THE MAMMALS OF BALLONA

Richard Dean Friesen, William Kelley Thomas, and Donald R. Patten

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LIST OF FIGURES

LIST OF TABLES

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INTRODUCTION

Salt marshes represent a unique biological community. They are subject to periodic tidal inundations, and, as a result, the habitat is very moist, the soils strongly haline and the biota are adapted to periodic submergence. In salt marshes of southern California, standing fresh water is often scarce, but freshwater dew is generally available in significant amounts (Coulombe, 1970). Some mammalian species, which are especially adapted to life in salt marshes, have evolved the ability to drink salt water. For most mammals, however, salt marshes represent "physiological deserts" in which water is plentiful, but largely unusable because of its high mineral content (Greene and Fertig, 1972).

This paper reports the status of mammal populations in the Ballona Creek region of Los Angeles County, California, the boundaries of which are shown in figure 1. This area contains highly altered to less disturbed plant communities associated with the southern remnants of the Playa del Rey salt marsh. The account which follows (a) summarizes our knowledge of current and historic mammalian populations which reside in, or have utilized, the Ballona Wetlands and its surrounding maritime uplands and (b) reports data from a year-long field study we conducted in various habitats of the region.

This marshy area, inundated by backwaters from the Santa

Monica Bay, is one of the last coastal salt marshes remaining in southern California. It lies in one of the two gaps through which the course of the Los Angeles River normally passes (Woodford et al., 1954) and in which 849 or more hectares (2,100 acres) of mudflat, shallow and lagoon habitat are historically known (early 1800's, Clark, 1979). The extent and sizes of such marshes along the coast of California have been reduced from Pliocene and Pleistocene times (Coulombe, 1970), but apparently the associated vegetation of these wetlands remained somewhat unchanged, particularly during the latter 25,000 years or so (Axelrod, 1958; Fisler, 1965).

Boundaries for our field studies, which include only about one-quarter of the original historic wetlands, were drawn with the Del Rey Bluffs to the south, Marina del Rey to the north, the Playa Del Rey dunes to the west and Lincoln Boulevard to the east. But to consider historic use of the Playa by mammals, distribution of mammalian species in maritime upland habitats adjacent to the ..s, such as the Del Rey Hills and the inland Los Angeles Basin, were considered.

ECOLOGICAL DESCRIPTION OF THE STUDY SITE

Historically, these emergent wetlands incorporated several plant communities which now are diminished to varying degrees. Discussion of these plant habitats are found in Gustafson (1981 this volume). Six broad categories of habitat use by mammals are considered here as shown in figure 1. (a) The mudflats habitat with emergent Salicornia (much of Unit 1), (b) dry areas with Salicornia (almost all of Unit 3), (c) the upland habitat adjacent to the Salicornia (throughout all units), (d) the upland dune

systems (in Unit 1 and Subunit B of Unit 2), (e) the surrounding bluffs and other fringe areas (adjacent to Unit 2) and (f) the freshwater riparian areas (within Subunit A of Unit 2 along the bluff).

HISTORIC UTILIZATION OF THE BALLONA REGION

The Los Angeles Daily Star, 9 April 1871, described La Ballona as a sea-shore retreat where "surf, and still-water swimming, baths, sailing, boating fishing and hunting...cannot be surpassed by any other on the Pacific Coast." Early maps of southern California (circa 1896 to 1926) and real estate brochures of La Ballona (Palisades del Rey) show the Ballona Wetlands as an extensive area, including the present wetlands area plus those areas where Marina del Rey, Venice and the Hughes Airport have now been developed. The coast of southern California consisted of a long stretch of sand dunes, creating lagoons and freshwater lakes by damming water which flowed down canyon streams from the interior (Holder, 1911). A large, shallow lagoon, perhaps 24 kilometers (15 miles) long is shown on some maps (1923 U.S.G.S. Venice quadrangle). This lagoon may have been open to the sea only during rainy seasons when fresh water flooded the marshland. Most of the year, the Ballona Wetlands may have been somewhat of a brackish or freshwater marshland and was unlikely to have been an important habitat for most marine mammals, although occasional sea otters (Enhydra lutris) or pinnipeds may have moved into the edges of the marsh. Northern fur seals (Callorhinus ursinus), California sea lions (Zalophus californianus), harbor seals

(Phoca vitulina) and northern elephant seals (Mirounga angustirostris) are currently known to occasionally come ashore for short periods or stand along the beaches adjacent to the wetlands. Several species of cetaceans also stand on these beaches with varying degrees of frequency.

Clark (1979) reviewed the history of land uses of Ballona Tidelands. Originally, Gabrielino Indians called these tidelands (loosely) a "place full of water." In 1868, following the Treaty adalupe Hidalgo (1848), 848.3 hectares (2,120.8 acres) of Ballona Tidelands were classified and mapped as "tide overflowed land," or 4th-class land, by Los Angeles County Surveyor, George Hansen. In the late 1800's, a harbor and town (Port Ballona) were planned for Ballona, but the plans were abandoned as the land boom subsided.

The U.S.G.S. 1896 Redondo quad outlines the tidelands as extending north and west of present-day Lincoln Boulevard (Fig. 2) with an ocean inlet below the Del Rey Bluffs. Clark (1979) further notes good vegetation cover over extensive sand dunes before 1920. Ballona Creek, though somewhat linear, possessed heavily vegetated banks. The well-developed sand dunes lay between the beach front and a channel which connected Ballona tidelands to areas in Venice.

By 1934, Ballona Creek had been straightened and channelized to the east of Lincoln Boulevard where it drained some 312 square kilometers (120 square miles) of the Los Angeles Basin. The runoff water from this upland expanse was released into the wetlands seaward of Lincoln Boulevard, evidently annually covering much of the marshland with fresh water. In 1938, the Army Corps

of Engineers dredged and channelized Ballona Creek all the way to the sea. The natural inlet at the Port Ballona site was blocked by sediments within two years (Clark, 1979).

Additional roads and levees were built in the wetlands to accommodate oildrilling pads in the 1930's, 1940's, and 1950's. Beginning in the 1940's, land near Lincoln Boulevard has been cultivated. By 1961, the construction of Marina del Rey on the northern side of Ballona Creek caused major changes. Much of the fill from dredging operations now covers Unit 3 to a depth of 4-5 meters.

In the 110 years since La Ballona seashore was described as "unsurpassed by any other on the Pacific Coast," mammalian fauna of the marshland, like that of most areas in southern California (Gustkey, 1980), has been altered from one "teaming with native wildlife" to a depauperate one, consisting of a few altered, native populations and populations of introduced species.

METHODS OF STUDY

To assess both past and present mammal compositions in the Ballona region, data from previous trapping studies and published accounts of field studies were consulted. Speciments and records of specimens were examined at the Natural History Museum of Los Angeles County (LACM), the San Diego Museum of Natural History (SDNHM), the Dickey Collection (UCLA) and the private collection of Robert G. Hannum, Northridge, California (RGH). The mammal collections of California State University, Long Beach, and Santa

Barbara Museum of Natural History did not possess any specimens from the Ballona region or Playa Del Rey. Specimens collected during this study are catalogued at the LACM, or under field numbers (RDF) to be catalogued at the LACM.

Two thousand and five traps were set between July 1980 and May 1981 as shown in figure 3 and Table 1. Traplines were placed to sample each habitat on the study site. Descriptions of each trapline are given in Table 2. One thousand eight hundred and sixty Sherman live traps and 165 Museum Specials were set. The Museum Specials, which are generally more sensitive than the Sherman live traps, were set in areas from which museum specimens of the Ornate Shrew (Sorex ornatus) previously had been taken.

We hunted for evidence of any use of the region by all species of mammals. Incidental observations of mammal tracks, scats, pickups or other signs also were recorded in our field books.

tal observations by other scientists and by local residents, who were using the property for activities such as falconry, were also noted. Transients living on the property generally avoided us and would not divulge their familiarity with the property.

Initial attempts to determine population densities using standard mark and recapture procedures were limited when our traplines and activities were being disturbed by resident human transients and by other recreational users. Some of our traps were stolen and many were set off or moved. Traplines had to be set nearly at dark and picked up at first light to increase their security. Usually, one of us slept near one of the traplines to protect the traps.

GENERAL SUMMARY OF RESULTS

Currently, nineteen species of mammals are known to reside or forage in the Ballona Wetlands (sensu stricta). Six of these are introduced species. Twenty additional species possibly utilize or are known and suspected to have occurred or foraged in the region, including adjacent maritime uplands. Table 3 lists these mammals, indicating what we believe is their present status. This fauna includes 1 marsupial, 2 insectivores, 8 bats, 3 lagomorphs, 13 rodents, 11 carnivores and 1 artiodactyl. Many of these species appear to be extirpated from the Ballona region. About 32 species, or their close relatives, have been within or in the vicinity of the Ballona region since Pleistocene times (1-3 million years ago)(Miller, 1971; Dice, 1925; Hall, 1936).

Mammals were included in Table 3 if they are thought to have occurred, or they presently occur, in the area of Ballona region in particular. For many species, direct evidence of their use of Ballona is available; others no longer use the region, but by direct evidence can be assumed to have done so. For example, Gustkey (1980) quotes a 1770's description of the nearby San Gabriel Valley as having an abundance of deer, antelope, foxes, squirrels, rabbits, grizzly bears, wolves and wildcats in addition to other vertebrates. Many of these species which reside or roost in the Los Angeles Basin adjacent to the Ballona region, doubtlessly moved out of their upland habitats to forage in the wetlands. But coastal urbanization has now isolated coastal marshes, effectively precluding most larger mammals from them.

Based on accounts in Burt and Grossenheider (1964) and Ingles

(1965), Envicom (1981, Appendix 4) reported 21 possible species of mammals from the Playa Vista study site (Playa Vista Master Plan includes property not within the boundaries of our study). Of these, seven species were reported to have been observed, including Spermophilus beecheyi, individuals of which we did not sight within our study boundaries. The California ground squirrel possibly may be found east of Culver Boulevard, accounting for this difference between our and Envicom's reports.

Envicom reported Peromyscus maniculatus as "common to uncommon." We did not find this species, nor was it found by Soholt and Jollie in 1969 (unpublished student project report prepared for Patten). Envicom also reported the two species of Rattus to [illegible]mon." We found them to be uncommon everywhere, although they are probably more common near the Hughes Airport property.

