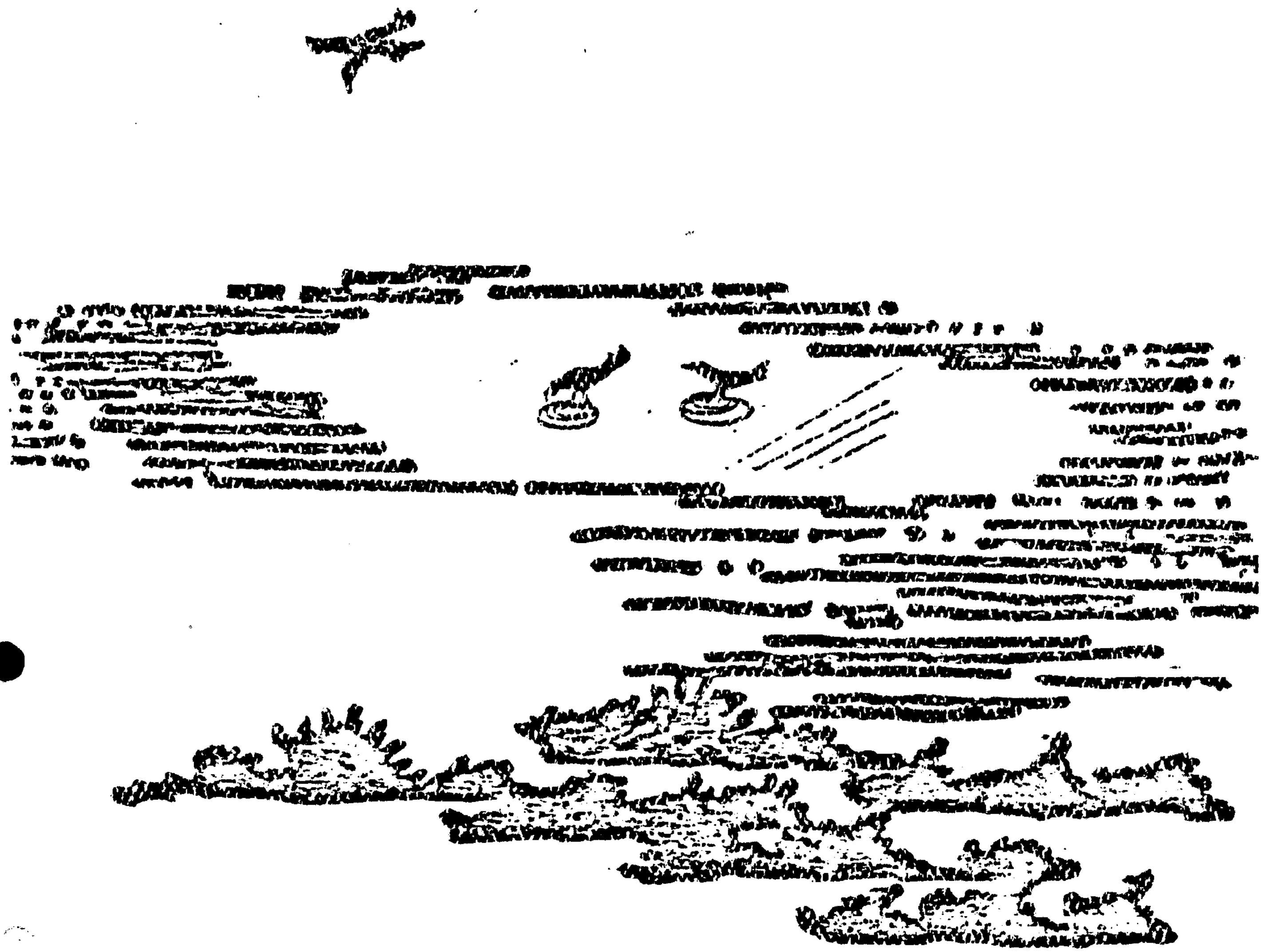
BIOTA OF THE BALLONA REGION
LOS ANGELES COUNTY



Supplement I

Marina Del Rey/Ballona Local Coastal Plan

LOS GELES COUNTY NATURAL
HIS Y MUSEUM FOUNDATION

THE BIOTA OF THE BALLONA REGION, LOS ANGELES COUNTY.

Edited by

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October 1981

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THE BIOTA OF THE BALLONA REGION, LOS ANGELES COUNTY

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THE BIOTA OF THE BALLONA REGION, LOS ANGELES COUNTY, CALIFORNIA: A SUMMARY OF THE NATURAL HISTORY MUSEUM STUDY.

Ralph W. Schreiber

INTRODUCTION

Coastal wetlands and estuaries are rapidly disappearing in the United States, and especially so in Southern California. Therefore, the value of such areas as habitat for wildlife and as open space for human aesthetics increases yearly.

The Ballona region near Marina del Rey contains one of the few remaining sizable marshlands in Los Angeles County. Prior to European colonization, this region was an ecologically diverse habitat; now it is greatly reduced and degraded by gradual urbanization. The construction of the Ballona Creek flood control channel in 1932 was the single most important factor reducing the wetlands areas. Construction of the Small Craft Harbor (Marina del Rey) in 1960-1962 also contributed to reduction of these marshes, and displaced considerable land used for agricultural purposes. Although some data exist on wildlife habitat use of the Ballona region (summarized by Jones and Stokes, 1981), the study reported here more fully documents the flora and fauna of the region than did previous studies. This work also provides the Department of Regional Planning of Los Angeles County with the data on which to base portions of the Marina del Rey Local Coastal Plan.

This final report incorporates comments made by staff members of the California Coastal Commission, California Department of Fish and Game, and the United States Fish and Wildlife Service Biological Services section.

METHODS AND RATIONALE

In discussing the Ballona region, we find it convenient to divide the region into four units as indicated on figure 1: Units 1, 2 and 3 and the Agricultural Lands. In describing our results, comments are directed to those specific units. The outlines and major features of those units are presented in the following section, Site Description.

Under contract to the California Coastal Commission, the initial bird surveys of the Ballona region began in February, 1979. Early data clearly indicated the need for a more extensive biological study of the region and in July, 1980, the Natural History Museum Foundation began a one-year study under contract to the Department of Regional Planning of Los Angeles County, as approved by the California Coastal Commission. The studies reported here were carried out by the staff, assistants and collaborators of the Life Sciences Division of the Los Angeles County Natural History Museum:

Plants: Robert J. Gustafson

Mollusks: Martin G. Ramirez and Dr. James H. McLean

Insects: Christopher D. Nagano, Dr. Charles L. Hogue, Roy R. Snelling and Julian P. Donahue

Fishes: Dr. Camm C. Swift and Gretchen D. Frantz

Reptiles and Amphibians: Marc P. Hayes and Craig Guyer

Mammals: Drs. Richard D. Friesen and Donald R. Patten, and W. Kelly Thomas

Birds: Drs. Charles F. Dock and Ralph W. Schreiber

The methodology for each discipline is described in each section report which summarize our findings. These individual studies were aimed at determining what species were present; their numbers, distribution, and biology.

We interpret those data collectively here to advise the Department of Regional Planning on the biotic interactions present on the property, to determine the extent of wetlands present and to advise on the extent of the surrounding habitats and what their interactions with the wetlands are. Our goal is to preserve a sufficient space with ecologically diverse habitats for long-term stability of the functional ecosystem.

SITE DESCRIPTION

The region that we studied is owned by Summa Corporation of Las Vegas, Nevada, and is bordered on the north by Fiji Way; on the east by Lincoln Boulevard; on the south by the bluffs, the Southern California Gas Company facilities, Culver Boulevard, and the horse stables and houses; and on the west by the dwelling units of Playa del Rey. The following are brief, introductory descriptions of the units used in this study. Details are contained in each section report, and especially the Botany description.

UNIT 1: Bounded on the west by a series of apartment complexes, on the north by a footpath paralleling the south bank of Ballona Creek Channel, on the east by agricultural fields, and on the south by a horse corral, and an embankment paralleling Culver Boulevard. Lower elevations support fairly homogeneous stands of pickleweed, while higher portions support mixed pickleweed and herbaceous vegetation. A large expanse of saltflat lies in the east-central portion of the unit, and an extensive mudflat lies adjacent to much of the northern boundary. When the flap gates are open, both habitats are flooded at high tide. Ditched saltwater canals are connected to the flood gates and connect throughout the unit and under Culver Boulevard into Unit 2. The western border of the unit is marked by a remnant dune system with a small, temporary pond within its willow stand. Elevated Southern California Gas Company access roads extend into the flats from the southeastern border of the unit.

UNIT 2: Bounded to the west by the confluence of Culver Boulevard and adjacent residential areas, to the north by Culver Boulevard, to the east by a Southern California Gas Company access road and to the south by the gas company facility and residential property with bluffs further to the south. Most of the study unit is covered by annual herbs, grasses and scattered pickleweed. The unit is crossed from west to east by two tidal canals bordered by narrow, essentially solid stands of pickleweed. A stand of eucalyptus trees and pampas grass borders the east edge of a sandy, alluvial fan opening out from a small ravine now paved as Cabora Street along the southern boundary. A small freshwater stream runs through the eucalyptus grove, receiving much of its input from street runoff. The western edge of this alluvial fan as well as much of the unit is covered by iceplant. A narrow area of exposed ground parallels Culver Boulevard along much of the northern boundary. This exposed ground, in a slight depression, fills with water after rains and high tides, forming temporary pools.

UNIT 3: Bounded to the west by residential structures and Fiji Way, to the north by Fiji Way, to the east by Lincoln Boulevard, and to the south by a road adjacent to Ballona Creek Channel. The central portion of the study unit is saltflats. These are surrounded by pickleweed and mixed pickleweed and annual vegetation. The northwestern portion of Unit 3 also supports mixed pickleweed and herbaceous vegetation. Higher elevations support grasses and scattered shrubs. A coyote brush-pampas grass shrubland dominates large portions of the east, west and north-central portions of this unit. Minimum elevations are 12 feet above mean high tide in this region, maximum is 16 feet. A drainage channel parallels Fiji Way along the north-eastern boundary. The south-central and southeastern border of this unit

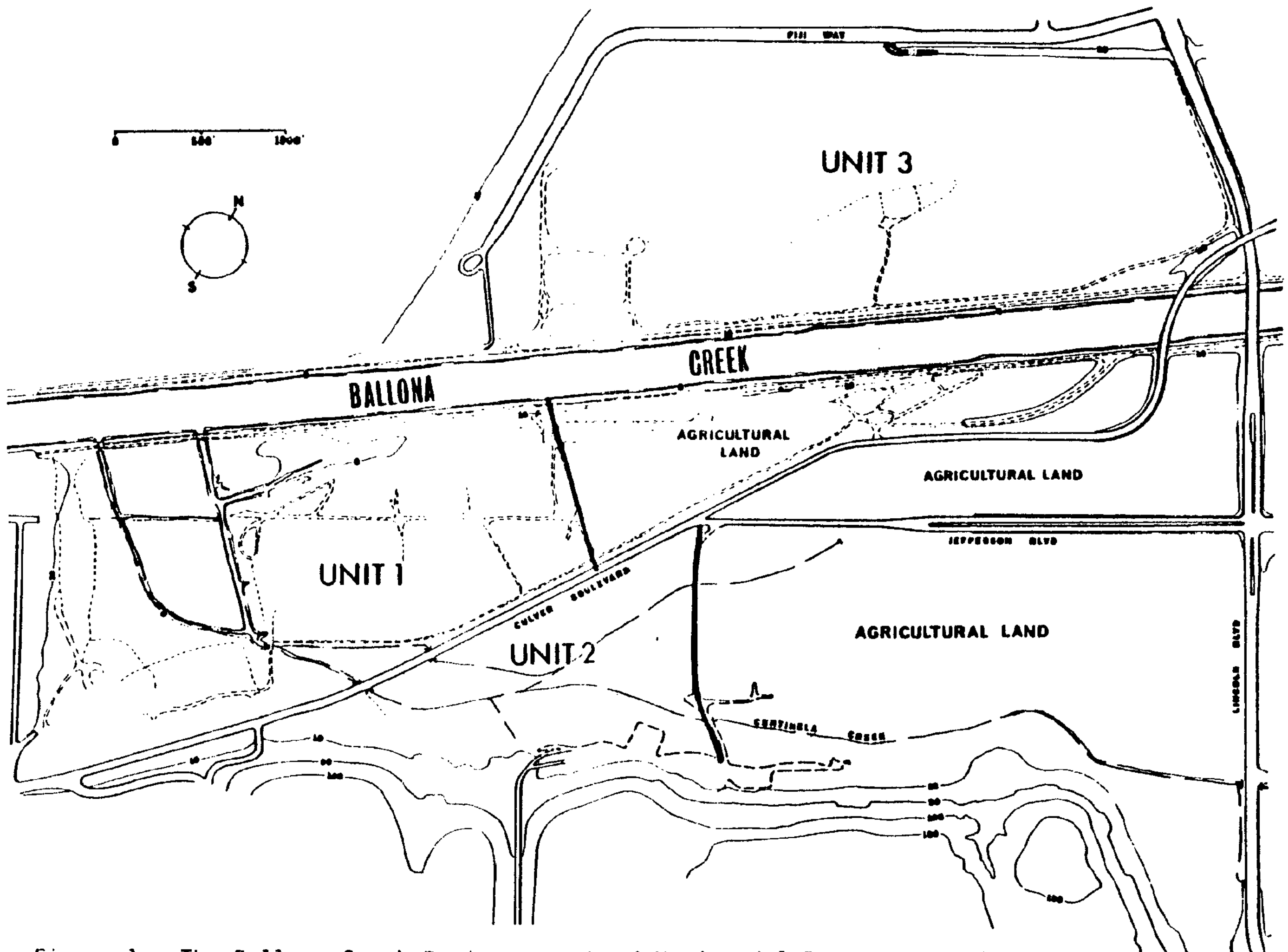

Figure 1. The Ballona Creek Region, south of Marina del Rey, Los Angeles County, California, showing study units used in the Natural History Museum study.

consists of coarse elevated fill dominated by large laurel-sumac. An access road lines the southern edge of the unit. This road connects with a complex of short, elevated access roads to gas company wells on the western edge of this unit. Unit 3 is entirely dredge spoil.

AGRICULTURAL LANDS: The Agricultural Lands (=Fields) are bounded to the west by the Southern California Gas Company access roads, to the north by the Ballona Creek Channel, to the east by Lincoln Boulevard, and to the south by the gas company facility and 150-foot bluffs. The fields are bisected by Jefferson Boulevard and the eastern portion of Culver Boulevard. Most of the area consists of periodically plowed and cultivated fields with scattered patches of grasses and herbs. In the western portion just south of Jefferson Boulevard, the Jefferson storm drain connects to a canal of Unit 2 under the gas company road. The western and eastern portion of the southeast section of fields is slightly lower in elevation and fills with storm water runoff during rainy periods. The southern border of the unit is a steep, sandy bluff dominated by large stands of castorbean and California sage. Sandy alluvial fans form at the terminus of two ravines on the south border. One ravine, at the southeast corner of the unit, contains Lincoln Boulevard. The other, in the south-central bluff area just east of the gas company facility, is eroded by the runoff from Hastings Avenue. A partly channelized freshwater drainage (Centinela Creek) flows through the southern portion of this unit from east of Lincoln Boulevard. Another freshwater habitat is a bulrush-dominated patch on the east edge of the Hastings Avenue ravine, which is fed by a seep at the base of the bluffs. Cabora Street is located midway up the bluff.

The California Coastal Act of 1976 defines wetland in Section 30121 of the Public Resources Code as follows:

> "'Wetland' means land within the coastal zone which may be covered periodically or permanently with shallow water and include saltwater marshes, freshwater marshes, open or closed brackish water marshes, swamps, mudflats, and fens."

To provide guidance in the practical application of this definition, the California Coastal Commission adopted Statewide Interpretative Guidelines for Wetland and Other Wet Environmentally Sensitive Habitat Areas ("Guidelines") as a decision of the Commission on February 4, 1981. According to the Guidelines, the Commission will make an independent conclusion using all relevant information available for a specific site, determining whether it will be considered wetland under the Coastal Act. Appendix D of the Guidelines, "Technical Criteria for Identifying and Mapping Wetlands and Other Wet Environmentally Sensitive Habitat Areas" ("Criteria") provides further guidance. The Criteria indicate that the U.S. Fish & Wildlife Service hierarchical system of wetland classification will be used "as a guide".

We have applied these Guidelines, Criteria and the Coastal Act to the data base gathered for this site to reach our conclusions of what specific areas should be defined as wetlands, and what areas should be defined in other descriptive terms for planning purposes in the Local Coastal Plan. This region is a biologically diverse area with many habitat communities, and the property must be considered acre by acre. Biologists must use several characteristics for designations of any habitat and must look for and find functional interactions between components of habitat.

Based on our data and their evaluation, we have concluded that the portions of the property which should be determined to be wetlands are the lower

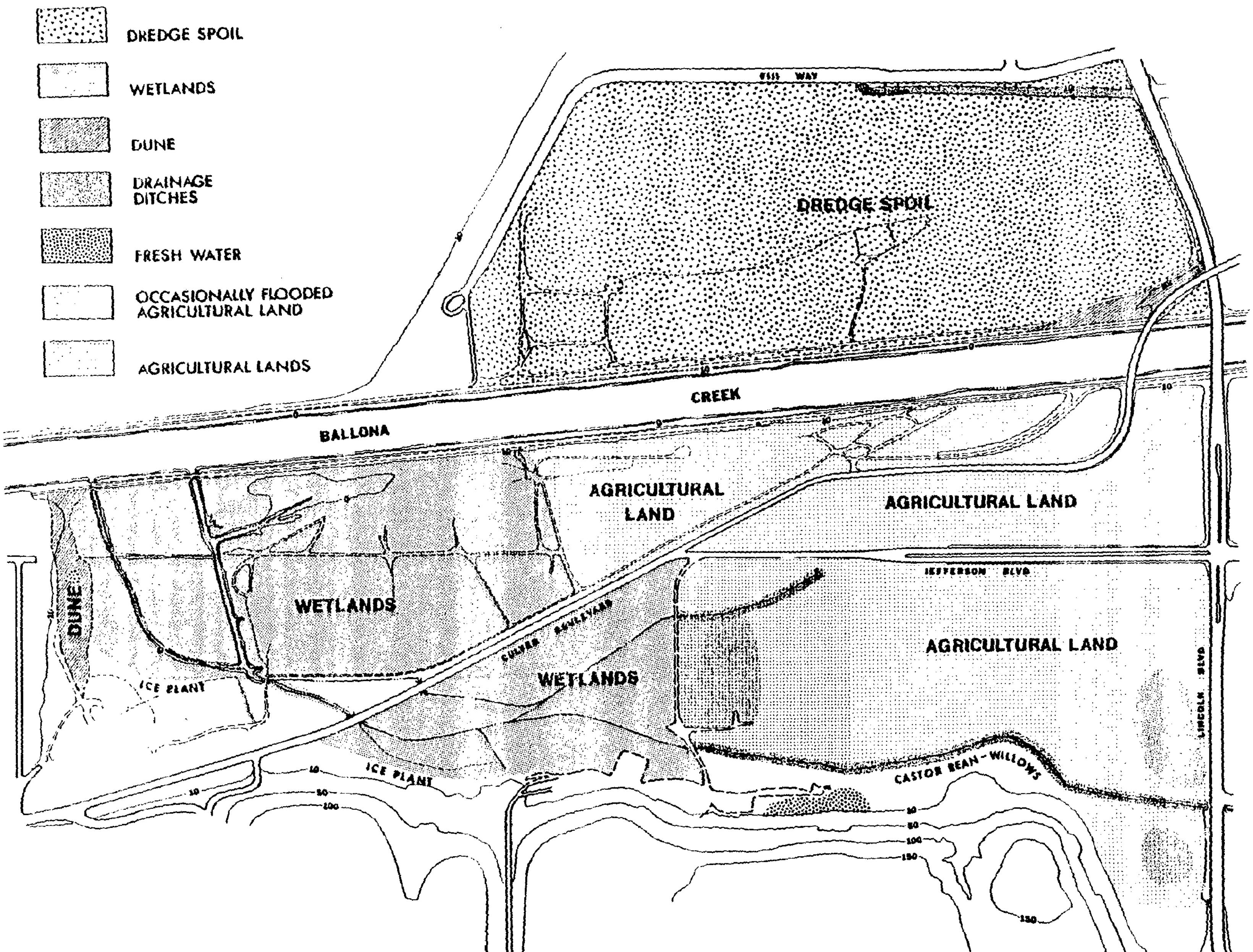

Figure 2. The present status of the units of the Ballona region.

elevations in Units 1 and 2 (Figure 2) considering the following factors:

1. the variety, high quality, and quantity of the saltwater marsh plant indicator species present.
2. the diversity of the animal populations present;
   a, the presence of fishes and marine mollusks which cannot exist out of water,
   b, the presence of aquatic insects, waterfowl, shorebirds, and the endangered Savannah Sparrows,
   c, the presence of mammals and reptiles/amphibians.
3. the presence of tidal influence.
4. the diversity, interactions,and productivity of the organisms present, and
5. the indications and prognosis that a viable, self-sufficient ecosystem is present and has a high probability of long-term continued existence with reasonable amounts of protection and management.

Based on our data and their evaluation, we have concluded that the portions of the property which should not be determined to be wetlands are the dredged spoil area north of the flood control channel and most of the agricultural lands considering the following factors:

1. the historical aspects and obvious ecological old field succession that has occurred on the dredged spoils.
2. the lack of diversity and productivity in populations of plants and animals found there, and
3. the obvious lack of tidal influence.

We believe that Unit 3, or even portions thereof, should not be designated wetlands because in a biological sense the definition lacks heuristic (predictive) value. Unit 3 should not be classified a saltwater marsh, a freshwater marsh, a brackishwater marsh, a swamp, mudflat, or fen. Early in the 20th century, this unit may have been marsh but the available aerial photographs clearly indicate that by the 1950's it had been converted to agricultural land. During construction of Marina del Rey in 1960-1962, the dredged spoils were placed on this unit and the agricultural use was destroyed. The marine bottom material was conducive to Salicornia growth in the central, lower portions of the dredged material. However, a series of historical aerial photographs since 1962 clearly indicate this community is deteriorating and breaking up into small pockets. Our subjective impression over the past two years of work on the Unit also indicates qualitative deterioration and comparison with the obivously healthy vegetation on Unit 1 clearly shows the poor quality of the hydrophilic plants on this dredged material. The present mean minimum elevation of 12 feet above mean high tide precludes long-term wetlands interactions as a functional community. Our entomological data confirm the absence of insects and other arthropods which require wet conditions and thus the lack of a true "wetlands" in this unit. These data indicate this unit is rapidly undergoing old field successional stages. In the Unit 3 dredged spoil area, the presence of Salicornia today is not a significant indicator of wetlands but merely indicates the remnants of the conditions created by bay bottom dredging. We believe this unit is properly simply called dredged spoil. With the presence of functional wetlands in Units 1 and 2, we believe that efforts should be placed on management and restoration of those areas rather than expending efforts on a community that was artificially constructed and will never serve as a wetlands habitat.

The California Coastal Act defines environmentally sensitive area in Section 30107.5 as follows:

"'Environmentally sensitive area' means any area in which plant or animal life or their habitats are either rare or especially valuable because of their special nature or role in an ecosystem and which could be easily disturbed or degraded by human activities and developments."

As noted in the "Guidelines," the Coastal Commission will make an independent determination based on all available data of whether a specific site is to be designated as an environmentally sensitive area. We believe that the following recommendations will assist in defining the specifics of this property in relation to such designations and in determining consistency with Section 30240 of the Coastal Act, which contains standards for siting development both within and adjacent to environmentally sensitive areas.

1. Preserve adequate large diverse space. Wetlands are not isolated, independently functioning systems and are dependent on associated watersheds and upland transition areas. Additionally, since ecological stability is related to habitat diversity and sufficient space, we believe that maintenance of a large contiguous area is the only alternative that meets the criteria of preserving the maximum number of species and a viable wetlands system within this region. Preserving small portions of various areas that are not connected by open, native habitat will not provide the stability needed in this region for long-term maintenance of the marsh. Units 1 and 2 are the center of the area to be protected. The portions of land needed to buffer and protect the wetlands and provide the ecological diversity necessary for stability in this region are: the bluffs and slopes to the south of Units 1 and 2 and extending to the east beyond Lincoln Boulevard; the dunes to the west of Unit 1 (see 5 below); the slightly higher portions of land immediately surrounding the wetlands; and the occasionally wet

agricultural lands immediately to the east of Unit 2 which grade onto the slopes and along the Centinela Creek drainage ditch. These areas might or might not be designated as ecologically sensitive habitat or buffer but they clearly fit the ecosystem concept and thus should not be separated from the wetlands. The dunes and slopes will provide buffer to the wetlands on the south and west and the Ballona Creek flood control channel on the north provides adequate buffer there. To the east we believe the construction of a nature center north of Culver Boulevard will buffer Unit 1. A road along the present gas company access road and construction of a tidal-influenced, freshwater lake with its mud flats area immediately east of that road would provide adequate buffer to Unit 2. Maintenance of open space with proper fencing along the north side of Centinela Creek after its relocation will provide protection to the north side of the bluffs. With protection of this total region incorporating the following recommendations we believe that both the spirit and letter of the Coastal Act laws are met in regards to habitat protection. Outside of these areas, any reasonable construction, under 60 feet, will probably not affect the wildlife within such a protected zone.

2. Increase saltwater flow and enhance littoral zone. The littoral zone is the area subject to tidal influence. Pickleweed (*Salicornia* spp.) is characteritically the dominant plant of the upper littoral zone along the southern California coast. Increasing the amount of tidal water entering the system would increase the productivity of the *Salicornia*, and the addition of the water onto Unit 2 would increase the density and health of these plants while causing the weedy higher-elevation plants there to decrease. With added water into Unit 1, the *Salicornia* would increase the area on which it grows and thus provide important additional habitat for Belding's Savannah Sparrows, one of the endangered species present on the wetlands.

As discussed below, breeding populations of Belding's Sparrows are limited to pickleweed. Expansion of stands of that plant could potentially increase the size of the Ballona population of the sparrow. This could be an important factor in the long-term survival of the species. Enhancing pickleweed quality and extent and its associated insect fauna would be beneficial to the total ecosystem stability. Increasing tidal flow with resultant stands of salt grass would also allow the Wandering Skipper, a rare insect, to increase the size of its current population. Pickleweed is also essential as primary foraging habitat for the Alligator Lizard.

Increasing the extent of the littoral zone would be accomplished by (1) installing tidal flow systems to allow unrestricted water movement from the Ballona Creek channel into the wetlands; (2) breaching the berms along the channels within the wetlands; (3) installing additional culverts under Culver Boulevard; and (4) by creating several additional channels. These steps should be carried out in Units 1 and 2. Wide culverts, including normally dry areas suitable for passage of terrestrial animals are essential to allow the organisms present to increase their populations and allow easy movement over the property. Increasing tidal flow would also provide the input of nutrients and flushing action necessary to support larger invertebrate and fish populations in Units 1 and 2.

While increased saltwater flow is generally desirable, flooding in some areas should be restricted so as to produce drier, higher habitats required for egg-laying and refuge sites by the herpetofauna and other animals. To this end, we suggest that the access roads to the gas company wells in the central area be modified to provide more gradual slopes and be planted with native vegetation; similar modification of the channel berms would also enhance their value to wildlife.

3. Preservation of mudflats. Mudflats provide exceedingly important

habitat for many organisms, most spectacularly the wintering water and shorebirds in the Ballona region. Many herbivorous-detrital-eating mollusks move about on the surface of the mudflats, and many invertebrates (i.e., polychaetes and insects) provide a source of food below the surface. The flats are also habitat for the Mudflat Tiger Beetle, which is greatly reduced from its original range in the United States. Many species of estuarine flies and beetles breed or develop in the mud. Preservation and enhancement of the flats are important to the stability of the ecosystem. The mudflats most important to the birds occur in Unit 1. In addition, the fields on the western portion of the agricultural lands are occasionally flooded during winter rains and at those times provide an important foraging area for the wintering shorebirds. The rainy period coincides with the presence of large numbers of wintering and migrant shorebirds in southern California. There is substantial movement of birds between Unit 1 and these occasionally flooded agricultural fields. It seems advisable to preserve an open flyway between these two regions. It is probable that an even more favorable situation could be created by providing for regular (or even permanent) flooding of this area. This would require grading and construction to allow tidal flow and freshwater intrusion. Any construction in the area should be undertaken in the dry season to avoid disturbance to the bird populations.

4. Limit access by humans and human artifacts. The Ballona wetlands show obvious degradation due to traffic by vehicles, domestic animals and humans on foot. The negative effects of such intrusion are particularly obvious in Units 1 and 2, where the disturbance to the natural functioning of the system cannot be overemphasized. Unit 1 is frequently used by horseback riders, presumably emanating from the stables immediately adjacent to the marsh on Culver Boulevard. Horse and other traffic severely damage

the existing vegetation and definitely inhibit growth of new plants by compacting the soil and crushing subterranean animal forms. Food and cover for animals are removed, and invertebrate and vertebrate life killed. Human intrusion also disturbs the activity cycles of all animals, especially the birds. Dogs and cats cause serious disturbance and actually kill wildlife.

Off-road vehicular- (ORV) caused mortality to animals and plants is a major problem in this region. Such traffic has increased during the two years of our study, and the effects of ORV's are potentially even more serious than those of horses or dogs, because of the deeper disturbances and much larger area they are able to cover.

We suggest that the wetlands in Unit 1 and 2; the buffer areas, especially the dunes; and the remainder of the management-support area should be restricted to allow only human-foot traffic for scientific and education purposes under strictly controlled conditions (see below #10 for nature center recommendation). All vehicular traffic and domestic animals must be entirely excluded.

5. <u>Preservation and enhancement of dune habitat</u>. Like marsh and estuarine systems, coastal dunes are becoming increasingly more rare in California. The west end of Unit 1 is an important dune habitat. The highest number of insect species restricted to the sea coast are found there. This area is inhabitated by the California Legless Lizard (<u>Anniella pulchra</u>), which can only survive in areas of loose sand. We found this lizard only on the dune and the sandy alluvial fan near the southwest corner of the Ballona region, but we suspect it is also present on the large alluvial fan near the southeast corner of the region. Maintenance and protection of these areas is strongly recommended, and as noted we suggest

that access by humans should also be prohibited in the dunes and alluvial areas.

6. Provision for freshwater habitat. Fresh water is an important component of this region and a balance between salt water and fresh water is essential to the environmental health of the wetlands. At present, the freshwater input to the region is primarily from the highly polluted Jefferson storm drain, Centinela creek drainage ditch, and runoff along with erosion from the bluffs on the south side of the property. This fresh water is important for the maintenance of the *Salicornia* in the wetlands during the winter rainy season, as it provides dilution of the salt water to the brackish conditions that define a saltmarsh. The drainage ditches support freshwater aquatic plants, freshwater fishes and are breeding sites for amphibians. The Pacific Tree Frog and Western Toad are dependent on the freshwater sites. Mosquito fish (*Gambusia affinis*) were introduced in the freshwater system and have become an important food source for birds and are also an important predator on mosquito (Culicidae) larvae.

Although drainage ditches are important as a freshwater source and habitat on this property, they have not been designed for this purpose. We suggest that they be rebuilt, and possibly moved, so that they can provide an enhanced and functional freshwater system within the larger region. Reclaimed water from sewage treatment could also be effectively used for enhancement of the wetlands by either constant input or occasional flow over Units 1 and 2.

7. Exclude dumping of solid waste and dissolved chemical pollutants. Much of the property is badly littered with trash. While this material may provide some habitat for organisms, it is unnatural and detracts from the overall aesthetic value of the property. Dumping and accidental littering should cease and the existing refuse should be removed.

Pollution of the aquatic portions of the region by hydrocarbon pesticides, heavy metals and other chemicals is a potential source of further degradation of the wetlands. The Mullet fishes captured during this study showed a high frequency of ended fins and other abnormalities associated with high pollution levels. An adequate means must be found to minimize the present pollution sources and to minimize undesirable contaminates such as pesticides, fertilizers, and heavy metals from entering the system.

8. Construction of tern breeding site and bird roosting-loafing area. Unrestricted tidal flow, as recommended above for augmentation and enhancement of the saltmarsh habitat, conflicts with the goal of maintaining a viable Least Tern colony in the region. Normal tidal action will flood the saltflats of Unit 1, where Least Terns nest when it is dry. The variety of breeding sites currently in use by Least Terns in California indicates that they will use a wide range of dry surfaces with a substrate appropriate for nest excavation. It should be feasible to elevate the breeding colony area above the high-tide level, thus avoiding periodic flooding. This could be accomplished by filling in the tern colony area with soil graded from the surrounding area during the early fall. This "island" should be topped by sand substrate which would be more favorable for nest construction than the existing saltflat. Any such efforts should, of course, be planned in consultation with the California Least Tern Recovery Team and timed to avoid conflict with tern breeding. This raised area would provide a permanent roosting-loafing site for shorebirds and waterbirds and would enhance the bird use of the region.

9. Increase the number of native trees, shrubs and low-growing vegetation compatible with moisture levels of the fauna. Trees and shrubs are limited

in the Ballona property and much of the area is dominated by introduced species of plants such as eucalyptus and iceplant (Carpobrotus edulis). These non-native plants are detrimental to a functional ecosystem; few animals feed on them, and the iceplant is crowding out native plants that are used by local organisms. The lack of trees and shrubs limits the foraging habitat; number of refuges and roosting-loafing sites; and prey items available for the resident and migrant vertebrates on the property. Our insect and reptile-amphibian data especially indicate that those species are most abundant in the native shrub vegetation that is available.

Additional native trees and shrubs should be planted around the margins of the wetlands, and this could be accomplished easily in areas such as surrounding berms and the access roads to the gas company wells. The iceplant should be eliminated, because it will eventually crowd out many of the native plant species. The dunes can be expanded by bringing in more sand to the south end of the system. Shrubs such as Laurel-Sumac (Rhus laurina), California Sage (Artemisia californicum), California Buckwheat (Eriogonum californicum) and lupine (Lupinus chamissonis) planted in sandy sites would greatly enhance the region as a diverse wildlife habitat.

10. Construction of nature center, observations sites and nature trails. A nature center should be constructed on the property, and provisions made for adequate funding of a full-time staff of naturalists and custodians to carry out natural history educational programs and maintenance and ranger service in the region. Access points to the marsh should be provided to allow appropriate recreational and scientific use of the region. Such activities as nature study by school groups, bird watching and photography, and walking in a green-protective zone would not conflict with conservation goals if properly planned and should be incorporated into the

development plans for the property. Elevated walkways could be provided which allowed observations of the wetlands and dune-riparian habitats without undue physical intrusion. A model system exists in the Florida Everglades and Corkscrew Swamp, where a series of walkways extend into various habitat types with sufficient buffer to preclude disturbing native wildlife. Periodic rest points provide interpretive information on the biology, geology and climatology of the region. Such a nature center would have the obvious benefit of increasing public awareness of the importance of wetlands and other native habitats and serve as a model for other such preserves in California.

THE VEGETATION OF BALLONA

Robert J. Gustafson

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Robert J. Gustafson

INTRODUCTION AND METHODOLOGY

The vegetation of the Ballona wetlands has been carefully mapped and discussed in previous reports (Envicom, Army Corps of Engineers, and UCLA). Apart from the plant species list prepared by Envicom and a partial list by Judith Clark for the UCLA report, an actual plant inventory had not been thoroughly undertaken with voucher specimens deposited into a credited institution. The present investigator is a taxonomist, not an ecologist, and it has been his primary purpose to collate a list of plant species over a one-year period beginning in July 1980 through August 1981. About 75 to 100 hours were spent walking over the study units on approximately 15 separate field trips. All the plants collected are deposited in the herbarium of the Natural History Museum, Los Angeles County. In addition, each herbarium sheet has a map of the study areas with an indication of the proximate locality where the plant was collected. No rare and endangered species were recorded from the sites, but some plants not previously found in Southern California either as escapes or adventives were discovered. In cases of uncertainty in identification, plants were sent to Tom Fuller and Doug Barbe at the Department of Food & Agriculture, Sacramento, who specialize in introduced weeds. No mapping or transects were undertaken by this investigator, although distribution of plant species in the various parcels was carefully noted.

WETLANDS DEFINITIONS

The U. S. Fish and Wildlife Service defines wetlands as follows: "...land where the water table is at, near or above the land surface long enough to promote the formation of hydric soils or to support the growth of hydrophytes. In certain types of wetlands, vegetation is lacking and soils are poorly developed or absent as a result of frequent and drastic fluctuations of surface-water levels, wave action, water flow, turbidity or high concentration of salts or other substances in the water or substrate. Such wetlands can be recognized by the presence of surface water or saturated substrate at some time during each year and their location within adjacent to vegetated wetlands or deep-water habitats."

