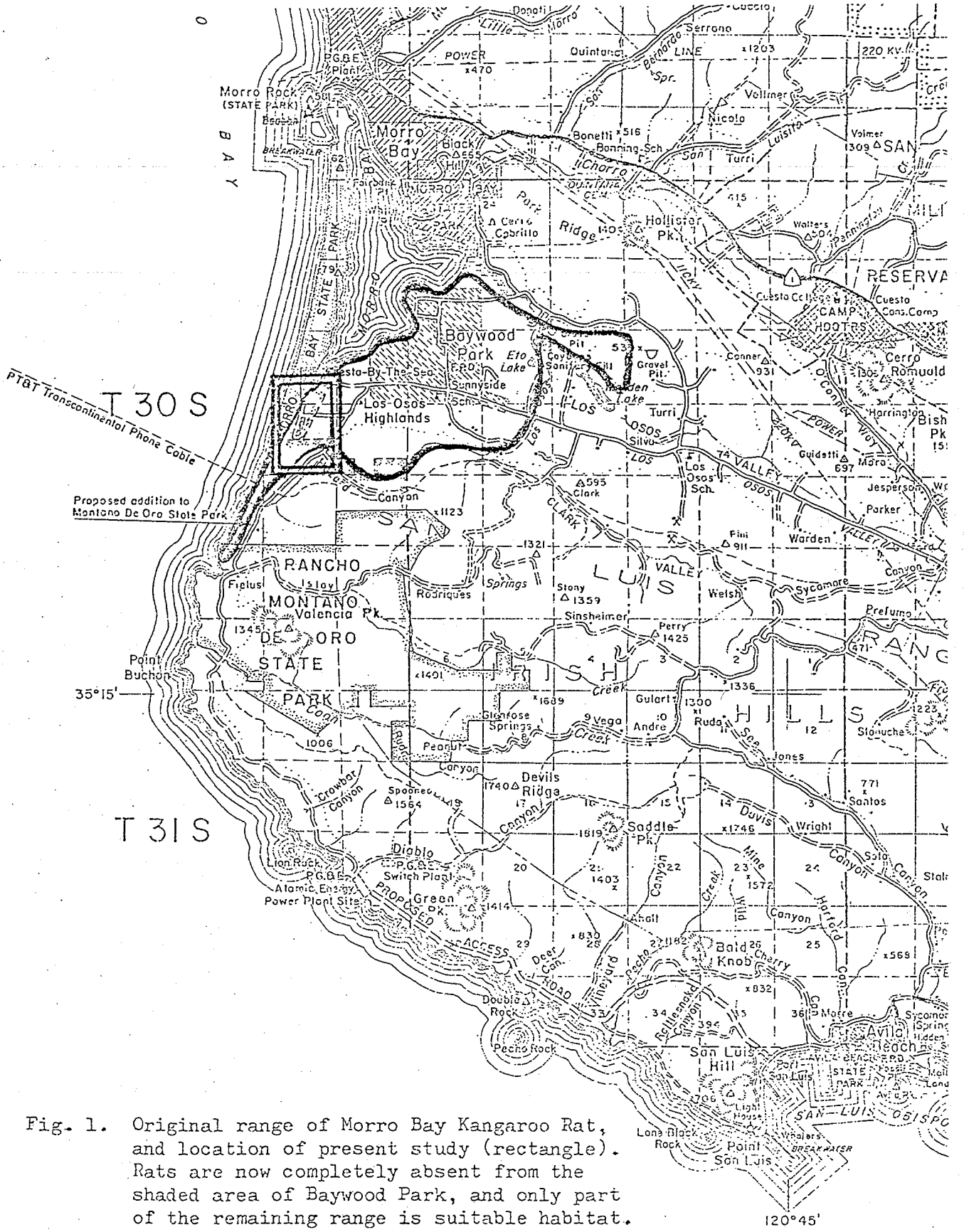

Fig. 1. Original range of Morro Bay Kangaroo Rat, and location of present study (rectangle). Rats are now completely absent from the shaded area of Baywood Park, and only part of the remaining range is suitable habitat.