Only four species of rodents were captured in the Sherman live traps (Table 1). The overall success of trapping was: in Unit 1, 10.5 percent (95 animals per 900 traps), in Unit 2, 5.0 percent (37 animals per 740 traps) and in Unit 3, 3.3 percent (12 animals per 365 traps). The relative abundance of the four species in the units indicates that, in several cases, only a few animals were actually captured, limiting the use of these figures to making rough estimates of abundances (Table 4).

Envicom (1981, Appendix 4, Tables E-1, E-2) reported live-trapping data collected during the months of September, October and March (year?) from various habitats in the Ballona Wetlands and surrounding areas. Mus musculus was captured in

low to moderate levels in all areas (weedy field, some pickleweek; weedy pickleweed/weedy field; pampas grass/coyote bush scrub/weedy field; weedy field/transitional pickleweed; plowed field; coastal scrub, weedy bluff). Reithrodontomys megalotis was captured only in the first two areas listed above, both essentially "weedy fields with pickleweed." No other species were taken except for a young Lepus. Out of 494 available traps set during the Envicom study, there were 76 incidences of traps being entered, but not set off, as evidenced by scats in the trap. (The "triggers" may not have been adjusted for very small mammals.) The success of the Envicom trapping was, therefore, about 27 percent. Our data indicate that Reithrodontomys populations are several times higher during the fall when Envicom data were collected than they are during the winter when most of our data were collected. Our overall success approximates that reported in Envicom's study if only comparable months are considered.

SPECIES ACCOUNTS

The following species accounts summarize our knowledge of mammals found in the Ballona region. Taxa are included in the accounts if specimens are known from Playa del Rey or from nearby areas, such as Palo Verde Hills, Santa Monica or Palms and are thought to range into the Ballona region, sensu lato, or to have done so previously. The natural history of many of these species remains incomplete. Systematic accounts follow Jones et al. (1979). General natural histories for many of these mammals are based on accounts given in Stephens (1906), Ingles (1965) and others as

cited. Pleistocene fossil records are taken from Miller (1971), Hall (1936) and Dice (1925).

Each account reports (1) if a taxon is endemic or otherwise unique to coastal marshes; (2) the number of specimens we trapped, observed, picked up and where, or the basis for including the species in the accounts if we did not take or see any specimens; (3) the distribution, both current and historic, in the region (by unit), and if there exists a Pleistocene fossil record for the species in strata near Ballona; (4) a statement about relative abundance, rarity or presence-absence of the species and (5) specimens examined by us. If no specimens were available to us [illegible] Playa del Rey and we suspected that the species may be part [illegible] fauna, we attempted to find specimens from nearby areas. In some cases, such specimens do not exist.

Order Marsupialia

Only one species of native marsupial is known to occur in North America.

Virginia Oppossum, Didelphis virginiana virginiana Kerr 1792

On several occasions, footprints of this species were found in the mud at the bottom of the surge channel in Unit 2. Two crushed skulls of this species were found at the base of the bluffs in Unit 2. Two specimens were found dead on roads (DOR). One specimen was found dead on Culver Boulevard between Units 1 and 2 (Fig. 1). Another DOR specimen was found at Lincoln Boulevard where it crosses Ballona Creek. This specimen was not kept because it had deteriorated and the skull had been destroyed by

vehicles.

This omnivorous mammal apparently was introduced into southern California circa 1871 from native southeastern United States populations (Los Angeles Daily Star, 2 June 1871). The Oppossum now is generally well established in low areas on the Pacific slope of California, and likely forages in all habitats of the Ballona region.

We believe this species to be a common resident in all areas of the region.

SPECIMENS EXAMINED: 1 from Playa Del Rey, 1.7 miles S, 0.9 miles E Venice City Hall (12 April 1981) RDF.

Order Insectivora

There are two native insectivores known to occur in the Ballona Wetlands area.

Ornate Shrew, Sorex ornatus californicus von Bloeker 1932

This taxon is subspecifically endemic to coastal wetlands in southern California. The type is from Playa Del Rey, Los Angeles County.

During our study, one specimen was collected by Marc Hayes in a pitfall trap set for small amphibians and reptiles.

Sorex cf. S. ornatus occurs in Rancho La Brea fossils and in deposits near Costa Mesa (Miller, 1971). This species occurs from Point Mugu to Nigger Slough (Hall, 1981) and is known to have occurred historically in small numbers throughout the Ballona region. Although we took only one specimen, this species probably still occurs in small numbers throughout the area.

These insectivores feed on adult insects and their larvae and pupae. Those at Ballona may also feed on the numerous amphipods found throughout the wet areas. Other species of Sorex are known to feed on insects, arachnids, snails and earthworms, all of which occur where Sorex ornatus forages in the Ballona area (Ingles, 1965). Sorex vagrans, common to salt marshes in the San Francisco bay area, swims readily at and below the surface of water. It builds its nests on the ground in higher areas.

SPECIMENS EXAMINED: 1 from 2 miles E Playa Del Rey (20 January 1924) UCLA; 1 male from Del Rey (20 September 1925) SDNHM; 1 from Playa Del Rey (18 December 1933) RHG; 1 from Playa Del Rey marsh (20 November 1968) LACM; 1 from Ballona region near Playa Del Rey (8 December 1980) RDF.

Broad-footed Mole, Scapanus latimanus occultus Grinnel and Swarth 1912

The nearest museum specimen is from Santa Monica. Fossil specimens are known from Pleistocene deposits near Costa Mesa (Miller, 1971).

This subterranean species occupies soft soils throughout California and most likely occurs on, or peripherally to, Ballona. These animals are active year round and likely eat earthworms and insects. Owls, snakes, skunks and weasels are likely predators of this nocturnal species.

Although no specimens, or signs of this species, were noted during this study, this mole is expected to occur in low numbers inside the study area.

SPECIMENS EXAMINED: None.

Order Chiroptera

Since the early 1900's, bat populations once inhabiting all areas of the Los Angeles basin have been reduced through the elimination of insect populations (through use of insecticides) and by disturbance of bat roosting sites. Bats are now rarely seen throughout the basin except in areas near mountains, as in Pasadena. No bats were sighted or taken during this study, but, doubtlessly, once were numerous around the Ballona region. Species are included here for which voucher specimens are known from nearby areas. There are eight species of bats known to have occurred in the area.

California Leaf-nosed Bat, Macrotus californicus californicus Baird 1858

No specimens of this bat were sighted or taken during the study, but a specimen taken from Palo Verde suggests this species may forage, or may have foraged, in the Ballona region. Owls and snakes are primary enemies of bats (Ingles, 1965).

This species is distributed throughout the southern one-fourth of California.

SPECIMENS EXAMINED: 1 female from Palo Verde (no date) LACM.

California Myotis, Myotis californicus californicus (Audubon and Bachman) 1842

This species occurs throughout California except in the highest life zones. Stephens (1906) reported this as a common bat in the vallies of California.

SPECIMENS EXAMINED: 1 male from Los Angeles (3 October 1938) LACM.

Big Brown Bat, Eptesicus fuscus bernardinus Rhoads 1902

Although most common in pine forests, this bat is found throughout various California habitats.

SPECIMENS EXAMINED: 3 females from Santa Monica (7 April 1921) SDNHM; 1 female from Santa Monica Mountains, Griffith Park Zoo (9 September 1944) LACM; 5 females, 1 male from Los Angeles (30 June 1936) LACM.

Red Bat, Lasiurus borealis teliotus (H. Allen) 1891

This migrating bat spends winters along the Pacific coast, moving inland during the summer where it occurs throughout California.

SPECIMENS EXAMINED: 1 from Los Angeles (25 October 1938) LACM.

Hoary Bat, Lasiurus cinereus cinerus (Palisot de Beauvois) 1796

This bat roosts in trees, spending the winter on the Pacific coastal slope, south from San Francisco. It moves inland and northward in late spring.

SPECIMENS EXAMINED: 2 females from Los Angeles (30 November 1936, 15 September 1942) LACM; 1 female from Palms (16 November 1939) LACM; 1 female from Santa Monica Mountains (21 November 1940) LACM.

Pallid Bat, Antrozous pallidus pacificus Merriam 1897

This species is represented in fossil beds near Costa Mesa (Miller, 1971). It is known to feed upon Jerusalem crickets and is abundant throughout much of California, except for the higher altitudes.

SPECIMENS EXAMINED: 2 females from Palms (27 July 1925, 21 May 1932) LACM; 1 female from University of Southern California campus (24 May 1971) LACM.

Brazilian Free-tailed Bat, Tadarida brasiliensis mexicana (Saussure) 1860

In California, this species is found chiefly in the Sonoran life zones.

SPECIMENS EXAMINED: 3 females, 4 males from Culver City (2-3 August 1928) SDNHM; 3 males, 7 females from Palms (30 August 1932, 11 March and 19 July 1933) LACM; 1 male from Palms (5 August 1928) SDNHM; 2 males from Santa Monica (7 August 1928) SDNHM.

Western Mastiff Bat, Eumops perotis californicus (Merriam) 1890

This is an uncommon bat, known only from southern California in 1906 (Stephens, 1906), occurring in arid and semiarid lowlands. Specimens have been taken near Ballona in Santa Monica and Palms.

SPECIMENS EXAMINED: 3 males from Santa Monica (1 January and 7 April 1921) SDNHM; 2 females from Palms (2 October 1925) SDNHM; 1 female from Palms (22 December 1925) LACM.

Order Lagomorph

Three species of lagomorphs are known to occur in the Ballona Creek area. One, the Brush Rabbit (Sylvilagus bachmani cinerescens), may not be found on the study site but is known to have occurred historically in adjacent maritime habitats. Envicom (1981) reported sighting this species.

Brush Rabbit, Sylvilagus bachmani cinerescens (J. A. Allen) 1890

No definite sightings of this species were made during this study, although the Brush Rabbit has occurred historically in the area. Envicom (1981) personnel reported observing at least one individual of this species during their field studies.

Pleistocene fossils of this species are known from deposits

at Rancho La Brea, Costeau Pit near El Toro and a site near Costa Mesa (Miller, 1971). This species is generally associated with chaparral, coastal sage scrub, or very thick brush, where it feeds or forbs and grasses. Some areas of the Ballona region contain suitable vegetation for this species.