Three parcels of land (designated as Units 1, 2 & 3, see maps) were carefully surveyed by the museum team for over a one-year period. As a result, the breakdown of wetlands within each of these parcels is defined as follows. Unit 1: approximately 72 acres bounded by the Ballona Channel on the west, Culver Boulevard on the east, the dune community on the south and the Gas Co. entrance on the north. Unit 2: west of the Gas Co. road, approximately 55 acres bounded by the bluffs to the south, Culver Boulevard to the west; east of the Gas Co. road on property which is bounded by the bluffs on the south, Jefferson Boulevard on the north and Lincoln Boulevard on the east are a freshwater marsh 2-3 acres in size just east of the Gas Co. facility, and a riparian community about 4 feet on each side of the Centinela Creek drainage ditch along its entire length. In the western part of the occasionally-flooded agricultural area degraded *Salicornia* is found. Unit 3 is the dredge spoils from the construction of the Marina in 1961-62. This 139-acre parcel contains approximately 62 acres of dry pickleweed (transitional) habitat. The presence of Salicornia has been used as an indicator of wetlands, but the existence of Salicornia, by itself, does not indicate conclusively that this area is a wetland biologically. Salicornia on this site is poor in quality, especially by comparison to that found in Units 1 and 2 which are subject to tidal flow. The pickleweed community of the spoils area is more or less confined to the central, lower portions of the fill which contain the salt pans. Whether or not hydric soils are present here seems to be a debatable point: the Shapiro report for the Corps maintaining there are, while the Fruit Growers Laboratory, Inc., findings indicate the exact opposite. Only further analyses will resolve the issue. Other factors that may play a part in the presence of Salicornia on this site are its hydrophytic as well as halophytic nature, the presence of sea water intrusion and capillary action which could provide sufficient moisture to maintain the community, or a perched water table. It would appear that the successional scrub community that is forming on the higher portions of the spoils is slowly advancing, probably because the winter rainfall has been leaching out the salts and washing them into the central depressions over the past 20 years. That the Salicornia persists is certainly an indication of its halophytic nature, although it has never been proved to be an obligate halophyte. Salt flats may be an important aspect of a salt marsh ecosystem, but this is not the case here because the spoils do not contain a salt marsh habitat, and there is no tidal influx. However, the land has value as open space and the opportunity to watch the development of an upland scrub community.

OCCASIONALLY FLOODED ARGICULTURAL AREA

In addition to the wetlands areas, there are 15 to 20 acres of occasionally flooded agricultural lands located east of the Gas Co. road in Unit 2 (see map).

VEGETATION TYPES

Three designated areas have been extensively surveyed over a one-year period and the results have been plotted on three maps (see Figures Bo-1-3 respectively). Because the boundaries between the plant communities are, or have been subject to topography, urban disturbance or soil type, one does not necessarily find a nice gradational pattern between them. The maps (legend adapted from Envicom report) indicate the major grouping of plants within each of the study areas. These maps correspond closely to the overall findings of the Shapiro report.

Estuarine Habitats

1. Pickleweed Saltmarsh (Fig. 4)

Pickleweed (*Salicornia*) is the dominant plant of this community. Two species occur at Ballona with *S. virginica* being the most abundant and found in all three units. *S. subterminalis* is locally common only in Unit 1. *Salicornia* is the most widespread halophyte in California saltmarshes. It forms a low-growing, dense stand south of the Ballona Channel in Unit 1, while in Unit 2 it is most prevalent west of the Gas Co. road. East of the road in the Agricultural area, *Salicornia* is present in limited areas where winter ponding occurs. Agricultural practices in previous years have resulted in the area being disced during the early summer months. The plants on the dredge spoils of Unit 3 are centrally located bordering the salt pans.

Within the pickleweed marsh proper are areas that are or have been invaded by aggressive weedy species. Iceplant (*Carpobrotus edulis*) has invaded the marsh in the southern part of Units 1 & 2 where it forms an almost impenetrable ground cover. Saltgrass (*Distichlis spicata*) is common in these transitional areas, especially in the southwestern section of Unit 1 where the marsh abuts against the sand dune community. It is frequent in Unit 2 throughout the pickleweed community and also is present in some upland areas, especially highly disturbed situations.

Sicklegrass (Parapholis incurva), an introduced European species naturalized in California saltmarshes, is relatively common in the central section of Unit 1 (also in the eastern half of Unit 2), especially along the drying edges of the pickleweed community. Other aggressive weeds such as Melilotus, Conyza, Rumex, Beta, Picris and Atriplex can also be found here. Introduced weedy species comprise approx. 15% of the total plant cover of the pickleweed communities and are most abundant on the berms or along paths through the marsh.

Since the Ballona saltmarsh lacks a low and middle marsh flora, the pickleweed occurrence is topographically lower than in other Southern California saltmarshes which have been subject to less disturbance. Many saltmarsh species are not found at Ballona, due perhaps to the restricted water-flow between the marsh proper and the channel. Although the pickleweed marsh at Ballona is considered a high marsh, several species (Monanthochloe littoralis, Limonium californicum, etc.) usually characteristic of this situation are absent. Before the advent of the flood control channel during the 1930's, it is possible that a natural barrier could have developed periodically which restricted the flow of water to the marsh. As it now stands, several factors such as stagnation, salinity, temperature fluctuations, etc., have kept the marsh at a low-level species density.

2. Mudflats and Saltflats (Fig. 5)

The vegetation of these areas is practically non-existent except for the presence of green algae which become abundant during the spring-summer months. Since these areas are slightly lower than the pickleweed communities, the salt crusts associated with them undoubtedly have a strong influence in limiting the vegetation. A thin layer of water often persists on these flats depending on the rainfall from the previous winter-spring months.

Freshwater Habitats

1. Willow Community (Fig. 6)

A unique community of willows (*Salix lasiolepis*, *S. laevigata*), *Populus fremontii*, *Juncus*, *Carex* and *Eleocharis* occurs in the southwestern section of Unit 1, just west of the sand dune community and immediately south of the *Distichlis*-*Salicornia* marsh, a curious association and juxtaposition of plant communities not known elsewhere in the county. Around the periphery of this community are several plants of an introduced Australian shrub, *Myoporum laetum*, which appears to be naturalizing.

Another type of willow community occurs in Unit 2 along the base of the bluffs above or south of Centinela Creek. Here the willows, *Salix lasiolepis*, grow in close association with castorbean, *Ricinus communis*, forming rather dense stands. The water is supplied to this area largely from urban runoff.

2. Freshwater Marsh (Fig. 7)

Along the drainage ditch of Centinela Creek, west of Lincoln Blvd., a freshwater habitat prevails for most of its length to the Gas Co. facility. Here the water becomes increasingly brackish with *Salicornia* prevailing along the ditch. In addition to introduced weeds like *Paspalum*, *Polygonum*, *Chenopodium*, etc., which comprise about 15% of the freshwater marsh flora, there are several native aquatics (*Scirpus robustus*, *S. californicus*, *S. olneyi*, *Eleocharis*, *Sagittaria*, *Typha*, etc.). *Ruppia maritima*, a submerged aquatic, is relatively common in the more western part of the creek. A large stand of *Scirpus olneyi* occurs close to the Gas Co. facility about 10 yards south of the ditch proper. *Typha latifolia*, *Urtica holosericea*, *Eleocharis*, *Cyperus* and *Salix* are also to be found here.

Terrestrial Habitats

1. Coastal Dune (Fig. 8)

Three areas of coastal dune community are found on the study sites. The most extensive is along the southwest boundary of Unit 1 where the dominants include *Lupinus chamissonis*, *Erysimum suffrutescens*, *Camissonia cheiranthifolia*, *Phacelia ramosissima* and *Abronia umbellata*. Parts of this area are being invaded by *Carpobrotus*. A small slip of land near the southeastern corner of Unit 3 also supports a coastal dune vegetation with *Croton californicus*, *Camissonia cheiranthifolia* and *Eriogonum parvifolium* as the most conspicuous elements. Invading this community are *Erodium botrys*, *Bromus rubens* and *Chrysanthemum coronarium*. This community probably arose subsequent to the building of the flood control channel during the 1930's or it could be a vestige of what was once a more extensive system. Remnants of a coastal dune community occur on the bluffs above Centinela Creek in Unit 2, now largely colonized by *Salix* and *Ricinus*.

2. Coastal Scrub (Figs. 9a & b)

The scrub commuity is present along the bluffs in the southern part of Unit 2 with *Haplopappus* species, *Corethrogyne filaginifolia*, *Elymus condensatus*, *Galium angustifolium* and *Lotus scoparius* as examples of typical plants found here. A successional coastal scrub community appears to be developing on the dredge spoils of Unit 3 characterized by the presence of *Rhus laurina*, *Rhus integrifolia*, *Artemisia californica*, *Gnaphalium microcephalum* and *Ricinis communis*. Many weedy annuals are also present, but *Chrysanthemum coronarium* becomes dominant in the late spring months. This community occupies less than 20% of Unit 3 and occurs along the southern boundary of the site just north of the channel.

3. Transitional Pickleweed and Salt Pan (Fig. 10)

During the construction of Marina del Rey in the early 1960's, the dredged earth was dumped into Unit 3 considerably altering the composition of the previous vegetation. The central section is salt pans and flats surrounded by *Salicornia*. Because the pans and flats are lower than the surrounding areas, rainwater is leaching out the salts in elevated portions of the spoils and concentrating them into this central depression. This dry pickleweed habitat is for the most part monotypic, but *Frankenia*, *Gasoul* and *Polypogon* are sometimes associated with it; *Salicornia* covers approx. 62 acres of the site.

3. Coyote Brush and Pampas Grass (Fig. 11)

On the higher elevations in the eastern part of Unit 3, a brushy scrub comprised of *Baccharis pilularis* ssp. *consanguinea* and *Cortaderia atacamensis* has become established. Neither of the plants mix to form a single plant community. *Baccharis* is also dominant in the northwestern section. Smaller herbaceous perennials are also found associated with them, such as *Gnaphalium chilense*, *Malephora crocea*, *Carpobrotus edulis*, *Sida leprosa*, *Centaurea repens* and *Verbascum virgatum*.

4. Agricultural Areas and Weedy Fields (Fig. 12)

Because of the extensive urban activity and filling and diking of the Ballona wetlands, several areas have become colonized by mostly introduced species, largely weedy in nature, wind-pollinated and annual in growth form. Several grasses (*Avena*, *Hordeum*, *Bromus*, *Festuca*, *Paspalum*, etc.), mustards (*Brassica* and *Raphanus*), composites (*Chrysanthemum*, *Picris*) form the basis of this category. Many members of the Chenopodiaceae are also associated with these fields (*Bassia*, *Salsola* and *Chenopodium*).

A few ornamentals (such as Phoenix, Eucalyptus, Ceratonia, Acacia) occur scattered throughout the parcels. Some were undoubtedly planted at some time in the past while others are probably adventives.

COMMENTS ON PLANT SPECIES AT BALLONA

There were a total of 235 plant species recorded from the primary study sites representing 50 plant families. Of these 235 species, 130 are introduced or naturalized, and 105 indigenous to California. Because of the continued disturbance at Ballona over the years, the weedy components cover approx. 40% of the total land under investigation. Approx. 15% of this figure can be attributed to the spread of Carpobrotus alone which if unchecked will continue to encroach not only on the salt marsh community but in the upland habitats where it is becoming established as well. The dredge spoils, Unit 3, contain a high percentage of introduced weeds (by volume), although a coastal scrub community comprised of primarily native shrubs has established itself. Even though this unit is comparatively new vegetatively speaking, at least 50% of the plant cover represents indigenous species (including the 62 acres of Salicornia). The weedy cover includes primarily annual grasses, composites, mustards and patches of iceplant (Carpobrotus and Melephora).

Unit 1 is covered by approx. 70% of native plants (mostly Salicornia, Frankenia, Distichlis and Atriplex). The weedy elements are confined to disturbed areas, berms, bridal paths; at least 15% of this parcel is covered by iceplant. Unit 2 west of the Gas Co. road is largely Salicornia, although weedier than in Unit 1, and covers about 65% of the property. The rest is largely iceplant and eucalyptus. East of the Gas Co. facility the land has largely been given over to agriculture and less than 20% of the parcel contains native plants (including the occasionally flooded areas where Salicornia and Cressa are growing). By comparison the Point Mugu salt marsh which was surveyed in 1977 contained 222 species of which 101 were introduced or naturalized. Since the Mugu lagoon contains one of the best preserved salt marshes in Southern California, the weedy elements in this instance contribute little in overall plant cover. Such is not the case of Ballona.

Unit 1

Lycium ferocissimum (Fig. 13, erroneously identified as L. halmifolium in some previous reports) is one of the great curiosities at Ballona in Unit 1. This South African saltmarsh shrub (identified by Fuller) consists of perhaps a half dozen plants, some of them apparently quite old. Whether it was planted deliberately or appeared as an adventive from cultivation at some time in the past is not known. The plant does not seem to be currently in cultivation in Southern California, which makes its appearance in the marsh even more surprising. Although it is said to form dense thickets in its native habitat, the plants at Ballona do not appear to be spreading. During the rainy season the shrubs were covered by a dense flush of new leaves but by mid-summer they appeared to be half-dead.

Several cultivated plants are present here, which include Agave attenuata, Crassula argentea, Schinus molle, Ceratonia siliqua and Chasmanthe aethiopica. Ordinarily, the Schinus and the Ceratonia are trees but in the marsh they appear as stunted shrubs. Myoporum laetum, which is reasonably common along the southwestern boundary of the site, appears to be naturalizing and thriving near the borders of the salt marsh. Suaeda californica has been reported from nearly every list of plants at Ballona no matter how incomplete. Interestingly enough, this saltmarsh native is sparingly represented at Ballona and is by no means common, confined primarily to the berm below the channel. Bassia hyssopifolia, one of the most abundant weeds, closely resembles Suaeda in its juvenile stages. This plant has either been overlooked or misidentified by past reviewers. In the same vicinity are located shrubs of Malacothamnus fasciculatus and Eriogonum fasciculatum, usually associated with a coastal sage scrub or chaparral community. A small population of hemlock, Conium maculatum, grows in a depression near the base of the berm. Close by milk thistle, Silybum marianum, and Bassia are the dominant weeds. Jaumea carnosa, a common saltmarsh composite prevalent in other California marshes, is represented by only a few centrally located populations, mostly along the sloughs. Monanthochloe littoralis and Juncus acutus, reported by the Army Corps of Engineers as occurring at Ballona, were not found by this investigator. Potentilla egedei and Limonium californicum might be anticipated but were not found. Of the five Atriplex species present on the site, only A. patula ssp. hastata is abundant, becoming a subdominant in the Salicornia marsh. Only a few specimens of A. californica are centrally located. Of the five Lupinus species, four are present in Unit 1. The annuals, L. truncatus and L. bicolor microphyllus, are fairly abundant in the early spring in the southern part of this site growing among the Carpobrotus or on disturbed grassy areas. L. succulentus was found sparingly along Culver Blvd. L. chamissonis, a silvery shrub to 3', is common in the sand dune area where it is a dominant along with Phacelia, Erysimum and Abronia. The willow woodland west of the sand dune area contains a variable population of Salix lasiolepis and some S. laevigata as well. Eleocharis macrostachya, Carex praegracilis and Juncus balticus, vegetatively similar, grow in close proximity to one another beneath the willows. One tree of Populus fremontii is associated with this habitat. In the Clark report from UCLA, Adenostoma fasciculatum was reported from the sand dune community. I believe this was mistakenly identified for Haplopappus ericoides, which it somewhat resembles. Three species of Camissonia occur on the sand dunes, C. cheiranthifolia, a perennial, is the most abundant along with two annual species, C. micrantha and C. bistorta. Because of the bridle paths throughout this area, at least three different mushroom genera were collected during the rainy season: Volvariella, Agaricus and Collybia. The best preserved Salicornia salt marsh occurs throughout Unit 1 with S. virginica more abundant than its counterpart S. subterminalis. The two species are quite distinct and easily to tell apart even when growing in proximity to one another. Frankenia grandifolia and Atriplex patula hastata are subdominants. Distichlis is frequent and common along sloughs and transition areas within the marsh. St. Augustine grass, Stenotaphrum secundatum, is becoming naturalized along some of the sloughs, especially in the western section of the site. Spergularia macrotheca is rather uncommon and confined more or less to the central area while Spergularia marina and Gasoul nodiflorum are abundant throughout. Gasoul crystallinum has been reported from Unit 1, but it did not turn up during this survey.

Unit 2

Unit 2 is divided into two sectors by the Gas Company road, the smaller, western section contains viable Salicornia saltmarsh, although generally weedier than that west of Culver Blvd. Weedy annuals have invaded the marsh along berms on the higher, drier, less saline areas. Only S. virginica is found here and not S. subterminalis, which is locally common throughout Unit 1. The planted Eucalyptus grove consists of two or three species which are apparently naturalizing. A single specimen of Albizia distachya was found in this grove, an interesting find, since the plant is not common in cultivation. Tetragonia tetragonioides was also collected here, although it might possibly occur in other parts of the study area, since it is weedy in nature and naturalizes easily in salt marshes. A large population of Anemopsis californica (Fig. 14) is found just south of the Eucalyptus grove growing intermixed with Carpobrotus. East of the Gas Co. road the land has largely been given over to agricultural use. During the rainy season, occasional flooding occurs throughout the western part of this section (in addition, some ponding occurs near Lincoln Blvd.) with Cotula coronopifolia, Lythrum hyssopifolia and Spergularia marina becoming dominants (Figs. 15 & 16). Some Salicornia, Cressa truxillensis, Atriplex patula hastata and Sida leprosa and Juncus bufonius are also prevalent. The freshwater marsh just east of the Gas Co. plant is largely dominated by Scirpus olneyi, which reaches 6' or more in height. Cyperus alternifolius, Cyperus eragrostis, Typha latifolia, Urtica holosericea, Polygonum lapthifolium, Juncus balticus, Eleocharis macrostachya and Salix lasiolepis are also to be found here. The drainage ditch of the old Centinela Creek becomes increasingly brackish as one travels west from Lincoln Blvd. Ruppia maritima, a submerged aquatic, is relatively common along the creek in somewhat brackish water, while Sagittaria calycina, a partially submerged aquatic, is frequent in the more eastern part of the ditch. Along the banks of this ditch occur several weedy and some native plants. Grasses such as Agrostis stolonifera, Leptochloa uninervia and Echinochloa crus-galli, associated with wet places, are present, the latter two common during the summer months. Native plants like Heliotropium curassavicum, Scirpus californicus, Scirpus robustus, Aster exilis, Typha domingensis, etc., are frequent along the ditch. In the southeastern section of Unit 2 just west of Lincoln Blvd. are several Canary Island palms, Phoenix canariensis. Near the palms, a dense stand of willows persists intermixed with Oenthera hookeri grisea and Conium maculatum. The size and vigor of the willow community would seem to indicate the presence of subsurface water. Gnaphalium, Digitaria, Amaranthus and Ricinus are the more common weedy elements. Several acres of wheat, Triticum vulgare, were planted in the agricultural areas in the spring. During the summer this land has been largely given over to lima bean culture (Phaseolus limensis). Sporadic plants of watermelon, Citrullus lanatus, were found throughout the agricultural fields indicating that perhaps this has been grown as a crop plant at some time in the past.

Unit 3

The dredge spoils of Unit 3 present a curious amalgam of plant species occupying a variety of habitats. The fill ranges from 10-16' above mean high tide. The most interesting assemblage of native plants in this area occur along the small strip of sand dune toward the southeast corner of the property. Two plants of Lupinus excubitus hallii are found here and associated with Croton californicus, Camissonia cheiranthifolia and a few plants of Eriogonum parvifolium. Weeds such as Erodium botrys, E. cicutarium, Chrysanthemum coronarium, Bromus rubens, etc., are abundant during the spring months on these dunes. Wandmullein, Verbascum virgatum, is relatively common along the southern boundary of the property, some plants often more than 5' tall. However, one does not find it elsewhere. A few cultivated plants also appear just north of the channel, like

Ceratonia siliqua, Acacia decurrens and Washingtonia sp., probably as adventives. Other cultivated plants (Narcissus tazetta, Iris pseudacorus, Gazania longiscapa) are scattered about the site but by no means common. Cichorium intybus is found to be locally abundant only in the extreme west part of Unit 3, while Centaurea repens is localized toward the southeastern end. Hemizonia ramosissima and Gnaphalium chilense are common in disturbed areas throughout. A single plant of Ribes malvaceum was found. Since it grows fairly close to a small population of Rhus laurina and R. integrifolia which are colonizing the site, it seems to indicate perhaps an early successional stage of coastal scrub or chaparral. Lotus scoparius, Artemisia californica and Gnaphalium microcephalum are other native plants closely associated with the above-mentioned shrubs. A pernicious thistle, Cirsium vulgare, seems to be confined to a few acres below the coyote brush scrub, but as more salts are leached from the soil, it can be expected to increase its range. Although Carpobrotus edulis is not as prevalent as in other sites at Ballona, it nonetheless is present and rapidly spreading. Another iceplant, Malephora crocea, with orange-red petals above, violet-magenta beneath, has probably been misdetermined as Carpobrotus aequilaterus in past reports. A large colony of this plant, up to 10' in diameter, is found in close proximity to the Carpobrotus. Its blue-green glaucous foliage and red flowers make it easily identifiable. A few small colonies of this same plant also occur in Unit 1. The Carpobrotus complex at Ballona seems to be a mixture of good edulis (yellow flowers) and edulis x aequilaterus (purple flowers). Both color forms grow together (Ferren, UC Santa Barbara). Many plants such as Picris echioides, Melilotus indica, Raphanus sativa, Brassica geniculata, Lactuca serriola, Stephanomeria virgata and Rumex crispus occupy a wide variety of habitats and as such are the most abundant dicots at Ballona. The weedy grasses, *Bromus rubens*, *B. diandrus*, *Hordeum leporinum*, *Paspalum dilatatum*, *Festuca myuros*, *F. megalura* and *Bromus mollis* constitute the greatest percentage of monocots. *Sorghum halepense* tends to be more concentrated in the agricultural areas, especially at the edge of plowed fields or along roadsides. Along the drainage ditch immediately south of Fiji Way, *Salicornia virginica* occurs along with several weeds.

PLANT SPECIES LIST

CODE DESIGNATION

I - Introduced plants, not indigenous to California.

N - Plants indigenous to California.

SM - Plants found growing in the salt marsh proper.

FM - Plants found growing in freshwater marsh situations.

CD - Plants found growing on coastal dunes.

WF - Plants found in weedy situations, agricultural land, along berms or elevated areas in the salt marsh, along roadsides bordering the area, open fields, etc. (This category refers to Units 1 and 2 only.)

DS - Plants found in the dredge spoils area north of the Channel only (Unit 3).

B - Plants found growing near the base of the bluffs along the southern boundaries of Unit 2 (the bluffs proper were not surveyed for this report).

	I	N	SM.	FM	CD	WF	DS	B
AGAVACEAE								
Agave attenuata	x					x		
AIZOACEAE								
Aptenia cordifolia	x					x		
Carpobrotus edulis	x		x		x		x	x
Carpobrotus edulis x aequilaterus	x		x		x		x	x
Delosperma cf. *litorale*	x						x	
Gasoul nodiflorum	x		x				x	
Malephora crocea	x		x				x	
Tetragonia tetragonioides	x					x		
ALISMACEAE								
Sagittaria calycina		x		x				
AMARANTHACEAE								
Amaranthus albus	x					x	x	
Amaranthus californicus		x				x		
Amaranthus deflexus	x					x		
AMARYLLIDACEAE								
Narcissus tazetta	x						x	
ANACARDIACEAE								
Rhus integrifolia		x					x	
Rhus laurina		x					x	x
Schinus molle	x					x		
APIACEAE								
Apium graveolens	x		x					
Apium leptophyllum	x					x		
Conium maculatum	x			x		x		
Foeniculum vulgare	x		x			x	x	x
ARECACEAE								
Phoenix canariensis	x					x		
Washingtonia sp.	x						x	

ASTERACEAE	I	N	SM	FM	CD	WF	DS	B
Ambrosia acanthicarpa		x			x	x	x	
Ambrosia chamissonis		x			x		x	
Ambrosia psilostachya		x			x	x	x	
Artemisia californica		x					x	
Artemisia douglasiana		x	x	x			x	
Artemisia dracunculus		x				x		
Aster exilis		x		x				
Baccharis glutinosa		x		x			x	
Baccharis pilularis ssp. *consanguinea*		x				x	x	
Centaurea melitensis	x					x	x	x
Centaurea repens	x						x	
Chaenactis glabriuscula var. *tenuifolia*		x			x			
Chondrella juncea	x				x			
Chrysanthemum coronarium	x					x	x	
Cichlorium intybus	x						x	
Cirsium vulgare	x						x	
Conyza bonariensis	x					x	x	x
Conyza canadensis	x					x	x	
Conyza coulteri	x					x	x	
Corethrogyne filaginifolia var. *virgata*		x				x		x
Cotula australis	x					x		
Cotula coronopifolia	x		x	x		x	x	
Gazania scaposa	x						x	
Gnaphalium beneolens		x				x		
Gnaphalium bicolor		x			x			
Gnaphalium californicum		x			x			
Gnaphalium chilense	x					x	x	x
Ghaphalium microcephalum		x					x	x
Gnaphalium ramosissimum		x				x		x
Grindelia robusta		x				x		
Haplopappus ericoides		x			x			
Hedypnois cretica	x				x	x		
Helianthus annus ssp. *lenticularis*		x				x	x	
Hemizonia ramosissima		x				x	x	
Heterotheca grandiflora		x			x	x	x	x
Jaumea carnosa		x	x					
Lactuca serriola	x					x	x	x
Malacothrix saxatilis var. *tenuifolia*		x				x	x	x
Matricaria matricarioides	x					x	x	
Osteospermum fruticosum	x						x	
Picris echioides	x					x	x	x
Senecio vulgaris	x					x	x	
Silybum marianum	x					x		
Solidago occidentalis		x	x					
Sonchus asper	x					x	x	
Sonchus oleraceus	x					x	x	
Stephanomeria exigua		x			x	x	x	
Stephanomeria virgata		x				x	x	x
Xanthium spinosum	x					x		
Xanthium strumarium var. *canadense*	x			x			x	

	I	N	SM	FM	CD	WF	DS	B
BORAGINACEAE								
Cryptantha intermedia		x			x			
Heliotropium curassavicum var. *oculatum*		x	x	x		x	x	
BRASSICACEAE								
Brassica geniculata	x					x	x	x
Brassica cf. *hirta*	x						x	
Brassica nigra	x					x	x	
Brassica rapa ssp. *sylvestris*	x					x	x	
Cakile maritima	x				x			
Coronopus didymus	x					x		
Erysimum suffrutescens		x			x			
Lepidium virginicum var. *pubescens*		x				x		
Lobularia maritima	x						x	
Raphanus sativus	x		x		x	x	x	x
Sisymbrium irio	x					x	x	x
CARYOPHYLLACEAE								
Polycarpon tetraphyllum	x					x		
Silene gallica	x					x		
Spergula arvensis	x					x		
Spergularia macrotheca		x	x					
Spergularia marina		x	x	x		x		
CHENOPODIACEAE								
Atriplex californica		x	x					
Atriplex lentiformis ssp. *breweri*		x	x					
Atriplex patula ssp. *hastata*		x	x			x		
Atriplex rosea	x					x	x	
Atriplex semibaccata	x		x			x	x	
Atriplex triangularis	x		x					
Bassia hyssopifolia	x		x			x	x	
Beta vulgaris	x		x			x	x	
Chenopodium album	x					x		
Chenopodium ambrosioides	x					x		
Chenopodium berlandieri var. *sinatum*	x					x		
Chenopodium murale	x					x	x	
Salicornia subterminalis		x	x					
Salicornia virginica		x	x				x	
Salsola iberica	x					x	x	
Suaeda californica		x	x					
Suaeda depressa var. *erecta*		x	x					

	I	N	SM	FM	CD	WF	DS	B
CONVOLVULACEAE								
Calystegia macrostegia var. *cyclostegia*		x					x	
Convolvulus arvensis	x					x	x	
Cressa truxillensis ssp *vallicola*		x	x			x	x	
Cuscuta californica		x			x			
Cuscuta campestris		x				x		
CRASSULACEAE								
Crassula argentea	x					x		
Crassula erecta		x	x			x	x	
CUCURBITACEAE								
Citrullus lanatus	x					x		
Cucurbita foetidissima		x				x	x	
CYPERACEAE								
Carex praegracilis		x		x				
Cyperus alternifolius	x			x				
Cyperus eragrostis		x		x				
Cyperus esculentus	x			x				
Eleocharis macrostachya		x		x				
Eleocharis montevidensis		x		x				
Scirpus californicus		x		x				
Scirpus olneyi		x		x				
Scirpus robustus		x		x				
EUPHORBIACEAE								
Croton californicus		x			x		x	
Euphorbia albomarginata		x					x	
Euphorbia peplus	x					x		
Euphorbia polycarpa		x				x		
Euphorbia serpens		x				x	x	
Euphorbia supina	x					x		
Ricinus communis	x				x	x	x	x
FABACEAE								
Albizia distachya	x					x		
Acacia decurrens var. *dealbata*	x						x	
Ceratonia siliqua	x					x	x	
Lotus purshianus		x			x			
Lotus scoparius		x			x	x	x	x
Lotus strigosus		x				x		

	I	N	SM	FM	CD	WF	DS	B
FABACEAE (contd.)								
Lupinus bicolor ssp. *microphyllus*		x				x		
Lupinus chamissonis		x			x			
Lupinus excubitus ssp. *hallii*		x					x	x
Lupinus succulentus		x				x		
Lupinus truncatus		x				x		
Medicago polymorpha	x					x	x	x
Melilotus albus	x		x			x	x	x
Melilotus indicus	x					x	x	
Phaseolus limensis	x					x		
FRANKENIACEAE								
Frankenia grandifolia		x	x				x	
GERANIACEAE								
Erodium botrys	x				x		x	
Erodium cicutarium	x				x	x	x	x
HYDROPHYLLACEAE								
Phacelia ramosissima var. *austrolitoralis*		x			x			
IRIDACEAE								
Chasmanthe aethiopica	x					x	x	
Iris pseudacorus "alba"	x						x	
JUNCACEAE								
Juncus balticus		x		x				
Juncus bufonius		x		x		x		
LAMIACEAE								
Marrubium vulgare	x					x	x	
LYTHRACEAE								
Lythrum hyssopifolia	x			x		x		

	I	N	SM	FM	CD	WF	DS	B
MALVACEAE								
Malacothamnus fasciculatus var. ?		X				X		
Malva nicaeensis	X					X	X	
Malva parviflora	X					X	X	
Sida leprosa var. *hederacea*		X				X	X	
MYRTACEAE								
Eucalyptus camaldulensis	X					X		
Eucalyptus tereticornis	X					X		
Eucalyptus viminalis	X					X		
MYOPORACEAE								
Myoporum laetum	X		X		X	X		
NYCTAGINACEAE								
Abronia umbellata		X			X			
OLEACEAE								
Fraxinus velutina		X				X		
ONAGRACEAE								
Camissonia bistorta		X			X			X
Camissonia cheiranthifolia ssp. *suffrutescens*		X			X		X	
Camissonia micrantha		X			X	X		
Oenothera hookeri ssp. *grisea*		X				X		X
OXALIDACEAE								
Oxalis pes-caprae	X					X	X	
PLANTAGINACEAE								
Plantago lanceolata	X					X	X	
Plantago major	X					X	X	
POACEAE								
Agrostis stolonifera ssp. *major*	X			X				
Arundo donax	X						X	

	I	N	SM	FM	CD	WF	DS	B
POACEAE (contd.)								
Avena fatua	X					X	X	X
Bromus diandrus	X					X	X	X
Bromus marginatus		X				X		
Bromus mollis	X					X	X	
Bromus rubens	X				X	X	X	X
Bromus wildenovii	X					X		
Cortaderia atacamensis	X					X	X	
Cynodon dactylon	X			X	X	X	X	X
Digitaria sanguinalis	X			X		X		
Distichlis spicata		X	X					
Echinochloa crusgallii	X			X				
Festuca megalura		X				X	X	
Festuca myuros	X					X	X	
Hordeum leporinum	X					X	X	X
Hordeum vulgare	X					X		
Leptochloa uninervia		X		X				
Lolium perenne ssp. *multiflorum*	X					X	X	X
Melica imperfecta		X				X		
Oryzopsis miliacea	X						X	
Parapholis incurva	X		X					
Paspalum dilatatum	X			X		X	X	
Phalaris paradoxa	X					X		
Poa annua	X					X		
Polypogon monspeliensis	X		X	X		X	X	
Schismus barbatus	X					X		
Setaria geniculata	X						X	
Sorghum halepense	X					X		
Stenotaphrum secundatum	X		X			X	X	
POLYGONACEAE								
Eriogonum fasciculatum		X				X		
Eriogonum gracile		X						X
Eriogonum parvifolium		X			X		X	X
Polygonum aviculare	X					X	X	
Polygonum lapathifolium		X		X				
Polygonum persicaria	X			X				
Rumex crispus	X		X			X	X	
Rumex fueginus		X				X		
Rumex salicifolius		X	X	X		X		X
PRIMULACEAE								
Anagallis arvensis	X			X		X	X	
RANUNCULACEAE								
Clematis ligusticifolia		X						X

	I	N	SM	FM	CD	WF	DS	B
RUBIACEAE								
Galium angustifolium		x						x
RUPPIACEAE								
Ruppia maritima		x	x					
SALICACEAE								
Populus fremontii		x		x				
Salix laevigata		x		x				
Salix lasiolepis		x		x			x	x
SAURURACEAE								
Anemopsis californica		x				x		
SAXIFRAGACEAE								
Ribes malvaceum		x					x	
SCROPHULARIACEAE								
Verbascum virgatum	x						x	
SOLANACEAE								
Datura meteloides		x				x	x	x
Lycium ferocissimum	x		x					
Lycopersicum esculentum	x							x
Nicotiana glauca	x					x	x	
Solanum douglasii		x				x	x	x
Solanum nigrum complex	x					x		
Solanum sarrachoides	x				x			
TYPHACEAE								
Typha domingensis		x		x				
Typha latifolia		x		x				
URTICACEAE								
Urtica holosericea		x		x				
Urtica urens	x				x	x		

	I	N	SM	FM	CD	WF	DS	B
VERBENACEAE								
Verbena lasiostachys		x					x	x
ZYGOPHYLLACEAE								
Tribulus terrestris	x					x		

Plants previously recorded as occurring at Ballona by the Envicom report for Summa but not collected during the LACM survey of the study sites during the 1980-81 season are listed below. Since the Envicom report covered a much larger area than the three study sites undertaken by the museum, it is quite possible that several of these plants occur on parts of the property not within the purview of this report. Unfortunately no plant material was kept as voucher specimens by the Envicom people.

Avena barbata (undoubtedly present on the study sites)

Carpobrotus aequilaterus (believed to be a misdetermined for *Malephora crocea*)

Chenopodium rubrum

Cyperus rotundus

Gasoul crystallinum

Gnaphalium luteo-album

Haplopappus squarrosus (present on the bluffs, but not in Units 1, 2 or 3)

Haplopappus venetus (present on the bluffs, but not in Units 1, 2 or 3)

Hoffmanseggia densiflora

Lippia nodiflora

Lotus corniculatus

Lycium halmifolium (a misdetermination for *L. ferocissimum*)

Salix hindsiana

Sesuvium verrucosum

Plants collected at Ballona prior to 1905 (old herbarium records) no longer occuring on the site.