SPECIMENS EXAMINED: 1 from Santa Monica Mountains, Franklin Canyon (26 January 1917) LACM; 2 from Santa Monica (2, 4 November 1917) UCLA; 2 females from Palms (22, 25 September 1926) SDNHM; 1 from Culver City (26 December 1926) LACM.

~t Cottontail, Sylvilagus audubonii sactidiegi (Miller) 1899

Cottontails were sighted in all units but were most numerous in Units 1 and 3. No cottontails were seen in Subunit A of Unit 2, although these rabbits probably range throughout the region at various times. Cottontails were flushed from thick stands of Salicornia in Unit 1, even at times when the bases of the Salicornia plants were covered with an inch of water from high tides.

Pleistocene fossils of this species are known from Rancho La Brea, Costeau Pit near El Toro, and of Sylvilagus cf. S. audubonii from deposits near Newport Bay and LaMirada (Miller, 1971). This Pacific slope form differs from the desert form (S. a. arizonae). The form found at Ballona is generally associated with thickets in grassy lands and is the common rabbit of lowland California. Most or all Sylvilagus on the Ballona property are of this species. It eats grasses, shoots and other kinds of vegetation.

SPECIMENS EXAMINED: 1 male from Palms (22 September 1926) SDNHM.

Black-tailed Jack Rabbit, Lepus californicus bennetti Gray 1843

Remains of lagomorphs were found throughout the study area, although Jack Rabbits were seen in only the drier areas. This hare is found in almost every ecological community of California (except in higher mountains). Jack Rabbits are present in all three units of the study area, although populations are most dense in Unit 3.

These hares eat many species of plants and are eaten by predators such as hawks, owls and gopher snakes.

Fossils of this species are found in Pleistocene deposits at Rancho La Brea, and Lepus cf. L. californicus fossils in deposits near El Toro, Orange County (Miller, 1971).

On several occasions when we stayed in Unit 3 all night (to protect our traps), hunters came in a 4x4 pick-up truck with hand-held spotlights and 22-caliber rifles, shooting rabbits from 9 PM to midnight. When questioned, these hunters claimed they frequently came to Unit 3 on Saturday nights to drink beer and shoot rabbits.

SPECIMENS EXAMINED: 1 from Del Rey (2 January 1934) LACM.

Order Rodentia

Ten species of rodents are known to occur in the Ballona area.

California Ground Squirrel, Spermophilus beecheyi beecheyi (Richardson) 1829

No individuals of this diurnal species were actually sighted during our study, although there appear to be burrows of this species in Subunit D of unit 2. Envicom (1981, Appendix 4) reported observations of abundant individuals of this species,

but evidently outside our study boundaries. A non-professional source (falconer) who has been using this property for about 18 years, reported seeing ground squirrels east of Lincoln Boulevard about five years ago for the first time.

This species is represented in Pleistocene fossil beds from Rancho La Brea, Costeau Pit near El Toro and San Pedro (Miller, 1971). Fossil beds near Newport Bay also possesses a closely related form, Spermophilus cf. S. beecheyi.

This ground squirrel is widespread throughout California, and frequently resides in maritime areas adjacent to the coast. It feeds principally on vegetation but also on insects or other animals.

Botta's Pocket Gopher, Thomomys bottae bottae (Eydoux and Gervais) 1836

Mounds of this species are abundant throughout the Ballona Region, except where soils are regularly soaked with water. The sand dunes in Unit 1 are especially well worked by this species. Even though Stephens (1906) reported this gopher as occurring throughout the coast wherever vegetation grows, Robert G. Hannum reported that populations of this species did not occur in the Ballona Wetlands until sometime in the 1950's. Apparently, the first movements into the marsh came along the old trolley brim, now abandoned, and finally into the levees with roads leading to the gas wells.

This species is represented in Pleistocene fossils from beds throughout the Los Angeles Basin (Miller, 1971). It occurs today throughout all of California except in drier and higher areas. Pocket gophers are important aerators of the soil through their

tunneling activities. Regurgitated pellets from a burrowing Owl (Athene cunicularia) living on the sand dunes at the Los Angeles International Airport contained mostly the remains of pocket gophers. Hawks and gopher snakes are the other primary predators.

SPECIMENS EXAMINED: 1 from vicinity Santa Monica (16 September 1917) UCLA; 1 from Palms (1 December 1925) UCLA; 1 male from Palms (5 November 1927) SDNHM; 1 from Sawtelle (2 November 1925) UCLA; 1 from Sawtelle (5 September 1926) SDMNH; 2 from sand dunes, 1 mile NW Hyperion, Del Rey, SE La Ballona Creek (9 September 1956, 24 September 1957) RGH; 1 from sand dunes back of Hyperion, SE La Ballona Creek outlet, Del Rey (29 March 1957) RGH; 5 from sand dunes NW La Ballona Creek, Playa Del Rey (29 April, 1 May, 5 May and 29 March 1970) RGH; 1 from off Culver Blvd., 1 mile SWjunction of Culver and Lincoln Blvds., Playa Del Rey (10 April 1981) RGH; 1 from Playa Del Rey, 1.0 miles S, 1.3 miles E Venice City Hall (12 April 1981) RDF.

Little Pocket Mouse, Perognathus longimembris pacificus Mearns 1898

This pocket mouse was described by von Bloeker (1932) as Perognathus longimembris cantwelli (type in LACM, from Hyperion) but was regarded as identical with Perognathus longimembris pacificus by Huey (1939).

This species is found in fine sandy soils of southern California where seeds can be found and stored. Numerous specimens of this subspecies were taken from the sand dunes and sandy surrounding, flatter areas at Playa Del Rey and El Segundo in the 1930's but appear to be extirpated now. Individuals of this species are long lived, sometimes living for as long as eight years (Edmonds and Fertig, 1972). We trapped for possible remnants

of this subspecies in and around the sand dunes at the end of the runways of the Los Angeles International Airport. These traps were set in areas with Buckwheat (Eriogonum) and other shrubs and forbs, likely habitat for any survivors. Although burrows of pocket gophers abounded, and scats and footprints of large carnivores were found throughout the region (most probably from a gray fox known to be living in the sand dunes), no Perognathus were found. In fact, the single animal caught in the Sherman live traps was a Horned Lizard (Phyrnosoma cornatum). The sand dunes of Ballona region, likewise, whow no signs of mammal activities other than pocket gophers and large carnivores, such as domestic dogs.

SPECIMENS EXAMINED: 1 from Hyperion (22 November 1918) LACM; 12 from Playa Del Rey (1 May and 29 August 1932) LACM; 4 from sand dunes, Vista Del Rey (4 June 1933, 5 June 1935, 25 June 1935)

4 from Del Rey (13 September, 30 June 1935) LACM; 8 from 1 mile N El Segundo (7, 8, 10, 11 June 1938) SDNHM.

California Pocket Mouse, Perognathus californicus dispar Osgood 1900

Fossils of this species, and a closely related form, are known from Rancho La Brea, Costeau Pit and Costa Mesa digs (Miller, 1971). Historically, this mouse may have frequented coastal salt marshes. Stephens (1906) reported this species from Los Angeles, although it is generally associated with chaparral growth.

SPECIMENS EXAMINED: None.

Agile Kangaroo Rat, Dipodomys agilis agilis Gambel 1848

No specimens of this species are known from Playa Del Rey, although Brown (1975, p. 9-31) reported that "a few Pacific (Agile) kangaroo rats (Dipodomys agilis) have burrows in open sandy

places" on the property adjacent to the sand dunes of the Los Angeles International Airport. Sandy areas around the Ballona Wetlands look favorable for this species.

Miller (1971) reports Pleistocene fossil specimens of Dipodomys from Costeau Pit, specimens of Dipodomys agilis from Rancho La Brea, and Dipodomys of cf. D. agilis from the La Mesa site.

This species, a seed eater, is characteristic of coastal sagebrush scrub of which there is a small stand in Unit 1. Stephens (1906) reported this species as being "common in the coastal region of southern California."

SPECIMENS EXAMINED: 1 from Sawtelle (19 October 1925) UCLA; 19 from Sawtelle (3, 4, 5 September and 17, 20, 22 October 1926, and 18 October 1928) SDNHM.

✓ Western Harvest Mouse, Reithrodontomys megalotis limicola von Bloeker 1932

Playa Del Rey is the type locality for this subspecies. Records indicate that this endemic form occurs as far north as Point Mugu and as far south as Anaheim Bay (Hall, 1981).

Fossils of this species are known from the beds of Rancho La Brea and Costa Mesa (Miller, 1971).

Reithrodonotomys was found to be most abundant in the wettest areas of Unit 1 and 2. It was replaced by Mus in the drier areas. This nocturnal mouse occurs throughout California, eating seed and fruits, frequently using covered runs made by voles. This salt-marsh subspecies, limicola, is efficiently adapted to drinking seawater--even more so than its similarly adapted sister species, the salt marsh harvest mouse (Reithrodontomys raviventris),

occurring only in the salt marshes around San Francisco Bay, California (Coulembe, 1970). Both of these species appear to exhibit major seasonal movements of their populations, ranging back and forth from low- to high-tide areas (Fisler, 1968).

SPECIMENS EXAMINED: 8 from Del Rey (15, 25 May 1929; 17 June 1929; 30 January 1932) LACM; 11 from along Culver Blvd., 0.8 miles SW Lincoln Blvd., Playa Del Rey (18 December 1933, 26 August 1934, 18 December 1934, 24 March 1935, 9 May 1935, 10 July 1955, 21 August 1955, 30 October 1955, 28 October 1956) RGH; 7 from Playa Del Rey Marsh (15, 24 November 1968; 14 December 1968) LACM; 4 from Playa Del Rey Salt Marsh, 1.8 miles S, 0.9 miles E Venice City Hall (11, 12 April 1981) RDF.

Deer Mouse, Peromyscus maniculatus gambelli (Baird) 1858

No specimens of this species were trapped on the study area, which has apparently been replaced by Mus or displaced because of other changes in the habitat required by deer mice.

ree Pleistocene fossil beds (Rancho La Brea, Costeau
.. and Costa Mesa) have specimens of this species (Miller, 1971).

This species is one of the most widespread North American mammals, appearing in most every terrestrial ecologic community. This makes its absence from the Ballona region especially surprising.