Amsinckia spectabilis

Chenopodium macrospermum v. *farinosum*

Cuscuta salina

Lasthenia glabrata v. *coulteri*

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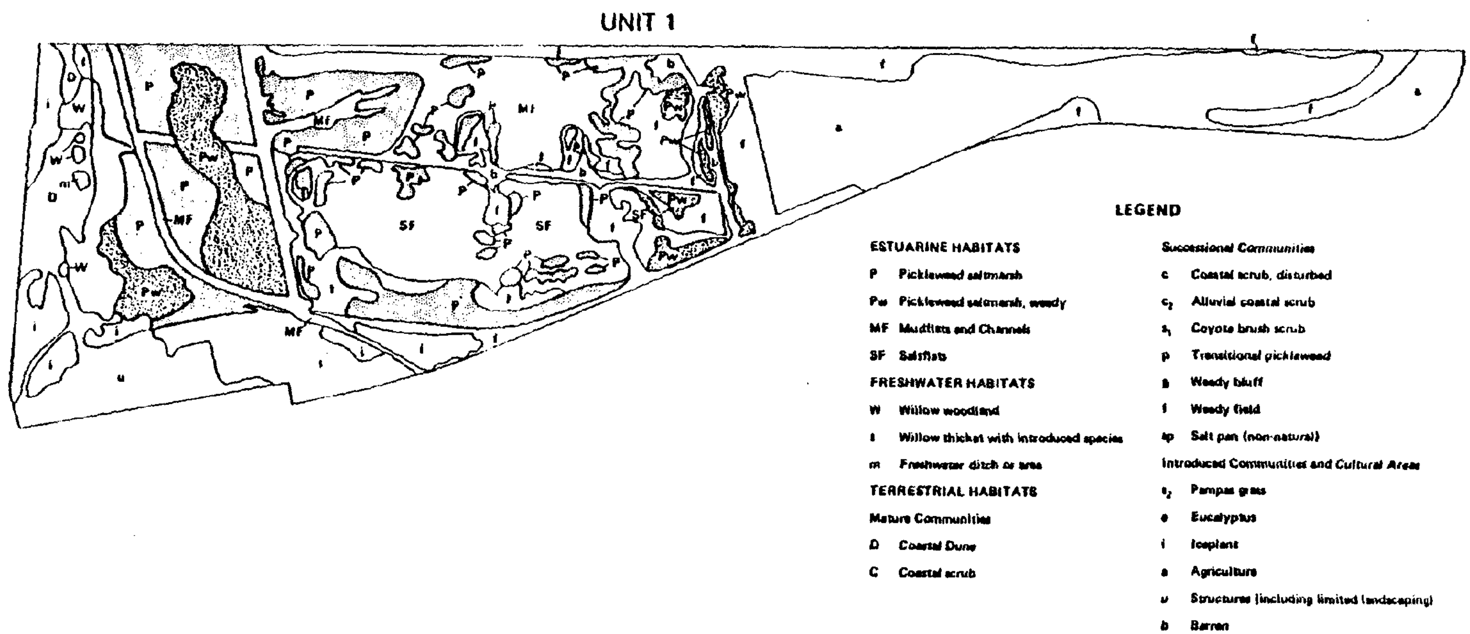
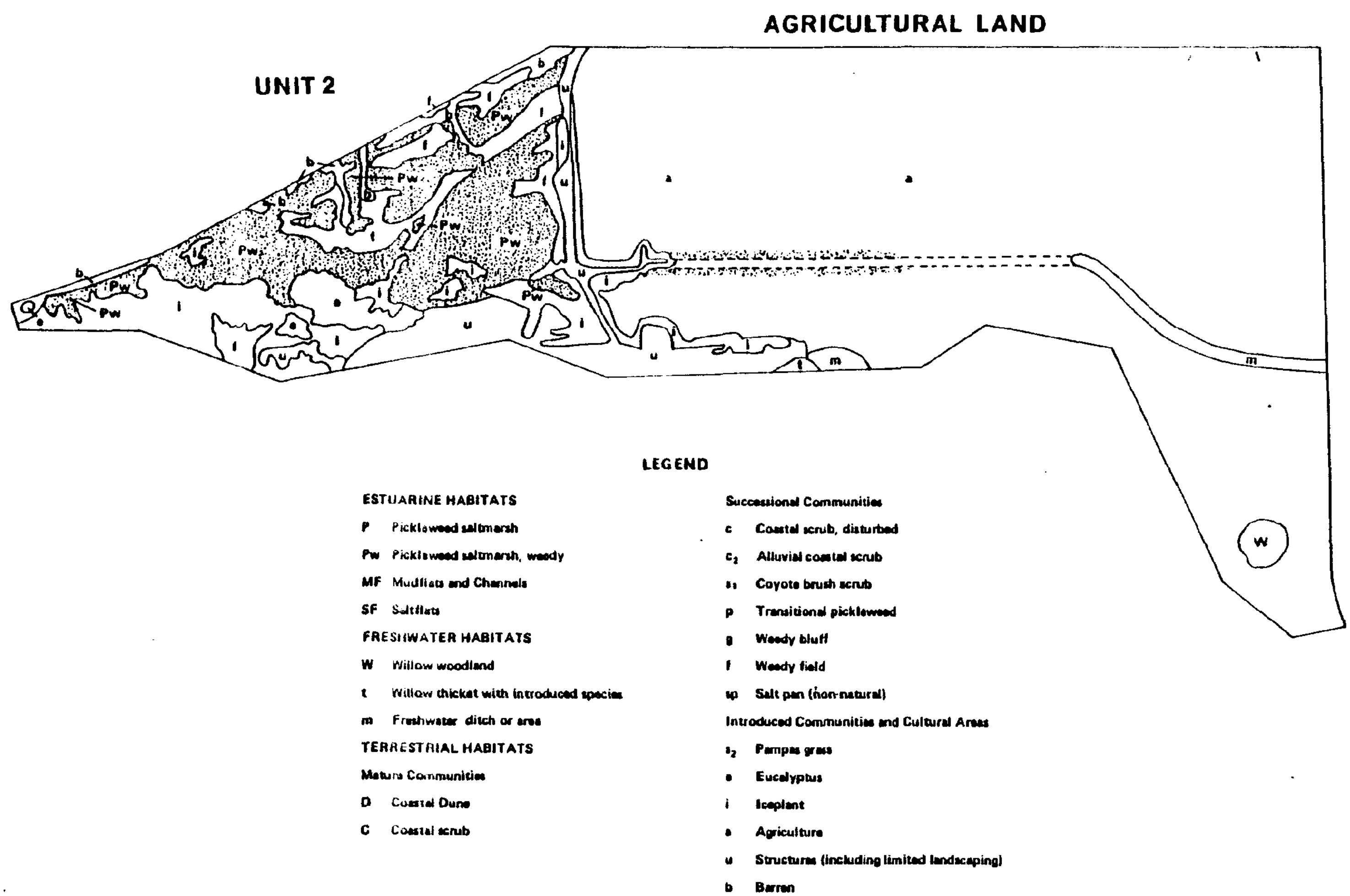


Bo- Figure 1

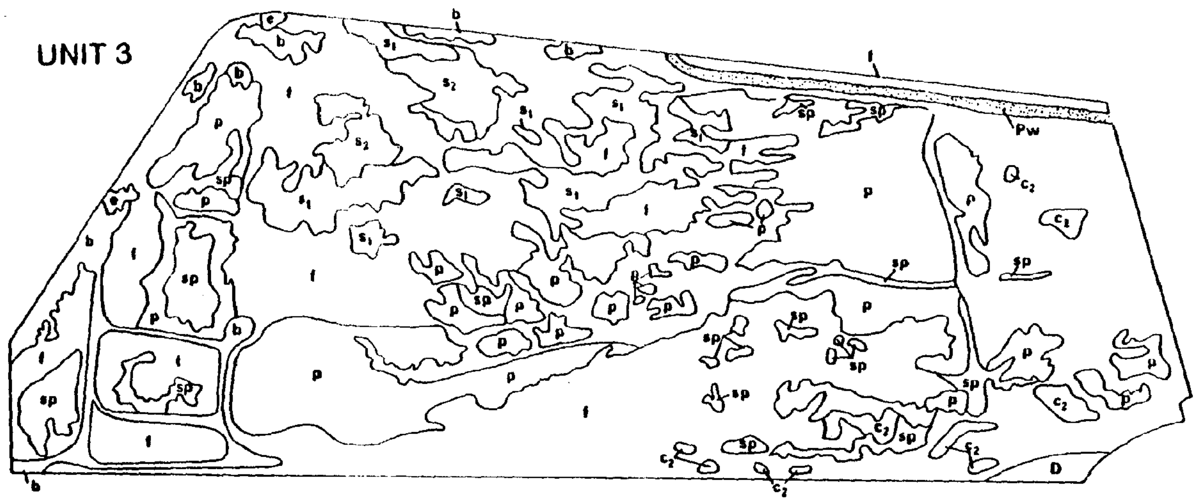
Unit 1 and Agricultural Lands -
Vegetation map with pickleweed community
indicated by shading
(redrawn from Envicom)



Bo- Figure 2

Unit 2 and Agricultural Lands -
Vegetation map with pickleweed community
indicated by shading
(redrawn from Envicom)

UNIT 3



LEGEND

ESTUARINE HABITATS

- P Pickleweed saltmarsh
- Pw Pickleweed saltmarsh, weedy
- MF Mudflats and Channels
- SF Saltflats

FRESHWATER HABITATS

- W Willow woodland
- t Willow thicket with introduced species
- m Freshwater ditch or area

TERRESTRIAL HABITATS

Mature Communities

- D Coastal Dune
- C Coastal scrub

Successional Communities

- c Coastal scrub, disturbed
- c_2 Alluvial coastal scrub
- s_1 Coyote brush scrub
- p Transitional pickleweed
- g Weedy bluff
- f Weedy field
- sp Salt pan (non-natural)

Introduced Communities and Cultural Areas

- s_2 Pampas grass
- e Eucalyptus
- i Iceplant
- a Agriculture
- u Structures (including limited landscaping)
- b Barren

Bo - Figure 3

Unit 3 - Dredge spoils vegetation map with dry pickleweed habitat indicated by small p (redrawn from Envicom)

Fig. 4 & 5 on next page

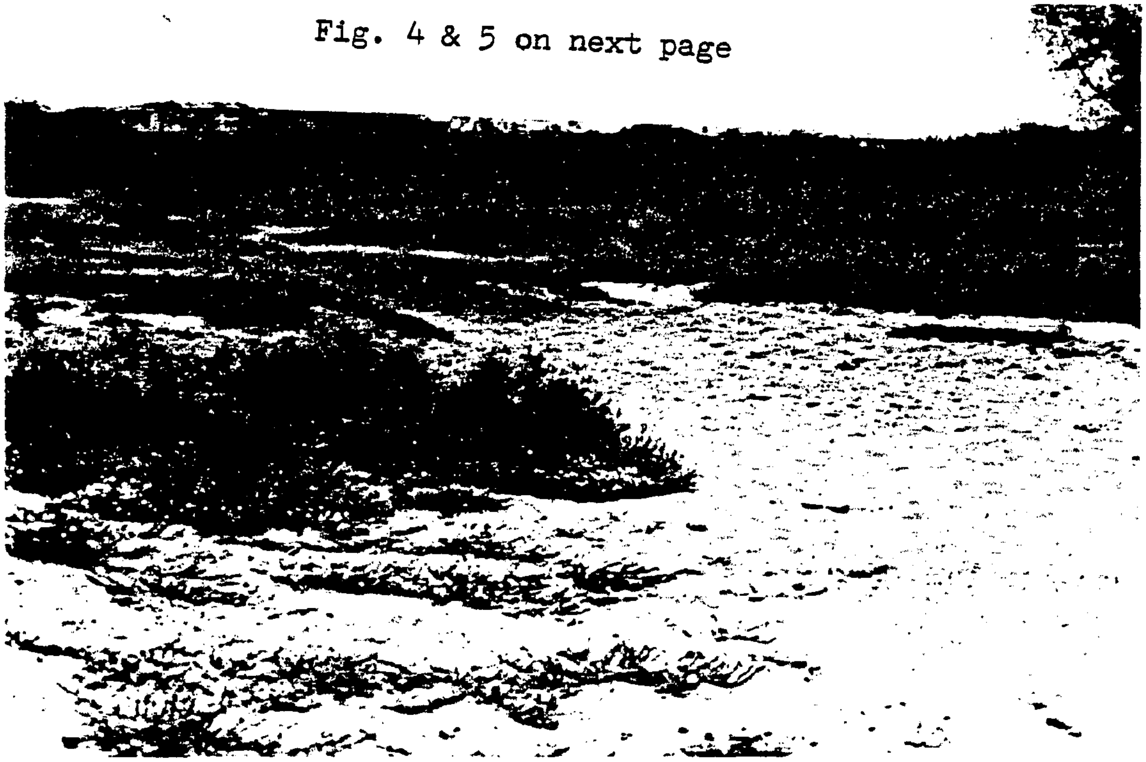


Fig. 6 & 8 - Unit 1, looking west. Coastal Dune in fore-
ground, willow community in rear.

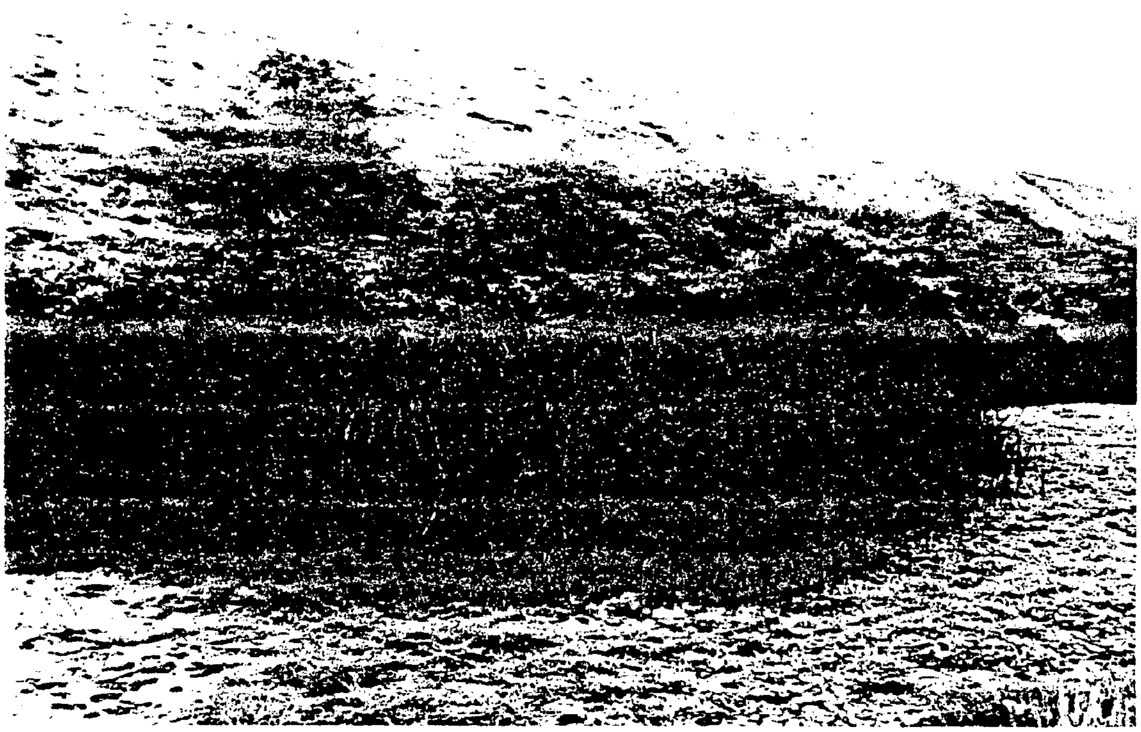


Fig. 7 - Unit 2, looking south. Freshwater marsh.

Fig. 4 - Unit 1, looking west. Pickleweed Saltmarsh.

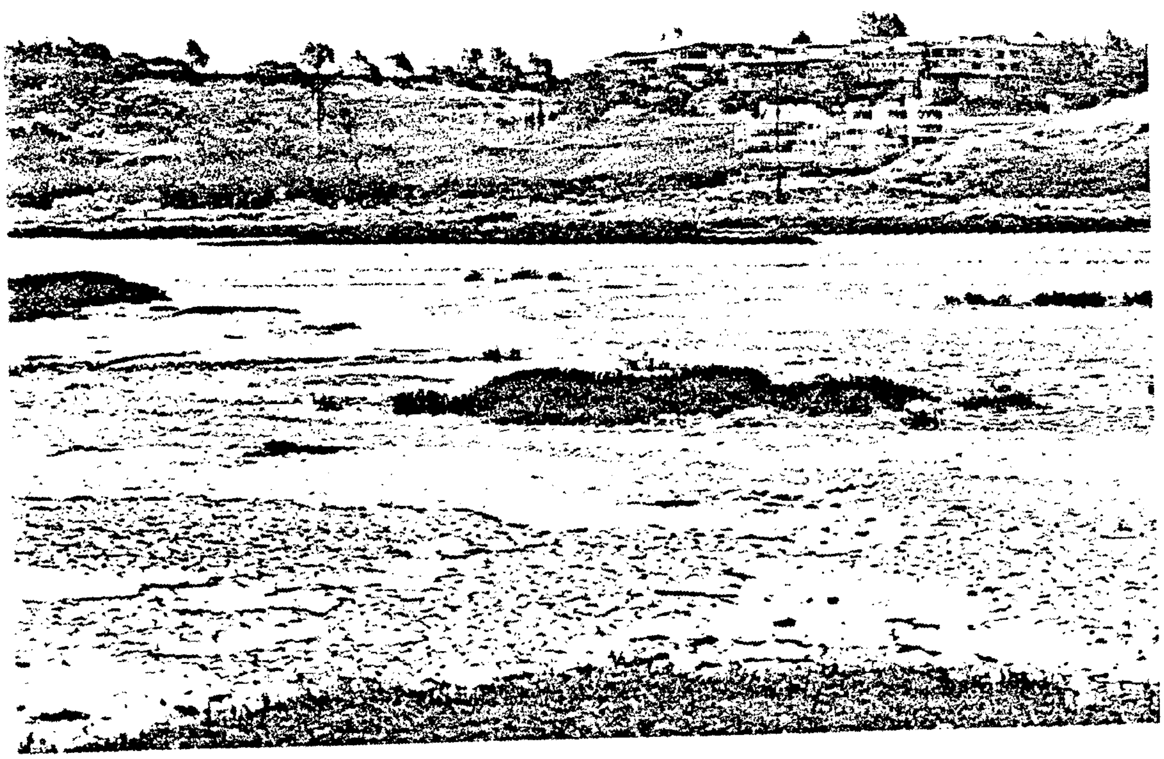


Fig. 5 - Unit 1, looking east. Saltflats & Mudflats

Fig. 9a - Unit 2, looking northwest. Coastal scrub, base of bluffs, with Salix & Ricinus predominating.

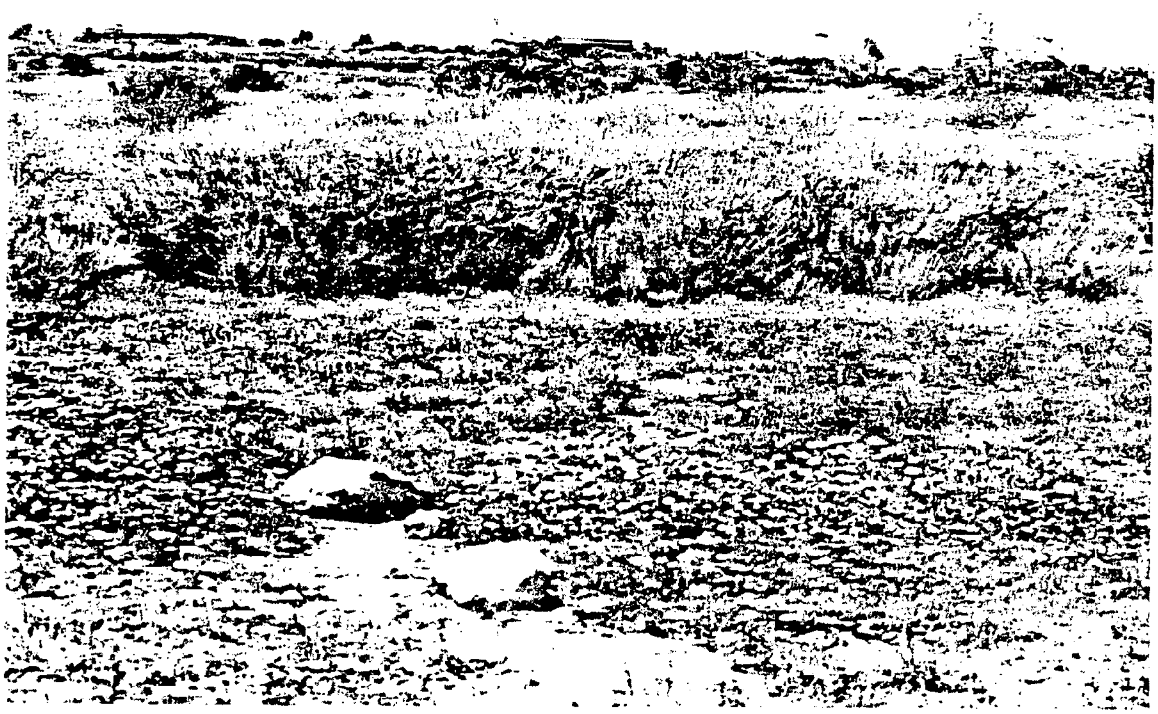


Fig. 9b - Unit 3, looking northwest. Scrub community.

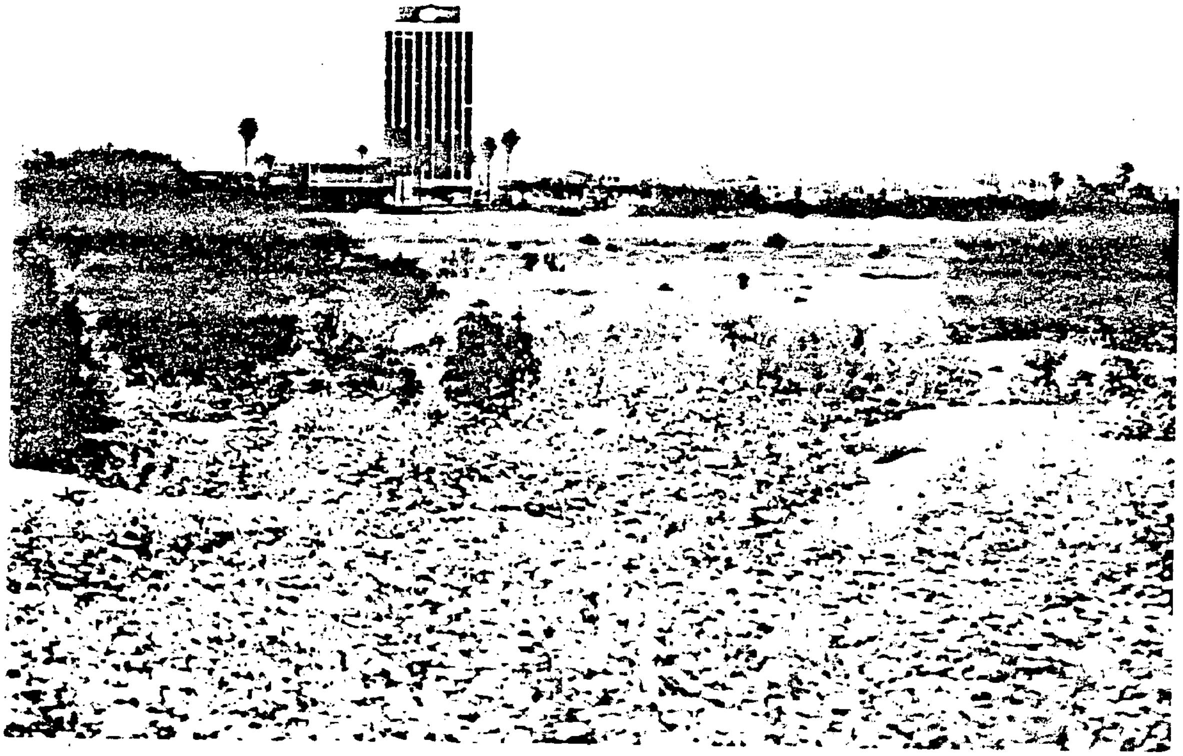


Fig. 10 - Unit 3, looking north. Dry pickleweed habitat in rear, scrub community in foreground.

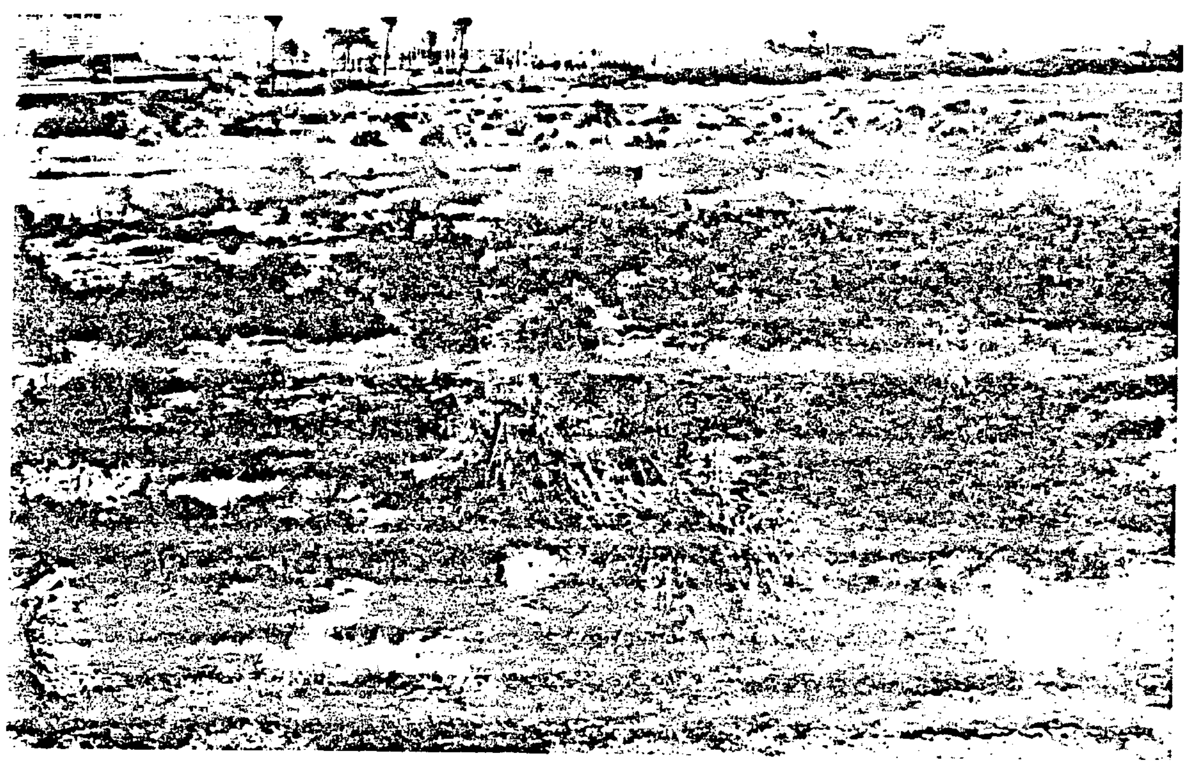


Fig. 11 - Unit 3, looking west. Coyote Bush scrub intermixed with Pampas Grass.

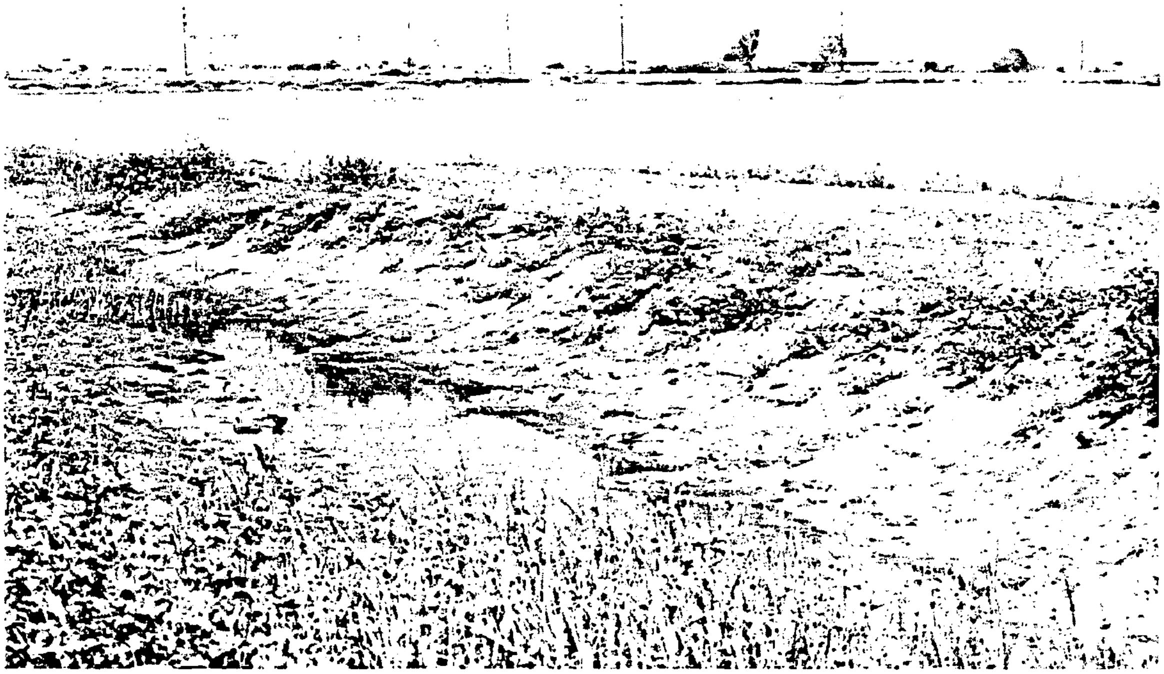


Fig. 12 - Unit 2, looking northwest. Agricultural land (Centinella Creek drainage ditch in foreground).

Fig. 13 - Unit 1, looking west. Lycium ferocissimum.

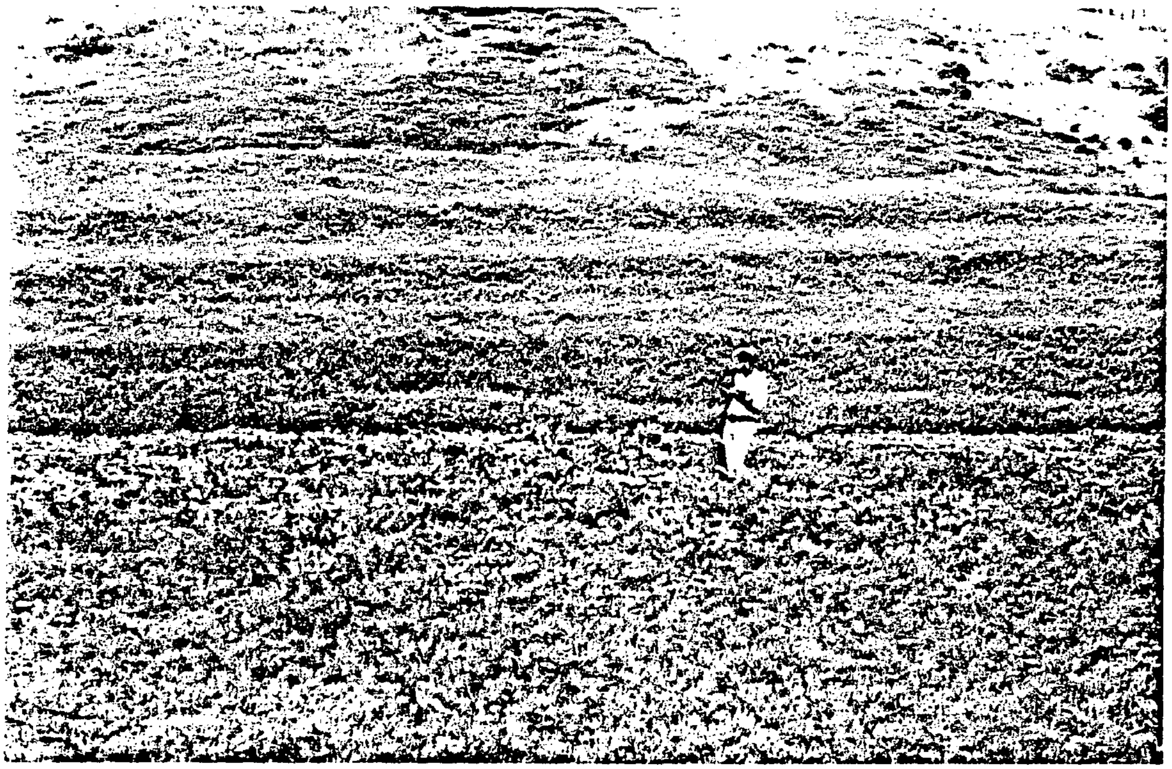


Fig. 14 - Unit 2, western section, looking east toward bluffs. Anemopsis californica & Carpobrotus edulis

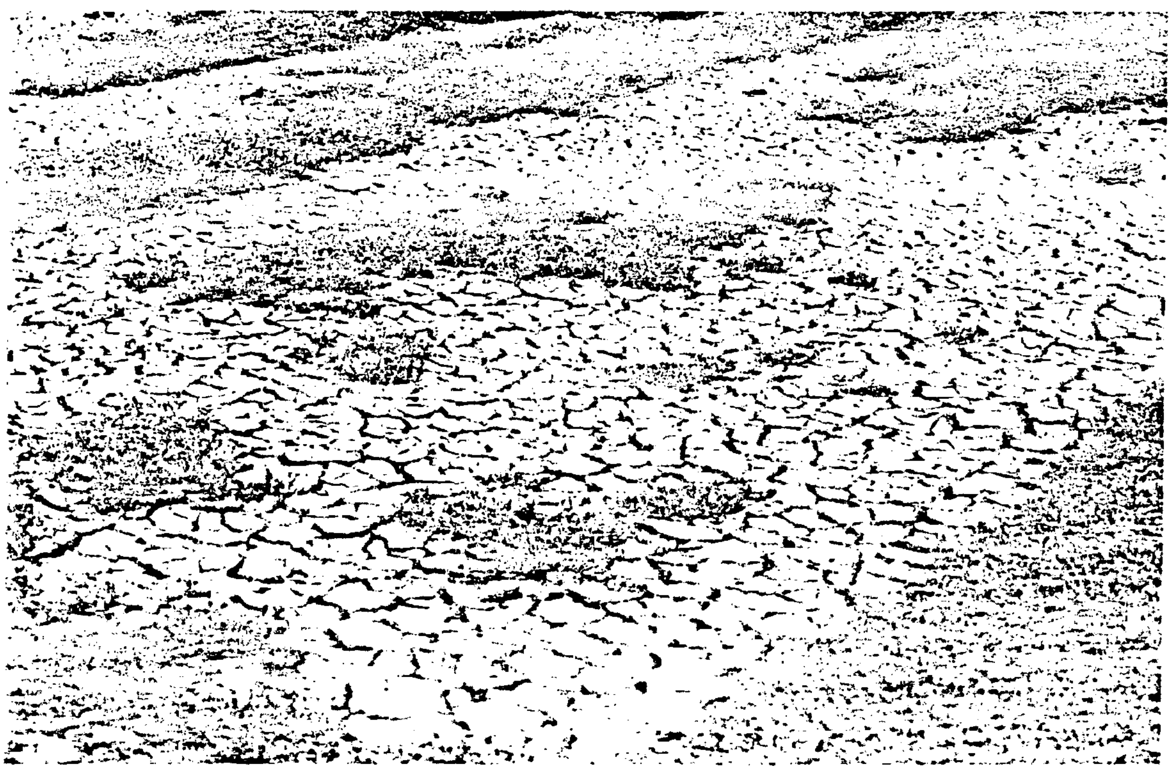


Fig. 15 - Unit 2, occasionally flooded agricultural area with Cotula coronopifolia.

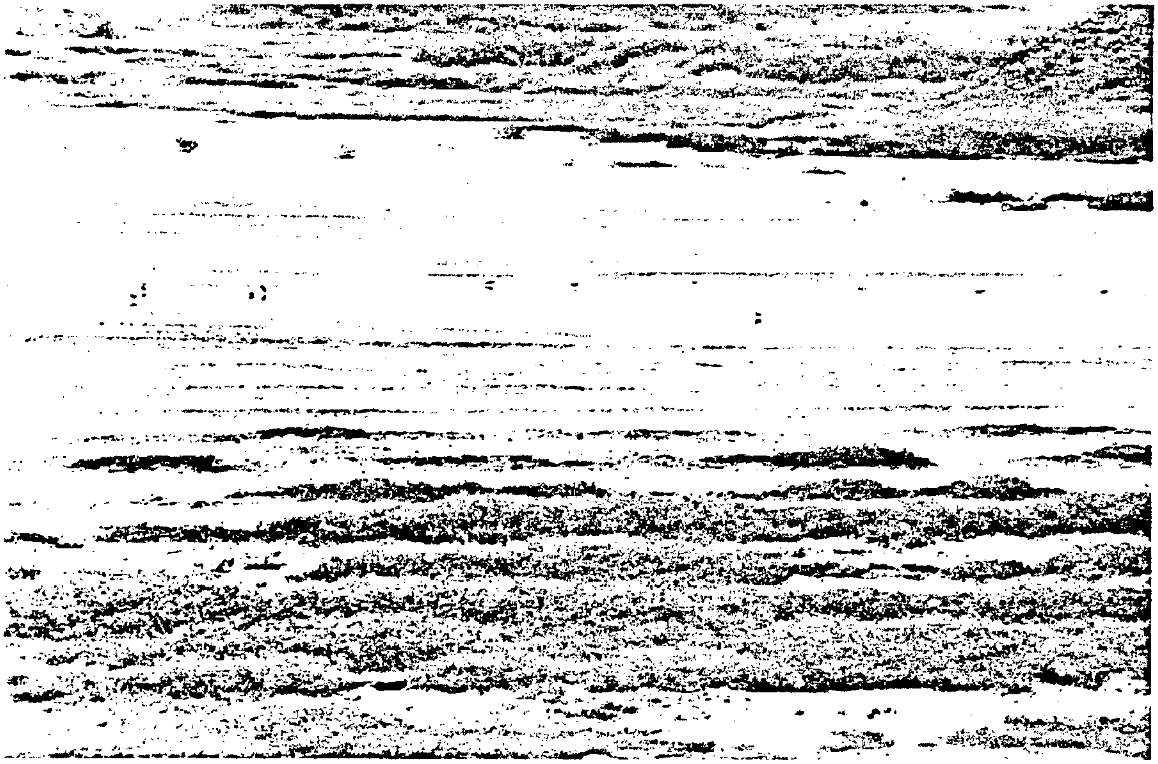


Fig. 16 - Unit 2, eastern section, looking east. Occasionally flooded agricultural land.

Photography by David Minor

THE INSECTS AND RELATED TERRESTRIAL ARTHROPODS OF BALLONA

Christopher D. Nagano, Charles L. Hogue, Roy R. Snelling
and Julian P. Donahue

THE INSECTS AND RELATED TERRESTRIAL ARTHROPODS OF BALLONA

The Insects and Related Terrestrial Arthropods of Ballona

Christopher D. Nagano, Charles L. Hogue, Roy R. Snelling
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INTRODUCTION AND LITERATURE SURVEY

The present study of the ecological condition of Ballona Creek Region ("BCR") is unusual in that it includes insects. For convenience, we use the term insect to refer to arachnids and other groups of terrestrial arthropods as well as true insects (Class Insecta). Although these animals are an important ecological component of terrestrial and freshwater ecosystems, they are seldom considered in environmental impact reports, even though insects are near the base of most food chains and interact with almost all life forms in natural land communities. They are essential food sources for birds and other vertebrates; they control vegetation and population numbers of other animals, including rodents and injurious insect species; and most importantly, they pollinate flowering plants, thus insuring their reproduction (Orsak, 1978). However, insects receive little attention by urban planners and natural resource managers because of their small size, the extreme difficulty in identifying most species and the incorrect assumption that they are biologically and ecologically insignificant.

Some insects are adapted for living only in close proximity to the ocean. They may require saline or sandy conditions or may feed on salt-loving plants (halophytes). Although often observed in large numbers in suitable habitats, such as salt marshes and coastal sand dunes, they are extremely sensitive to contact with man. The last fifty years has seen a tremendous urban expansion along the California coast, with a concomitant decline of all coastal wildlife, including insects, but very little is known of the specific causes and effects of their loss. Moore and Legner (1972, 1974) and Nagano (1981) have described insect habitat destruction and the need for further study of coastal entomology.

Increased awareness of the destruction of coastal environments has inspired new interest and publication of knowledge about insects living in salt marshes, sand dunes and other marine littoral habitats. The majority of literature on coastal insects has dealt with localities in parts of the world other than California (Gustafson and Lane, 1968; Gustafson, Lane and Lee, 1973), especially eastern North America (Arndt, 1914; Metcalf and Osborn, 1920; Saunders, 1966; Smalley, 1960; Brown, 1940; Davis and Gray, 1969), specific taxa of insects (Cheng, 1976; Doyen, 1976; Nagano, in press; Brown, 1948; Moore, 1956, 1964; Moore and Legner, 1973) or on coastline habitats other than salt marshes (Benedetti, 1973; Craig, 1970; Evans, 1968; Kompfner, 1974; Saunders, 1928).