Deer mice eat seeds, fruit and insect larvae and pupae (especially those of lepidopterans), but not food items of Microtus (grass, bark or leaves; Ingles, 1965). All vertebrate predators in the Ballona region would likely prey upon this species.

SPECIMENS EXAMINED: 3 from Playa Del Rey, along Culver Blvd., 0.8 miles SW Lincoln Blvd. (21 Aug, 11 September 1955; 28 January, no year) RGH; 1 from Redondo Beach (27 October 1968) LACM.

Southern Grasshopper Mouse, Onychomys torridus ramona Rhoads 1893

Grasshopper mice occur primarily in low, hot valleys (Hall, 1981) over most of the southern part of California. This species, although generally found in more arid habitats, occurs in the Los Angeles region today in small numbers and is present in the Pleistocene fauna of Rancho La Brea (Miller, 1971; Dice, 1925). Stephens (1906) took this grasshopper mouse from along the seashore in southern California. About 90% of the diet of this nocturnal mouse is animal food, 80% of which is arthropods (Ingles, 1965). They generally prefer grasshoppers but will also eat tenebrionid beetles and lizards.

Enemies of grasshopper mice include weasels, owls and snakes.

SPECIMENS EXAMINED: None.

Dusky-footed Woodrat, Neotoma fuscipes macrotis Thomas 1893

Although a potential resident, no individuals were found during this study. This species is represented in Pleistocene fossil beds from near Costa Mesa (Miller, 1971). Neotama cf. N. fuscipes is reported from fossil digs near San Pedro.

This species occupies much of the Pacific slope of California. Brown et al. (1975) noted stick houses made by this species near the sand dunes of the Los Angeles International Airport, and Stephens (1906) reported this species as inhabiting the seacoast

of southern California.

Predators of wood rats include owls, foxes, coyotes and large snakes.

SPECIMENS EXAMINED: 18 from Sawtelle, Los Angeles County (23 May, 21 November, 3 December 1929; 20 March, 20 January 1930; 27 November 1927) LACM.

California Vole, Microtus californicus stephensi von Bloeker 1932

This form is endemic to coastal marshes of southern California, occurring only from Point Mugu to Sunset Beach. The type locality is Playa Del Rey.

Three specimens were trapped. Two of these were on Unit 1 and the other in Subunit A of Unit 2, all in areas of Saltgrass chilis spicta) where runways abounded. Coulombe (1970) suggests these circumstances imply saltgrass is used as a major food source for Microtus.

This species, and a closely related form, is found as Pleistocene fossils in beds throughout the Los Angeles Basin and vicinity (Miller, 1971).

Scats and runs of this species indicate populations are found on the levees around Ballona Wetlands, but most are concentrated in Units 1 and 2. Although this salt-marsh form of Microtus is primarily granivorous, individuals also appear to utilize some halophytes, such as Salicornia, which are able to sustain these voles for considerable time (Fisler, 1968). Thus, this vole generally occurs in upland meadows and grassy places where burrowing is possible, but also in areas subjected to daily high tides (Fisler, 1961, 1968). This vole swims well, sometimes up

to 6.1 m (20 feet), and remains submerged up to 20 seconds (Fisler, 1961), indicating that it is well adapted for salt-marsh living. Even at times when its home range is flooded, individuals will stay put by swimming until the high tides subside (Fisler, 1968). Johnston (1957) reported that this vole builds its nest on the soil surface, irrelevant of tidal height. Some populations of Microtus vary cyclically over a three- or four-year period, probably in conjunction with predation cycles (Ingles, 1965).

SPECIMENS EXAMINED: (type specimen) Del Rey, Los Angeles County, California (3 May 1930) LACM; 1 from Playa Del Rey (24 October 1925) UCLA; 14 from along Culver Blvd., 0.8 miles SW Lincoln Blvd., Playa Del Rey (13, 20 May 1933; 28 August 1934; 28 January, 9, 19, 24 March 1935; 8 June 1955; 15 January 1957) RGH; 1 from along railroad embankment, NW corner Lincoln and Culver Blvds., (10 July 1955) RGH; 1 from Playa Del Rey, 1.7 miles S, 0.9 miles E Venice City Hall (11 April 1981) RDF.

Muskrat, Ondatra ziebethicus (Sabine) 1823

Sometime after the beginning of this century, this species was introduced into the Ballona Wetlands, evidently by escaped individuals from fur farms. Robert G. Hannum reported seeing them in the 1930's in the duck club that once occupied the site of Unit 3. This flooded area was thickly populated with tules or cattails at the time a habitat favored by muskrats. One night, one of us (Friesen) nearly (?) captured an animal closely resembling a muskrat on the brim around the overpass at Ballona Creek, where it passes under Culver Boulevard. The animal, much larger than a Rattus, moved slowly and rather awkwardly through

the weeds toward the creek. No scats of Rattus or any other large rodent were found in the vicinity. No other evidence was noted in our study.

One specimen of Ondatra (species unknown) was found in the Pleistocene fossil dig at Costeau Pit (Miller, 1971).

This species occurs in many southern California canals and waterways into which they were introduced from the Colorado River. They are found throughout the San Joaquin Valley wherever water is found and are known from the brackish waters of Suisan Bay (Macdonald, 1976).

SPECIMENTS EXAMINED: None.

Norway Rat, Rattus norvegicus norvegicus (Berkenhout) 1769

This rat was captured in each of the three units and is probably present in low numbers through the study area.

Originally from China and introduced into the Pacific states around 1850 (Stephens, 1906), this species is widely distributed in California where it occurs around dwellings and dumps throughout cities.

This omnivorous rat swims readily and is a good digger and ..er. It likely forages in small numbers throughout the Ballona region. Although specimens were taken in all units, this species is seldom seen far from buildings.

Predators of the norway rat include owls, hawks, foxes, weasels and snakes.

SPECIMENS EXAMINED: 1 from Playa Del Rey, 1.0 miles S, 1.3 miles E Venice City Hall (12 April 1981) RDF.

House Mouse, Mus musculus brevirostris Waterhouse 1837

We have captured this species throughout the Bollona region.

Introduced from Spain through Latin America, this species now occurs in fields and dwellings near human habitations. It appears to have displaced native mice in some places (Ingles, 1965) and probably replaced Peromyscus maniculatus in the Ballona area.

This mouse is omnivorous, eating fruits, seeds and other plant matter, but also eats insects and other animals when available. Coulombe (1970) notes this species is able to live in pure stands of Salicornia at Ballona. Fertig and Edmonds (1969, 1970) documented the ability of this species to live in areas, such as salt marshes, where fresh water is in short supply. Essentially, the species is adapted to aridity.

Natural predators of this species include owls, hawks, snakes, foxes, weasels, skunks and raccoons (Ingles, 1965), all food species originally found in the Ballona region but now reduced in numbers.

SPECIMENS EXAMINED: 19 from Playa Del Rey Marsh (9, 10, 14, 24, 25 November, 14 December 1968) LACM; 2 from Playa Del Rey (1 November 1941, 4 December 1965) LACM; 4 from along Lincoln Blvd., 0.8 miles SW Lincoln Blvd., Playa Del Rey (11 October 1955, 28 October 1956, 1 July 1957) RGH; 9 from Playa Del Rey Salt Marsh, 1.8 miles S, 0.9 miles E Venice City Hall (11, 12 April 1981) RDF.

Order Carnivora

Ten species of carnivores are known to occur in the Ballona

area.

Coyote, Canis latrans ochropus Escholtz 1829

This species was not seen during the study, and most likely, no longer occurs on this site.

Both Rancho La Brea and Costeau Pit near Costa Mesa possess Pleistocene fossils of this species. A closely related form occurs in Pleistocene beds near Buena Park (Miller, 1971). This large carnivore occurs throughout California in nearly all communities including maritime habitats adjacent to the coast (Stephens, 1906). In the Ballona region, its food potentially consists of insects, rabbits, hares, ground squirrels and voles. Dens are usually enlarged holes of badgers or ground squirrels.

SPECIMENS EXAMINED: None.

Domestic Dog, Canis familiaris Linnaeus 1758

Domestic dogs were encountered on many occasions in the study area, both accompanied by humans and running free. This carnivore probably feeds on rabbits, mice, raccoons and birds.

SPECIMENS EXAMINED: None.

Gray Fox, Urocyon cinereoargenteus californicus Mearns 1897

This species, and a closely related form, are represented in Pleistocene fossils from Rancho La Brea and La Mirada near Buena Park (Miller, 1971).

Macdonald (1976) lists this species as a one-time, salt-marsh component, ranging down to hunt and feed from adjacent maritime and upland habitats. One fox was sighted on 15 September 1981 by Marck Hayes in the agricultural land one-half way between

Jefferson Boulevard and Centinela Creek. It appeared to be stalking a morning dove. Envicom (1981) reported observing at least one individual of this species during their field studies.

SPECIMENS EXAMINED: None.

Raccoon, Procyon lotor psora Gray 1842

Tracks of this species were seen several times in the bottoms of surge channels in Unit 2.

This mammal occurs throughout coastal California and was reported around some of the bays along the seacoast as early as 1906 by Stephens. Dogs running loose on the Ballona property probably limit raccoons to small numbers in the more protected areas on the fringe of the wetlands.

Raccoons are omnivorous, eating any small mammal or other vertebrate and many kinds of vegetable matter. These animals spend most of their lives near water, making Ballona Wetlands an ideal place for them. Dogs, more than humans, tend to disturb them.

SPECIMENS EXAMINED: None.

Long-tailed Weasel, Mustela frenata latirostra Hall 1936

One partial skull (most of the basal portions) of this species was found on the study site in Unit 1.

Both Rancho La Brea and Costeau Pit fossil beds have specimens of this species (Miller, 1971), which now occurs throughout much of non-desert California and most likely is found in small numbers in all habitats of the Ballona region.

It hunts both in daytime and nighttime, often climbing in

and out of rock piles and scrub, looking for small mammals and birds. It preys upon such species as Microtus, Reithrodontomys and Thomomys, as well as small Sylvilagus and Lepus.

SPECIMENS EXAMINED: 1 from Playa Del Rey (15 December 1927) LACM; 1 from alongside Culver Blvd., 0.03 miles NE Lincoln Blvd., Del Rey (9 June 1957) RGH; 1 from Ballona Wetlands (10 October 1980) RDF; 8 from Culver City, Sawtelle and Palms (May and April 1928) UCLA.