The intertidal insects of California are treated comprehensively only in identification guides by Evans (1980) and Doyen, Schlinger and Daly (1975). The first of these works dealt primarily with species that inhabit open beaches, and the latter only with the central California coast.

Lane (1969) made the first study of the insects of a California salt marsh on a locality in east San Francisco Bay. He used a variety of collecting methods and found flies and true bugs to be the most abundant. Later, Cameron (1972, 1976) investigated the trophic levels and effects of tides in a salt marsh in San Pablo Bay. The butterflies of Suisun Marsh in Solano County were surveyed by Shapiro (1974, 1976), who found 43 species. However, it is important to note that Suisun Marsh is approximately 440,000 acres in size, versus the approximately 100 acres of BCR and is surrounded by relatively undisturbed hills of oak woodland and annual grassland.

The beetles (Minnesang, 1980) and flies (Assis de Moraes, 1977) that inhabit Anaheim Bay have also been surveyed. This is a salt marsh located within the Seal Beach Naval Weapons Station, some forty miles south of Ballona Wetlands. Minnesang (1980) found 114 species of beetles, and Assis de Moraes (1977) collected 97 species of flies. Anaheim Bay is a larger salt marsh habitat than BCR.

As with BCR, sand dunes are often associated with salt marshes. Powell (1981) described the condition of coastal sand dunes in California. Although the sand dunes at the west end of Unit 1 were not mentioned, this site has a number of insect species peculiar to the sea coast. He and Nagano (1981) note that this habitat type are among the most rapidly disappearing in the state. Powell and Doyen, of the University of California (Berkeley), have surveyed some of the coastal sand dune systems, especially for beetles and moths (results reported by Powell, 1981). Pierce (Pierce and Pool, 1938) collected on the El Segundo Sand Dunes, a formerly extensive sand dune system extending from the Los Angeles International Airport south to the Palos Verdes Peninsula. However, it is difficult to compare the insects of BCR and the material collected by Pierce, because he concentrated on beetles and largely neglected other taxa, such as bees and wasps. In fact, there has never been a complete survey of the overall insect fauna of a pristine coastal locality in southern California. Unfortunately, the few remaining estuaries, sand dunes and beaches have been so altered by man that it may no longer be possible to determine the nature of the original insect fauna.

As is typical with most environmental impact reports, the one previous study on BCR includes practically no data on insects. The report by Envicom (1979) notes only that the Wandering Skipper (Panoquina errans), an insect considered for Threatened Species status, inhabits the site and that insects and other invertebrates are utilized as food by various species of vertebrates.

Our report could have easily been much larger; however, we have covered the most important aspects of the insect life of BCR for this study. It is obvious that BCR is an oasis for a diverse population of insects and a very important source of information about the insects of the Los Angeles Basin and the southern California coastline.

MATERIALS AND METHODS

The authors made a fully documented collection of insect specimens and associated data of BCR which form the basis for this investigation. A voucher collection of insects is necessary because of the impossibility of identifying most of the species in the field and the need for later verification.

Specialized and comprehensive collecting methods were employed to insure maximum diversity; these included direct capture with aerial, sweep and aquatic nets; trapping with baited pitfall, malaise, yellow pan and ultra-violet light traps; soil sifting to collect subsurface taxa; and Berlese funnel sampling.

The aerial net is used to collect flying and other rapidly moving insects. Sweep nets were used by brushing the net back and forth on shrubbery and other vegetation to capture the insect inhabitants. Aquatic nets were used to dip up insects in streams and ponds.

Baited pitfall traps consist of wide-mouthed jars which are buried in the soil until the opening is flush with the surface of the ground.

Fluids, such as anti-freeze or soapy water, are placed at the bottom of the container. Peanut butter or rotting meat is sometimes used as bait and attractant. The insects fall into the jar where they drown and are preserved in the fluid. These traps could not be used to their full effectiveness in BCR due to theft and vandalism.

Malaise traps are tent-like devices used to capture flying insects. The traps are placed for long periods in a natural flyway, such as a stream bank or on paths through wooded areas. Large and random samples of insects thus are trapped. However, it could not be used as much as desired, again because of vandalism.

Many nocturnal insects are attracted to ultraviolet light, where they can be easily captured. This method uses a 15-watt blacklight suspended over a funnel leading to a bucket containing cyanide, a killing agent. Insects are attracted to the light, fall through to the bucket, where they are overcome by the poison fumes and killed. The ultraviolet light traps were used effectively in several places during the sampling of BCR.

A metal screen was used to shift dirt or sand in order to find subterranean insects. Many of the unique taxa from the sand dunes of Unit 1 were captured with this method.

The Berlese funnel consists of a 40-watt light bulb suspended over a leaf litter sample in a large metal funnel. The heat from the lamp drives the insects down until they fall into a jar of alcohol placed under the spout of the funnel. With this method, many types of minute or secretive insects otherwise overlooked can be captured.

Insect specimens were killed and preserved as appropriate in alcohol or on pins. Each specimen was labelled and given a code number. The latter keys it to ecological data recorded on a data form (Fig. 1) designed for

Figure 1

Every collection (record) has an individual number (1) keying it to four kinds of data (which can be transferred to any number of IBM cards): ecology, host information, insect identification and insect information. Data for each of these is recorded thusly:

Ecology (card): (7) spatial Unit at BCR in which the collection was made; (8-10) macrohabitat, with letter abbreviations as specified by Clark, 1979; (11-16) date; (17-20) time period of capture; (21-40) initials of collectors; (41-50) two-digit habitat codes (01 = plant host, 02 = animal host, 03 = stagnant water, 04 = freshwater, 05 = salt (sea) water, 07 = brackish water, 08 = in soil, 09 = horse dung, 10 = carrion, 11 = dead plant, 12 = under object on ground, 13 = attracted to light, 14 = UV light trap, 15 = Malaise trap, 16 = pan trap, 17 = pitfall trap, 18 = bait trap, 19 = in air, 20 = on top of ground, 21 = sitting on plant or other object, 22 = in animal sign, 23 = Berlese funnel). (51) photograph taken (Y = yes, N = no).

The Host Information (Card) section is used if the insect was collected on plant or animal host. This card has the same record number (1-5) as the Ecology Card. Other data as follows (7-16) family; (17-26) genus; (27-46) species; (47-66) subspecies of the host is recorded; whether the hosts was collected is noted (Y = yes, N = no); and (68-71) the museum catalog number if the host was collected.

Each specimen collected is recorded in the section called Insect Identification (Card). (7-11) family of the organism (first five letters only); (12-31) genus; (32-51) species; subspecies; (72) and a space for a voucher code (s = sighted only; c = collected and preserved; I = seen by person other than the biologists conducting the survey; R = captured and released).

The Insect Information (Card) has the same record number (1-5) as the

Ecology Card. This card accompanies each Insect Identification Card and provides data on each species. (6) It has a card number; (7-16) a two-digit activity code (18 = flying, 19 = crawling, 20 = resting, 21 = found dead, 22 = feeding, 23 = no observations, 24 = mating, 25 = feeding); (17) whether a photograph was taken (Y = yes, N = no); a single-digit (18) abundance code (1 = single, 2 = few, 3 = numerous, 4 = very numerous, 5 = swarming); if it was collected as an egg (19), nymph (20), larva (21), pupa (22) or adult (23); and a note section of 50 spaces for any additional information.

FIGURE 1

Natural History Museum of Los Angeles County
Ballona Wetlands Survey 1980-1981
ENTOMOLOGY FIELD NOTES
CALIFORNIA:Los Angeles County, Ballona Wetlands

Ecology Card

Record #	1)__ __ __ __ __
Card #	6) 1
Unit #	7)__
Macrohab.	8)__ __ __
Date	11)__ __ __ __ __ __
Time	17)__ __ __ __
Collect.	21)__ __ __ __ __ __
	27)__ __ __ __ __ __
	33)__ __ __ __ __ __
	39)__ __
Habitat	41)__ __
	43)__ __
	45)__ __
	47)__ __
	49)__ __
Photo	51)__

Host Information Card

Record #	1)__ __ __ __ __
Card #	6)__
Family	7)__ __ __ __ __
	12)__ __ __ __ __
Genus	17)__ __ __ __ __
	22)__ __ __ __ __
Species	27)__ __ __ __ __
	32)__ __ __ __ __
	37)__ __ __ __ __
	42)__ __ __ __ __
Subspec.	47)__ __ __ __ __
	52)__ __ __ __ __
	57)__ __ __ __ __
	62)__ __ __ __ __
Specimen	67)__
Cat. #	68)__ __ __ __

Insect Identification Card

Record #	1)__ __ __ __ __
Card #	6)__
Family	7)__ __ __ __ __
Genus	12)__ __ __ __ __
	17)__ __ __ __ __
	22)__ __ __ __ __
	27)__ __ __ __ __
Species	32)__ __ __ __ __
	37)__ __ __ __ __
	42)__ __ __ __ __
	47)__ __ __ __ __
Subspec.	52)__ __ __ __ __
	57)__ __ __ __ __
	62)__ __ __ __ __
	67)__ __ __ __ __
Voucher	72)__

Insect Information Card

Record #	1)__ __ __ __ __
Card #	6)__
Activity	7)__ __
	9)__ __
	11)__ __
	13)__ __
	15)__ __
Photo	17)__
Abundan.	18)__
Egg	19)__
Nymph	20)__
Larva	21)__
Pupa	22)__
Adult	23)__
Notes	27-72)____________
	____________

rapid conversion to a computer-based filing system.

Specimens were identified in the laboratory or sent to specialists. They were analyzed for their ecological significance to BCR. Approximately 10,000 specimens representing 475 species were collected. It is important to note that the identification of many specimens is pending further examination by specialists. 300 hours in the field and over 2000 hours in the laboratory were spènt by the senior author on this study.

ENTOMOLOGICAL PERSPECTIVE OF THE BALLONA CREEK REGION

Ballona Creek Region contains one of the few remaining coastal salt marshes left in southern California and thus is an important site for insects specialized for this habitat. It serves as a refugium for insects because of the relatively undisturbed habitats and availability of native vegetation for insects that have been extirpated from other such places on our portion of the California coastline. Because of their relative minuteness, insects can survive in small areas as long as the habitat is not greatly disturbed by urban development, recreation, pesticide or other destructive human use.

BCR was divided into arbitrary spaced geographical units called "Units" for accuracy and ease of reference in the discussions following. See the introduction of this report by Ralph Schreiber for a detailed description of these areas.

UNIT 1

Unit 1 not only holds the greatest diversity of insects, but also the most significant species in terms of rarity or restricted occurrence to the coastline of southern California. A number of such species were collected on the sand dunes located at the extreme west end of Unit 1.

The sand dunes deserve special attention, because, despite their relatively small size, they have the most species of any single habitat type at BCR. Insects that are rare or restricted to the coastline are found here: Subterranean Sand Dune Beetle (Coelus ciliatus); Dorothy's Sand Dune Weevil (Trigonoscuta dorothea dorothea); Belkin's Horse Fly (Apatolestes belkini); Seashore Robber Fly (Cophura clausa); wingless wasps (Brachycistis species); sand dune cockroaches (Arenivaga species); Panther Fly (Neomydas pantherinus); and several genera of rare bees and wasps (see Species List). Noteworthy among these is the Yellow-faced Bee (Hylaeus punctatus) known elsehwere only from Europe. This is the first time this bee has been found in North America.

The willow strand adjoining the sand dunes supports a number of native insect inhabitants. A species that is widespread in southern California but uncommon is Morse's Shield Back Katydid (Neduba morsei). The willow wood is used as a food source by the Locust Clearwing Moth (Paranthene robinae) and Western Drywood Termites (Incisitermes minor). Other common and widespread insects feed on the willow leaves, such as the leaf beetles (Pachybrachus species and Psyllobora viginmaculata) and various leaf- and stem-mining species (see Species List). The leaf litter under the willow trees provides cover for many species of ground-dwelling insects, such as springtails (Collembola), bark lice (Psocoptera), beetles, silverfish (Thysanura) and mites.

The pickleweed portions of Unit 1 support many insects that are only found in regions with wet saline soils, such as coastal salt marshes and estuaries. The largest populaton of the Wandering Skipper (Panoquina errans) at Ballona is found here. Other pickleweed inhabitants include the Brine Fly (Ephydra riparia); long-legged flies (Dolichopodidae); midges (Chironomidae); Pale Shore Bug (Sadula pallipes); ground beetles (Tachys and Bembidion);

and rove beetles (Staphylinidae). The Frail Springtail (Onychirus debilis) known elsewhere from France and Alaska was collected in the Salt Grass (Distichlis spicata).

The salt marsh flies, ground beetles, rove beetles (especially the genus Bledius) and a population of the Mudflat Tiger Beetle (Cicindela trifasciata sigmoidea) inhabit the mud and salt flats of Unit 1. All of these insects spend a portion of their lives burrowing in the saline mud.

Horse stables are located in the southwestern corner of Unit 1. It is important to recognize the great damage to the ecosystem inflicted by the horses and the abundant pest flies (Calliphoridae and Muscidae) whose larvae develop in horse droppings. These flies may be involved in mechanical disease transmission and are known nuisances.

The weedy portions of Unit 1 support numerous species of insects. These are widespread and common types adapted for existence in fallow fields and vacant lots. Introduced insects, such as the Cabbage Butterfly (Pieris rapae) and the Argentine Ant (Iridomyrmex humilis) are the most conspicuous.

Several species of aquatic insects are found in the numerous fresh and brackish waters of Unit 1. The most abundant species is the Salt Marsh Water Boatman (Trichocorixia reticulata) which is probably a significant food source for shorebirds and fishes (Nagano, 1981).

The large number of species of insects inhabiting Unit 1 can be attributed to the numerous species of native plants which provide food and the varied habitats available.

UNIT 2

There are three basic insect habitats in Unit 2: pickleweed, weedy fields and eucalyptus grove. Many of the insects are the same as Unit 1 except that the diversity and abundance is lower.

The salt marsh vegetation (pickleweed and saltgrass) supports a large population of the Wandering Skipper (Panoquina errans). Numerous individuals and mating pairs were observed throughout this habitat. Brine Flies (Ephydra riparia), the Pale Shore Bug (Sadula pallipes), the Mudflat Tiger Beetle (Cicindela trifasciata sigmoidea) and the ground and rove beetles observed in the pickleweed of Unit 1 were also found here. Although Unit 2 has a smaller amount of pickleweed and saltgrass than Unit 1, it still supports viable and healthy populations of salt marsh insects.

The brackish water is inhabited by aquatic insects such as the Salt Marsh Water Boatman (Trichocorixia reticulata) and small water scavenger beetles (Tropisternus species).

The weedy field portion is inhabited by common and widespread insects that feed, breed and develop here. Although common, these insects are an important part of the BCR ecosystem that provide food for vertebrates and perform other essential roles.

The extensive stand of eucalyptus and other introduced plants on the south side of Unit 2 is inhabited by a few insects that are common and widespread in western North America. These include overwintering Monarch Butterflies (Danaus plexippus), Mourning Cloak Butterflies (Nymphalis antiopa), Argentine Ants (Iridomyrmex humilis) and Black Widow Spiders (Lactrodectus mactans hesperus). The depauperate insect fauna can be attributed to the lack of an abundance of native plants at this site. It is a historical fact that few, if any, Australian insects were introduced originally with eucalyptus, and few native North American species have adapted to it as a food host. Essential oils also give the foliage a natural resistance to insect feeding.

UNIT 3

The insect life found in Unit 3 is representative of the coastal strand

and the greater Los Angeles Basin rather than exclusively coastal wetlands. Although it does not have as great a diversity of species as Unit 1, it does have large populations of a few native insect species. Many of these are now very rare or extinct from the coastal regions of Los Angeles County due to habitat destruction and urban growth.

The majority of the vegetation of Unit 3 is pickleweed, scrubland (weedy or fallow field) or transtitional between the two. The many weedy and introduced plants support few species of insects; none were observed on the Pampas Grass (Cortaderia atacamensis). Adult Rabbit Bot Flies (Cuterebra lepivora) were seen and collected in the scrub-land; this is an endoparasite of the rabbit populations at BCR.

A nest site of approximately 300 Common Sand Wasps (Bembix americana comata) was found in the northeastern corber of the pickleweed portion. These wasps are important predators of flies. A nest site of the Solitary Bee (Diadasia consociata) is located in the middle of the pickleweed. These bees are important pollinators of many of the native plants in Unit 3.

It is important to note that insects that require permanent sources of saline water or mud are not found in the pickleweed portion of Unit 3. These water-dependent species, which do occur in both Units 1 and 2, are the Wandering Skipper (Panoquina errans), Long-legged flies (Dolichopodidae), the Mudflat Tiger Beetle (Cicindela trifasciata sigmoidea), and the Pale Shore Bug (Saldula pallipes). The absence from Unit 3 of these water-dependent species maybe due to the unreliable and unpredictable presence of water, which appears to be ephemeral and occasional in occurrence.

A semideveloped sand dune is found in the southeastern corner of Unit 3 where some dune vegetation occurs. No sand dune insects were seen or collected, and it is unlikely that any inhabit this site. The many rocks in the soil and the fact that the sand has been artificially placed (Schreiber, pers. comm.) may explain their absence.

Unit 3 is used by many people to ride their off-road vehicles (ORV). This is expecially evident in the pickleweed portions where the soil has been severely scarred. For details of the damage to the insect populations by ORVs, seen the Problems and Conclusions Section of this paper.

The only portion of Unit 3 where true moisture dependent insects occur is in the drain ditch on the northeastern corner. Here there are low density populations of the Wandering Skipper (Panoquina errans), the Mudflat Tiger Beetle (Cicindela trifasciata sigmoidea), Brine Fly (Ephydra riparia), long-legged flies (Dolichopodidae) and the Pale Shore Bug (Saldula pallipes).

The value of Unit 3 to native insects lies in the large amount of open space and vegetation which provides food, cover and nesting sites. Very few sites of similar size and ecological diversity are left along the coastline of Los Angeles County.

AGRICULTURAL LANDS

The Agricultural Lands consist of various gabitats, such as the base of the bluffs, Centinela Creek, cultivated fields and grove of introduced vegetation ("the junkyard") located north of Culver Blvd. The majority of the Agricultural Lands supports few species of insects.

The cultivated fields are used for the production of crops and are plowed or are covered by a few weedy species of plants. The marjority of insects found within the agricultural fields are transient or "pest" species. The Gray Hairstreak Butterfly (Strymon melinus pudica) probably feeds on leguminous plants cultivated on the site.

The weedy portions bordering the agricultural fields also support a depauperate insect fauna, consisting of widespread and common species. Bumblebees (Bombus species) and other native bees were frequently observed feeding on flowers.

Centinela Creek Drainage Ditch which runds through the south side of the Agricultural Lands is another important insect habitat at BCR. The water supports squatic insects and also terrestrial species that feed on emergent portions of hydrophytic plants. The Wandering Skipper (Panoquina errans) and the Mudflat Tiger Beetle (Cicindela trifasciata sigmoidea), Pale Shore Bug (Sadula pallipes), Brine Fly (Ephydra riparia) and ground and rove beetles (Carabidae and Staphylinidae) are found in the ditch from the gas plant east as far as saline water occurs. The population densities of these insects are lower than those in Units 1, 2 or 3.

The vegetation at the base of the bluffs supports an insect fauna typical of weedy fields and the Coastal Sage Scrub community. No unusual or especially rare insects were observed or collected.

The "junkyard" located north of Culver Blvd. has low insect diversity. Several extremely large colonies of the Argentine Ant (Iridomyrmex humilis) were found under the numerous boards, mattresses and other debris, but no rare or unusual species were discovered here.

The fields next to the gas plant road are filled with rain water during the winter and spring months. Numerous species of insects use the temporary plant life that develops then as food, cover and breeding source. Aquatic insects inhabit the water and serve as food for shorebirds.

BALLONA CREEK CHANNEL

The Ballona Creek Channel has very few species of permanent insect inhabitants because of the rocky substrate which prevents most ground-burrowing forms from becoming established, the high spring and winter flood waters which eliminate all but the hardiest species and the lack of diverse vegetation food sources.

Three species of tiger beetles populate the Ballona Creek Channel. Two, the Red Belly Tiger Beetle (Cicindela haemorrhagica haemorrhagica) and the Oregon Tiger Beetle (C. oregona oregona), are widespread in western North America. The third, the Mudflat Tiger Beetle (C. trifasciata sigmoidea), which is also found in Units 1, 2, 3 and a portion of the Agricultural Lands, has been extirpated from most of its range in the United States. Nagano (in press) postulates that the Ballona Creek Channel population of the last species susceptible to human disturbance and is in danger of being eliminated. gle nest each of the Honey Bee (Apis mellifera) and the California Ant (Pogonomyrmex californicus) were discovered on the north bank nnel. The Honey Bee nest is located in an old storm pipe, and the Ant colony is found on the ground in a sandy area. Due to the rela- numbers of Honey Bees observed at BCR, it is highly probable that e only colony in the area. This feral insect, through not native, t in the pollination of the local flowering plants. Commercial ever, have been placed in the agricultural area (as of 1 July 1981). ous algae-feeding flies of an undetermined family were observed ks within the intertidal zone. The Hairy Shore Bug (Sadula comatula) beneath debris in the same area. No insects were seen or collected he seawater in the channel.

from these insects, most of the species observed in the channel g on the few weedy plants or are transients. Although this is the ity where some of these insects are found at BCR, they are not diverse t when compared to other units.

SPECIES LIST

impossible to reduce all of the biological data known for the species t BCR into a simple graphic presentation; this is true by reason a's complexity and the multiple stages in the life cycles of insects. s List is a very general summary of the salient and most important BCR's insect fauna. Biological and ecological data are presented nsect species observed or collected at BCR. Bibliographic sources when possible, for data that are unusual or poorly known. The is an explanation of each category:

1-5. Unit of occurrence: the unit at which the species was found.

Macrohabitat--where the species was seen, collected or known to inhabit:

6. Introduced community: primarily non-native plants, such as the eucalyptus grove in Unit 2.

7. Agricultural: cultivated lands, such as in the Agricultural Unit.

8. Weedy field: mixture of native and non-native plants, such as the portions lacking pickleweed of Unit 3.

9. Salt pan: small areas in the pickleweed that do not support plant life due to extremely high salt levels.

10. Transitional pickleweed: portions that contain both weedy field and pickleweed.

11. Sand dune: coastal sand dune.

12. Fresh water: primarily freshwater plants.

13. Willow: portions with _Salix_ species.

14. Saltflat: extensive flat dry areas of the saltmarsh covered with a crust of salt.

15. Mudflat: muddy non-vegetative portions of the saltmarsh wet by seawater during tides.

16. Pickleweed: portions with _Salicornia_ and associated vegetation.

Occurrence--the resident status of the species:

17. Resident: permanent.

18. Transient: a temporary inhabitant (non-migratory).

19. Migrant: a temporary, migratory inhabitant.

20. Unknown: resident status is unknown.

Season of Occurrence--time of the year when the species is active as adult:

21. Spring: February to May.

22. Summer: June to August.

23. Fall: September to October.

24. Winter: November to January.

Abundance--the approximated population size of the species:

25. Very common: extremely abundant.

26. Common: abundant.

27. Occasional: sparse.

28. Rare: only a few individuals seen or collected.

Autecology--ecological niche of the species (most conspicuous stage, usually adult):

29. Herbivore: feeds on plant matter.

30. Carnivore: feeds on animal matter.

31. Omnivore: feeds on both plant and animal matter.

32. Parasite: feeding on a living organism without immediately causing its death.

Synecology--ecological interactions with other species (especially trophic role):

33. Mammal prey: eaten by mammals.

34. Bird prey: eaten by birds.

35. Reptile prey: eaten by reptiles.

36. Amphibian prey: eaten by amphibians.

37. Fish prey: eaten by fish.

38. Other prey: eaten by animals not listed above.

39. Pest species: insect is known to annoy or cause damage to man or his possessions.

40. Other information.

See Appendix 1 for the list of species from BCR.

TAXA OF SPECIAL SIGNIFICANCE

Some of the insects that have been collected at BCR are outstanding for one reason or other: few collection records exist, they have been or are being proposed for Endangered or Threatened Species status, they have very restricted or reduced ranges, or they represent important populations for the study of biogeography and insect evolution.

1. Belkin's Horse Fly (Apatolestes belkini; Diptera: Tabanidae): A single adult was collected on the sand dunes of Unit 1. Only a half-dozen specimens are known to science. It has been found on coastal sand dunes from Ensenada, Baja California, Mexico to Playa Del Rey, California. At the present time, nothing is known of the biology or ecology of this species, but judging from its closest relatives, it is not a blood feeder. It probably requires the sand dunes for larval development.

2. Mudflat Tiger Beetle (Cicindela trifasciata sigmoidea; Coleoptera: Cicindelidae): This tiger beetle was collected along the Ballona Creek Channel, the salt and mudflats of Unit 1, the muddy portions of the pickleweed next to Culver Blvd. in Unit 2, the Centinela Creek drainage east of the gas plant in the Agricultural Lands and in the slough of Unit 3. Originally it was probably an inhabitant of the Venice Salt Marsh but was exterminated from all but BCR after the nearby Marina del Rey was constructed. Nagano (in press) documented the range reduction of this beetle. It is restricted to coastal areas where it inhabits tidal regions or estuaries. It is now found in only seven of the 31 localities it was known originally to inhabit in the United States.

3. Sand Dune Tiger Beetle (Cicindela hirticollis gravida; Coleoptera: Cicindelidae): Specimens now in the Museum of Comparative Zoology, Harvard University, were collected at Playa Del Rey in 1906. It occurs only on clean,

light-colored sand at the mouths of estuaries or barrier beaches (Nagano, in press). Nagano has examined old topographic maps of BCR and has determined that the only suitable habitat was at the mouth of Ballona Creek. Tiger beetles are very important in marine littoral ecosystems and have been greatly reduced in range in southern California (Nagano, in press). C. hirticollis gravida is now found at only four of 24 localities it was known to have inhabited in southern California (Nagano, in press). This species apparently is extinct from BCR.

4. Wandering Skipper (Panoquina errans; Lepidoptera: Hesperiidae): Large populations of this skipper are found in the saltmarsh portions of Units 1 and 2. Samller populations are found in the slough on the northeast corner of Unit 3 and along the Centinela Creek drainage which runs along the bluffs in the Agricultural Unit. It is found in close association with the larval foodplant, Salt Grass (Distichlis spicata), which grows amongst pickleweed. For reasons unknown, the Wandering Skipper can develop only on Salt Grass that is wet by sea water or in soil that is very moist. This insect is rapidly disappearing from its range because of the continuous destruction of its coastal habitats. It was one of 24 species of California butterflies considered by the federal government for Threatened or Endangered Species status (Donahue, 1975). Nagano is currently studying the present distribution and size of its few remaining populations.

5. Wingless Wasp (Brachycistis species; Hymenoptera: Tiphiidae): Females of this wasp were collected in pitfall traps and males in ultraviolet light traps in the sand dunes of Unit 1. The females in this genus are wingless, very rarely seen and almost unknown from coastal areas. The males possess wings and are attracted to ultraviolet lights at night. Nothing is known of the biology of these animals; the males and the flightless females are so

structurally different that they undoubtedly lead distinct lives.

6. Sun spider (Eremobates new species; Arachnida: Solpugida): These animals were collected in pitfall traps located on the sand dunes of Unit 1. The species collected is new to science and is to be named by a specialist. It is distributed elsewhere in California and is NOT ENDEMIC to BCR. This species is nocturnal and predaceous on other invertebrates.

7. Dorothy's Sand Dune Weevil (Trigonoscuta dorothea; Coleoptera: Curculionidae): This beetle is common beneath native plants in the sand dunes of Unit 1. It is found only on coastal sand dunes from Point Dume south to Orange County (Pierce, 1975). Because of its extremely local occurrence in a fragile disappearing habitat, it might become a candidate for Threatened status.

8. Yellow-faced Bee (Hylaeus punctatus; Hymenoptera: Colletidae): This bee is known only from western Europe and BCR. It might have been accidentally introduced into the wetlands by human agency or it could be a native insect, posing an interesting problem for biogeographers. Numerous specimens were collected on the sand dunes and near the willow grove in Unit 1.

9. Sweat Bee (Lasioglossum species; Hymenoptera: Halictidae): This bee genus is in need of revision, and it is impossible to ascertain if the eight unidentified species of Lasioglossum are new to science or merely unrecognizable with current knowledge.

10. Frail Springtail (Onchiurus debilis; Collembola: Onychiuridae): One of the most interesting and difficult to explain distributions of any insect known, this springtail is found in France, Alaska and BCR (Bellinger, pers. comm.). A single specimen was collected in a Berlese funnel using leaf litter from the saltmarsh of of Unit 1. There are three possible ways Onchyrius debilis could have arrived at Ballona Wetlands: via human transportation, as

a stowaway aboard an airplane or boat; via natural means of transportation, on ocean drift or in sail on the feet of migratory birds; or it may have been a resident of the west coast of North America for hundreds of millions of years, since before continental drift had separated the continents.

INTRODUCED SPECIES

The impact of terrestrial arthropods known to be introduced in natural ecosystems is not fully understood. A common problem when species newly enter a region is a population explosion and intensive competition with the native wildlife. Well-known examples are the Norwegian Rat (Rattus norwegicus) and the Starling (Sturnus vulgaris). Such problems are especially acute in isolated areas, such as nature preserves or islands. Several adventive insects were discovered during this study and their effects assessed as far as possible.

Common Dysderid Spider (Dysdera crocata) is a spider originally native to Europe that specializes on sowbugs for food. It is common throughout BCR, and the impact on native spiders is unknown.

The most abundant insect at BCR is the Argentine Ant (Iridomyrmex humilis) which arrived in Louisiana in 1890 from South America. From the southeastern United States, this species spread to the warmer parts of California where it is now a ubiquitous household pest. It is not unusual to collect 10,000+ individuals in single baited pitfall trap at BCR. The relatively low numbers of native ant species (2) is probably due to the highly aggressive and competitive nature of the Argentine Ant. This ant is displacing native ant species in other areas of southern California as well, such as in the Santa Monica Mountains and on Santa Catalina Island. Further studies on the ecology and biology of this economically important animal are critically needed to determine its effect on native ant species.

Introduced into eastern North America in the nineteenth century, the Cabbage Butterfly (Pieris rapae) has since spread across the continent to the Pacific Coast. It is one of the most common butterflies at BCR. The impact of Pieris rapae on the native butterfly fauna is probably neutral, since the larvae feed on weedy wild mustard (Brassica) and radish (Rhaphanus).

The Honey Bee (Apis mellifera) was introduced to California in the middle of the nineteenth century. It is now found nearly everywhere in the state. Snelling has observed that hives have been recently placed on the Agricultural Lands and the Honey Bee population has dramatically increased. This may lead to the serious problem of the native bees and the Honey Bees competing for a limited number of flowers.

It is not known when the Yellow-faced Bee (Hylaeus punctatus) was introduced to BCR or if it is a native insect. Further studies are needed to determine the ecology and the effect this insect has on the resident bee fauna.

Hylaeus bisinatus is a close relative of the above bee that was collected at BCR. H. bisinatus was introduced to North America in the late nineteenth century and has since spread to most of the United States. The effect on native bees is negligible.

The earwigs (Forficula auricularia and Euborellia annulipes) are species introduced into North America from the Old World. They are well established and common at BCR. The effect of these omnivorous insects on the native fauna is unknown, but they may prey intensively on ground beetle larvae (Carabidae).

ENDANGERED AND THREATENED SPECIES

No species of insects now known to be under state or federal protection have been detected at BCR. Despite intensive searching for both, we found neither the El Segundo Blue Butterfly (Euphilotes battoides allyni), an Endangered Species known only from the El Segundo Sand Dunes, nor the Palos

Verdes Blue Butterfly (Glaucopsyche lygdamus palosverdesensis), a rare subspecies found only on the Palos Verdes Peninsula.

The Globose Dune Beetle (Coelus globosus) was proposed for consideration as Threatened by the Xerces Society (Anon., 1979) but has not been given that official status to date. It occurs in the foredunes bordering nearby Dockweiler State Beach, but there are no records of the species from BCR.

PROBLEMS AND CONCLUSIONS

1. BCR is one of the few localities in Los Angeles County with large populations of coastal insects. BCR is a refugium for many species of insects that were once widespread but are now largely extirpated from the coast. Insects are a critical component of the marine littoral and wetlands ecosystem. They are the primary converters of plant matter to protein and thus provide food for many vertebrates, such as birds, mammals and reptiles.

2. BCR retains populations of insects whose loss of range elsewhere has been or is being documented: Mudflat Tiger Beetle (Cicindela trifasciata sigmoidea) and Wandering Skipper (Panoquina errans).

3. BCR is important for entomogeographical reasons, i.e. explanation of the presence of a bee and a springtail known elsewhere only from Europe and Alaska in the case of the springtail.

4. Horseback riding throughout Unit 1 is very destructive. Intensive animal, human and off-road vehicle traffic is highly detrimental to native animals and plant life (Nagano, 1980, 1981, in press; Powell, 1981; Weaver and Dale, 1978). These activities cause compaction of the soil, crushing subterranean insects and destroying vegetation, removing food and cover. Machines, animals and people step on or drive over and kill insects that are on the surface of the soil. Nagano (1980) noted the numbers of tiger beetles at Border Field State Park in San Diego County was significantly lower in areas

that had large numbers of horseback riders and horses than in areas that were not so used. In the same report, he also noted the importance of restricting human visitors to established trails on the coastal sand dunes of McGrath State Beach in Ventura County in order to minimize the damage to the flora and fauna. Horses in Unit 1 cause the greatest amount of environmental destruction because their numbers are proportionately greater than human and ORV traffic. It has been noted throughout the field work of this study that the horseback riders tend to disregard established trails and prefer traveling through ecologically sensitive portions such as the sand dunes, mudflats and pickleweed. The rich insect life of these habitats will be eliminated if the horses are allowed to continue their unrestricted ravages.

5. The greatest number of insect species restricted to the sea coast are found at the sand dunes at the west end of Unit 1. This site is subject to traffic by large numbers of humans, equines and occasional ORV's. It is highly probable that the insect fauna of the sand dunes will become extinct if this disturbance continues.

6. Another serious problem is the rapid spread of the introduced ice-plant (Carprobotus edulis) in Units 1, 2 and 3. No insects have been observed feeding on the leaves and relatively few species visit the flowers. Bees of the genera Agapostemon and Bombus feed on the pollen and nectar, but it should be noted that these insects are "general" feeders and will use flowers of most any plant. Some spider species use the iceplant as a site for their webs, but they use almost any low-lying plant or other structure for this purpose. Iceplant is spreading rapidly and will soon crowd out a number of native plant species which are intensively used by insects.

7. Pesticides are a well-known threat to insect populations, especially those species sensitive to other deleterious disturbances to their environment.

If these harmful chemicals enter BCR from any adjoining urban development, then many of the native insects could be eradicated. It will be unlikely that the exterminated species will reestablish themselves because of the lack of any proximate salt marshes or estuaries that can provide a source of new immigrants.

8. The amount of sea water is of indirect, though critical, importance to many insects at BCR. Several species of salt marsh flies (Dolichopodidae, *Ephydra riparia*, Chironomidae) can only develop in moist or wet saline mud. The adults may require high humidity for their well being and for successful mating.

The larvae of the Wandering Skipper (*Panoquina errans*) can only live on Salt Grass (*Distichlis spicata*) that is wet by sea water or in soil that is very moist. The larvae of the Mudflat Tiger Beetle (*Cicindela trifasciata sigmoidea*) are only found in mud or sand at or just above the mean high-tide mark. It is interesting to note that during high tides these burrows are covered by water. Wilson (1974) noted that some riparian species of tiger beetles in the northeastern United States survive being covered by high river waters.

Beetles of the ground beetle genus *Bembidion* and rove beetles, especially the genus *Bledius*, are inhabitants of the mud and salt flats of BCR. Both of these families are predaceous on flies and their larvae. *Bledius* feed on simple algae (Minnesang, 1980).

Pale Shore Bugs (*Sadula pallipes*) are common inhabitants of the pickleweed, mud and salt flats. These insects are always found near saline water at Ballona Wetlands. Shore bugs are important predators of flies and other invertebrates.

If the tidal flow is increased, it is highly likely that populations of the salt marsh insects will increase.

9. Continued monitoring of the insect life of BCR is essential. We are still finding species unrecorded from the locality and Los Angeles County on each field trip. We have identified 475 species to date and estimate that as many as 1200 species actually may inhabit BCR.

10. The entomological character of the BCR indicates that it is basically a natural coastal salt marsh and associated sand dune. This conclusion was reached by the presence of insect indicator species of marine coastal habitats, for the marsh--the Wandering Skipper (Panoquina errans), Brine Fly (Ephydra riparia) and Mudflat Tiger Beetle (Cicindela trifasciata sigmoidea); for the dune--Dorothy's Sand Dune Weevil (Trigonoscuta dorothea) and Belkin's Horse Fly (Apatolestes belkini).

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Appendix 1

Appendix 1 is the list of species that were found at BCR. For an explanation of the number categories see pages E-13 to E-15.

Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Notes
Crustacea Isopoda Oniscidae Armadillidium vulgare (Latr.)	●	●	●		●	●	●	●		●	●	●	●				●				●	●	●	●	●				●									●			29. decaying plant material and young plants 38. prey of Dysdera crocata
Porcellio laevis Koch	●	●	●		●	●	●	●		●	●	●	●				●				●	●	●	●	●				●									●			29. decaying plant material and young plants 38. prey of Dysdera crocata
Arachnida Spirobolida Parajulidae Parajulidae species	●										●						●				●	●		●			●		●												
Arachnida Solpugida Erematobidae Eremobates new species	●										●						●					●					●			●											17. not endemic
Araneida Ctenizidae Aptostichus species	●										●						●							●			●			●										●	40. build web-like burrows from which ambush prey (Kaston, 1978:68-72)
Oecobiidae Oecobis species	●										●						●							●			●			●										●	40. probably lives under stones (Kaston 1978:75)
Dysderidae Dysdera crocata Koch	●	●	●		●	●	●	●		●	●	●	●				●				●	●	●		●					●											17. introduced from Europe (Thompson 1979:26) 30. preys on sowbugs (Thompson 1979:26)
Oonopidae Scaphiella hespera Cham.	●										●		●				●				●		●			●				●											
Gnaphosidae Zelotes species	●										●						●					●						●		●										●	40. probably lives in web-lined tube nest from which leaves to hunt insects (Kaston 1978:200)

Taxon	Notes
Herpyllus species	
Poecilochroa species	
Orodrassus species	
Pholcidae Psilochorus species	40. web spinner (Kaston 1978:96)
Clubionidae Chiricanthum species	40. tube nests in rolled up leaves on ground (Kaston 1978:210) sometimes bites humans (Thompson 1979:29)
Phrurotimpus species	
Anyphaenidae Anyphaena species	
Teudis species	
Salticidae Salticidae species	40. ambush prey, no web (Kaston 1978:240)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
Agelenidae Agelenidae species	●																●					●						●		●											
Lycosidae (2-3 undetermined species)	●	●	●		●	●	●	●		●	●	●	●				●				●	●	●		●					●										●	40. hunt prey on ground (Kaston 1978:181)
Oxyopidae Peucetia viridans (Hentz)	●										●						●					●						●		●										●	30. hunts prey on vegetation, no web (Thompson 1978:28)
Theridiidae Dipoena species	●												●				●				●						●			●											
Lactrodectus mactans herperus Cham. and Ivy		●				●											●				●						●			●											
Mimetidae Mimetus species	●										●						●				●	●			●					●											30. other spiders (Kaston 1978:175)
Araneidae Eustala species	●										●						●				●	●			●					●											
Tetragnthidae Tetragntha species		●						●									●					●	●		●					●										●	40. orb web (Kaston 1978:162)
Zoridae Lutica maculata Marx	●										●						●					●	●		●					●										●	40. hang in vegetation during daytime (Kaston 1978:224)

Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Notes
Linyphiidae Linyphiidae species		●				●											●				●						●			●										●	40. web spinner (Kaston 1978:116)
Micryphantidae Micryphantidae species	●												●				●				●				●					●											
Dictynidae Dictyna species	●												●				●				●				●					●										●	40. web spinner (Kaston 1978:78-79)
Insecta Collembola Onychiuridae Onychiurus debilis (Moniez)	●															●	●				●							●	●												17. species known elsewhere only from France and Alaska (P. Bellinger, pers. comm.)
Isotomidae Cryptopygus thermophilus (Axelson)	●	●	●			●				●	●					●	●				●						●		●												
Proisotoma schoetti (Dalla Torre)		●				●											●				●						●		●												
Isotomurus species	●	●				●								●			●				●						●		●												
Archisotoma interstitialis Delamare	●															●	●				●					●			●											●	40. genus known only from marine intertidal (Christiansen and Bellinger 1980:608)
Isotoma maritima Tullberg	●															●	●				●					●			●												

	1	2	3	4	5	6	7	8	9	[illegible]	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	[illegible]	[illegible]	36	37	38	39	40
Sminthuridae *Sphaerida pumilis* (Krausbauer)	●		●							●	●						●				●						●		●											
Entomobryidae *Pseudosinella octopunctata* Borner	●		●								●			●			●				●						●		●											
Entomobrya guthriei Mills		●				●											●				●						●		●											
Entomobrya multifasciata (Tullberg)		●				●											●				●						●		●											
Entomobrya Juveniles #1	●															●	●				●						●		●											
Entomobrya Juveniles #2			●							●							●				●						●		●											
Entomobrya Juveniles #3	●													●			●				●						●		●											
Entomobrya Juveniles #4	●										●						●				●						●		●											
Entomobrya Juveniles #5	●													●			●				●						●		●											

Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Note
Hypogastruridae *Xenylla wilsoni* Gama	●		●							●	●						●				●						●		●												
Hypogastrura essa Christ & Bell.	●															●	●				●						●		●												
Hypogastrura denticulata (Bagnall)	●													●		●	●				●						●		●												
Diplura Campodeidae *Campodea folsomi?*	●											●					●				●							●	●												29. fungal spores?
Thysanura Lepismatidae *Allacrotelsa spinulata* (Packard)	●										●		●				●				●					●					●										
Microcoryphia Minertellidae *Machilinus* species	●										●						●					●				●					●										
Odonata Aeschinidae *Anax junius* (Drury)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				●	●	●				●			●											12. immatures in fresh water
Aeschna species	●										●							●				●						●		●											18. immatures in mountain streams
Libellulidae *Pantala hymenea* (Say)	●											O				●				●			●				●			●											12. immatures in fresh water

Species	Columns marked (1–40)	Remarks
Pantala flavescens (Fab.)	1, 2, 12 (o), 16, 20, 21, 22, 27, 30	12. immatures in fresh water
Tarnetrum corruptum (Hagen)	1, 2, 16, 17, 21, 22, 26, 30	16. observed ovipositing in tidal channel (Centinela Creek?)
Coenargrionidae Argia species	1, 5, 8, 12, 17, 21, 22, 23, 27, 30	12. immatures in fresh water
Enallagma species	1, 5, 8, 12, 17, 21, 22, 23, 27, 30	12. immatures in fresh water
Orthoptera Acrididae Timerotropis rebellis (Saussure)	1, 3, 8, 15, 17, 22, 28, 29	
Chimarocephala californica (Brunner)	3, 10, 17, 22, 28, 29	
Melanopus species?	1, 13, 17, 22, 26, 29	
Tettigoniidae Scudderia furcata Brunner	1, 11, 17, 22, 27, 29	40. stridulates, arboreal.
Neduba morsei Caudell	1, 11, 13, 17, 22, 28, 29, 40	40. ground dweller

Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Remarks
Gryllacrididae *Stenopelmatus fuscus* Haldeman	●							●									●				●	●	●					●			●										31. subterranean root feeder
Ceuthophilus californicus Scudder	●										●						●					●					●		●											●	40. subterranean, usually occupies gopher holes
Pristoceuthophilus species	●										●						●					●				●			●											●	40. ground dwelling
Gryllidae *Oecanthus argentinus* Saussure		●	●													●	●					●					●		●											●	40. stridulates; arboreal
Gryllus assimilis (Fabr.)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				●	●	●		●						●									●	40. stridulates; ground dweller
Mogoplistidae *Hoplosphyrum boreale* Scudder	●										●						●					●				●			●											●	40. ground dweller
Polyphagidae *Arenivaga* species	●										●						●				●	●	●	●			●		●											●	40. females wingless; males winged. Both borrow in sand (Powell & Hogue 1979:57)
Dermaptera Labiduridae *Euborella annulipes* (Lucas)	●	●										●					●					●	●			●					●									●	40. ground dweller; always under objects
Forficulidae *Forficula auricularia* Linne			●							●							●					●	●			●					●									●	40. ground dweller; always under objects

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
Isoptera Kalotermitidae Incisternes minor (Hagen)	●												●				●					●					●		●												29. collected in dead willow branch
Embioptera Oligotomidae Haploembia solieri (Rambur)	●										●						●				●							●	●											●	17. introduced (Powell & Hogue 1979:79-80) 29. scavenger on dead plant material 40. lives in web mats, under objects on ground
Pscoptera several unidentified species	●	●	●		●	●	●		●	●	●	●				●	●				●	●	●			●			●												
Thysanoptera several unidentified species	●	●	●	●	●	●	●	●		●	●	●	●			●	●				●	●	●			●			●	●											
Hemiptera Corixidae Trichocorixa reticulata (Guer. Men.)	●	●	●		●									●	●	●	●				●	●	●		●						●			●			●			●	31. microorganisms 40. saltwater indicator species of salt marshes
Saldidae Sadula pallipes (Fabr.)	●	●	●		●									●	●	●	●				●	●	●			●				●											
Sadula comatula (Parshley)				●											●		●					●						●		●											
Miridae Miridae species 1	●							●												●		●						●	●												
Miridae species 2				●				●												●		●						●	●												

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Miridae species 3	●		●								●					●	●				●						●		●											
Miridae species 4		●	●													●	●				●						●		●											
Lygus species 1	●												●							●		●						●	●											
Lygus species 2		●						●												●		●						●	●											
Lygus species 3	●															●				●		●						●	●											
Lygus species 4		●														●				●		●						●	●											
Lygus species 5	●																●				●						●		●											
Lopidea marginata Uhler	●										●						●				●					●			●											
Closterocoris amoenus (Prov.)	●												●				●					●						●	●											

Taxon	Marked (1–40)	Notes
Reduviidae Zelus tetracanthus Stal	1, 11, 17, 22, 27, 30	30. other insects
Reduviidae species	3, 16, 17, 22, 28, 30	30. other insects
Pentatomidae Thyanta pallidovirens (Stal)	1, 11, 17, 21, 28, 29, 40	29. plant sap 40. arboreal
Cydnidae Microporus obliquus Uhler	1, 11, 17, 23, 28, 29, 40	40. subterranean
Rhytidoporus compactus (Uhler)	1, 11, 17, 22, 28, 29, 40	40. subterranean
Neuroptera Hemerobiidae Hemerobius pacificus Banks	1, 11, 12, 13, 17, 21, 22, 23, 24, 27, 30	30. larvae, mites and aphids
Chrysopidae Chrysopa carnea Steph.	1, 11, 17, 21, 22, 23, 27, 30, 31	30. larvae, other insects 31. adults (honeydew, pollen, sometimes other insects)
Myrmeleontidae Brachynemurus ferox (Walker)	1, 11, 17, 22, 23, 27, 30	40. Larvae in sandpits (prey traps)
Myrmeleon arizonicus Banks	1, 11, 17, 22, 23, 27, 30	40. larvae in sand pits (prey traps)

Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Notes
Coleoptera Cicindelidae Cicindela oregona oregona (LeConte)				●										●	●		●				●	●	●				●			●											30. larvae in burrows in mud
Cicindela haemorrhagica haemorrhagica LeConte				●										●	●		●				●	●	●			●				●											30. larvae in burrows in mud
Cicindela trifasciata sigmoidea LeConte	●	●	●	●	●									●	●	●	●				●	●	●			●				●											17. Restricted to estuaries and bays on southern California - Baja California. Reduced to 7 localities, threatened? (Nagano, in press)
Cicindela hirticollis gravida LeConte																	●				●	●	●							●											17. Harvard Museum record, extinct BCR. Reduced to 4 localities in southern California.
Carabidae Pterostichus californicus (Dejean)	●	●									●			●		●	●				●	●	●			●				●					●					●	35. Anniella pulchra (M Hayes, pers. comm.) 40. ground dweller
Calosoma semilaeve LeConte	●							●			●						●				●							●		●										●	30. caterpillars 40. strongly odiferous
Amara californica (Dejean)	●	●	●		●		●	●									●				●			●		●			●	●										●	29. adults, arboreal 30. larvae 40. large numbers collected in pickleweed at night, Area 3. Ground dweller
Calathus ruficollis ruficollis Dejean	●		●					●			●						●				●	●	●	●		●				●										●	40. ground dweller
Agonum californicum Dejean			●								●						●					●						●		●										●	40. occurs near water; ground dweller

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
<u>Agonum crenistriatum</u> LeConte?		●														●	●					●						●		●										●	40. ground dweller
<u>Agonum maculicolle</u> Dejean	●															●	●				●							●		●										●	40. ground dweller
<u>Bembidion</u> near <u>quadrulum</u> LeConte	●	●	●							●				●		●	●				●	●	●				●			●										●	30. adult, dead and dying insects 40. occurs near water; ground dweller
<u>Tachys corax</u> LeConte	●													●			●				●					●				●										●	40. ground dweller
<u>Anisodactylus californicus</u> Dejean	●										●						●				●						●			●										●	40. ground dweller
<u>Bradycellus</u> species			●													●	●				●						●			●										●	40. ground dweller
<u>Stenolophus</u> species			●													●	●					●					●			●										●	40. ground dweller
<u>Apristus laticollis</u> LeConte	●	●												●			●				●						●			●										●	40. ground dweller
Dytiscidae <u>Rhantus gutticollis</u> (Say)	●	●														●	●					●					●		●	●										●	30. aquatic invertebrates and small vertebrates 40. aquatic freshwater

Taxon	Marked columns (1–40)	Notes
Hydrophilidae Tropisternus species	1, 2, 16, 17, 22, 27, 29, 30, 40	29. adult, algae (Anabaenea; Clathrocystis) 30. larvae 40. fresh and brackish water
Enochrus species	1, 2, 16, 17, 22, 27, 29, 30, 40	29. adult, algae (Spirogyra, Mongeotia) 30. larvae 40. fresh and brackish water
Histeridae Hypocacus lucidulus LeConte	11 (O), 27, 30	11. collected at Venice Canal 30. fly larvae (Arnett 1960:372)
Saprinus lugens Eeichson	2, 16, 17, 22, 27, 30	30. fly larvae (Arnett 1960:372)
Xerosaprinus lubricus LeConte	2, 8, 17, 22, 27, 30	30. dead animal, record on dead Lampropeltis getulus
Xerosaprinus species	2, 8, 17, 22, 28, 30	30. dead animal, record on dead Lampropeltis getulus
Miscellaneous unidentified species	1, 3, 10, 11, 17, 22, 23, 26, 30	
Staphylinidae Bledius strenus Casey	1, 2, 3, 14, 15, 16, 17, 22, 23, 26, 29	
Paederus? species	5, 16, 17, 22, 28, 30	

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Notes
Philonthus species 1	●															●	●					●						●		●											
Philonthus species 2			●					●									●				●							●		●											
Philonthus species 3	●										●						●				●							●		●											
Bledius species	●	●	●											●	●	●	●					●					●		●												
Ptinidae Ptinidae species 1	●										●						●					●						●	●												
Ptinidae species 2	●										●						●				●							●	●											●	
Scarabaeidae *Aphodius fucosus* (Schmidt)	●										●						●				●							●	●											●	29. adult, decaying vegetation. larvae? 40. under *Lupinus* (Venice Canal)
Aphodius lividius (Olivier)	●										●						●				●							●	●											●	29, 40. horse droppings?
Aphodius rugatus (Schmidt)	●										●						●				●							●	●												

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
Parathyce palpalis Horn	●					●					●						●				●							●	●											●	40, adult, Lupinus
Bupreshidae Acmaeodera labyrinthica Fall	●										●						●					●						●	●												29. larvae, stem borer; adult, flower feeder
Elateridae Elater lecontei (Horn)	●										●						●					●						●	●												
Anchastus cinerepennis (Esch.)	●										●						●				●						●		●												
Melanotus longulus longulus (LeConte)	●																●				●						●		●												
Melanotus species	●																●					●						●	●												
Dermestidae Dermestes species		●															●					●					●			●											30. Carrion, record on dead Lampropeltis getulus
Anthrenus lepidus conspersus (Casey)	●	●	●			●		●		●	●						●				●					●			●												29. adult, flowers of Carprobotus edulis
Anthrenus verbasci (Linne)	●										●						●				●							●	●												29. adult on Lupinus

	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40	
Bostrichidae Bostrichidae species	1, 11, 17, 22, 28, 29, 40	40. adult, pickleweek litter
Cleridae *Phyllobaenus subfasciatus* (LeConte)	3, 10, 17, 22, 28, 29	
Melyridae *Collops* near *marginellus* LeConte	1, 4, 13, 14, 17, 21, 22, 28, 30	30. other insects
Trichochrus nigrinus Casey	3, 8, 17, 21, 25, 29, 40	40. adults, flowers of *Chrysanthemum coronarium*
Trichochrus suturalis (LeConte)	1, 3, 8, 10, 17, 21, 26, 29	
Coccinellidae *Coccinella californica* Mann.	1, 8, 10, 17, 22, 23, 26, 30	30. other soft-bodied insects (especially aphids)
Hippodamia convergens Guerin	1, 8, 10, 17, 21, 22, 23, 24, 26, 30	30. other soft-bodied insects (especially aphids)
Exochomus fasciatus Casey	1, 10, 17, 21, 28, 30	
Olla abdominalis (Say)	1, 10, 17, 22, 28, 30	30. other soft-bodied insects (especially aphids)

	Columns marked (1–40)	Notes
Cryptolaemus montrouzieri Muls.	● 1, 11, 17, 21, 28, 30	30. mealy bugs
Chilocorus bivulnerus Muls.	● 3, 11, 17, 22, 28, 30	30. other soft-bodied insects (especially aphids)
Psyllobora vigintimaculata (Say)	● 1, 13, 17, 22, 27, 29, 40	40. willow
Colydiidae *Anchomma costatum* LeConte	● 1, 11, 17, 22, 23, 26, 30	
Tenebrionidae *Eleodes gracilis distans* Blaisdell	● 1, 3, 8, 11, 17, 21, 22, 23, 27, 29, 40	40. adult, ground dwelling; larvae, subterranean
Amphidora nigropilosa LeConte	● 1, 11, 17, 23, 27, 29, 40	40. adult, ground dweller
Cratidus osculans LeConte	● 1, 11, 17, 23, 24, 27, 29, 40	40. adult, ground dweller
Coelus ciliatus Esch.	● 1, 11, 17, 21, 22, 23, 24, 26, 29, 33, 35, 38, 40	38. Therevid fly larvae 40. restricted to sand dunes, sand dune indicator species; for life history see Doyen (1976)
Systena blanda (Mel.)	● 1, 11, 17, 23, 28, 29, 40	40. adult, ground dweller

Coniontis species	40. adult, ground dweller
Epantius obscurus (LeConte)	40. adult, ground dweller
Oedemeridae *Nacerdes melanura* (Linne)	17. introduced 40. larvae in moist decaying wood, including driftwood
Mordellidae *Mordella* species	40. adult in flowers
Cerambyeidae *Ipochus fasciatus* LeConte	29. larvae woodborer
Chrysomelidae *Diabrotica undecimpunctata undecimpunctata* (Fabr.)	29. larvae root feeder
Altica carinata Germar	
Cryptocephalus castaneus LeConte	40. adult on willows
Metachroma californicum Crotch	

Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Notes
Metachroma species	●		●							●	●						●					●						●	●												
Stenopodius flavidius Horn		●	●					●		●							●				●	●						●	●											●	40. adult on Malva
Erycephala morosa (LeConte)		●						●									●					●						●	●												
Diachus species	●												●				●					●						●	●												
Alticinae species	●	●						●			●						●				●	●						●	●												
Pachybrachus species	●												●				●				●	●				●			●											●	40. adult on willow
Curculionidae Trigonoscuta dorothea dorothea Pierce	●										●						●					●	●			●			●											●	40. restricted to coastal sand dunes, sand dune indicator species (Pierce 1975:38-41)
Listoderes obliguus (Klug)	●										●						●						●					●	●												17. introduced from Brazil 29. larvae, tuberous roots
Sitona californica Fahraeus	●	●								●	●						●				●	●						●	●												

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
Apion proclive LeConte	●										●						●				●						●		●												40. adult on *Lupinus*
Smicronyx cinereus Motsh.	●	●														●	●				●						●		●												
Onychobaris (?) species	●	●									●					●	●				●	●					●		●												
Cylindrocopturus (?) species	●					●											●					●						●	●												
Curculionidae species			●					●			●						●				●							●	●					●							34. Burrowing owl pellet (collection number 00766)
Lepidoptera Pyralidae *Uresiphita reversalis* (Guenee)	●	●	●								●						●				●	●	●			●			●												
Loxostege immerens (Harvey)	●										●						●				●							●	●												
Euchromius ocellus (Howarth)	●	●	●							●	●					●	●				●	●					●		●												
Lipographis fenestrella (Packard)			●							●							●				●							●	●												

Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Notes
Pterophoridae *Agdistis americana* B. & L.		●						●								●	●				●						●		●												
Oecophoridae *Martyhilda gracilis* (Walsh.)	●										●						●					●						●	●												
Sessildae *Paranthene robinae* (H. Edwards)	●										●		●				●					●					●		●												29. larvae wood borer in *Populus* and *Salix*
Penstemonia hennei Enge.?		●						●									●					●					●		●												
Geometridae *Merochlora faseolaria* Gn.	●										●						●					●						●	●												
Euphyia implicata multilineata Pack.	●										●						●					●						●	●												
Arctiidae *Estigmene acrea* (Drury)					●							●					●					●						●	●												29. larva, variety weedy species
Noctuidae *Hemeroplanis* species	●										●						●					●				●			●												
Heliothis phloxiphaga G. & R.	●										●						●					●				●			●												29. larva, various unrelated plants

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
Autographa californica (Speyer)	●	●	●		●	●		●		●	●						●				●					●			●										●		29. larva, variety of plants
Lacinpolia stricta Wlk.			●								●						●				●				●				●												
Zosteropida herpites Grt.	●										●						●					●					●		●												
Discestra chartaria Grt.			●								●						●				●					●			●												
Perizoma custodiata Gn.	●	●	●					●	●	●	●			●	●	●	●				●	●	●		●				●												
Caenurgia togataria Wlk.	●	●	●				●	●	●	●	●			●	●	●	●				●	●	●		●				●												
Schinia scarletina Sm.	●										●						●				●							●	●											●	29. larva, *Stephanomaria* 40. adult, diurnal
Laphygma exigua Hbn.	●										●						●						●					●	●										●		29. larva, variety of plants
Hemieuxoa rudens Marv.			●								●						●				●							●	●												

Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Notes
Sphingidae *Hyles lineata* (Fabr.)	●	●				●		●		●	●					●	●				●					●			●										●		29. larva, wide variety of plants
Papilionidae *Papilio zelicaon zelicaon* Lucas	●	●	●			●		●		●							●				●	●	●			●			●												29. larva, *Foeniculum vulgare*
Pieridae *Pieris rapae* (Linne)	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●				●	●	●			●			●												17. introduced 29. larva, cruciferous plants (probably *Brassica* at BCR)
Pieris protodice Boisd. & LeConte			●					●									●				●	●	●				●		●												29. larva, cruciferous plants (probably *Brassica* at BCR)
Colias eurytheme eurytheme Boisd.	●	●	●		●	●	●	●		●	●	●				●	●				●	●	●				●		●												29. larva, leguminous plants
Phoebis sennae marcellina (Cramer)		●				●												●			●	●	●					●	●												29. larva, *Cassia*
Danaidae *Danaus plexippus* (Linne)	●	●	●		●	●	●	●		●	●	●	●					●			●	●	●				●		●												29. larva, *Asclepias*
Danaus gilippus strigosus (Bates)	●		●			●		●			●								●		●	●	●				●		●												29. larva, Asclepiaceae (Colorado Desert)
Nymphalidae *Cynthia cardui* (Linne)	●												●				●				●	●	●					●	●												29. larva, various plants (probably *Malva* and *Lupinus* at BCR)

Species	Sites (●, columns 1–40)	Notes
Cynthia virginiensis (Drury)	1, 11, 17, 21, 22, 23, 28, 29	29. larva, *Gnaphalium* and *Anaphalis*
Cynthia annabella Field	1, 2, 3, 5, 6, 7, 8, 11, 12, 13, 17, 21, 22, 23, 26, 29	29. larva, *Malva parviflora*
Nymphalis antiopa antiopa (Linne)	1, 2, 3, 5, 6, 8, 11, 12, 13, 17, 21, 22, 23, 24, 27, 29	29. larva, *Salix*, *Populus*, *Ulmus*
Agraulis vanillae incarnata (Riley)	1, 11, 18, 21, 22, 23, 27, 29	18. introduced 29. larva, *Passiflora* (adults probably stray from nearby houses)
Lycaenidae *Apodemia mormo virgulti* (Behr)	1, 11, 17, 21, 28, 29	29. larva, *Eriogonum*
Strymon melinus pudica (H. Edwards)	1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 17, 21, 22, 23, 25, 29, 39, 40	29. larva, variety of plants 40. probable main breeding site bean fields
Callophyrs dumetorum dumetorum (Boisd.)	1, 3, 11, 17, 21, 27, 29	29. larva, *Lotus scoparius* and *Eriogonum*
Plebeius acmon acmon (West. & Hewit.)	1, 11, 17, 21, 22, 23, 28, 29	29. larva, *Astragalus* and *Lotus*
Glaucopsyche lydamus australis Grinnell	1, 8, 11, 17, 21, 27, 29	29. larva, *Lotus scoparius*

Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Notes
Leptotes marina (Reakirt)	●	●	●	●	●	●	●	●		●	●	●	●				●				●	●	●	●	●				●												29. larva, Plumbago, Medicago, and Astragulus
Brephidium exilis exilis (Boisd.)	●	●	●	●					●	●	●			●	●	●	●				●	●	●	●	●				●											●	29. larva, Chenopodium and Atriplex 40. probable indicator species of saline soils
Hesperidae Paroquina errans (Skinner)	●	●	●		●				●					●	●	●	●				●	●	●			●			●											●	29. larva, Distichlis spicata 40. salt marsh indicator species
Hylephila phyleus (Drury)	●	●	●	●	●	●	●	●		●	●	●	●				●				●	●	●			●			●												29. larva, Bermuda Grass
Erynnis funeralis (Scudd. & Burgess)	●										●						●				●						●		●												29. larva, Lotus
Diptera Tipulidae Dicranoptycha occidentalis Alexander	●	●	●							●						●	●				●					●			●												
Culicidae Aedes squamiger Coq.	●	●			●										●	●	●				●						●		●	●										●	30. females bite humans 40. larva, brackish water; salt marsh indicator species
Culiseta inornata (Williston)	●	●			●						●		●		●	●	●				●						●		●	●										●	30. females occasionally bite humans 40. larva, ground pools, brackish water; associated with A. squamiger
Chironomidae Chironomidae species 1	●	●	●					●			●					●	●				●				●															●	40. larva aquatic

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Notes
Chironomidae species 2	●	●	●								●					●	●				●		●		●				●											●	40. larva aquatic
Chironomidae species 3			●													●	●				●				●				●											●	40. larva aquatic
Bibionidae Bibio albipennis albipennis Say	●										●						●				●					●			●												29. larva decaying organic matter in soil
Stratiomyidae Nemotelus arator Mel.	●	●	●		●	●	●	●		●	●	●	●	●			●				●	●				●			●											●	40. larva aquatic
Tabanidae Apatolestes belkini (Philip)	●										●						●					●						●	●											●	29. adult probably nectivorous 40. larva probably subterranean sand dunes
Therevidae Psilocephala lateralis Adams?	●													●			●					●						●		●											
Thereva nebulosa Krober?	●					●		●			●						●				●					●				●											
Therevidae species 1	●										●						●				●							●		●											30. larva of Coelus ciliatus
Therevidae species 2	●										●						●				●							●		●											

Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Notes
Mydaidae Neomydas pantherinus (Gerst.)	●										●						●					●					●			●										●	30. larva probably predaceous on other insects 40. larva probably subterranean
Asilidae Ablautus coquilleti Wilcox	●										●						●				●						●			●										●	40. probably restricted to sand dunes
Cophura clausa Coquil.	●										●						●						●	●				●		●										●	40. probably restricted to sand dunes; coastal species
Stenopogon brevisculus Loew	●										●						●					●						●		●											
Mallophora fautrix fautricoides Curran	●							●									●					●						●		●											30. adults, commonly honeybees
Acroceridae Turbopsebius diligens (Osten Sacken)	●												●				●					●						●				●									32. larva, internal parasite burrowing spiders
Bombyliidae Villa species?	●										●						●				●							●	●			●									32. larva, other insects
Villa atrata (Coquil.)	●													●			●					●				●			●			●									32. larva, other insects
Villa lateralis (Say)	●	●	●	●				●		●	●			●			●				●	●				●			●			●									32. larva, other insects

Taxon	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Notes
Poecilanthrax species	●														●		●					●					●		●			●									32. larva, caterpillars
Exprosopa doris (Osten Sacken)?	●															●	●					●						●	●			●									
Lepidanthrax species?	●										●						●				●						●		●			●									
Bombylius species?		●		●										●		●	●					●					●		●			●									32. larva, wild bee larva
Dolichopodidae Dolichopodidae species	●	●	●	●	●				●					●	●	●	●				●	●	●	●	●					●											
Hydrophorus species?	●	●			●							●		●	●	●	●				●		●		●					●											
Syrphidae Eristalis brousii Williston	●											●					●				●	●					●		●											●	40. larva aquatic
Eristalis tenax (Linne)	●										●						●				●					●			●											●	17. introduced 40. larva aquatic
Eristalis aeneus (Scopoli)											●					●	●					●				●			●											●	40. larva aquatic

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Paragus tibialis (Fallen)	●		●							●	●						●					●					●		●											
Scaeva pyrastri (Linne)	●										●						●				●					●			●											
Chrysotoxum species	●										●						●				●						●		●											
Copestylum mexicana MacQuart	●										●							●				●						●	●											
Pseudodoros clavata (Fab.)			●							●							●					●						●	●											
Sphaerophoria species	●		●							●	●						●					●					●		●											
Eupeodes volucris Sacken	●										●						●				●	●					●		●											
Syrphini species	●	●									●		●				●				●	●					●		●											
Otitidae *Melieria occidentalis* Coquil.	●										●						●						●					●	●											

Tephritidae
Eutreta angusta Banks

Trupanea californica Mall.?

18. probably from sea beach
29. larva, moist decomposing kelp

Coelopidae
Coelopa vanduzei Cresson

Sepsidae
Sepsidae species

40. larva, develops in saline water; indicator of saline soil

Ephydridae
Ephydra riparia macellaria Egger

Ephydridae species

32. larva, Cottony Cushion Scale

Cryptochaetidae
Cryptochaetum iceryae

18. probably from sea beach
29. larva, moist decomposing kelp

Anthomyiidae
Fucellia pacifica Mall.

Muscidae
Musca domestica Linne

Sarcophagidae Blaesoxipha plinthpyga (Wied.)	32. larva, other insects
Tachinidae Archytes metallicus (Rob.-Des.)	
Cylindromyia nana (Townsend)	
Peleteria species	32. larva, internal rabbits (Meyer and Bock, 1980:489-493)
Cuterebridae Cuterebra lepivora Coquil.	
Siphanoptera Pulicidae Hoplopsyllus glacialis foxi Ewing	32. adult, external rabbits
Dolichopsyllidae Malaraeus telchinum Roths.	Record Hubbard 1947:200, not collected 32. adult, external Microtus
Hymenoptera Tenthredinidae Phyllocolpa species	

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
Euura species	●												●				●				●	●				●			●												29. willow leaf gall maker
Braconidae *Apanteles* near *megathymi* Riley	●												●				●					●					●					●									32. caterpillars
Apanteles species 2	●										●		●				●					●					●					●									32. Ex gelechioid moth larva in willow leaf gall (collection no. 00742)
Apanteles species 3	●												●				●					●						●				●									
Bracon species 1	●										●						●					●						●				●									
Bracon species 2	●										●						●					●						●				●									
Chelonus species 1	●												●				●					●						●				●									
Chelonus species 2			●					●									●					●						●				●									
Rogas species					●	●										●	●				●						●					●									

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ichneumonidae Anomalon species 1			●					●									●					●					●					●								
Anomalon species 2	●					●											●					●						●				●								
Calliphialtes notandus (Cress.)	●										●						●				●	●					●					●								
Campoplex species	●										●						●					●					●					●								
Coccygomimus hesperus Town.?	●										●						●					●						●				●								
Compoctonus species	●										●						●					●						●				●								
Diplazon laetatorius Fab.	●										●						●					●						●				●								
Exochus nigripalpus subobscurus Townes	●										●						●					●						●				●								
Gelis species	●										●						●				●							●				●								

32. Syrphid flies

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Glypta species	●										●						●					●						●				●								
Homotropus decoratus (Cress.)				●										●			●				●							●				●								
Homotropus maculitrons (Cress.)	●										●						●				●							●				●								
Hyposoter species 1	●												●				●				●							●				●								
Hyposoter species 2	●												●				●					●					●					●								
Hyposoter species 3	●										●						●					●						●				●								
Ichneumoninae species 1	●		●							●	●						●					●						●				●								
Ichneumoninae species 2			●													●	●					●						●				●								
Itamoplex species			●										●				●				●							●				●								

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Lissonota species			●										●				●				●							●				●								
Netelia species	●												●				●				●							●				●								
Pristomerus _spinator_ (Fab.)			●					●									●					●						●				●								
Pterocormus species 1	●	●								●			●				●					●					●					●								
Pterocormus species 2	●										●						●					●						●				●								
Pterocormus species 3			●													●	●				●							●				●								
Pterocormus species 4			●							●						●	●					●						●				●								
Scambus species 1	●												●				●					●						●				●								
Scambus species 2	●										●						●				●	●						●				●								

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Scambus species 3	●										●						●					●					●					●								
Scambus species 5	●										●						●					●					●					●								
Scambus species 6			●					●									●					●						●				●								
Scambus brevicornis (Grav.)	●										●						●					●						●				●								
Temelucha species 1	●										●						●				●							●				●								
Temelucha species 2	●					●					●						●					●						●				●								
Tromatobia ovivora (Boh.)	●					●											●					●						●				●								
Tromatobia variabilis (Holm.)	●										●						●					●						●				●								
Xanthocampolex species 1			●					●									●					●					●					●								

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Xanthocampolex species 2			●					●									●					●						●				●								
Xanthocampolex species 3				●										●			●				●							●				●								
Mymaridae Mymaridae species	●										●						●				●					●						●								
Encyrtidae Encyrtidae species	●										●						●				●					●						●								
Pteromalidae Pteromalidae species	●										●		●				●					●	●			●			●	●		●								
Eurytomidae Eurytomidae species	●										●		●				●					●				●			●			●								
Eurytoma species	●												●				●					●						●				●								
Chalcidae *Brachymeria* species			●					●									●					●						●				●								
Spilochalcis species 1	●					●											●					●						●				●								

Chrysis fuscipes Brulle	
Hedychridium species	
Tiphiidae *Brachycistis agama* (Dalla Torre)	32. beetle larvae
Brachycistis species	40. females wingless, ground dweller
Mutillidae *Sphaeropthalma* species	40. females wingless, probably ground dweller
Scoliidae *Campsomeris tolteca* (Sauss.)	32. scarab beetle larvae
Formicidae *Pogonomyrmex californica* (Buckley)	29. seeds 40. ground nests

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Notes
Iridomyrmex humilis (Mayr)	●	●	●	●	●	●	●	●	●	●	●	●	●				●				●	●	●	●	●						●								●	●	17. introduced 40. ground nest, usually under objects
Leptothorax andrei Emery	●												●				●				●						●			●											
Vespidae Polistes aurifer Sauss.	●		●					●			●						●					●				●				●										●	30. caterpillars 40. hanging paper umbrella nests
Polistes apache Sauss.	●					●											●					●						●		●										●	17. introduced 30. caterpillars 40. hanging paper umbrella nests in trees
Vespula pensylvanica (Sauss.)	●					●											●					●						●			●									●	40. ground nests
Eumenidae Ancistocerus tuberculiceps sutterianus (Sauss.)	●										●		●				●				●	●						●		●										●	40. nests in old Mud Dauber (Sceliphron) nests
Ancistocerus spilogaster Cam.	●										●		●				●				●						●			●										●	40. nests in twigs, makes mud cells on rocks
Ancistocerus species	●												●				●					●						●		●											
Pompilidae Episyon conterminus posterus Fox	●					●											●					●						●		●										●	30. spiders 40. nests in sand

Anoplius imbellis Banks	30. spiders 40. nests in ground near water
Anoplius relativus (Fox)	30. spiders
Episyron quinquenotatus hurdi Evans	30. spiders (Epeira)
Pompilus solonus (Banks)	30. spiders (Lycosa)
Evagetes species	30. social parasite of other Pompilidae
Evagetes padrinus (Vier.)	30. social parasite Episyon, Anoplius 40. found in sandy places
Aporinellus taeniatus Kohl	30. probably preys on jumping spiders 40. nests in sand
Aporinellus apicatus Banks	
Sphecidae Sceliphron caementarium (Drury)	30. spiders 40. builds mud nests

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Bembix americana comata Parker 30. flies 40. nests in dry compact sand	●	●	●	●	●						●			●			●				●	●	●		●					●										●
Lindenius tecuya Pate 30. other insects 40. nests in sandy to gravelly soil near water				●										●			●					●						●		●										●
Oxybelus uniglumis (Linne) 30. flies 40. nests in sand	●		●	●						●	●			●			●					●				●				●										●
Tachysphex alpestris Rohw.	●		●							●	●						●				●	●				●				●										
Tachysphex species 1	●										●						●				●	●					●			●										
Tachysphex species 2	●		●						●	●							●				●						●			●										
Tachysphex species 3	●		●							●	●						●				●	●					●			●										
Tachysphex species 4			●							●							●				●							●		●										
Tachysphex species 5			●							●							●				●	●					●			●										

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
<u>Tachysphex</u> species 6	●		●							●	●						●				●	●					●			●										
<u>Tachysphex</u> species 7	●										●						●					●						●		●										
<u>Mimesa</u> species 1	●										●						●					●						●		●										
<u>Mimesa</u> species 2	●										●						●					●					●			●										
<u>Steniolia</u> <u>duplicata</u> Prov. (30. flies; 40. nests in sandy soil)			●							●							●				●							●		●										●
<u>Miscophus</u> species 1	●										●						●						●					●		●										
<u>Miscophus</u> species 2			●								●						●				●	●					●			●										
<u>Miscophus</u> species 3			●							●							●				●	●					●			●										
<u>Miscophus</u> species 4			●							●							●					●						●		●										