Badger, Taxidea taxus jeffersonii (Harlan) 1825

No signs of this species were found on the study site, although [illegible]cene fossils are known from Rancho La Brea (Miller, 1971). [illegible]906, Stephens noted that badgers were "not very common in California."

This species is now very localized throughout California. Its numbers are being rapidly reduced by additional cultivation and other human encroachments on their hunting grounds and by reduction of their food items, such as gophers, rats, mice, voles and groud squirrels. These food species are obtained by digging them out of their burrows, often in the late afternoon and early evening.

SPECIMENS EXAMINED: 1 from Los Angeles, corner of Santa Barbara and Hoover (14 June 1938) LACM.

Western Spotted Skunk, Spilogale gracilis phenax Merriam 1838

No signs attributable to this species were found during the study. Stephens (1906) reported this skunk as a common resident in valleys of southern California.

Pleistocene fossils of Spilogale putorius are reported in Rancho La Brea deposits (Miller, 1971). This nocturnal species occurs throughout communities in California, except in the deserts and high mountains.

SPECIMENS EXAMINED: None.

Striped Skunk, Mephitis mephitis holzneri Mearns 1897

One individual of this species was discovered by Marc Hayes in Subunit D of Unit 2 while he was looking for reptiles in a large burrow. Othe signs of this species were not discernible during the study, although it likely ranges throughout the region.

This skunk is present in Pleistocene fossils at Rancho La Brea (Miller, 1971). Many striped skunks are known to live in coastal sand dunes where they hunt on the beaches, digging out sand crabs (Ingles, 1965). Numerous carnivore scats were found on the sand dunes at El Segundo (at the end of the runways of the Los Angeles International Airport) that contained numerous crab parts. Some of these scats may have been from skunks, although none were sighted by us. Brown et al. (1975) reported them as occasional dwellers of the LAX sand dunes.

SPECIMENS EXAMINED: None.

Domestic Cat, Felis catus Linnaeus 1758

No cats were encountered during our study, although Envicom (I981) reported this species as "abundant" during their studies. Feral cats may occur around the Hughes Airport property, an area not included in our boundaries.

SPECIMENS EXAMINED: None.

Bobcat, Felis rufus californicus Mearns 1897

No evidence that this species now inhabits the Ballona region was found. It likely has been extirpated because of human disturbances and the limited size of the available area. Stephens (1906) reported this cat as "common" in brushy parts of coastal southern California.

Fossil remains of this lynx are found at Rancho La Brea (Miller, 1971). A closely related form, Lynx cf. L. rufus, appears in deposits near Buena Park.

Bobcats prey upon small birds and mammals, such as pocket gophers, ground squirrels, deer mice, voles, bush rabbits, cottontails, hares and woodrats.

SPECIMENS EXAMINED: None.

Order Artiodactyla

One species of artiodactyl is known to have occurred in Ballona area.

Mule Deer, Odocoileus hemionus californica (Caton) 1876

Deer are primarily browsers on trees and shrubs and may have ranged into the Ballona region along riparian bottoms. Although no signs of this species were not found during our study, mule deer are present throughout the Santa Monica Mountains today, generally preferring more upland habitats.

Pleistocene fossils of this species are known from Rancho La Brea (Miller, 1971). A closely related form has been described from digs at Newport Bay, San Pedro and La Mirada (Miller, 1971).

SPECIMENS EXAMINED: None.

DISCUSSION

Our results, and those of others (Soholt and Jollie, 1969; Fisler, 1961, 1963, 1968; Coulombe, 1970; Eilers, 1980; Greene and Fertig, 1972; Johnson and Rudd, 1957; and others), call attention to the diversity of habitats in the Ballona region. Several aspects of this diversity, and the unique character of salt marshes, are discussed below in light of our data. Smith (1980) reviews some of the relationships that govern the need for diversity or patchiness in terrestrial environments. Potential densities of mammalian species (and other wildlife) with "small home ranges and requiring two or more habitat types"--the precise case of the salt-marsh endemics, Microtus, Reithrodontomys and Sorex--are "roughly proportional to the sum of the type of peripheries" (p. 583). Smith also notes that "the abundance of resident species requiring two or more cover types appear to depend upon the degree of interspersion of numerous blocks of the smae kind" (p. 583). Most likely, the stability of salt-marsh endemic mammalian taxa is greatly enhanced by the interspersion of habitat types in Ballona region.

Fossil records indicate that the diversity of mammalian species from the area around the Ballona region is a dynamic property. Nevertheless, Macdonald (1976) points out that, presently species diversity of Pacific coast marsh taxa (including numerous invertebrates) appear to be low, but that densities are high--a situation typically found in "extreme, highly fluctuating physical environments."

MARK-RECAPTURE STUDIES

Data from part of our initial attempt to do mark-recapture

studies on the site are reported in Table 5. These data are based on trapline 8 from Unit 1 with 100 traps set each night. Several trends are apparent in the data. Fewer animals were captured in the colder months, evidently because the rodent populations had dropped from earlier levels. During the colder winter months, about half the few Reithrodontomys we caught (Table 1) were recaptured animals (previously toe-clipped) and half new individuals. Mus sometimes was not trapped at all, or only one or two individuals were recaptured. Most recaptured individuals that were taken in December and February were animals that had been originally marked in November. The few individuals trapped in December and February for the first time were not ed the following nights. Thus, ...

SPECIES ABUNDANCES BETWEEN UNITS

Comparative abundances of rodent species captured in the three Units (Table 4) show that endemic Reithrodontomys are dominant in Unit 1 (7 captures per 100 traps), whereas the non-native Mus is dominant in Units 2 and 3 (2-5 captures per 100 traps). Mus, however, is found in all three Units at levels between 2-5 captures per 100 traps set.

Native Microtus are found at low levels in both Units 1 and 2 (one individual per 300 to 500 traps). This species evidently co-occurs with Mus in most or all coastal marshes of California. Lidicker (1966) reported field and laboratory observations between these two species on Brooks Island in San Francisco Bay. The distinctly different ecologies of these two species suggest that they may not directly compete for food

sources and, therefore, may easily coexist. Both species are fairly aggressive, evidently avoiding encounters. They may compete for nesting sites, however. The larger Microtus likely would win such competition, since this species clearly won all encounters Lidicker observed between these two species in laboratory studies. It is likely, nevertheless, that both species will continue to persist in the Ballona region, especially since Mus appears to remain established in any area it gains a foothold (Schwarz and Schwarz, 1943).

Rattus norvegicus also is found at low levels in localized areas of all three Units. Rattus generally does better in settled areas where garbage, and other food sources produced by human activity, are continually available--it does not particularly persist in open field situations wherever buildings are available. The low densities of this species in the marshlands is not surprising. The marshlands, in fact, probably contribute little to the presence of Rattus populations in commercial buildings and elsewhere throughout Marina del Rey.

Peromyscus maniculatus gambelli, now apparently absent or in very low numbers in the region, once was fairly common. Most likely, Mus musculus replaced Peromyscus. The demise of native rodents usually occurs wherever Mus is introduced (Schwarz and Schwarz, 1943). Specimens of Peromyscus were collected by Robert G. Hannum from Playa Del Rey as late as 1955 (see the species account of Peromyscus maniculatus), but individuals were apparently absent 14 years later by the time Soholt and Jollie (1969) trapped the same area.

Our data agree with those of Soholt and Jollie (1969; personal communication, 1981) showing significant differences in the abundance of rodents between drier and wetter areas of the Ballona region as shown in Table 6. We generally caught more Mus in higher, drier areas adjacent to the Salicornia than in the Salicornia itself. Specifically, trapline 3 in Unit 1, set along a cultivated edge having both wheat and Salicornia, and trapline 12, set on the grassy area behind the commercial buildings on Culver Boulevard, had more Mus than Reithrodontomys (Table 1). In contrast, all other successful traplines set in wetter parts of the marsh of Unit 1 had more Reithrodontomys. In Unit 2, where our traplines were bounded by surge channels or less uniform Salicornia stand with little raised upland (lacking berms), only Mus musculus were captured. It appears to us, then, that in the more diverse marsh--presumably the more natural situations or "pristine" areas of the region--the native species, Reithrodontomys, is more abundant. We are using the word "pristine" here in the sense that an undisturbed marsh would naturally possess uplands (berms, banks, hillocks) along its edge and probably throughout the marshland, providing more diversity than a rather uniform area of tidally flooded Salicornia. To native mammals, the diversity appears to be important.

PHYSIOLOGICAL ADAPTATIONS

According to Macdonald (1976), only a small number of animals (including invertebrates) found in Pacific coast salt marshes are restricted to these habitats. Yet, several mammalian taxa endemic to Ballona region (Reithrodontomys megalotis limicola, Microtus californicus stephensi and Sorex ornatus salicornicus)

are metabolically adapted to drinking seawater. Other small mammals, not being so adapted, are generally excluded from strict existence in marshes. Many larger species can regularly move to areas with fresh water, such as riparian areas. Fisler (1963) has shown that related upland subspecies of salt marsh rodents are not adapted to drinking salt water as are the endemic marshland forms. For example, Microtus californicus living in uplands from San Francisco Bay are not able to subsist by drinking seawater. The three endemic rodents of Ballona Wetlands, along with others found in marshes in San Francisco Bay (Reithrodontomys raviventris and Sorex sinuosus), utilize halophytic plants as food, and likely have developed their unique ability to drink seawater as a result of eating these highly salty plants. The water available in these plants may indeed provide a major amount of these animals' daily needs.

Such adaptations to living in salt-laden habitats, while highly unusual, are not unique. Dipodomys microps (the Chisel-toothed Kangaroo Rat), living in saltflats in western North America deserts, is able to utilize leaves of halophytic Atriplex plants by shaving off the salty surface layers with especially adapted lower incisors. Several other species of Dipodomys, especially D. merriami, are able to live entirely without free water (Kenagy, 1972). It appears that these marshland and desert species are not routinely stressed by lack of fresh water (Greene and Fertig, 1972).

MOVEMENT PATTERNS

Movement patterns of marshland mammals also appear to be

unique. Saltmarsh Microtus populations, for instance, exhibit movement patterns over four times longer distances than do individuals of upland populations of the same species (Fisler, 1968). These movements are probably related to tidal influences to which Microtus is not well adapted. Reithrodontomys, in contrast, appears to be better adapted to tidal fluctuations, now showing much lateral movement in the marshlands (Fisler, 1968; Johnston, 1957).