Species	Marked characters (1–40)	Notes
Philanthus pacificus Cresson	1, 3, 10, 11, 17, 21, 22, 26, 30, 40	30. other Hymenoptera 40. nests in sandy soil
Solierella albipes (Ashmead)	1, 11, 17, 21, 22, 28, 30	30. other insects
Sphex ichneumoneus (Linne)	1, 6, 17, 22, 27, 30, 40	30. crickets and katydids 40. ground nests in hard packed sand or soil
Liris aequalis (Fox)	1, 3, 6, 16, 17, 22, 27, 30	
Liris argentata (P. de Beauv.)	1, 3, 10, 11, 17, 22, 27, 30	30. crickets
Tachytes distinctus F. Sm.	1, 11, 17, 22, 27, 30	30. grasshoppers
Prionyx thomae Cam.	1, 6, 17, 22, 28, 30	30. grasshoppers
Prionyx parkeri Boh.	1, 6, 17, 22, 26, 30	30. grasshoppers
Ammophila azteca Cam.	1, 6, 17, 22, 26, 30	30. caterpillars

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40

Species	Notes
Ammophila cleopatra Menke	30. caterpillars (Macrurocampa marthesia)
Ammophila species	
Larropsis tenuicornis (F. Sm.)	30. Ceuthophilus and Pristoceuthophilus at BCR (probable)
Diodontus species	30. aphids and leafhoppers
Astata nevadica Cresson	30. hemiptera
Astata nubeula Cress.	30. hemiptera, stinkbugs
Microbembix californica Bohart	30. dead arthropods
Dryudella caerulea (Cress.)	30. hemiptera
Megachilidae Osmia clarescens Ckll.	40. nests in abandoned Sceliphron nests

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
Megachile _perihirta_ Ckll.	●							●									●				●							●	●												
Megachile _concinna_ F. Sm.	●					●											●					●						●	●												17. introduced
Anthidium _palliventre_ Cress.	●										●						●				●	●				●			●												
Melittidae _Hesperapis_ _ilicifoliae_ (Ckll.)	●										●						●				●							●	●												
Colletidae _Hylaeus_ _punctatus_ (Brulle)	●					●					●						●					●					●		●												20. known elsewhere only from Europe
Hylaeus _bisinuatus_ Foerster	●					●											●					●						●	●												17. introduced
Colletes _hyalinus_ _gaudialis_ Ckll.	●					●					●						●					●					●		●												
Colletes _fulgidus_ Swenk	●					●											●					●						●	●												
Colletes _slevini_ Ckll.	●					●											●					●					●		●												

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Halictidae _Halictus_ _ligatus_ Say	●		●			●		●		●	●		●				●				●	●				●			●											
Halictus _rubicundus_ (Christ)	●		●					●		●	●						●				●	●						●	●											
Halictus _farinosus_ Smith	●					●											●					●						●	●											
Halictus _tripatitus_ Ckll.	●										●						●					●					●		●											
Agapostemon _texanus_ Cress.	●		●							●	●						●				●	●					●		●											
Agapostemon _angelicus_ Ckll?	●		●			●		●		●	●						●				●	●				●			●											
	40. females indistinguishable from females of _Agapostemon_ _texanus_																																							
Lasioglossum _pavonotum_ (Ckll.)	●					●					●						●				●	●				●			●											
Lasioglossum species 1	●		●					●		●	●						●												●											
Lasioglossum species 2	●		●	●				●		●	●			●			●					●					●		●											

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Lasioglossum species 3	●												●				●					●						●	●											
Lasioglossum species 4	●		●					●		●	●						●				●						●		●											
Lasioglossum species 5	●	●	●					●		●	●						●				●	●					●		●											
Lasioglossum species 6	●										●						●					●						●	●											
Lasioglossum species 7	●					●											●					●						●	●											
Lasioglossum species 8	●					●											●					●						●	●											
Lasioglossum tegulariforme (Crwfd.)	●		●	●				●		●	●			●			●					●					●		●											
Lasioglossum Kincaidii (Ckll.)	●					●					●						●				●	●					●		●											
Lasioglossum sisymbrii (Ckll.)	●										●						●				●							●	●											

	Positions marked (1–40)	Notes
Lasioglossum *incompletum* (Crfd.)	1, 11, 17, 21, 28, 29	
Sphecodes species 1	1, 10, 11, 17, 22, 27, 29	
Sphecodes species 2	3, 10, 11, 17, 22, 28, 29	
Andrenidae *Andrena* *candida* F.Smith	1, 11, 17, 21, 28, 29	
Andrena *prunorum* Ckll.	1, 11, 17, 21, 28, 29	
Nomadopsis *hesperia* *hesperia* (Sw. and Ckll.)	3, 11, 17, 22, 27, 29	
Anthophoridae *Xylocopa* *varipuncta* Patton	1, 3, 11, 12, 13, 17, 21, 22, 27, 29, 40	29. Larva,pollen 40. nests in dead wood
Hypochrotaenia *formula* (Vier.)	1, 2, 3, 6, 8, 10, 11, 17, 22, 23, 27, 28, 40	29. Usurpator of *Agapostemon* nests
Anthophora *californica* Cress.	1, 4, 6, 11, 14, 17, 21, 22, 27, 29	

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	
Anthophora curta Prov.	●		●							●	●						●				●	●				●			●												
Anthophora flavocincta (Huard)	●		●			●		●		●	●					●	●					●				●			●												
Anthophora urbana Cress.	●		●			●				●	●						●					●					●		●												
Zacasmia maculata (Cress.)	●										●						●					●					●		●												29. Usurpator of Anthophora (Micranthophora) nests
Diadasia consociata Timberlake	●		●			●					●					●	●					●			●				●												
Diadasia lutzi Ckll.		●														●	●				●							●	●												
Epeolus minimus (Robt.)	●										●						●					●					●		●												29. Usurpator of Colletes nests
Melissodes lupina Cress.			●					●									●					●						●	●												
Melissodes tepida timberlakei Ckll.	●		●	●		●		●		●	●						●				●	●			●				●												

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	Notes
Melissodes pallidisgnata Ckll.			●					●									●					●					●		●												
Melissodes species			●					●									●					●						●	●												
Ceratina acantha Prov.	●		●			●		●		●	●						●				●	●				●			●												
Ceratina arizonensis Ckll.	●					●					●						●				●	●					●		●												
Xeromelecta californica (Cress.)			●					●									●					●					●		●												29. Usurpator of Anthophora nests
Apidae Apis mellifera Linne	●	●	●	●	●	●	●	●		●	●	●	●			●	●				●	●	●		●				●											●	17. introduced 40. Common Honey Bee
Bombus crotchii Cress.	●	●				●					●						●				●	●						●	●											●	40. nests in ground
Bombus californicus F.Sm.	●		●					●		●	●						●				●	●					●		●											●	40. Nests in ground
Bombus edwardsii Cress.	●					●		●		●							●				●	●					●		●											●	40. nests in ground

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Bombus sonorus Say 40. nests in ground	●	●	●	●	●	●	●	●		●	●	●	●			●	●				●	●	●		●				●											●
Bombus vosnesenskii Rad. 40. nests in ground	●	●	●			●		●		●	●					●	●				●	●				●			●											●

Species List: addendum

The following species of Homoptera have recently been identified; however, no further information is available at this time.

Family Cicadellidae:	*Amphigonallia severini* DeLong
	Aceratagallia longula Van Duzee
	Prariana sidana (Ball)
	Euscelidius variegatus Kirshbaum
	Graphocephala atropunctata (Signoret)
	Friscanus friscanus (Ball)
Family Membracidae:	*Spissistilus festinus* (Say)
Family Flatidae:	*Mistharnophantia sonorana* Kirkaldy
Family Achilidae:	*Orgerius triquestris* Doering and Darb.
Family Delphacidae:	*Pissonotus delicatus* Van Duzee
Family Psylliidae:	*Psylla curta* Tuthill
	Craspedolepta pulchella (Crawford)
	Trioza minuta Crawford
	Trioza maura Forster

Appendix 2

The identifications of the following micro-wasps (Hymenoptera) were received too late to have been included in the entomological analysis of BCR.

Species	Season collected	Unit	Habitat
Ceraphron species A	spring	1	sand dune/willow
Platygaster species A	spring	1	sand dunes/willow
Diapriinae new genus	spring	1	sand dunes
Tetrastichus species	spring	1	sand dunes
Tachinaephagus zelandicus	summer/spring	2/3	weedy field/pickle-weed
Gonatocerus species	spring	1	sand dunes
Ageniaspis species ?	spring	1	sand dunes
Eupteromalus species	spring	1	sand dunes
Torymus species	spring	1	sand dunes
Paraholaspis species	spring	1	sand dunes
Eurytoma species	spring	1	sand dunes
Alloxysta species	spring	1	sand dunes
Pachyneuron species	spring	1	sand dunes
Eridontomerus species	spring	1	sand dunes
Ablaxia species	spring	1	sand dunes
Mesopolobus species	spring	1	sand dunes
Habrocytus species	spring	1	sand dunes
Notoglyptus species? (petiolate)	spring	1	sand dunes
Mesopolobus species (sessile)	spring	1	sand dunes
Hormius species	no further details		
Ephedrus new species (parasite of aphids)	no further details		
Opius new species (parasite of leafmining muscid fly)	no further details		

Appendix 3

Appendix 3 is a letter from the Los Angeles County Mosquito Abatement District in answer to a request for information about possible mosquito problems at BCR.

LOS ANGELES COUNTY WEST MOSQUITO ABATEMENT DISTRICT

W. JEFFERSON BOULEVARD, CULVER CITY, CALIFORNIA 90230 • Phone 827-3448

August 26, 1981

Christopher D. Nagano
Research Asso.
Entomology Section
L.A. County Museum
900 Exposition Blvd.
Los Angeles, CA 90007

Dear Mr. Nagano:

This is in response to your request relative to mosquito breeding which may occur or have occurred in the Ballona Wet-Lands.

There are areas included in the map that have had mosquito breeding at various times. When breeding does occur, appropriate control measures are taken.

Any future development of the area must provide for good water management, provide access for inspections and for appropriate control.

Hoping this will be of assistance to you.

Very truly yours,

Norman F. Hauret

Norman F. Hauret
Manager

THE MARINE MOLLUSKS OF BALLONA

Martin G. Ramirez

INTRODUCTION

The marine mollusks of Ballona were surveyed during 1980-81 in order to compare the mollusks with those of similar, but undisturbed salt marsh faunas in southern California.

METHODS

During July, 1980, I made a preliminary survey of the molluscan fauna, making random collections of dead shells along the tidal channels. This enabled a general assessment of the mollusks present. For the quantitative sampling, seven stations (Figure 1) were established. All stations were fully exposed at low tide. Monthly samples were taken from each of these stations over a ten month period from August, 1980, through May, 1981. Samples were taken from the center of the channel at each station using a core tube 33 cm in circumference x 18 cm in height, volume 1,559 cc.

Core samples were wet-seived in the field with a 1.0 cm sieve box and transported in plastic bags to the laboratory for further seiving of the mud. The mollusks recovered were transferred to shallow pans for examination and identification. Living mollusks and dead mollusk shells were recovered in this way. The epifaunal species that live abundantly on the mud surfaces at or slightly below the high water line (*Melampus olivaceus*, *Assiminea californica*, and *Cerithidea californica*) were recovered as dead shells. Other species, all of which live epifaunally on the mud surfaces exposed at low tide, or burrow infaunally in the mud, were recovered primarily as dead shells, although living examples of all species were verified. A voucher collection representing each species has been deposited in the LACMNH permanent collection.

RESULTS

Scientific and common names of the marine species found in this study are listed in Table 1, which also gives the stations from which each species was collected. Additional references to the species at the Ballona from other survey reports are also given in Table 1. All species are characteristic salt marsh forms, as described and illustrated in McLean (1978) and Abbott (1974). Thirteen bivalve species were collected in the present study, three of which (*Chione californiensis*, *Laevicardium substriatum*, and *Tresus nuttalli*) were found only as dead valves during the preliminary survey. Two additional bivalves, *Ostrea lurida* Carpenter, 1864, and *Spisula* sp., were reported from Ballona by Reish (1980). Of the 13 species collected in this study, seven were not found by Reish (1980). Six gastropod species were found in the present study, only one of which was reported by Reish (1980).

Table 2 shows the total number of specimens of each species collected from each station over the ten month period from August, 1980, to May, 1981, and also the total number of specimens of each species from all stations combined over the ten month period. Of the 16 species appearing in the quantitative samples, station 4 was the most diverse, having 14 species. Differences in diversity between the stations are not significant; all the abundant and relatively common species (*Macoma nasuta*, *Protothaca staminea*, *Tagelus californianus*, *Acteocina inculta*, *Assiminea californica*, *Cerithidea californica*, and *Melampus olivaceus*) were present at each station. The higher count of species at some stations is a result of the occurrence of species that are sporadic and represented by very few numbers. These sporadic species are *Cryptomya californica*, *Leptopecten latiauratus*, *Mytilus edulis*, *Saxidomus nuttalli*, *Tellina carpenteri*, *Zirfaea pilsbryi*, *Bulla gouldiana*, and *Haminoea virescens*.

Table 3 shows the sampling results of each species by month, also giving the total number collected, which matches the same tally in Table 2. Although the monthly results show some fluctuation, with a trend toward greater abundance of most species during the fall months, these results, which are based primarily upon dead shells, are not significant.

In addition, dead shell of three fresh water species /*Gyraulus parvus* (Say, 1816); *Helisoma* sp.; and *Physa virgata* Gould, 1855/ were collected along the Centinela Creek drainage ditch. Such species occur away from salt marshes in fresh water, though their shells commonly wash into the marshes (McLean, personal communication).

CONCLUSIONS

Despite its relatively small area, the Ballona salt marsh supports a varied aggregation of invertebrate animals, of which the mollusks are an important component. The Ballona salt marsh is comparable in the diversity and abundance of its molluscan fauna to the two salt marsh localities in southern California--Mugu Lagoon, Ventura County, and Mission Bay, San Diego County (MacDonald 1969a, 1969b). Essentially the same species are present in all three salt marshes.

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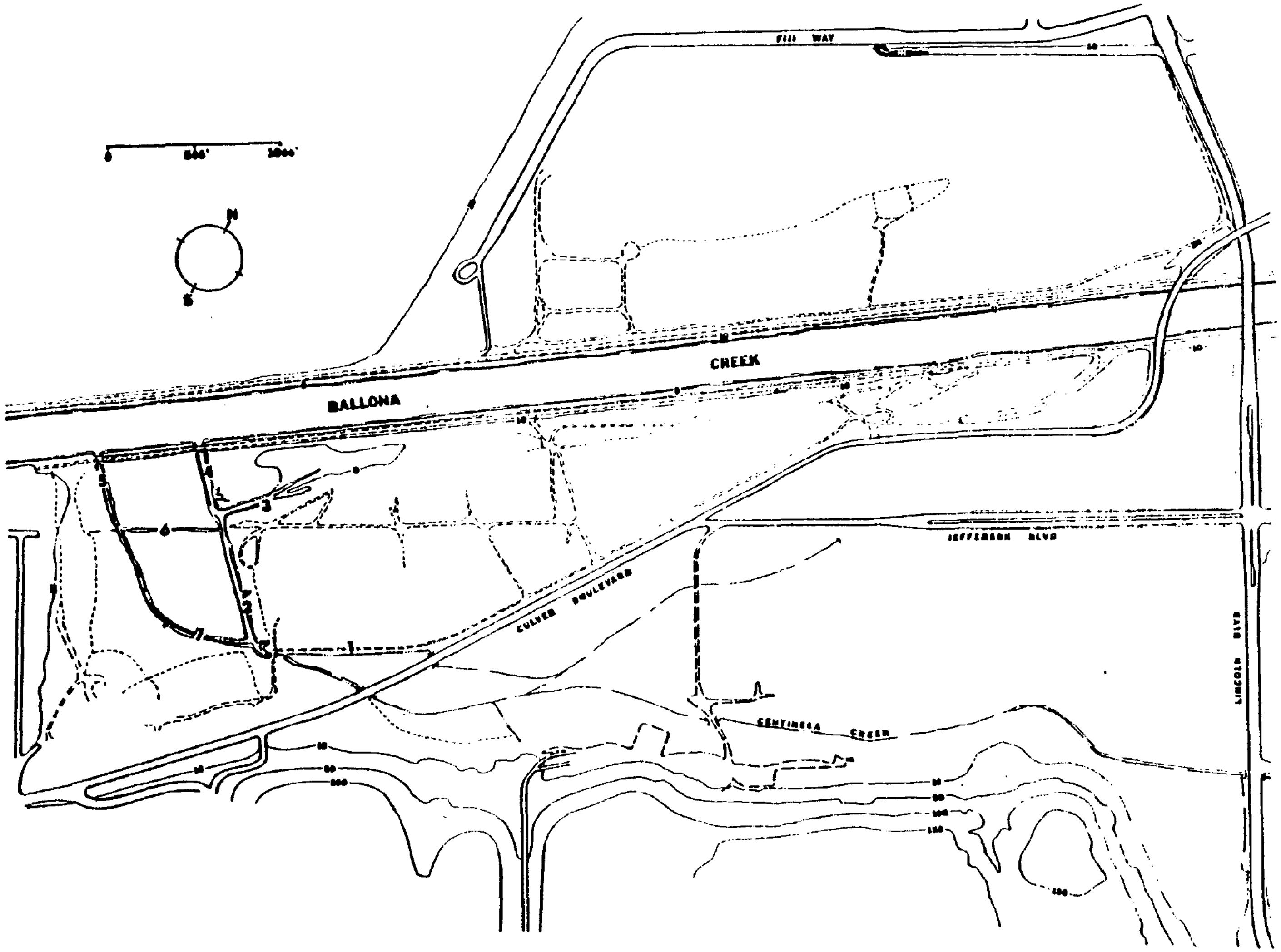

Figure 1. Marine mollusk collecting stations, 1980-1981.

TABLE 1

Marine Mollusks of Ballona Collected 1980-81

Name	Stations	Additional References
CLASS PELECYPODA (BIVALVES)		
Chione californiensis (Broderip, 1835) California Chione	P*	
Cryptomya californiaca (Conrad, 1837) California Glass Mya	4	Reish, 1980
Laevicardium substriatum (Conrad, 1837) Egg Cockle	P	
Leptopecten latiauratus (Conrad, 1837) Wide-eared Scallop	4	
Macoma nasuta (Conrad, 1837) Bent-Nose Clam	1-7	Reish, 1980
Mytilus edulis Linnaeus, 1758 Bay Mussel	1-2,4-5	Metz, 1978 Reish, 1980
Protothaca staminea (Conrad, 1837) Littleneck Clam	1-7	Metz, 1978 Reish, 1980
Saxidomus nuttallii Conrad, 1837 Washington Clam	4	
Tagelus californianus (Conrad, 1837) California Jacknife Clam	1-7	Bakus, 1975
Tagelus subteres (Conrad, 1837) Purplish Jacknife Clam	1-5	Reish, 1980
Tellina carpenteri Dall Carpenter's Tellin	4	
Tresus nuttalli (Conrad, 1837) Gaper Clam	P	
Zirfaea pilsbryi Lowe, 1931 Rough Piddock	4	Reish, 1980
CLASS GASTROPODA (MARINE SNAILS)		
Acteocina inculta (Gould, 1855) Small Acteocina	1-2,4-7	
Assiminea californica (Tryon, 1865) California Assiminea	1-7	

TABLE 2

Total numbers of each species by station over the ten month period, August, 1980, to May, 1981. Also showing the total number of specimens of each species from all seven stations combined, and the number of species collected at each station.

Stations	1	2	3	4	5	6	7	Total
Pelecypoda								
Cryptomya californica				5				5
Leptopecten latiauratus				4				4
Macoma nasuta	12	8	27	39	28	29	13	156
Mytilus edulis	1	2		15	12			30
Protothaca staminea	2	8	20	193	50	22	3	298
Saxidomus nuttallii				1				1
Tagelus californianus	6	16	16	13	8	5	8	72
Tagelus subteres	11	29	9	11	1			61
Tellina carpenteri				1				1
Zirfaea pilsbryi				3				3
Gastropoda								
Acteocina inculta	13	3		14	1	1	1	32
Assiminea californica	324	70	1	17	71	77	14	574
Bulla gouldiana	1		2					3
Cerithidea californica	578	1109	529	1630	303	111	433	4693
Haminoea virescens					1			1
Melampus olivaceus	40	35	3	64	16	64	58	279
Species/station	10	9	8	14	10	7	7	

TABLE 3

Numbers of each species from all stations by month. Also showing the total number of specimens for the ten month period from August, 1980, to May, 1981.

	AUG	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	TOTAL
Pelecypoda											
Cryptomya californica	4	1									5
Leptopecten latiauratus	1	2	1								4
Macoma nasuta	23	15	18	22	11	12	15	15	12	13	156
Mytilus edulis	5	4	7			5	1	2	3	3	30
Protothaca staminea	39	36	46	45	21	31	30	30	8	12	298
Saxidomus nuttallii							1				1
Tagelus californianus	9	15	16	8	2	9	1	5	4	3	72
Tagelus subteres	8	5	4	5	2	14	7	6	5	5	61
Tellina carpenteri	1										1
Zirfaea pilsbryi	1	1	1								3
Gastropoda											
Acteocina incluta	2		12	6	4	6	1			1	32
Assiminea californica	75	69	35	42	112	177	23	21	24	46	574
Bulla gouldiana	2			1							3
Cerithidea californica	352	473	651	765	499	415	361	463	473	241	4693
Haminoea virescens			1								1
Melampus olivaceus	14	25	43	16	39	29	39	37	28	9	279

ESTUARINE FISH COMMUNITIES OF BALLONA

Camm C. Swift and Gretchen D. Frantz

ESTUARINE FISH COMMUNITIES OF BALLONA

LIST OF FIGURES

LIST OF TABLES

Estuarine Fish Communities of Ballona

Camm C. Swift and Gretchen D. Frantz

INTRODUCTION

Ballona Marsh is a highly modified remnant marsh on the western edge of the Los Angeles Basin bordering on Santa Monica Bay. Most of the original marsh has been channelized and developed into marinas and condominiums. Ballona Creek is enclosed in a concrete-lined channel and 140 hectares remain separated from the creek by two sets of tide gates (Fig. 1). Although the fish faunas of several coastal estuarine areas of southern California are well studied (Allen and Horn, 1975; Lane and Hill, 1977; Horn, 1981) and some work has been done on Ballona Marsh (Reish, 1980) and the nearby Marina del Rey Harbor (Soule and Oguri, 1977, 1980), the fish community of the marsh was poorly known. Only in Lane and Hill's (1977) study on Anaheim Bay were small upper slough habitats regularly sampled, the only kind of habitat present in Ballona. Lane and Hill did not calculate diversity indices, nor did they discuss the upper marsh as a distinct unit. Thus, this is the first detailed study of an upper marsh fish community in southern California, and provides interesting comparisons with other local marshes and with estuarine areas in other parts of the world. A baseline of information is also provided for assessing future changes in the fish fauna.

METHODS AND MATERIALS

We sampled fourteen stations monthly, from July 1980 through June 1981, among the tribut[illegible] channels of the marsh (Fig. 1): three (Nos. 3, 4, 7) with a large seine, 5 x 1.8 m, with 3.2 mm mesh, and the remaining ten (1-2, 5-6, 8-13) with a 1.8 x 1.2 mm, 6.3 mm mesh seine. We collected plankton with a one-meter diameter plankton net with 0.505 mm mesh. Each seine station consisted of two hauls along the center of the channel at relatively low tides (-0.1 to +0.5 m), when the net swept all or most of the channel. Numerous, relatively short, repetitive sampling drags such as these increases sampling effectiveness, and the level of replicability can be predicted (Livingston, 1976). Stations 3 and 7 were deep holes, in contrast to the typically shallow sloughs of the 11 remaining localities as well as most of the marsh. Collections in Unit 1 fell within 2 hours of low tide. Since Unit 2 was only affected at high tides, collections were always during constant low-tide levels of a few hours' duration.

Fishes were counted, standard length was measured and most fish were released to prevent decimation of the populations. Occasionally, aliquots were taken of large samples, and numbers and biomass were partially estimated, particularly with large samples of postlarval gobies (Gobiidae) in spring. Occasional representative samples were preserved in 5% formalin.

At the low tides, about 3,730 square meters of water surface existed, and our samples covered 9.5% of this (355.12 sq. m) (Table 1). From July through December, we did not collect station 13, or it was dry and 9% of the area was sampled. Dates of collections appear on Table 2. Salinity and temperature were taken from the surface usually before collecting, occasionally after. Salinities were determined by refractometer. A study of top and bottom salinities during a tidal cycle on 15 August 1980 showed these to be identical at low tide in the marsh. Dimensions and bottom type remained stable through the study, and variation in aquatic vegetation is also noted (Table 1). Plankton samples were taken in the main channel (vicinity of Station 4) on incoming tide 2-3 hours after low tide. We estimated the volume strained when the opening of the net was not completely submerged. On 15

August 1980, we set a series of eight minnow traps (baited with frozen squid and anchovy) during the incoming and high tide: four in the channel at Stations 2, 3, 4 and 7, and four on the *Salicornia* flats in the high intertidal north of Station 7, north of Station 5, and east and west of Station 2. The traps on the flats were submerged only for 1 to 2 hours of highest tide, and the one east of Station 2 was only 3/5 inundated.

Diversity (H') was calculated with the method of Shannon-Weaver (1963):

$$H' = -\sum_{i=1}^{s} P_i \log P_i$$

where Pi is the proportion of individual fish (or their biomass) in the ith species. We used natural logarithms in our calculations. The measure of the difference between samples used was the percentage similarity index of Whittaker and Fairbanks (1958).

$$PS = 100(1.0-0.5\Sigma[Pia-Pib])$$

where Pia is the proportion of individuals (biomass) in the ith species of sample a and Pib for sample b. We used these measures to compare our samples by area and season and also to compare them with other southern California estuaries. Livingston (1966) has shown a high degree of correlation among the several most common measures of diversity including H', when applied to collections of estuarine fishes.

Common and scientific names follow Robins et al. (1980) and are listed on Table 2 for Station collections and Table 3 for larval (plankton) collections. Diversity calculations are based on the regular seine stations (Table 1) only, and both larvae and incidental juveniles and adults are listed for the plankton samples (Table 2). Other collections appear in text discussion but not in the tables.

DESCRIPTION OF THE AREA

The area studied consists of two Units (Fig. 1) traversed by tidal channels or sloughs of about 1.5 ha of surface water at mean tide levels. The area is part of the Marina del Rey Harbor-Ballona Channel estuarine area, which together have about 200 ha of surface water. The channels are mostly quite straight, and the two largest pass through culverts under Culver Boulevard and empty into Ballona Creek channel through larger culverts with tide gates. Channels in Unit 1 fluctuated with the tide, but the channels in Unit 2, being about one meter higher, fluctuated only during the upper 1/4 to 1/3 of the high tide. During the remainder of the tide cycle, little or no fluctuation occurred in Unit 2. During minus tides, water in Ballona Creek Channel falls below the levels in Unit 1, and 30 minutes to 1.5 hours of static low tide occur in the marsh (i.e. Stations 3 and 4) depending on the height of the tide. Broad areas of shallow flats adjacent to channels mostly drained at low tide. A few hypersaline pools on the west edge of Unit 1 were fishless during this study.

Seasonal fluctuation in low-tide salinity and temperature occur (Fig. 2). Salinities were generally high (15-34 $^{o}/oo$) and were full strength only occasionally at the entrance to Ballona Channel (Stations 1 and 3) and were fresh only at the uppermost Stations (9, 11, 12, 13). At Station 3, above the tide gates, the salinity would usually be in the high twenties at low tides. As the tide started to come in, fresh water that extended down Ballona Flood Control Chanel would push in on top of the saline water. As the tide rose, the fresh water would be pushed farther up Ballona Channel and the surface water at Station 3 got progressively saltier until high tide, when full-strength seawater existed from top to bottom. As the tide went out, surface salinity would initially decline faster than the bottom. By low tide, mixing of the outflowing water equalized top and bottom salinities to similar values. Stratification also occurred on incoming and high tide at Stations 1, 2, 3, 5, 6 and 7, with the surface salinity 3 $^{0}/oo$ (Station 1) to 9 $^{0}/oo$ (Station 2) lower at the surface than at the bottom. High salinities were maintained in the warm months in Unit 1 by evaporation on shallow flats inundated only at high tides. This water was often hypersaline and was recorded up to 52 $^{0}/oo$ just northeast and upstream of Station 4. During the cool months, the salinity of water on the flats was comparable to nearby channels, and increased fresh-water inflow caused a general decrease in values. Water temperature fluctuated in a bimodal pattern, lower in mid-summer, increasing in late summer-early fall, decreasing again in late fall to low levels in winter. Water temperature rose regularly into April, declined in May, and rose again in June. The mid-summer decrease is probably due to the increased fog near the coast, allowing the shallow marsh water to cool, and the fall increase is caused by the lack of fog, allowing the sun to warm the water considerably. Later in winter, cold air, increased cloud cover, and cold ocean temperature combined to cool the water again. The May reduction was not as strong as the previous July, but indicates that often the highest water temperatures may occur in spring and fall with a mid-summer depression due to fog cover. This would only occur in upper shallow marshes where solar radiation can significantly alter temperatures and substantial mixing with local marine waters does not take place. Coastal ocean temperatures regularly fluctuate from winter lows to late summer highs as do other connecting well-mixed bays, but the two sets of culverts restrict flow in the marsh and probably enable solar effects to predominate, as they would have in the original shallow marsh closed or only narrowly open, to the ocean.

The culverts opening to Ballona Channel were open through fall 1980, but those of the main channel at Station 3 were covered with plywood from late December to June 1981. These were placed to divert a large sewage spill down Ballona Channel, 12-18 December, and apparently protect adjacent farm land and business from high spring tides. Intermittently the gates were removed, or moved from the marsh side to the flood control channel side of the culverts. Considerable water flowed around the gates, and tides rose and fell in the marsh with little visible difference. Tides were probably delayed slightly and did not reach the highest levels possible, but were otherwise normal. The gates served as a partial barrier to waterflow only.

FISHES

Engraulidae

Engraulis mordax. The northern anchovy was only taken as two eggs in March and one larva in plankton hauls in March. It is common in larger bays and harbors in California (Allen and Horn, 1975; Horn, 1981), but rarely occurs in shallow, upper slough areas.

Cyprinodontidae

Fundulus parvipinnis. California killifish were the fourth most abundant fish and were common throughout the year. Greatest abundance was in the summer months, and there was a shift in abundance from Unit 1 to Unit 2 during the winter. Adult tuberculated males in breeding color occurred from April to September. The first young of the year were observed in June. California killifish were taken or observed in water ranging from fresh to 38.4 ^{o}/oo, well within the tolerance range of this species (Barlow, 1963). Trapping on 15 August 1980 took three fish in the channels and 24 on the flats during incoming and high tides, demonstrating movement onto the flats at this time. Fritz (1977) studied the biology of this species in Anaheim Bay.

Poeciliidae

Gambusia affinis. Mosquitofish, a non-native species, widely introduced to control mosquitos, entered California in 1922 and were established in the Los Angeles Basin by 1930 (Miller, 1961). They were the second most abundant fish but were abundant only in Unit 2. Summer collections in Unit 1 (Stations 6 and 7) took occasional individuals, and mosquitofish were most abundant at the stations with low salinities (Station 9) and in the fall. They occurred in shallow, flat Salicornia-choked pools and channels between the main channels of Units 1 and 2, and our data are for the main channels only. Newly spawned young were first taken in April, and individuals 15 mm or less were taken as late as November. We took mosquitofish in water up to 52.8 $^{o}/oo$ at Station 12 in August. Fifty to sixty dead and dying mosquitofish were observed 70-100 m upstream of Station 9 on 9 July 1980.

Atherinidae

Atherinops affinis. Topsmelt were the third most abundant species and were absent during the winter (late December to February), apparently moving seaward into Marina del Rey or Santa Monica Bay. They were almost entirely confined to Unit 1, and two size classes were apparent in the fall. The first young of the year appeared in March. Horn (1981) reviewed the information available on life history of this species in southern California and showed that topsmelt are commonly one of the dominant species in southern California bays and estuaries. They feed largely on zooplankton.

Leuresthes tenuis. Four grunion larvae were taken in the plankton hauls in September and May. Grunion are common in southern California but rare in bays and marshes (Walker, 1952).

Atherinopsis californiensis. Eight jacksmelt larvae were taken, five in the December plankton haul, two in March and one in April, coinciding with the winter spawning peak of this common coastal fish (Feder, Turner, and Limbaugh, 1974) that is rare in coastal marshes.

Cottidae

Leptocottus armatus. Staghorn sculpin were taken in small numbers in Unit 1 and were the seventh most abundant species. Small juveniles appeared in winter and early spring collections, indicating a late fall and winter spawning as documented for other southern California populations (Tasto, 1977; Horn, 1981). Usually this species invades brackish and freshwater portions of estuaries, but we did not collect it in Unit 2. It was taken at salinities of 15.6 ^{o}/oo to 36.0 ^{o}/oo.

Gobiidae

Acanthogobius flavimanus. The yellowfin goby was introduced to the Pacific coast from Japan in the late 1950's and was first observed in southern California in 1977 (Haaker, 1979). Both juveniles and adults were collected in the marsh with juveniles predominating in spring collections. Our collections are the first southern California records north of Palos Verdes Peninsula. This goby was taken only in the higher salinity of Unit 1 (at salinities of 20.4 ^{o}/oo to 36.0 ^{o}/oo) despite its propensity for brackish and freshwater elsewhere. Populations of this species should be watched to document its spread in southern California.

Clevelandia ios. The arrow goby was numerically the most abundant species. Arrow gobies were present throughout the year and were most abundant from late winter through spring when large numbers of young of the year were present. Almost all records are for Unit 1 with small numbers taken at Station 10 (Unit 2) in the fall. Because of their burrowing habitat, adult arrow gobies, were probably undersampled in general. Our collections indicate a late winter spawning time, and the young of the year dominated the collections in Unit 1 in March and April. Horn (1980) emphasized the probable great importance of gobies in the food web of bays and marshes in transferring energy from low trophic levels to the higher ones (i.e., shorebirds, that prey on gobies).

Quietula y-cauda. The shadow goby was taken only three times in the spring and apparently occurs in very low numbers in the marsh. Brothers (1975) extensively studied the biology of this species, the arrow goby and the cheek-spot goby in the San Diego area.

Gillichthys mirabilis. Mudsuckers were mostly taken in Unit 1 and were the fifth most abundant species. Sixteen fish were taken in Unit 2, and one of these (March) was taken in fresh water. Young-of-the-year were common in the spring and coincided with the spawning season documented by Weisel (1947), Barlow (1963), Barlow and de Vlaming (1972). One series of eight traps set during high tide on 15 August 1980 demonstrates a greater abundance of mudsucker than our seine collections indicate. Channel traps caught 18, and traps on the flats took 28 fish. Twelve of the channel fish were taken in the exceptionally deep hole at Station 7. *Gillichthys*, like *Fundulus*, moves onto the flats at high tides. Its scarcity in our low-tide station collections indicates that it retreats into slough-side crab burrows (Barlow, 1963), rather than into the slough channels as do *Fundulus*.

Ilypnus gilberti. Three larval cheekspot gobies were taken in the plankton in July, and two juveniles were seined in April; they are apparently very rare.

Goby A. Fifteen small larval gobies are *Ilypnus gilberti* or *Quietula y-cauda*, three in December, one in April and eleven in June; they cannot be distinguished further.

Goby C. Five small larval gobies taken in March are *Clevelandia ios*, *Lethops connectens* or *Lepidogobius lepidus* and cannot be distinguished further.

Mugilidae

Mugil cephalus. Striped mullet were taken only in Unit 1 and probably represent one year class that grew successively larger (July to April) and then left the marsh, since no mullet were collected in May and June. The mullet collected in July ranged form 91-110 mm SL ($\bar{x}$ = 108 mm SL); those taken in March ranged from 93 to 212 mm SL ($\bar{x}$ = 166 mm SL). Mullet were taken at salinities of 12.6 ^{o}/oo to 36.0 ^{o}/oo. Young-of-the-year are occasionally taken in the lower portions of coastal streams in mid- and late winter (LACM records). Many of the mullet showed fin deformities that have been associated with high pollution levels in other areas (Sindermann, 1978). Nineteen of 41 mullet we actually measured (41%) showed eroded fins or anatomical deformities. Out of 76 fish tallied in Ballona Marsh (some jumped over our net or otherwise escaped), these represent 26%. Some of these fish may have been caught on successive months, and deformed fish could have been more vulnerable to capture. However, even a considerably lower (<2-3%) incidence would indicate abnormal conditions. Sindermann (1978) documents that in brackish pond (12 ^{o}/oo), 4-5 ppm of crude oil caused fin erosion in most of the mullet exposed in 6-8 days. He notes a wide variety of other pollution related effects on a variety of fish species, and only a detailed study of Ballona Marsh would disclose the conditions existing.

Bothidae

Paralichthys californicus. One juvenile California halibut (103 mm SL) was collected at Station 4 in August at a salinity of 36.0 ^{o}/oo. Haaker (1977) has extensively documented the life history of this species in Anaheim Bay, where juveniles (under 300 mm in length) were common inhabitants. He found the youngest fish appeared in April and May and remained in the marsh about one year after which they departed to deeper coastal water. This is a valuable sport species that relies on shallow bays for nursery areas elsewhere in southern California and would become more common in Ballona Marsh if conditions improved.

Pleuronectidae

Hypsopsetta guttulata. The diamond turbot was the most commonly caught species of flatfish and was taken primarily at Station 5, where the greatest amount of shelly substrate occurred. All but one fish seined were young-of-the-year taken in November, December, March, April and May at salinities of 30.0 $^{o}/oo$ to 40.8 $^{o}/oo$. Two diamond turbot eggs were taken in March, and two non-metamorphosed larvae were taken in May. Diamond turbot are common bay and estuary inhabitants (Lane, 1977) that should be more common in Ballona Marsh.

Pleuronichthys verticalis. Nine eggs of the horny head turbot were in the March plankton haul. This species is common in California coastal waters but rare in upper marshes (Fitch, 1963).

Pleuronichthys ritteri. Three eggs of the spotted turbot were taken in the March plankton haul. This species is common in California coastal waters but is rare in upper marshes (Fitch, 1963).

Embiotocidae

Embiotoca jacksoni. A large adult black perch was taken at Station 3 in March, obviously a straggler from the outer marina area. Black perch are common game fish around shallow southern California reefs, jetties and kelp beds (Feder, Turner and Limbaugh, 1974).

Cymatogaster aggregata. One young-of-the-year shiner perch, 32 mm SL, was taken at Station 3 in April. The shiner perch is a common sport species in bays and marshes in southern California (Odenweller, 1977) and would become more common if conditions improved in Ballona Marsh.

Blenniidae

Hypsoblennius gentilis. The bay blenny is represented by one transforming "ophioblennius" larvae taken in the August plankton haul. This species is undoubtedly common on the hard substrate in protected areas just outside the marsh, as it is in many southern California localities (Stephens et al., 1970).

Clinidae

Heterostichus rostratus. The giant kelp fish is represented by three larvae taken in the March plankton haul. This species is common around shallow reefs, jetties and kelp beds in southern California and spawns from March to July (Feder, Turner and Limbaugh, 1974).

Clinid A. Two larvae in the December plankton haul are clinids and represent either Gibbonsia or Neoclinus, each with three southern California species. Several of these species undoubtedly occur in Marina del Rey but are rare in upper marsh habitats (Feder et al., 1974).

Sciaenidae

Seriphus politus. The queenfish is represented by nine postlarvae taken at Station 3 in May. It is a common schooling species in shallow coastal marine waters (Feder, Turner and Limbaugh, 1974) and spawns April to August in southern California (Goldberg, 1974). Only juveniles occasionally occur in back bays and estuaries (Klingbeil, Sandell and Wells, 1977).

Genyonemus lineatus. One white croaker larvae was taken in April; this is a common croaker in larger bays and along the southern California coast (Feder et al., 1974).

DISCUSSION

The Ballona marsh and tributary creek undoubtedly was once similar to many others along coastal southern California. Its extent under unimpacted conditions is shown on an early map of the southwestern Los Angeles Basin (Redondo Sheet, U. S. Geological Survey, 1896 edition, based on surveys done in 1894) (Fig. 3). Typically a broad marsh area existed behind a long sand spit with only a narrow opening to the sea. This opening probably often closed to the ocean during the summer and fall, leaving a brackish lagoon until high winter inflows opened it again. When open, build-up of sand at the mouth would prevent the tide in the marsh from fluctuating fully. Without full daily flushing, the water in the marsh would stay relatively fresh and temperature would fluctuate more widely as it still does in relatively pristine coastal lagoons elsewhere in California.

Today the marsh has been heavily modified. Channelization of the harbor and creek established and maintained full, regular tidal flow to most of the area. Both this increased mixing with sea water and reduced freshwater inflows brought higher salinity, which along with temperature vary in parallel with nearby open coastal areas. Regular tidal cycles also maintain deeper more well-defined channels in the actual marsh than under original conditions. The Culver Boulevard barrier artifically maintains a low-tidal fluctation in Unit 2 and consequently shallower channels exist there. Below in Unit 1, almost complete tidal fluctuation occurs, channels are much deeper, and at least two tributaries are actively eroding headward. In Unit 2 temperatures are generally higher, reflecting the influence of solar radiation in warming shallow water. Unit 1 values, particularly Stations 1 and 3 near the inlet of the marsh are more in parallel with the sea. Man's activities have fortuitously created somewhat original physical conditions in Unit 2 and highly modified conditions in Unit 1. The restricted water flow through culverts and/or flapgate at Ballona Creek channel and through Culver Boulevard has restricted the movement of fishes and has caused faunal differences between the two areas.

Twenty-five species of fish were collected in the marsh (Tables 2 and 3), comprised of 13,389 juveniles and adults, 278 larvae and 439 eggs. Fourteen eggs were identified to species, and the rest fall into about ten categories and are not identified further. Ten species were only taken as eggs, larvae or postlarvae, Engraulis mordax, Atherinopsis californiensis, Leuresthes tenuis, Hypsoblennius gentilis, Heterostichus rostratus, Seriphus politus, Clinid A, Genyonemus lineatus, Pleuronichthys verticalis and P. ritteri. Three were taken only once, Embiotoca jacksoni, Cymatogaster aggregata and Paralichthys californicus, and one was taken only twice, Ilypnus gilberti. Two are introduced species, not native to California, Gambusia affinis and Acanthogobius flavimanus. The remaining nine species are common inhabitants of coastal bays and estuaries from Morro Bay to northern Baja California. We did not find a large number of species that have been recorded from other southern California bays and marshes such as Anaheim Bay (Lane and Hill, 1977), Colorado Lagoon (Allen and Horn, 1975) and Mugu Lagoon (MacDonald, 1976 [from Horn]), for two reasons: First, our collections represented uppermost tidal channel habitats only, since the larger, deeper open lagoonal areas were not present at Ballona. Second, flap gates and the shallow Ballona Creek Flood Control Channel separate the marsh from deeper water, interrupting the habitat continuum from shallow marsh to deeper bay, and thus preventing species invasion.

Most of the additional species are not typical of deeper water or are only occasional invaders of the shallow marsh. Three species, Paralichthys californica, Cymatogaster aggregata and Hypsopsetta guttulata would be more common under natural conditions. Three species not recorded, Syngnathus leptorhynchus (bay pipefish), Platichthys stellatus (starry flounder) and Eucyclogobius newberryi (tidewater goby), should occur. Bay pipefish are usually restricted to grass beds that were largely absent at Ballona. Tidewater gobies are found in the upper, freshwater portions of coastal lagoons and are sensitive to habitat modification. They probably occurred at Ballona in the past but have been eliminated. Starry flounders are not as common in southern California as they are in cooler estuaries north of Point Conception. Flatfishes were rare in our study in general, and some unknown factor is causing this.

The fish community diversity H' fluctuated relatively regularly with the season in each area, for a variety of reasons. Unit 1 had high diversities in summer and low diversities in winter. Unit 2 had the opposite with both areas having roughly equal diversities in the winter (Fig. 4). Unit 1 decreased in diversity in the fall because topsmelt left the area, and California killifish and goby species became less abundant. Topsmelt left the marsh, but some California killifish and gobies (Clevelandia and Gillichthys) moved into Unit 2 increasing the diveristy there. The tendency for Fundulus parvipinnis to invade fresher water in fall and winter has been documented elsewhere (Miller, 1939, 1943, LACM unpublished records). In the spring, killifish and gobies moved back out of Unit 2 causing the diversity to decline again. The concomitant increase of these in Unit 1 along with 1) increasing large numbers of young-of-the-year gobies (Quietula, Gillichthys, Acanthogobius and, predominantly, Clevelandia) and later 2) return of Atherinops affinis, caused the diversity here to rise again. Our H' was calculated from numbers of specimens rather than biomass, and since the vast majority of our fish fell between 20 and 120 mm SL and were slender or elongate fusiform in shape, the diversity trends would not be altered significantly by using biomass.

The diversity measure, H', ranges from .55 to 1.57 in Unit 1 and .07 to .67 in Unit 2. Haedrich (1975), Livingston (1976) and Horn (1981) discussed the general increase of the value of this measure with lack of disturbance to the habitat, and Horn (1981) discussed values for several southern California lagoons. Often values up to .75 or .80 represent highly impacted, modified estuaries, whereas values of 1.5-1.7 are calculated from data on relatively pristine systems in southern California. Values from sampling stations in a relatively pristine tropical estuary in the southern Gulf of Mexico ranged from 0.5-2.50 (Yanez-A., Amezcua and Day, 1980), and Livingston (1976) found wide variation in diversity due to salinity and temperature fluctuations in a relatively unpolluted south temperate estuary in Florida. Ballona Creek received an estimated 4 to 5 million gallons of untreated sewage from an accidental leak on 12 December 1980. This occurred after the diversity in Unit 2 had risen to winter levels, but before a significant decrease occurred in Unit 1. If the sewage reduced fish populations and/or forced them from Unit 1 into Unit 2, lower than normal diversity in Unit 1 would result.

The increase in numbers of fish-eating birds during the winter migratory period probably also accounts for some reduction in number and diversity of fishes in Unit 1. Horn (1981) noted that California estuarine gobies probably are a significant food source for shorebirds, and Swift et al. (1977) noted that cyprinodont fishes (Fundulus and Gambusia in this study) are often heavily preyed upon by fish-eating birds, particularly herons and egrets. Definite increases in the populations of such birds during the winter are documented elsewhere (Dock and Schreiber, this study), but quantitative data on their predation on fishes is lacking. Diversity values in the summer fall in the range of those for other relatively unimpacted estuaries in southern California. Fall, winter and spring values are lower, mostly because of seasonal movements of the few dominant species (*Atherinops affinis*, *Fundulus parvipinnis* and *Clevelandia ios*) and because Ballona is an upper marsh where the fauna is expected to be smaller and less diverse than in a larger bay (Horn and Allen, 1976; this paper). Bird predation, the restricted openings to the marsh and occasional pollution certainly affected the magnitude of these fluctuations, but to an as-yet-undetermined extent, and clearly diversity values reflect the interaction of natural and manmade influences on composition of the fish community.

The generally low-diversity figures for Ballona are due to a combination of location in the upper marsh, small marsh area, and impact of human modification. Estuarine biologists long ago noted the decrease in diversity at the upper end of estuarine systems (Hedgpeth, 1957) based on the numbers of species. Diversity is usually lowest in the 5 to 8 $^{0}/oo$ range (Khlebovich, 1969) and increases again as one proceeds into strictly freshwater habitats. Without comparative data on lower, middle, upper and strictly freshwater portions of comparable estuaries, we cannot separate these three factors. Data presented by Horn and Allen (1976) predict that the Ballona marsh, with an area of only about 1.5 hectares of water surface at mean tide (Units 1 and 2), should have a fish fauna of only a few species. The smallest estuaries studied by them, Los Pensaquitos Lagoon (22 ha) and Tijuana Estuary (59 ha) had 22 and 29 species, respectively. Obviously the Ballona marsh fauna is only a small part of the larger Marina del Rey-Ballona Creek estuarine area, and its large species list is due to association with this larger area. These areas combined have about 200 ha of water surface at mean tide, close to Alamitos Bay (166 ha) and Elkhorn Slough (216 ha) that have 43 and 69 species, respectively. Forty-four species (not including two non-natives) have been reported from Marina del Rey estuarine areas (Soule and Oguri, 1980; this study) and about 50 would be expected from an estuary of this size. In Unit 1, summer diversity values are within the range of relatively unmodified estuaries elsewhere. In Unit 2 the human encroachment is greatest, and the low diversity values reflect this effect. One of the two dominant fish in Unit 2 (Gambusia affinis) is not native, and removal of it would lower the values even more. Our data indicate a relatively normal fish fauna in Unit 1, and a highly impacted and depauperate one in Unit 2. Removal or amelioration of the barrier between them (Culver Boulevard) would result in Unit 2 converging towards the condition found in Unit 1. If the barrier between Unit 1 and Ballona Creek were also removed, a salt marsh would be established that would resemble those now present in upper Newport Bay, Anaheim Bay and Mugu Lagoon, and the number of species, biomass and diversity of fishes would all increase.

Ballona Marsh would not return to its original condition, which was a large, mostly fresh and brackish, marsh open to the ocean only seasonally. Such localities remaining today in southern California have only a few fish species, usually Fundulus parvipinnis, Eucyclogobius newberryi and Gasterosteus aculeatus, and occasionally Atherinops affinis, Cymatogaster aggregata, Hypsopsetta guttulata, Leptocottus armatus and a few other species. They also have very low diversity as is predicted from the typically low salinity of this habitat. A fish species unique to the brackish and freshwater lagoon habitat (Eucyclogobius newberryi) was probably eliminated in the middle of this century, and several other species of organisms typical of this habitat remain under altered conditions.

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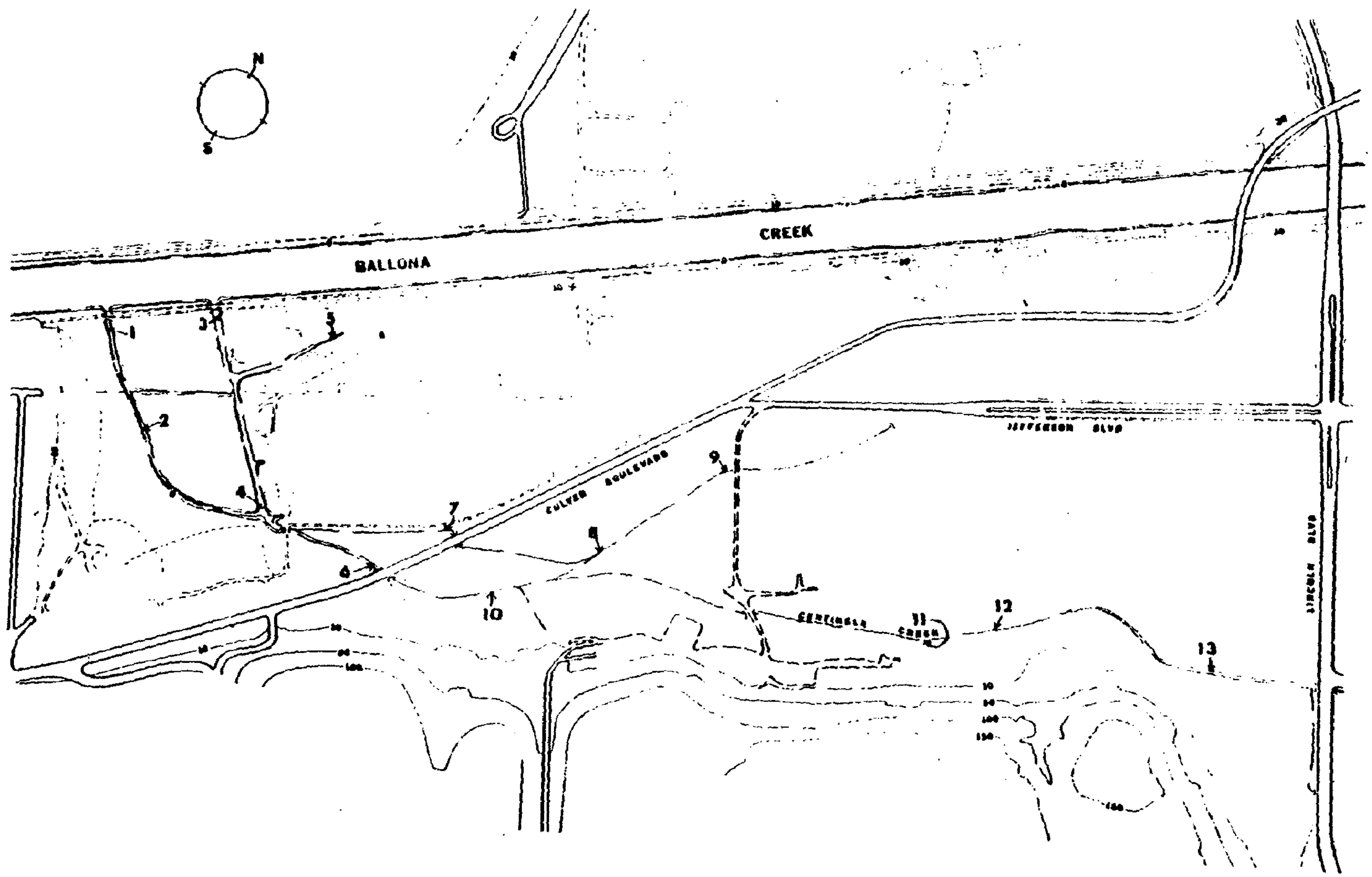

Figure 1. Ballona Creek Marsh showing the collecting Stations described in the text.

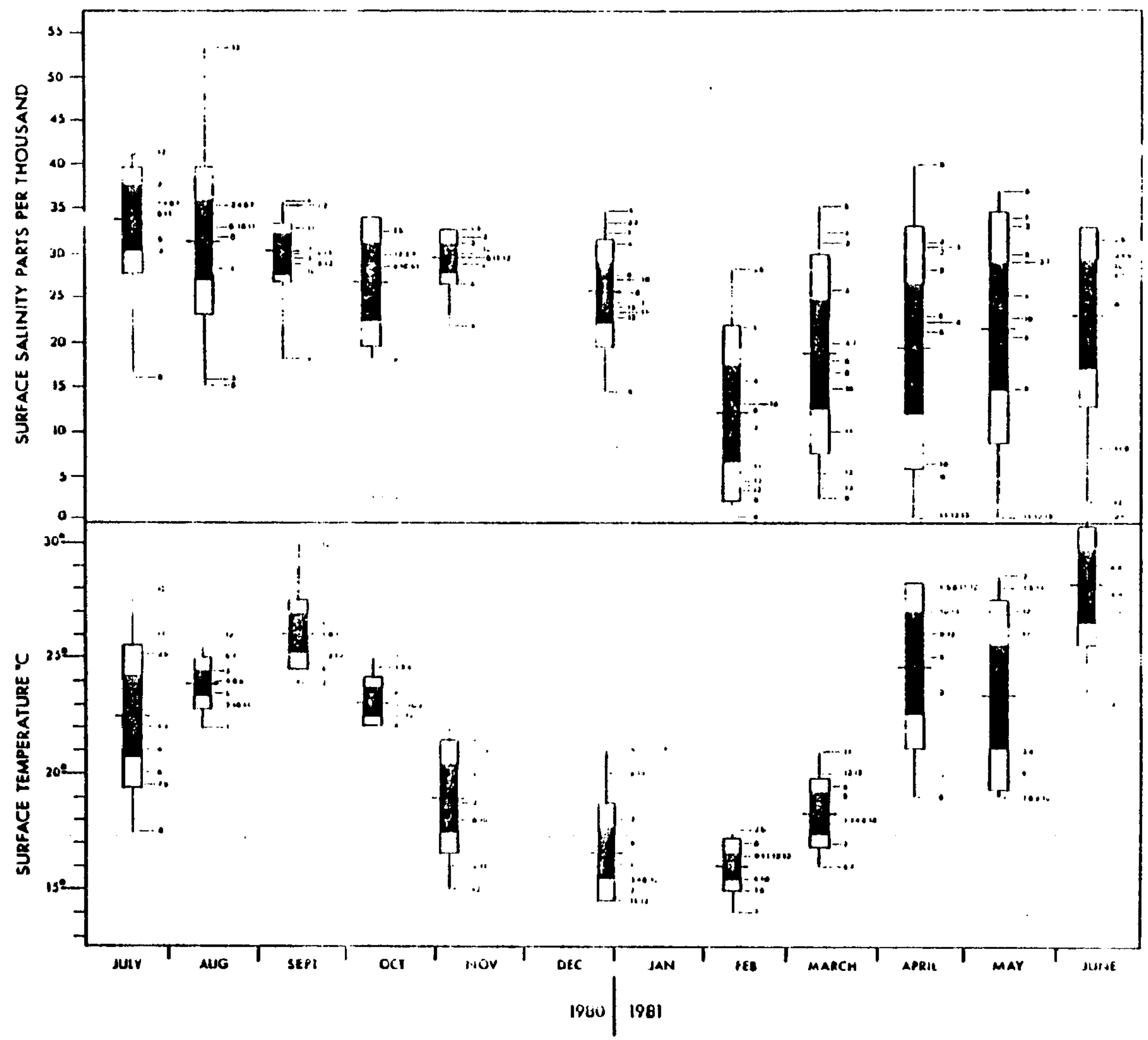

Figure 2. Surface salinity and temperatures recorded in Ballona channels during this study. Numbers lie opposite values for that particular station. The ends of the vertical lines represent the range of values, the strong horizontal line the mean, the black columns equal two standard errors on either side of the mean, and the open columns equal one standard deviation from the mean.

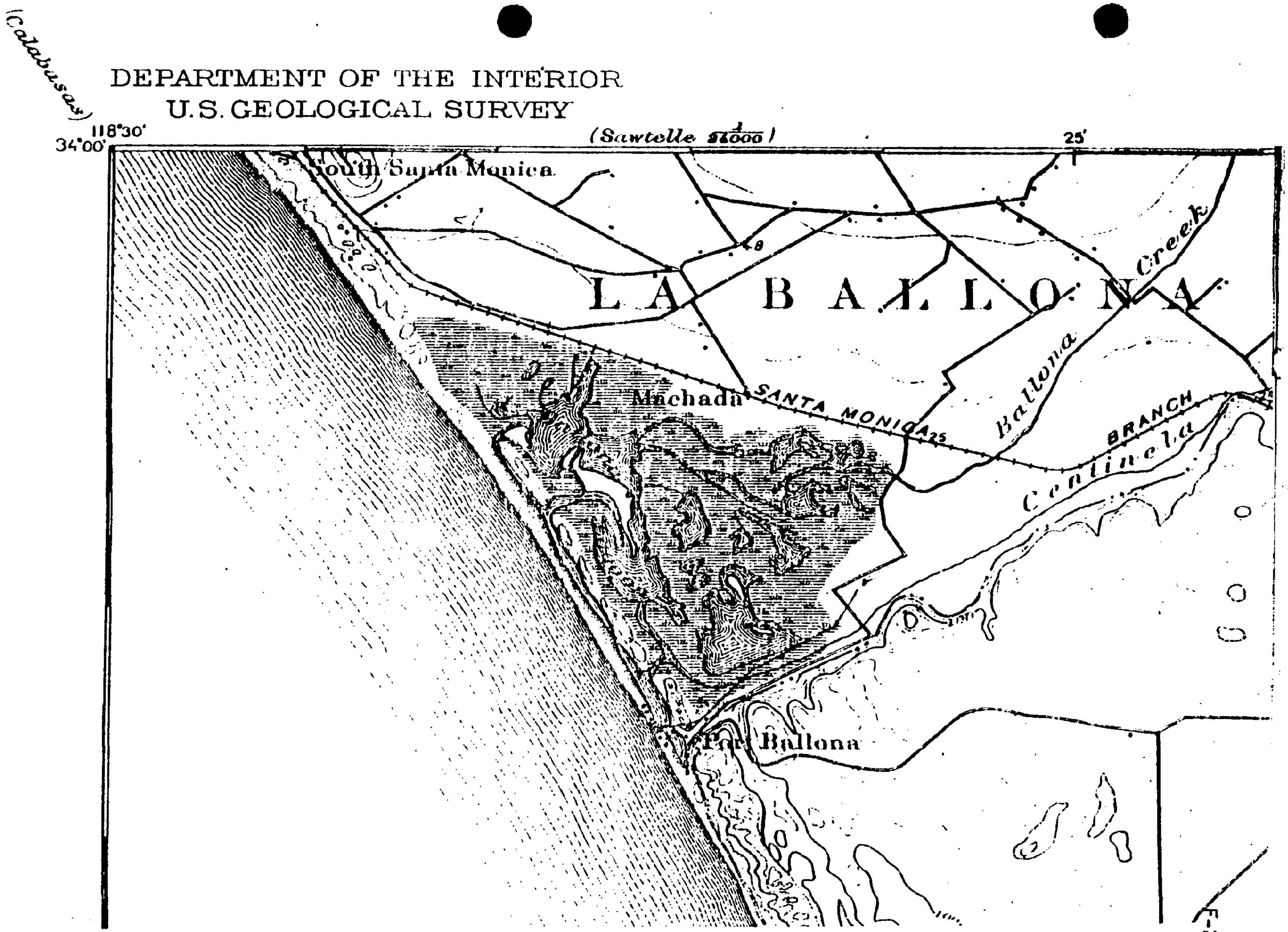

Figure 3. Topographic Map of Ballona Marsh, Redondo Sheet, U. S. Geological Survey, 1896 edition, based on surveys done in 1894.

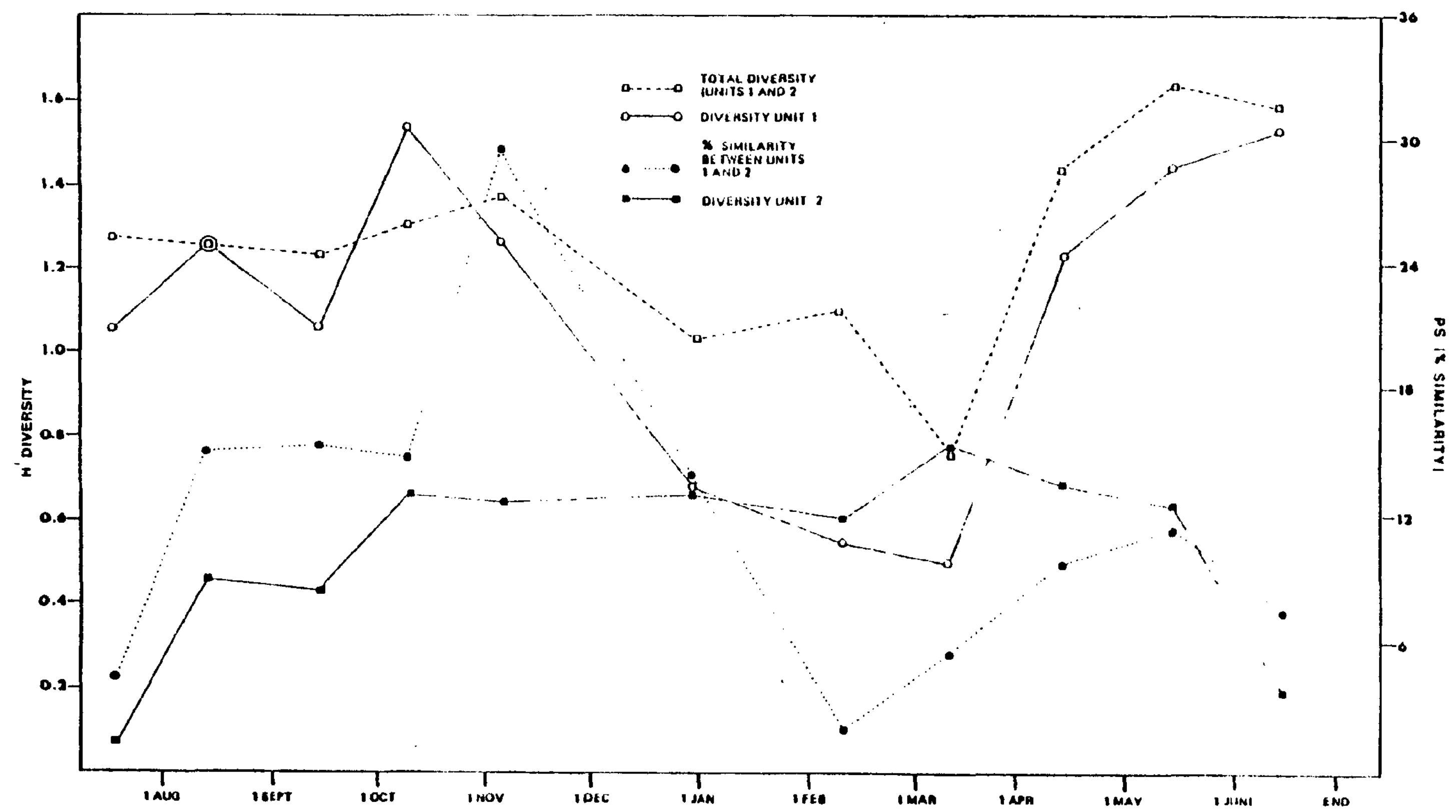

Figure 4. Diversity (H') of Units 1 and 2 and the percent similarity (PS) between the two units.

TABLE 1. Description and regular collection stations

Station	Deepest Depth (cm)	Estimated Average Width (m)	Bottom	Macroscopic Vegetation	Area or Volume Sampled (sq. m)	Remarks
1	10-40	0.75-2.1	Soft mud scattered shell.	None	13.12	Just inside small tide tidegates
2	2-30	0.75-1.0	Soft mud, scattered shell.	None	19.5	Small slough.
3	80-140	5-6	Mostly firm and with shell, mud at edges.	None	101.25	Just inside large tide-gates.
4	40-70	4-5	Soft sand, mud at edges.	None	93.75	Below junction of three sloughs.
5	4-35	0.6-1.0	Mud covered with shell hash in channel.	None	12.75	Just below 0.5 m high high falls over mudbank.
6	20-40	0.8-1.2	Soft mud with rocks and shell, live mussels.	None	3.375	Below culvert under Culver Blvd.
7	60-80	3-4	Soft to firm sand with shell, glass and rocks.	None	26.25	"
8	20-30	1.2-2.0	Soft mud.	Much green algae & *Ruppia* in warm months.	12.0	---
9	30-45	2-3	Soft mud.	Much *Scirpus robustus*, algae.	7.875	Below culvert on road.
10	4-20	1.0-1.5	Soft mud.	*Ruppia maritima* and green algae in warm months.	12.75	---

Table 1 (continued)

Sta.	Deepest Depth (cm)	Estimated Average Width (m)	Bottom	Macroscopic Vegetation	Area or Volume Sampled (sq. m)	Remarks
11	10-20	0.4-0.6	Soft mud.	Green algae in warm months.	15.0	---
12	25-40	0.5-1.2	Firm sandy mud.	Green algae in warm months.	18.75	Agricultural. lacking shore vegetation.
13	20-30	1.0-1.5	Soft mud.	Green algae, _Potamogeton pectinatus_, in warm months.	18.75	Agricultural, not collected July, August, dry September, October, November.
Plankton	1.0-1.5	6-7	Over firm to soft sand.	None	73.7 cu. meters	Some hauls net not completely submerged, see text.

Table 2 (continued).

13 May 1	2	12 June 1	2	Total 1	Total 2	Total	Common Name
66	35	75	4	1230	796	2026	California Killifish
11	131	14	168	143	3333	3476	Mosquito fish
361		143		2842	2	2844	Topsmelt
-		-		58	0	58	Striped Mullet
7		2		88	0	88	Pacific staghorn sculpin
		-		2	0	2	Cheekspot goby
		-		20	0	20	Shadow goby
316		89		4253	89	4342	Arrow goby
73	5	24	3	313	16	329	Longjaw mudsucker
48		20		180	0	180	Yellowfin goby
		-		1	0	1	California halibut
3		-		12	0	12	Diamond turbot
		-		1	0	1	Black perch
		-		1	0	1	Shiner perch
		-		9	0	9	Queen fish
894	171	367	175	9153	4236	13389	

Table 3. Fishes taken in plankton hauls in Ballona Marsh, July 1980 to June, 1981.

Asterisks mark larger (postlarval or larger) fishes taken incidentally with larval forms. Clinid A, Goby A, and Goby C are defined in text.

	Jul	Aug	Sep	Oct	Nov	Dec	Feb	March	April	May	June	Total Larvae	Total Juveniles & Adults	Total
Engraulis mordax (Northern anchovy)								1				1	-	1
Fundulus parvipinnis (California killifish)			1*	*3(6)				2*			1	1	6	7
Atherinops affinis (Topsmelt)	15 122*	1*	7*	*4(8)				5	1*(2.5) 1 (2.5)	123 4*	1* 80	226	140	366
Leuresthes tenuis (California grunion)			1							3		4	-	4
Atherinopsis californiensis (Jacksmelt)						5		2	1 (2.5)			8	-	8
Hypsopsetta guttulata (Diamond turbot)										2		2	-	2
Leptocottus armatus (Pacific Staghorn sculpin)						1						1	-	1
Hypsoblennius gentilis (Bay blenny)			1									1	-	1
Heterostichus rostratus (Giant kelpfish)								2				2	-	2
Clinid A (see text)						2						2	-	2
Ilypnus gilberti (checkspot goby)	3											3	-	3
Clevelandia ios (arrow goby)	3*	18*	22*	*2(4)		175*		424*	85*	61*		-	790	790
Quietula y-cauda (shadow goby)														
Gillichthys mirabilis (Long jaw mudsucker)						2 2*		5*	2*(50) 1 (2.5)	74* 2	2*	5	85	90
Goby A (see text)						3			1 (2.5)		11	15	-	15
Unident. Goby						1 (yolk sac larva)						1	-	1
Goby C (see text)								5				5	-	5
Genyonemus lineatus (White croaker)									1 (2.5)			1	-	1

THE MAMMALS OF BALLONA

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

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THE MAMMALS OF BALLONA

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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 wetlands, 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 of Guadalupe Hidalgo (1848), 848.3 hectares (2,120.8 acres) of the 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 forty 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. Anecdotal 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 be "common." 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 from Playa del Rey and we suspected that the species may be part of this 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 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

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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.

Desert 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) LACM; 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.

Three Pleistocene fossil beds (Rancho La Brea, Costeau Pit 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 (_Distichilis 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 climber. 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 Pleistocene fossils are known from Rancho La Brea (Miller, 1971). In 1906, 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 (1981) 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 the 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 recaptured 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 in a more 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 marshes. 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 marshland 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 and 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 <u>Peromyscus maniculatus gambelii</u> 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 <u>Peromyscus maniculatus</u>, <u>Dipodomys agilis</u> and <u>Perognathus longimembris</u>, 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.

ACKNOWLEDGMENTS

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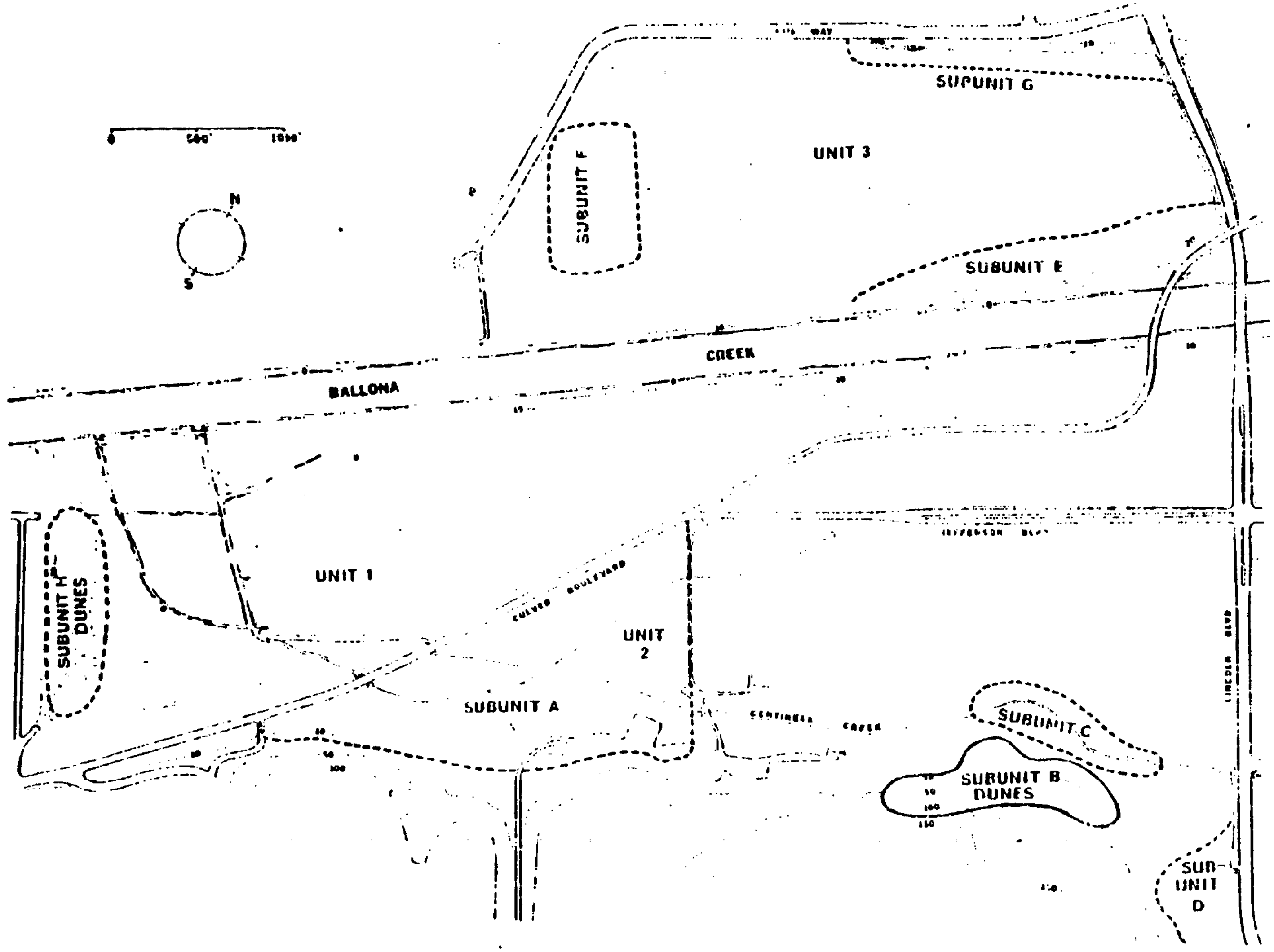

Figure 1. Study region, indicating Units and subunits used in mammal discussion.