TROPHIC RELATIONSHIPS

Mammals are important elements in the trophic webs of coastal ..bes. Macdonald (1976) discusses some of these relationships. Mammalian herbivores, and the food items they graze upon or hunt, include Sylvilagus audubonii (leaves and shoots), Reithrodontomys megalotis (seeds and fruits) and Peromyscus maniculatus (seeds and fruits). Carnivorous mammals, and their prey, include Sorex ornatus (insects, snails, earthworms, arachnids), Didelphis virginiana (insects and other animals), Mustela frenata (small mammals and birds), Rattus norvegicus (garbage and carrion), Mus musculus (insects and other animals), plus the ten carnivores listed in Table 3 (other mammals, birds, or other animals). Major predators upon mammals include, in addition, snakes, owls, White-tailed Kites, all of which feed on smaller mammals, and Great Blue Herons, Marsh Hawks, and Red-tailed Hawks, all of which prey upon larger mammals. The top carnivores once included Lynx rufus, Urocyon cinereoargenteus, Taxus taxidea and Canis lantrans.

MITIGATIONS AND RECOMMENDATIONS

The following recommendations were developed with the goal of creating a viable, self-sustaining area dominated by a coastal marsh community. Ideally, once established, this system should require a minimal amount of active management.

Two aspects guided our recommendations. First, one of size. Because small populations are more vulnerable to extinctions resulting from population fluctuations, drought or disease, as exemplified by populations studied by Lidicker (1966), we recommend the preservation of a large area of the Ballona region to insure large mammalian populations having the best chance for stability. Second, one of ecological diversity and stability. A number of studies cited by Smith (1980) have shown that areas with greater varieties of ecological situations have more species. Thus, we recommend the preservation of a large area of the Ballona region to insure the largest number of mammalian species a chance for survival. The endemic salt-marsh taxa of mammals discussed in this paper will have decreased chances for survival unless a stable, self-sustaining and diverse ecosystem can be created in the Ballona region. The marsh, coastal dune, freshwater riparian and dry upland habitats and their associated ecotones provide this diversity.

Saving a large area with varied habitats is essential to create the most stable setting for a coastal marshland mammalian fauna. Habitats in this area would require some restoration, including some passive measures, such as deregulating tidal

fluctuations by removing tide gates, and some active measures, such as removing certain non-native plant species and reintroducing native taxa. For purposes of making recommendations, we divided the Ballona region area into estuarian, coastal dune, fresh water, as described by Envicom (1981) and maritime habitats, which include dry upland areas bordering the marsh.

ESTUARIAN HABITATS

These habitats include pickleweed saltmarsh, mudflats, channels and saltflats. At present, tidegates and berms deprive the wetlands of adequate flushing. The pristine nature of the wetland was considerably different when it included freshwater input from Ballona and Centinela Creeks.

Reithrodontomys megalotis limicola, Sorex ornatus salicornicus and Microtus californicus stephensi are now present in these habitats and would be expected to persist if the area now inundated by tidal fluctuations were increased. Peromyscus maniculatus gambelii, which has probably been displaced by Mus musculus, could be reintroduced--but will not likely become reestablished. Schwarz & Schwarz (1943) note that once established, populations of Mus musculus usually remain established.

Fisler (1961) has shown that individuals of Microtus almost always include high areas not inundated by water into their home ranges. The old trolley berm running through Unit 1 could be lowered and re-established with salt grass as ideal upland for Microtus.

We recommend that the size of the estuarian habitat be

increased and that Peromyscus maniculatus gambelii be re-introduced.

COASTAL DUNE HABITATS

These habitats include two areas. One is Subunit B of Unit 2, but the most important is Subunit H of Unit 1, located at the west end of the study area. These dunes have been greatly altered by equestrian activities. Typical species of this habitat, such as Peromyscus maniculatus, Dipodomys agilis and Perognathus longimembris, have been reported on nearby dunes in El Segundo (Brown et al., 1975), although our recent trapping efforts in the El Segundo sand dunes (July 1981) produced no individuals of these species.

Restoration of the dune areas should include the removal of buildings, stables and all non-native vegetation (such as Castor Beans) and the bringing in of additional sand. Native plant species should be re-introduced and established prior to the re-introduction of native mammal populations taken from adjacent coastal populations.

FRESHWATER HABITATS

Presently, these habitats are restricted to Centinela Creek and a small area at the base of the bluffs on the south side of Unit 2. The maintenance of a permanent fresh water source is important to larger mammals.

MARITIME UPLANDS AND BERMS

These habitats are dispersed throughout the study area, including the raised berms in and around the Salicornia and the bluffs on the south border of Unit 2. The diversity provided by these habitats is useful to at least 13 mammalian species that could, or do, inhabit these areas. Four of these, Mustela frenata, Mephitus mephitus, Procyon lotor and Didelphis virginiana, are important predators which help to provide stability to the entire ecosystem through ecologic interactions. These areas are also useful buffers for the estuarine community.

BUFFER ZONES

A sufficient buffer is needed to protect the habitat supporting the mammals. A zone sufficiently protective of birds will be adequate for mammals.

PROTECTION OF BALLONA REGION

Throughout our study, we became aware of the heavy uses of the Ballona region for activities such as horseback riding, hunting, fishing, motorcycle riding and dog walking. Numerous human transients live there, and falconers exercise their birds. We believe these disruptive uses should be stopped, and the normal use of the region should be limited to designated, established trails. Because of its position and accessibility, this rare and unique area can be a valuable educational resource for the Los Angeles population.

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LITERATURE CITED

Axelrod, D. I. 1958. Evolution of the madro-tertiary geoflora. Bot. Rev. 24:434-509.

Brown, T., D. Force, and P. Castro. 1975. Fauna. Physical Environmental Studies, Los Angeles International Airport Series, Volume 3. Pp. 9-1 to 9-73. Los Angeles Department of Airports and the Federal Aviation Administration.

Burt, W. H., and R. P. Grossenheider. 1964. A field guide to the mammals: Field marks of all species found north of the Mexican boundary. Houghton Mifflin Company, Boston. 284 pp.

Clark, J. 1979. Ballona wetlands study; a report prepared by faculty and masters degree candidates, The School of Architecture and Urban Planning. Univ. California and The Conservation Foundation, Los Angeles and Washington, D.C., (vii) + 66 + (ii) + 45 pp. June 18.

Coulombe, H. N. 1970. The role of succulent halophytes in the water balance of salt marsh rodents. Oecologia 4:223-247

Dice, L. R. 1925. Rodents and lagomorphs of the Rancho La Brea deposits. Carnegie Inst. Washington, Publ. 349(7)119-130, August.

Edmonds, V. W., and D. S. Fertig. 1972. Longevity of the pocket mouse, Perognathus longimembris. Southwest. Nat. 17(3):293-312, October 6.

Eilers, P. 1980. Ecology of a coastal salt marsh after long-term absence of tidal fluctuation. Bull. Soc. California Acad. Sci. 79(2):55-64.

Envicom Corporation. 1981. Ecological investigations for Playa Vista Master Plan, dated 1979. In Summa Corp. Appendices. Environmental Profile of the Playa Vista Master Plan Area. Prepared by Jones and Stokes Associates, Inc. Sacramento, California. Appendix 4.

Fertig, D. S., and V. W. Edmonds. 1969. The physiology of the house mouse. Sci. Amer. 22(4):103-110, October.

_____. 1970. Water requirements of mice. Pest Control 33(6):18, 22, 24, 28, 30-31, June.

Fisler, G. F. 1961. Behavior of salt-marsh Microtus during winter high tides. J. Mamm. 43(1):37-43, February.

_____. 1963. Effect of salt water on food and water consumption and weight of harvest mice. Ecology 44(3):604-608, Summer.

_____. 1968. Adaptations in movement patterns of two species of salt-marsh rodents. Bull. So. California Acad. Sci. 67(2):96-103.

Greene, J. R., and D. S. Fertig. 1972. Water sources for house mice living in salt marshes. Physiological Zoology 45(2):125-129, April.

Gustkey, E. 1980. A time when wildlife had a different meaning. Los Angeles Times, 12 December 1980 (Part III), pp. 1, 18.

Hall, E. R. 1936. Mustelid mammals from the Pleistocene of North America with systematic notes on some recent members of the genera Mustela, Taxidea and Mephitis. Carnegie Inst. Washington Publ. 473:41-119 + 5 pls., November 20.

_____. 1981. The mammals of North America. 2 Volumes. John Wiley & Sons, New York. 1181 pp. + 90 pp. index.

Holder, C. F. 1911. Life in the open. Not read by us. (Cited in Gustkey, 1980.)

Huey, L. M. 1939. The silky pocket mice of southern California and northern Lower California, Mexico, with the description of a new race. Trans. San Diego Soc. Nat. Hist. 9(1):47-54, August 31.

Ingles, L. G. 1965. Mammals of the Pacific States, California, Oregon, and Washington. Stanford Univ. Press, Stanford, xii + 506 pp.

Johnston, R. F. 1957. Adaptation of salt marsh mammals to high tides. J. Mamm. 38(4):529-531, November.

Johnston, R. F., and R. L. Rudd. 1957. Breeding of the salt marsh shrew. J. Mamm. 38(2):157-163, May.

Kenagy, G. J. 1972. Saltbush leaves: Excision of hypersaline tissue by a kangaroo rat. Science 178:1094-1096.

Lidicker, W. Z., Jr. 1966. Ecological observations on a feral house mouse population declining to extention. Ecol. Monogr. 36:27-50, Winter.

Macdonald, K. B. 1976. Plant and animal communities of Pacific North America salt marshes. In V. J. Chapman (ed.), Wet Coastal Formation. Ecosystems of the World Series. Elsevier Scientific Publishing Co., Amsterdam.

Miller, W. E. 1971. Pleistocene vertebrates of the Los Angeles

basin and vicinity (exclusive of Rancho La Brea). Nat. Hist. Mus. Los Angeles Co. Sci. Bull. 10, viii + 124 pp., February 17.

Schwarz, E., and H. K. Schwarz. 1943. The wild and commensal stocks of the house mouse, Mus musculus Linnaeus. J. Mamm. 24(1):59-72, February 20.

Sea-shore Retreat Is Now Open. 1871. Los Angeles Daily Star, 16 June 1871. Pages 2-3.

Smith, R. L. 1980. Ecology and field biology. Chapter 20, Community structure. Harper & Row, Publishers, New York. Pp. 578-611.

Sumner, L. F., and K. G. Jollie. 1969. A survey of the rodent fauna of two southern California salt marshes. Unpublished student manuscript. Office of Curator of Mammalogy, Natural History Museum of Los Angeles County.

Stephens, F. 1906. California mammals. West Coast Publishing Co., San Diego, California. 351 pp.

von Bloeker, J. D., Jr. 1932. A new race of Perognathus longimembris from southern California. Proc. Biol. Soc. Washington 45:127-130, September 9.

Woodford, A. D., J. E. Schoellhamer, J. G. Vedder, and R. F. Yerkes. 1954. Geology of the Los Angeles Basin. In

R. H. Jahns (ed.), Geology of Southern California. Bull. 170, California Dept. Natural Resources, Div. of Mines, San Francisco, California.

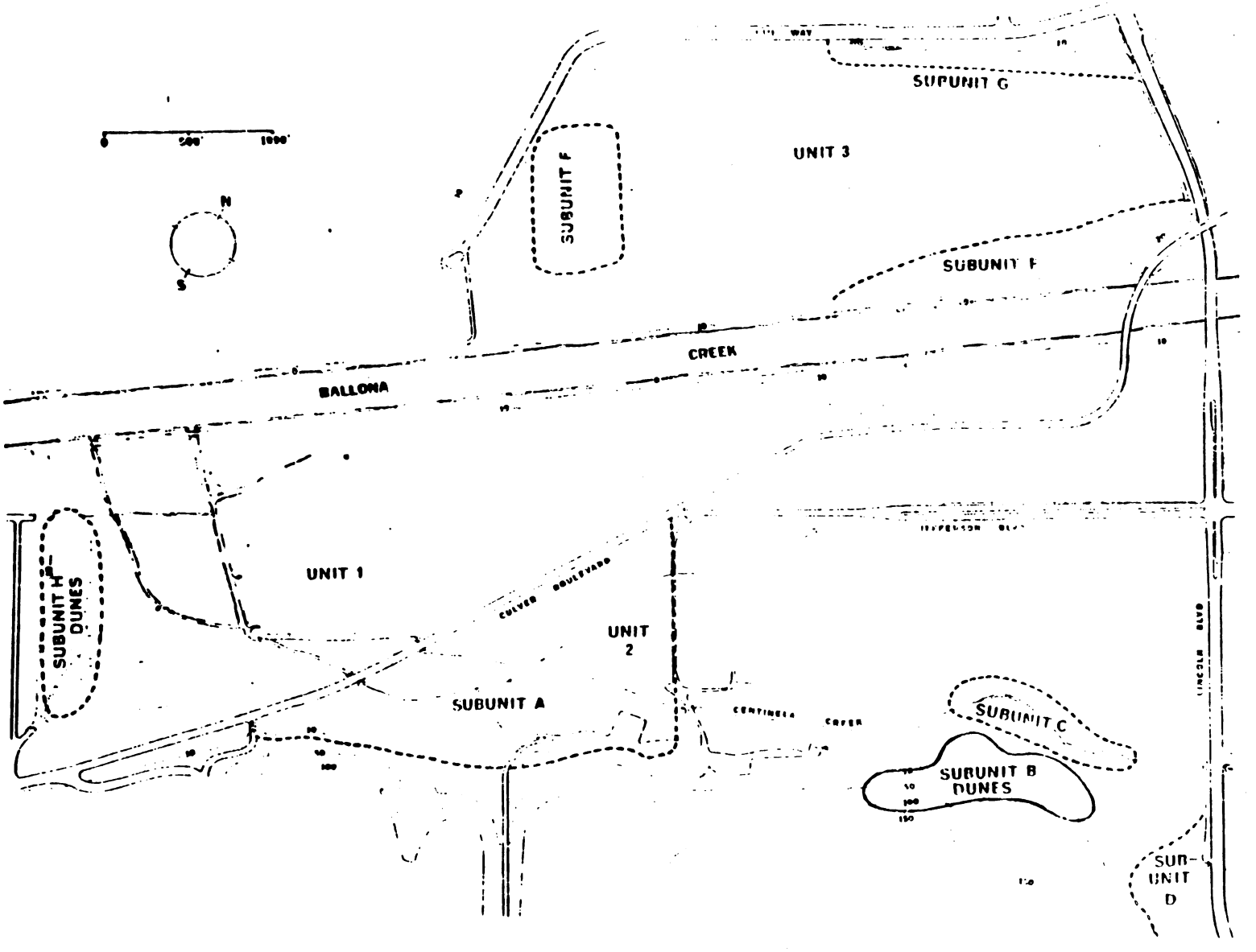

Figure 1. Study region, indicating Units and subunits used in Mammal discussion.

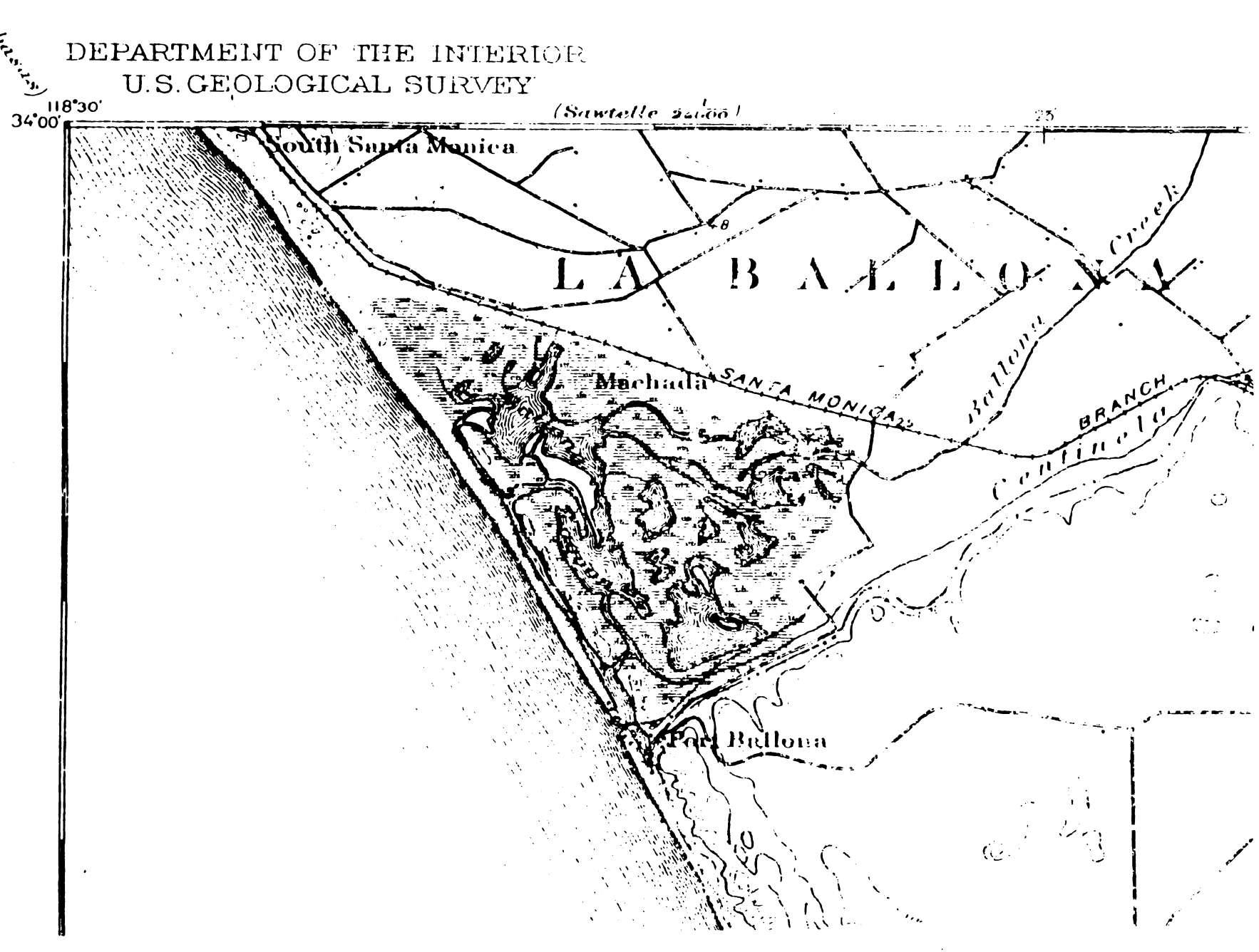

Figure 2. USGS Redondo guad map from 1896 showing tidelands in the Ballona region.

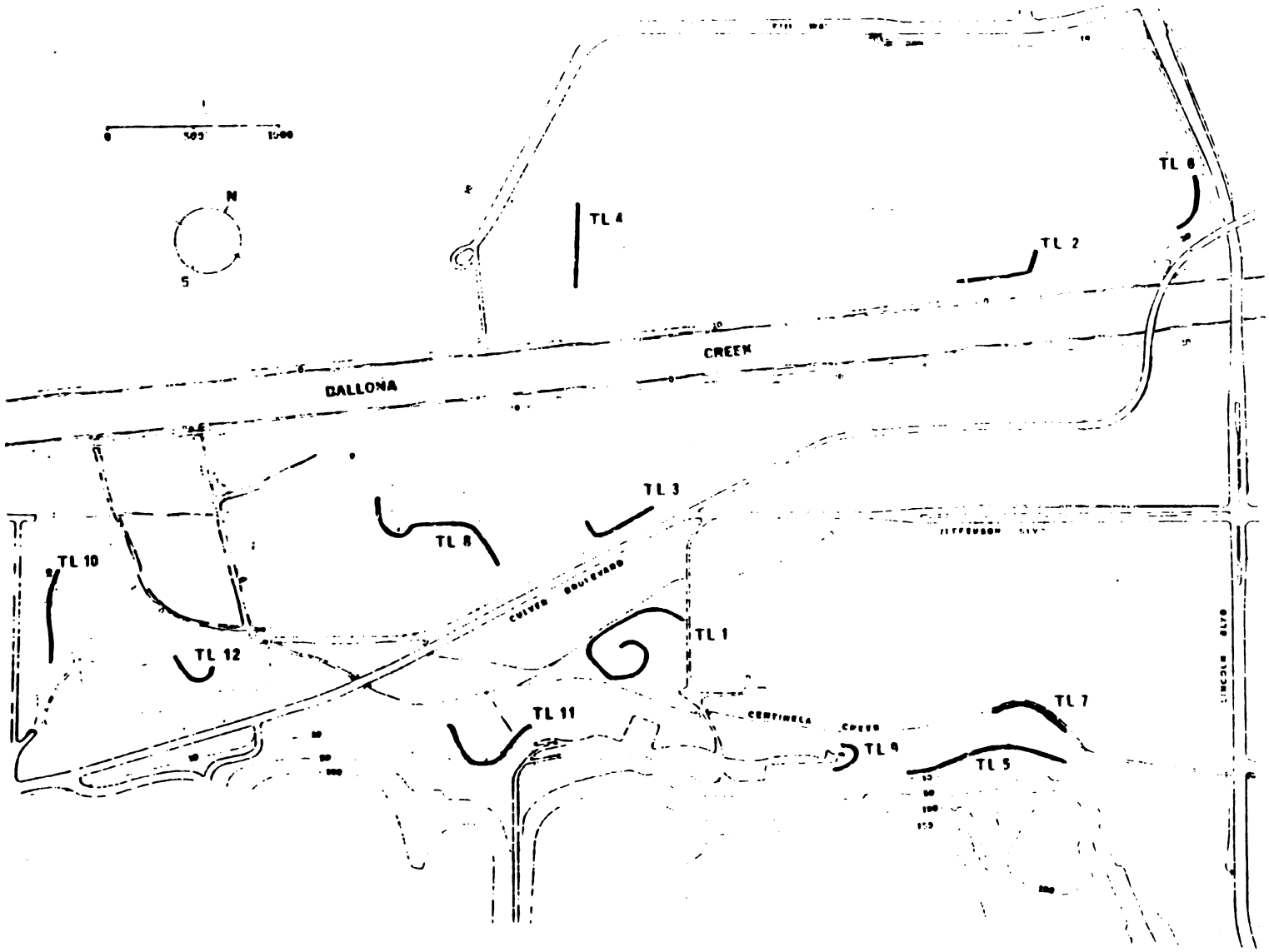

Figure 3. Locations of trap lines (TL) used to study mammal populations.

TABLE ONE. Summary of 1980-81 trapping data in Ballona region. Units and subunits are as shown in Figure One. Trapline numbers are as shown in Figure Three.

UNIT	DATE	SUB-UNIT	TRAPLINE NO.	NO. OF TRAPS	NUMBER OF INDIVIDUALS CAPTURED			
					Mus musculus	Reithrodontomys megalotus	Microtus californicus	Rattus norvegicus
1	6/8/80	-	3	75	6	2	0	0
	8/11/80	-	8	160	5	16	0	1
	9/11/80	-	8	100	8	19	0	0
	10/11/80	-	8	100	0	5	1	0
	21/12/80	-	8	125	0	9	0	0
	22/12/80	-	8	125	0	2	1	0
	5/2/81	-	8,10	100,25	0	4	0	0
	6/2/81	-	8,10	100,25	2	5	0	0
	12/4/81	-	12	25	9	4	0	0
TOTAL				900	30	62	2	1
2	5/8/80	A	1	70	5	0	0	0
	6/8/80	A	1	70	2	0	0	0
	27/9/80	B	5	60	1	0	0	1
	28/9/80	B	5	60	3	0	0	0
	29/9/80	B	5	60	0	0	0	0
	8/11/80	C	7	60	6	0	0	0
	9/11/80	C	7	60	4	1	0	0
	10/11/80	C	7	60	2	0	0	0
	13/3/81	A	11	60	0	0	0	0
	14/3/81	A	11	60	0	0	0	0
	11/4/81	A	11	60	7	0	0	0
	12/4/81	A	11	60	2	2	1	0
TOTAL				740	32	3	1	1
3	5/8/80	E	2	60	0	1	0	0
	6/8/80	F	4	30	0	0	0	0
	27/9/80	E	6	60	6	0	0	1
	28/9/80	E	6	60	3	0	0	0
	29/9/80	E	8	60	0	0	0	0
	8/11/80	E	2	30	0	0	0	0
	12/4/81	E	2	65	0	0	0	1
TOTAL				365	9	1	0	2

TABLE TWO Trapline descriptions. Numbers refer to traplines shown in Figure Three.

Trapline Number	Description
1	Periodically flooded area of uniform Salicornia, bordered by channels.
2	Highly rutted fill covered with strand and weedy vegetation.
3	Wet Salicornia to previously cultivated land.
4	Dry area including Salicornia and Anise, crossing Gas Company access roads.
5	Sandy and weedy dune remnant between hillside and cultivated field.
6	Sandy fill from creation of Marina, covered with strand and weedy vegetation.
7	Along surge channel remnant of Centinela Creek.
8	In and through edge between Salicornia and birm areas.
	Around fresh water seepage at base of bluffs.
10	Weedy sand dune area heavily used by domestic dogs and horses.
11	Includes Eucalyptus grove and adjacent Salt grass patches in Ice plant tract.
12	Dense grassy areas not inundated by tidal waters.

TABLE THREE. MAMMALS OF THE BALLONA REGION.

COMMON NAME	SPECIES	SALT MARSH	RIPARIAN	SAND DUNE	MARI-TIME
Virginia Oppossum	Didelphis virginiana	+	F	F	+
Ornate Shrew	Sorex ornatus	+	+	P	+
Broad-footed Mole	Scapanus latimanus	-	H	P	P
California Leaf-nosed Bat	Macrotus californicus	SF	SF	HF	HF
California Myotis Bat	Myotis californicus	PF	PF	PF	PF
Big Brown Bat	Eptescius fuscus	PF	PF	PF	PF
Red Bat	Lasiurus borealis	PF	PF	PF	PF
Hoary Bat	Lasiurus cinereus	F	F	F	F
Pallid Bat	Antrozous pallidus	PF	PF	F	F
Brazilian Free-tailed Bat	Tadarida brasiliensis	F	F	F	F
Western Mastiff Bat	Eumops perotis	F	F	F	F
Brush Rabbit	Sylvilagus bachmani	H?	H?	-?	+?
Audubon Cottontail	Sylvilagus audubonii	+	+	+	+
Black-tailed Hare	Lepus californicus	+	+	+	+
California Groud Squirrel	Spermophilus beecheyi	-	-	+	+
Botta's Pocket Gopher	Thomomys bottae	+	+	+	+
Little Pocket Mouse	Perognathus longimembris	-	-	H	H
California Pocket Mouse	Perognathus californicus			S	S
Pacific Kangaroo Rat	Dipodomys agilis	-	-	H	H
Western Harvest Mouse	Reithrodontomys megalotis	+	+	+	+

COMMON NAME	SPECIES	SALT MARSH	RIPARIAN	SAND DUNE	MARITIME
Deer Mouse	Peromyscus maniculatus	S?	S	H	H
Southern Grasshopper Mouse	Onychomys torridus			H	H
Dusky Footed Wood Rat	Neotoma fuscipes	-	-	H	H
California Meadow Mouse	Microtus californicus	+	+	-	+
Muskrat	Ondatra zibethicus	+	+	-	-
Norway Rat	Rattus norvegicus	+	+	+	+
House Mouse	Mus musculus	+	+	+	+
Coyote	Canis latrans	HF	HF	H	H
Domestic Dog	Canis familiaris	+	+	+	+
Gray Fox	Urocyon cinereoargenteus	F	F	+	+
Grizzly Bear	Ursaus arctos	SF	SF	SF	SF
[illegible]oon	Procyon lotor	F	F	F	+
Long-tailed Weasel	Mustela frenata	+	+	F	+
Badger	Taxidea taxus	SF	SF	SF	S
Spotted Skunk	Spilogale gracllis	PF	P	P	P
Striped Skunk	Mephitis mephitis	+	+	+	+
Domestic Cat	Felis catus	F	F	F	+
Bobcat	Felis rufus	SF	S	S	S
Mule Deer	Odocoileus hemionus		S		S

SYMBOLS:

Taxa known to occur (+) or forage (F); possibly occurring (P) or foraging (P historically known to have occurred (H) or foraged (HF); suspected to have occurred (S) or foraged (SF) historically.

TABLE FOUR. Comparative abundance of captured species in each unit. Units and subunits are as shown in Figure One.

UNIT	SUBUNIT	# OF TRAPNIGHTS	CAPTURES AS A PERCENT OF TRAPNIGHTS IN EACH UNIT			
			Mus musculus	*Reithrodontomys megalotus*	*Microtus californicus*	*Rattus norvegicus*
1	-	900	3.3	6.9	0.2	0.1
2	A	380	4.2	0.5	0.3	0.0
2	B,C	360	4.4	0.3	0.0	0.3
3	E,F	365	2.5	0.3	0.0	0.5

TABLE FIVE. Summary of recapture data for Reithrodontomys megalotis and Mus musculus from trapline number eight as shown in Figure three.

	SPECIES					
	Reithrodontomys megalotis			Mus musculus		
Date	No. caught	No. & % recaptured		No. caught	No. & % recaptured	
8/11/80	16	-	-	10	-	-
9/11/80	19	0	0%	9	2	25%
10/11/80	8	3	38%	1	1	100%
21/12/80	9	3	33%	0	-	-
22/12/80	2	0	0%	0	-	-
	4	2	50%	2	1	50%
	5	3	60%	2	2	100%

TABLE SIX. Trapping results from Soholt and Jollie (1969), showing differences between wet and dry habitats.

AREA	FROM BALLONA CREEK TO SAND DUNES AT WEST END OF MARSH	BETWEEN BALLONA CREEK AND CULVER BOULEVARD	
	sandy and dry areas not subject to flooding	dry, high areas not subject to flooding	wet areas subject to flooding
Number of trap-nights	176	168	188
Number of Specimens Captured	3	15	22
	3 *Mus musculus*	5 *Mus musculus* 10 *Reithrodontomys megalotis*	1 *Sorex ornatus* 11 *Mus musculus* 8 *Reithrodontomys megalotis* 2 *Microtis californicus*