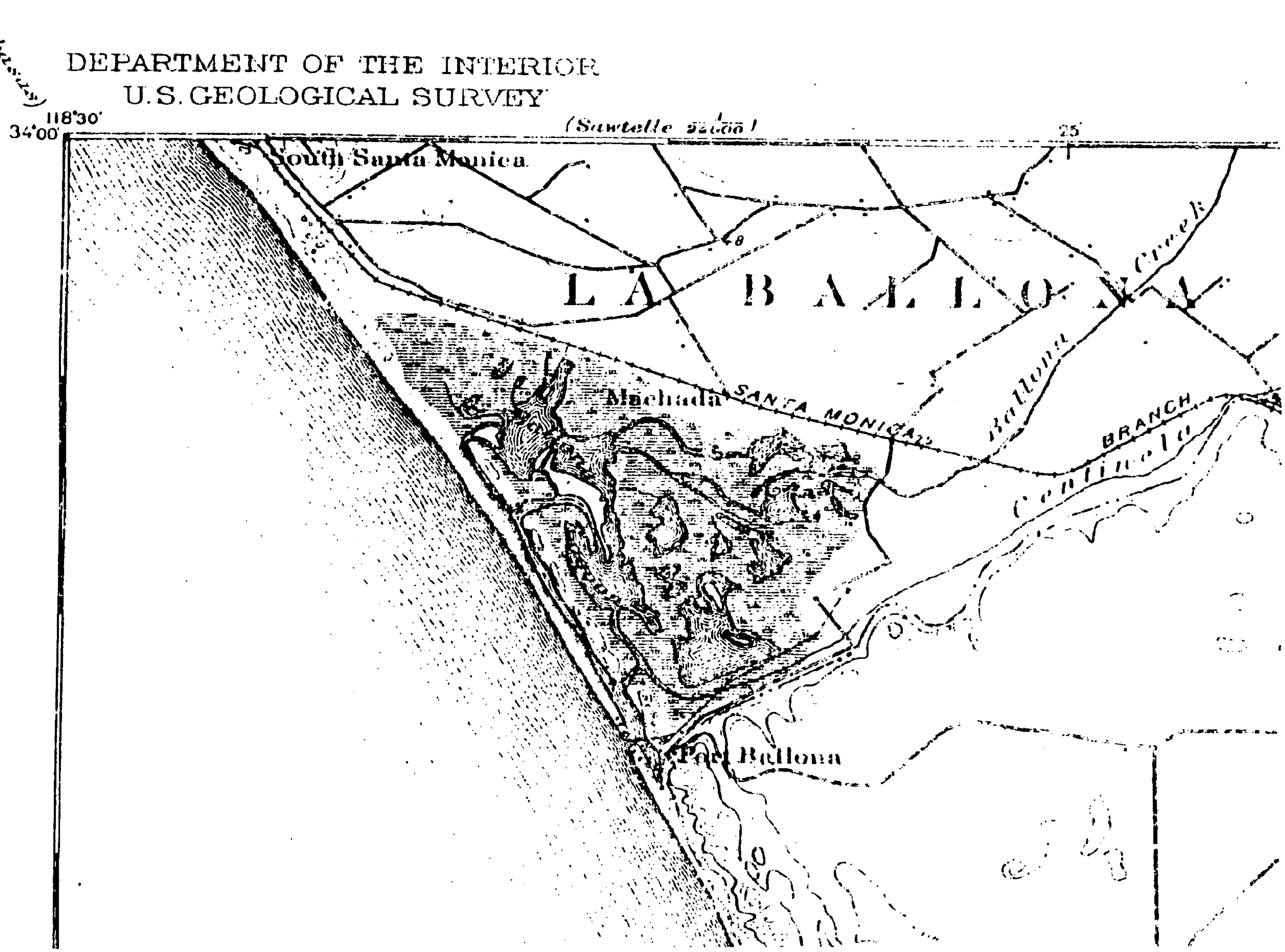

Figure 2. USGS Redondo guad map from 1896 showing tidelands in the Ballona region.

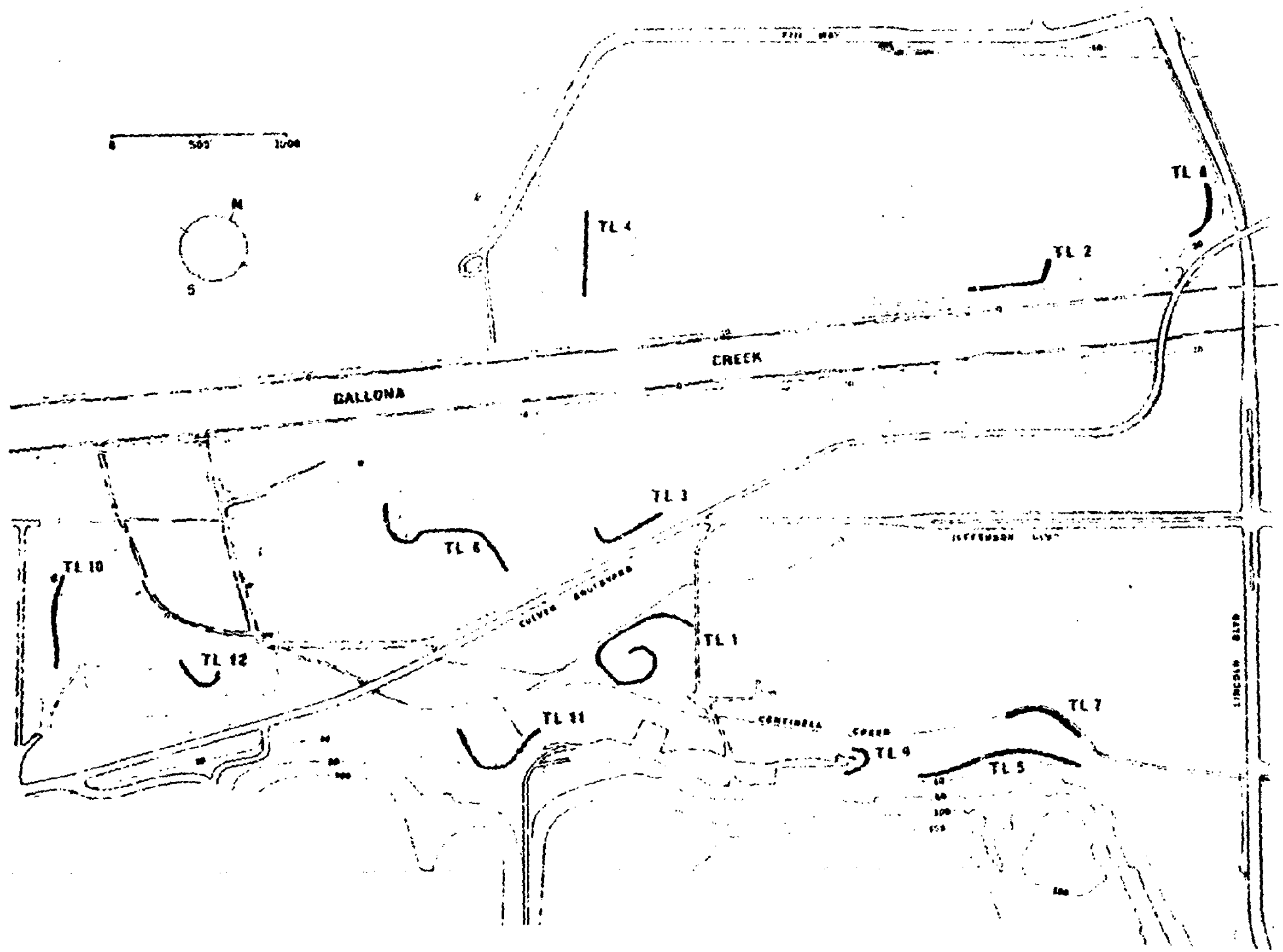

Figure 3. Locations of trap lines (TL) used to study mammal populations.

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.
9	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	REPARIAN	SAND DUNE	MARI-TIME
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
Raccoon	Procyon lotor	F	F	F	+
Long-tailed Weasel	Mustela frenata	+	+	F	+
Badger	Taxidea taxus	SF	SF	SF	S
Spotted Skunk	Spilogale gracilis	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	-	-	
5/2/81	4	2	50%	2	1	50%	
6/2/81	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_

THE HERPETOFAUNA OF BALLONA

Marc P. Hayes and Craig Guyer

THE HERPETOFAUNA OF BALLONA

LIST OF FIGURES

THE HERPETOFAUNA OF BALLONA

Marc P. Hayes and Craig Guyer

INTRODUCTION

Reptiles and amphibians are vital components of many North American ecosystems. However, because many are cryptic or secretive and because they have little economic importance to man, these vertebrates are often overlooked in ecosystem studies. The importance of reptiles and amphibians was emphasized by Turner et al. (1976) who studied *Uta stansburiana* in a desert ecosystem and found this lizard to be as important as mammals and birds with respect to numbers, biomass and energetics. Other reptiles and amphibians are equally abundant in other ecosystems and undoubtedly have similar importance to those ecosystems as *Uta* does in the desert.

Our primary purpose in surveying the Ballona herpetofauna was to provide a framework through which sound management decisions for the region could be made. Early on, we became aware of how diffuse the basic literature on the species occurring at Ballona was. Therefore, a second purpose was to consolidate ecological data for these animals from the scientific literature to provide an easily accessible base for future studies. To this point, concise species accounts were written covering the following general topics: geographic distribution, general habitat preference, daily and seasonal activity patterns, growth, reproduction, population structure, food preferences, and predators. Our data summarize information on over 500 marked animals and over 1,500 observations of marked and unmarked animals of nine species (six reptiles and three amphibians). These data are compared to similar data from other populations. For species which have been studied from widely separated geographic regions, we have compared Ballona data with the closest populations or to studies of the same subspecies. Some species were captured or sighted so infrequently that little information is available for Ballona. In these cases, we have relied on studies of these species in similar habitats or localities in an effort to predict their ecology at Ballona. The topics we have chosen to cover should also indicate the following: sensitive habitats for reptiles and amphibians, species that are sensitive to perturbations, seasons during which each species might be sensitive to perturbations, and how each species fits into the Ballona ecosystem.

METHODS

Our primary sampling method was transects located in three designated units. We attempted to cover all major vegetative types and habitats. We sampled on three days each month from September 1980 through January 1981 and then four days from February 1980 through July 1981. Diurnal sampling was done with two people between 06:00 and 19:00 hours. We attempted to optimize the time of sampling based on our previous knowledge of the behavior of the species present. The duration of each sampling period varied from three to six and one-half hours, but we attempted to standardize distance so we sampled a roughly equivalent area each time. In addition, we did limited nocturnal sampling during the months of February, April, and June between 19:00 and 24:00 hours on six different days.

During a transect, we attempted to search beneath most movable surface objects and to capture any animal that did not require extensive time to pursue. We caught most species by hand, but the swifter lizards

(Sceloporus and Uta) required noosing. We marked most captured animals for future identification. We marked lizards except the legless lizard (Anniella) and tree frogs by toe clipping. We marked gopher snakes with a ventral scale clip. We did not mark Kingsnakes, instead we recorded their individually distinctive pattern of rings. We recorded the following measurements on most animals: 1) snout-vent length (the standard body length measurement); 2) weight (with Pesola spring scale); 3) tail length and its condition, broken or unbroken (when appropriate); and 4) cloacal temperature (with a Schultheis rapid-reading thermometer). We recorded the sex of each animal whenever possible. In addition, we recorded time of day, location, and behavior of captured individuals as well as the major vegetation type with which they were associated. Environmental temperatures adjacent to captured animals were recorded whenever possible. All animal-related temperature data are from September 1980 through March 1981. Finally, we recorded miscellaneous observations on reproductive condition, predators, food and other pertinent data that might contribute to a more complete knowledge of the sampled fauna whenever possible. Many individuals escaped capture. For these we recorded time of day, location and habitat used. Where possible, we noted the age class, sex, and reproductive status (females only).

On each sampling date, we took qualitative and quantitative climatic data. Qualitative data included an estimation of cloud cover, degree of air pollution and wind conditions. Quantitative data included relative humidity (taken with a sling psychrometer) and air temperature. Frequently, we took the last two measurements several times over a sampling period, but most often we took them twice, at the beginning and at the end of each sampling period.

For historical records, we collected a voucher of each of the nine recorded species. These vouchers will be deposited in the herpetological collection of the Los Angeles County Natural History Museum. For the first five months of the study, we placed a series of 17 small pitfall traps in different habitats. Returns on these trappings were so low that we removed these traps in late February 1981. From July to September 1980, insect pitfalls used by the entomology team caught many lizards (Gerrhonotus, Sceloporus and Uta). We added data from lizards caught in these traps after August 15, 1981 to growth plots for the respective species. We supplemented transect sampling with a regular checking of paved roads, for road kills before and after each sampling, and with limited sightings and collections made by Dick Friesen (mammals), Chris Nagano (insects), Ralph Schreiber (birds) and Robert Bezy (herpetology section Los Angeles County Natural History Museum).

Much of the data presentation that follows are scattered plots and frequency distributions which require no explanation. In the summary, faunal data compared over designated units and habitats based on the physiognomically dominant plant species were standardized for the time spent in each area and each vegetative habitat, respectively. This was calculated by simply taking the number of a given species observed in an area or habitat category and dividing it by the number of hours spent in the respective unit. This calculation gives values of relative density with units of individuals per observation hour. Our transect organization and the natural variation within designated Unit 1 required that we subdivide this area into two units to meaningfully discuss its herpetofauna. We divided Unit 1 into a dune portion (D) on its southwest boundary and a Unit 1A which comprises the remainder of this area.

SPECIES ACCOUNTS

Class Amphibia - Amphibians

Order Urodela - Salamanders

Family Plethodontidae - Lungless Salamanders

Pacific Slender Salamander - Batrachoseps pacificus

This is the only salamander known to occur at Ballona. Batrachoseps pacificus, like other species in this genus, is specialized for subterranean life. It has an attenuate, worm-like body with tiny limbs and a tail which, when unbroken, is less than twice the body length. Batrachoseps cannot actively burrow, and therefore, must rely on passages excavated by other organisms or produced by agents such as root decay and soil shrinkage (Yanev 1980). Adults exceed 40 mm in body length. This salamander is brown to yellow in life with a distincively light-colored venter and underside of tail. Ballona individuals have rust-orange blotching on the dorsal surface of the tail and lower back on a light brown ground color. The species ranges from the Santa Monica and San Gabriel mountains in Los Angeles county to northwestern Baja, California (Yanev 1980). Like other Batrachoseps, it is a secretive, sedentary species (Hendrickson 1954; Cunningham 1960; Maiorana 1978a). Batrachoseps are observed under surface debris during periods of sufficient moisture (Stebbins 1966). Only two individuals of this species were observed during this study, both on Unit 3 (Figure 1). Both were found under boards on well-drained high ground, one in association with thick Rhus laurina leaf litter and the other in thick matted grass next to a rodent burrow system.

We found one individual each on February 13 and March 9, 1981 on moist substrates with shade temperatures of 12.4°C and 14.5°C, respectively.

Cunningham (1960) commented on the close correspondence between B. pacificus body temperatures and substrate temperatures. He reports substrate temperatures on which salamanders were found ranging from $4^{o}C$ to $21^{o}C$, encompassing the two substrate temperatures on which the Ballona individuals were found. Brattstrom (1963) reports cloacal temperatures of $19.5^{o}C$ and $19.6^{o}C$ for two individuals emerging from a flooded hole in September.

Daily and seasonal activity is largely influenced by moisture (Cunningham 1960). Both individuals in this study were observed following winter and early spring rains. Insufficient data exist to show daily and seasonal activity patterns at Ballona. However, we expect Ballona populations to parallel what is known for other populations of this species. Fall rains initiate seasonal activity (Cunningham 1960). Surface activity continues as long as sufficient moisture is available. The diel pattern is typically a nocturnal one, with salamanders emerging at dusk and showing increased activity on moist or foggy nights. When the sky is overcast, Batrachoseps become active before darkness. Their general nocturnal habits and use of subterranean or surface objects as diurnal retreats allows this species to avoid extreme thermal conditions and dessication. The cessation of rainfall coincides with a general decrease in activity which culminates in aestivation when surface moisture is depleted. Limited rainfall over the winter as well as limited nocturnal sampling are the probable cause of only two individuals of this species being encountered at Ballona.

Reproductive information on B. pacificus is sparse, and no information is available for Ballona; however, we expect published data on reproductive patterns at other localities to be similar. Like other salamanders in this genus, B. pacificus lays terrestrial eggs. Jelly-encapsulated eggs (ca. 6 mm capsular diameter) are deposited in moist sites underneath surface cover (Davis 1952), and perhaps underground. The timing of egg deposition is unclear, but it may be before the wet season. Davis (1952) reported on the hatching of 18 eggs, first discovered on December 20, 1950 at Pasadena, which hatched between January 18 and 30, 1951. Presumably, these were all from the same female. Stebbins (1951) describes two female B. pacificus, obtained December 17, 1947 at Altadena, which contained 15 and 21 fully-developed eggs, apparently ready to be laid.

Like most lungless salamanders, B. pacificus has direct development. It lacks an aquatic larval stage and the young hatch with essentially adult morphology. Davis (1952) reported the size of newly hatched individuals as between 17 and 20 mm total length. Cunningham (1960) did not see individuals hatch but suggested that individuals between 21 and 23 mm total length found on January 20 and February 1, 1956 were recently hatched. By March 1, Cunningham found young B. pacificus of 29 to 34 mm total length (13 to 18 mm body length) presumably from the same cohort. This suggests that early growth is rapid. Campbell (in Stebbins 1951) observed three size classes of B. pacificus near Monrovia on March 16, 1929 which had total lengths of 30 mm, 45 to 60 mm, and 90 to 120 mm, respectively. Using Stebbins' tail proportion for adult B. pacificus and accounting for an increase in tail length as the individual grows, a feature known to occur in other Batrachoseps species (Stebbins 1951), Campbell's size groups correspond to body lengths of approximately 22 mm, 28 to 35 mm, and 45 to 55 mm, respectively. Growth rates have been estimated by Hendrickson (1954) for B. attenuatus at 5-10 mm/year for juveniles (less than 35 mm body length) and at 0-2 mm/year for adults (greater than 35 mm body length). If one couples these rates with Campbell's size classes for B. pacificus, allowing for the larger size in the latter a correspondingly more rapid growth to above 40 mm of body length, then Campbell's size groups represent young hatched that year, juveniles after one year of growth, and individuals two years or older (adults), respectively. If these estimates are correct, the 40 and 58 mm body length B. pacificus observed by us at Ballona represent an individual just entering the adult size group and roughly two years old, and an adult probably well in excess of two years of age. Hendrickson (1954) estimated that the largest individuals in the B. attenuatus populations he studied could not be less than 10 years of age. It would not surprise us if the large 58 mm female observed at Ballona was close to this age. Size and age at first reproduction for B. pacificus is unknown. There is no apparent sexual dimorphism in size or coloration (Stebbins 1951).

Knowledge of population structure for Batrachoseps is rudimentary. Both Cunningham (1960) and Hendrickson (1954) commented on the small numbers of salamanders observed in juvenile size classes. Both inferred higher juvenile mortality but caution that juvenile size classes frequently use refuges other than surface objects sampled in both these studies. Maiorana (1977) provided evidence of field mortality due to heat stress and/or dessication in B. attenuatus. This may be an important source of mortality, especially for juveniles that may be particularly susceptible because of their small size. Nothing is known of population sex ratios.

B. pacificus ate annelid worms, earwigs and terrestrial isopods in an urban habitat (Cunningham 1960). Maiorana (1978b) found B. attenuatus ate primarily collembolans and mites in less disturbed habitat. Based on the invertebrate fauna we observed, a diet of small terrestrial insects and crustaceans is suspected.

To our knowledge, the nocturnal and generally secretive habits of Batrachoseps preclude them being eaten by most predators. The two snake species occurring at Ballona do not eat Batrachoseps as part of their normal diet. One of these, the Kingsnake (Lampropeltis getulus), died after being fed Batrachoseps (Cunningham 1960). Other species reported as predators on Batrachoseps by Stebbins (1954) are not known to occur at Ballona. Potential predators at Ballona are the western toad, Bufo boreas, and some birds, like the Brown Towhee, Pipilo fuscus, that spend considerable time foraging in leaf litter where Batrachoseps is likely to occur.

SPECIES ACCOUNTS

Class Amphibia - Amphibians

Order Anura - Frogs and Toads

Family Bufonidae - Toads

Western Toad - Bufo boreas

The Western Toad (Bufo boreas) is the largest amphibian found at Ballona. Adults exceed 80 mm snout-vent length. The color of the Western Toad is greenish to light brown with dark spots over the dorsal area and lateral surfaces. The skin contains numerous warty protuberances which are often tan in color. A thin mid-dorsal stripe is found from between the eyes to the vent. Short hind legs restrict their locomotion to a waddle or short hops. B. boreas is distributed from southern Alaska south to Baja, California along the coast and to central Nevada, Utah, and Colorado at inland localities and from the Pacific coast east through British Columbia, western Montana, western Wyoming, and central Colorado. A variety of habitats are occupied by B. boreas from sea level to 3000 m (Stebbins 1966).

We found only two individuals at Ballona, one an adult female found under a rug at a trash pile on the Agricultural Lands, and the other an adult found dead at the intersection of Culver and Jefferson Boulevards adjacent to Unit 1 (Figure 1). In addition, C. Nagano (Pers. Comm.) reported toads from the east end of Unit 3 early in 1980.

The rarity of toads at Ballona is surprising since this animal is one of the most abundant amphibians in coastal California. This species typically requires lakes, ponds, or pools of freshwater that remain for the duration of the breeding months in spring and early summer. The only such habitats at Ballona are the Bulrush Marsh, eastern Centinela creek and the Jefferson Drain just east of the intersection of Culver and Jefferson Boulevards along Jefferson on the Agricultural Lands, and the dune pond on Unit 1 (D). Since toads are able to return to breeding sites after migrating long distances (Tracy and Dole 1968; Gorman and Ferguson 1970), these animals could range widely at Ballona and need not be localized around these breeding sites.

Surprisingly little ecological data are available for B. boreas. We predict that the following summary for toads in southern California is representative of B. boreas at Ballona. Breeding occurs between January and July (Hill 1948) with most occurring during the spring months of March and April (Mullally 1952; Stebbins 1954; Tracy and Dole 1969). Adults are normally nocturnal during this time and migrate to the breeding site from as far as 300 m (Tracy and Dole 1968). Males are the first to arrive at the breeding site. Females have up to 16,500 eggs that are laid in long strings (Storer 1925). Adults disappear from the breeding site three to four weeks after breeding (Tracy and Dole 1968) and do not reappear until the next breeding season. These adults probably enter rodent burrows or burrow in loose soil (Mullally 1952) and remain dormant during this time.

Tadpoles metamorphose in late July at about 20 mm snout-vent length (Lillywhite, Licht, and Chelgren 1973). These juveniles are largely diurnal and bask to maintain their body temperatures at 26^{o} to 27^{o}C (Brattstrom 1963; Lillywhite, Licht, and Chelgren 1973). This range of temperatures insures rapid growth and these toads reach a mean size of 32 mm by the following

April (Lillywhite, Licht, and Chelgren 1973). An additional two years are probably required before sexual maturity is reached, but the size at reproductive maturity is unknown (Stebbins 1951; Dunlap 1959). Sexual dimorphism is marked, some females attaining 127 mm snout-vent length, while the largest males barely exceed 100 mm. Tadpoles and juveniles B. boreas probably incur heavy mortality. Some breeding sites probably dry before metamorphosis can take place. Tadpoles may be eaten by wading birds (herons and egrets) and southern alligator lizards (Gerrhonotus multicarinatus) are also known to feed on tadpoles (Cunningham 1956). Subadults and adults possess parotoid glands which secrete a neurotoxin, which protects them from predation and probably assist in increasing their survival relative to younger animals.

Tadpoles scrape algae and detritus from the bottom film of pools (Stebbins 1951). After metamorphosis, the major prey items are beetles (principally carabids), ants, and spiders (principally lycosids) (Schonberger 1945; Campbell 1970). During the breeding season adult females eat more than adult males (Schonberger 1945).

SPECIES ACCOUNTS

Class Amphibia - Amphibians

Order Anura - Frogs and Toads

Family Hylidae - Treefrogs

Pacific Treefrog - Hyla regilla

The most abundant amphibian at Ballona is the Pacific Treefrog (Hyla regilla), a small hylid frog with an adult size of over 32 mm snout-vent length. This frog occurs in several different color phases and patterns. Color varies from light green or reddish-bronze to tan with dark brown blotches. All color phases have a black eye mask that runs from the nostrils to the shoulder. H. regilla are found from southern British Columbia south through Baja California and from the Pacific coast east through western Montana and Idaho and all but eastern Nevada. Within this range, H. regilla occurs from sea level to 3300 m (Stebbins 1966).

At Ballona, we found Pacific Treefrogs wherever slow moving or standing freshwater occurs (Figure 1). Most of our sightings are from the base of the bluff forming the southeast boundary of the Agricultural Lands, particularly the Scirpus freshwater marsh. These frogs are also common along eastern Centinela creek. We heard few calling males at the Eucalyptus grove in Unit 2 where a pool formed by street runoff is found. During the winter, we heard calling in clumps of pampas grass on Unit 3 and at other times in the cattails near the Jefferson Drain culvert just east of the intersection of Culver and Jefferson Boulevards. A final locality for Pacific Treefrogs is the dune pond at the southwest end of Unit 1. Here, we observed tadpoles and successful metamorphosis.

Size data indicate two age classes for Hyla regilla at Ballona, juveniles and adults (Figure 2). Juvenile growth is rapid. The mean size of newly transformed frogs at the dune pond increased at approximately 0.14 mm/day. The smallest size at transformation was 11 mm.

The size at sexual maturity is unknown. However, the adult size class at Ballona are typically greater than 30 mm snout-vent length. Jameson (1956; 1957) noted a similar size at metamorphosis and a similar growth pattern for frogs in Oregon. However, transformed frogs in Oregon grew about twice as fast as those at Ballona (Jameson 1956).

The cloacal temperatures from the only four adult frogs encountered averaged 18.0°C (15.0 to 19.2). All temperatures were of frogs found hiding under surface objects. These are well within the ranges of temperatures reported for other *H. regilla* populations (Cunningham and Mullally 1956; Brattstrom 1963). Eggs are able to withstand temperatures of 30 to 35°C (Schechtman and Olson 1941) and tadpoles survive temperatures up to 34°C (Cunningham and Mullally 1956).

During winter months adult males were heard calling during daylight hours, indicating that at least a portion of the population remained active during the day. During one night in February 1981, 50-60 calling males were located from the freshwater marsh and flooded areas in the Agricultural Lands. We did not sample all nighttime hours so we do not know the extent of nightly activity of adult frogs. It is likely peaks of activity occur during the early evening and early morning hours of winter and spring months as they do in other southern California populations (Brattstrom and Warren 19-5). Newly-transformed frogs were found during all daylight hours from mid-April to mid-July. This group is diurnal until they approach adult size, as was reported by Cunningham and Mullally (1956).

We do not know the extent of nocturnal activity for these juveniles. Calling males were not heard during the day after May 4, 1981. During three nights in June 1981 we heard no choruses. Cessation of chorusing probably occured in late May, similar to the data reported for Idaho *H. regilla* (Schaub and Larsen 1978), but much earlier than the July date reported for southern California populations (Brattstrom and Warren 1955).

We captured or heard adult *H. regilla* during all months except October (Figure 3). During most of the year we found few adults (September through November and April through June). Nearly all activity was during winter months (December through March), when breeding occured (Figure 3). This is typical of southern California populations (Schechtman and Olson 1941, Brattstrom and Warren 1955). We were unable to determine if males arrive earlier than females as they do in other populations since we did not sample breeding sites at night (Jameson 1957, Schaub and Larsen 1978; Brattstrom and Warren 1955).

The Ballona population is composed primarily of adults much of the summer, fall and winter months. Large numbers of newly metamorphosed juveniles appear in early May through June with lesser numbers appearing through September. Egg and tadpole mortality are probably high with some areas incurring total mortality due to dessication of the breeding site. Juveniles and adults probably also incur heavy losses, with few individuals surviving more than one year similar to the frogs found in Oregon (Jameson 1957).

We observed no matings or egg masses. We found three gravid females between February 9 and 27, 1981 indicating clutches were laid in February or early March. We first observed tadpoles March 20 in the dune pond. We found other tadpoles in a temporary pool between two fields on the Agricultural Lands on March 27, and in the bulrush marsh below the bluffs on April 16, 1981. We observed metamorphosis in the dune pond on May 4, and in the freshwater on May 11. The temporary pool on the Agricultural Lands dried before any tadpoles reached metamorphosis. We caught recently metamorphosed frogs along the bluff that forms the southeast boundary of the Agricultural Lands from April 16 through June 1981, indicating that another breeding site exists in this general area. Another recently metamorphosed frog was observed along Centinela creek near the northeast boundary on September 20, 1980. This indicates very late breeding in Centinela creek, probably when flow rate recedes following winter rains. We have no evidence of reproduction on Unit 3 even though we heard calling males there. We suspect most breeding takes place early in the year when pools of water collect winter rain. However, breeding may occur as late as June in Centinela Creek. This is similar to the length of breeding observed in Oregon (Jameson 1957), but is much earlier and longer than the breeding season in Idaho (Schaub and Larsen 1978).

Since we found no eggs and found only large tadpoles, we cannot estimate development time or clutch size and frequency for H. regilla at Ballona. In other parts of its range, female Pacific Treefrogs contain 500 to 750 eggs during any breeding season and lay them in several clutches of five to 60 eggs (Smith 1940).

Little is known of the feeding habits of H. regilla and we made no attempt to determine food of this species at Ballona. Tadpoles feed on attached and suspended algae and detritus (Stebbins 1951). Post-metamorphic Pacific Treefrogs from several populations in southern California ate beetles, flies, leafhoppers and true bugs (Brattstrom and Warren 1955). This is probably typical of Ballona. We did not observe predation at Ballona. Suspected predators are cats, rats, opossum, egrets, herons, and white-tailed kites.

California Legless Lizard - Anniella pulchra

The California Legless Lizard (Anniella pulchra) is unique among Ballona lizards in lacking limbs. Its long, slender, snake-like body is adapted for a fossorial existence in sand and loose soil. It is longer than the Southern Alligator Lizard in snout-vent length, but is much less robust. The lizards are silver-grey in color with a yellowish venter. There are often a pair of lateral and a single mid-dorsal, dark stripes from the head to the tip of the tail. Legless lizards are found from the San Francisco Bay region south to Baja California and from the Pacific coast to the Coast ranges in southwestern California. They are found in coastal dunes, alluvial fans, and loose humus of oak-pine woodlands from sea-level to 1920 m (Stebbins 1966).

We captured only two legless lizards at Ballona: One January 30, 1981 on the dune along the southwest edge of Unit 1, and another May 19, 1981 under a small board on the sandy alluvial fan on Unit 2 (Figure 4). We suspect that these lizards also occur at the larger alluvial fan along base of the bluff, on the Agricultural Lands. These appear to be the only suitable habitats for legless lizards at Ballona.

In addition to the two adults mentioned above we observed tracks on the dune on Unit 1. The occurence of their distinctive sinusoidal tracks indicate that legless lizards at Ballona maintain low levels of activity from September through April, followed by increasing activity in May and June (Figure 5). This activity peak is later than the May peak reported by Stebbins (1966). This pattern also appears to contradict the findings of Brattstrom (1965), who reports that legless lizards burrow as deep as 1.5 m into soil to avoid high summer temperatures.

We have no information on reproduction at Ballona. Ovulation occurs from May through July in this live-bearing lizard, with young born September through November (Miller 1944). One to four (typically two) young are produced per female each year (Miller op. cit.).

The two A. pulchra we observed in January and May were 113 mm and 130 mm snout-vent length, respectively. This corresponds to individuals over two and just three years old according to the size groups of Miller (op. cit.). Juveniles are approximately 50 mm snout-vent length at birth and by the end of the next year reach 80 to 90 mm. During the following year, subadults will grow to 120 mm, when they reach adult size. Thus legless lizards require three years to reach maturity (Miller op. cit.). Sexual dimorphism favors males, the largest attaining 185 mm snout-vent length. In contrast, the largest females attain 155 mm (Miller op. cit.).

Legless lizards bask during morning hours by moving just under the soil surface from under vegetation to soil exposed to the sun. During the midday hours the animals retreat to areas under vegetation and then return to open areas to bask during evening hours (Miller 1944; Cunningham 1959b). A. pulchra maintain their body temperature between 20 and 28°C, when possible, but have been found with temperatures as low as 7.8 and as high as 30°C (Brattstrom 1965; Bury and Balgooyen 1976; Gorman 1957). The soil must also remain moist for this species to survive (Bury and Balgooyen 1976; Miller op. cit.). The species is sedentary and does not wander (Miller op. cit.). Food consists primarily of beetles (carabids), insect larvae, and spiders. Since this animal is so secretive, it probably has few predators. Fisher (1901) reported shrike predation on Anniella. Other suspected predators at Ballona are cats, opossum, and American Kestrels.

Southern Alligator Lizard - Gerrhonotus multicarinatus

The Southern Alligator Lizard is the largest of the four lizard species known to occur at Ballona. It is the most widespread lizard next to Sceloporus occidentalis, and can be found over all areas above the tidal flux (Figure 6). Adults average about 120 mm in body length. When unbroken, the somewhat prehensile tail is over twice the body length. Its limbs are small, and the head is relatively large. Diverse in color patterns, this lizard varies from brown to yellow with various degrees of blotching or barring. The species ranges from central Washington state to north-central Baja California (Lais 1976). Like other alligator lizards, this is a secretive species which is generally found in dense vegetation (Stebbins 1966).

Fifty-three body temperatures had a mean of 21.9°C (range 10.4 to 30.2°C). This is lower than that of Brattstrom (1965), but is similar, except for a narrower range, to the data of Cunningham (1966) for 150 body temperatures. Our data agree with Cunningham (1966) in that Gerrhonotus is probably seldom exposed to extremely high temperatures.

Despite general agreement, thermal data on G. multicarinatus are unclear. We believe this confusion results primarily from an inadequate knowledge of its ecology. The primary difficulty in understanding these data is the recognition of when lizards are active. Since our data agree with Brattstrom (1965) in that this species does not actively bask (contra Cunningham 1966), its source of body heat is undoubtedly warmer substrates. Further, since all data suggest that Gerrhonotus frequently uses surface objects to modify its body temperature, the key to understanding activity patterns is recognizing what Gerrhonotus does while under surface cover. Except for short time periods when lizards are observed by either moving surface debris or on open ground, we are largely ignorant of this species' activity. The impression we gain from our data is that Gerrhonotus appears to have a broad thermal range (roughly 20-30°C) whose mean value is considerably lower than for basking species. It appears to raise its body temperature by contact (thigmothermy) at low environmental temperatures, and simply moves to avoid warmer microenvironments at higher temperatures. What Gerrhonotus does when avoiding warmer microenvironments should be investigated.

Daily and seasonal activity patterns for G. multicarinatus are also poorly understood because of its unobservability. Our data show G. multicarinatus is capable of year-round activity at Ballona. Because over 95% of our observations on Gerrhonotus were made by overturning surface objects (see Methods section), this biases the sampling toward this activity segment. Figure 7 does not show seasonal activity, but instead seasonal variation in the utilization of surface objects. It shows peak use of surface objects during February. As noted previously, Gerrhonotus probably opportunistically uses these rapid-heating surface objects to elevate its body temperature when environmental temperatures are coolest. As ambient temperatures increase when summer is approached, use of such objects both decreases and shifts to a bimodal use pattern (early morning and late afternoon). We suspect that activity under thick vegetation occurs frequently and that the months following February into early summer would show equivalent activity levels, if this activity segment could be adequately sampled.

Matings of Gerrhonotus are reported from March 24 at Whittier to May 5 at Newport (Goldberg 1972). G. multicarinatus lays clutches of five to 41 (mean = 13) leathery, immaculate white eggs (burrage 1965). Egg size varies from 13 x 8 mm to 18 x 10 mm (Fitch 1935). Shaw (1943) reports a pocket gopher burrow as a nest site. Deposition dates vary from late May in San Diego county to late June in Los Angeles county (Shaw 1943; Atsatt 1952). Our data suggest an incubation period of 10 weeks with female egg deposition taking place in June, similar to Goldberg's figure of 11 weeks (Goldberg 1972). Burrage (1965) gives in vitro evidence of multiple clutches. We feel Burrage's gestation and incubation periods were shortened by in vitro conditions and that third clutches in a field population are probably not possible, with second clutches being a rare event. Clustering of our growth data suggest that a single, synchronous clutch was laid by females during 1980 (Figure 8). At Ballona, a 30 mm individual caught by a pitfall trap on August 24, 1980 was recently hatched, as reported body sizes of newly hatched lizards vary from 26 to 36 mm (mean = 33 mm) (Fitch 1935; Shaw, op. cit.; Burrage 1965). This agrees with hatchling emergence reported in August, September and October by Goldberg (op. cot.).

Three size classes of alligator lizards can be distinguished over a year (Figure 8). Young of the year and juvenile animals in their first full year of growth (ca. 30-80 mm snout-vent length), subadults in their second full year of growth (ca. 80-100 mm snout-vent length) and adults (over 100 mm). During the fall, subadults merge with adults and become indistinguishable from the latter. At Ballona, marked juveniles grew rapidly after January 1, 1981. Growth rates varied from .06-.26 mm/day (mean .15 mm/day; n = 10). We have but a single estimate for late fall-early winter growth in juveniles, which was considerably slower (.03 mm/day). Subadults grew less rapidly than juveniles after January 1 (mean = .09 mm/day, range .04-.13 mm/day for n = 5). Adults grew even more slowly over the same period (mean = .04 mm/day, range .00-.07 mm/day for n = 6). We have no estimates of late fall-early winter growth for subadults and adults, but suspect the values would be equal to or lower than those obtained for juveniles over the same period. We observed the first recognizably gravid female on May 4, 1981, but most gravid females were observed from late May through early June. We observed females which had laid eggs in mid-late June, which agrees with previously noted late June egg deposition dates (Atatt 1952). A 95 mm body length female was our smallest reproductive individual. This is similar to the 92 minimum reproductive size noted for females at Whittier (Goldberg 1972). Our data suggest that lizards attaining an average adult size of 115 mm must be at least three years old. Growth rates observed in this adult size range suggest individuals approaching the largest size observed at Ballona may be five years old. Lais (1976) reported a maximum size of 175 mm snout-vent length for G. multicarinatus. If our growth rates are typical, they suggest some individuals can live to a considerable age. We distinguished no sexual dimorphism in size. We could distinguish males larger than 65 mm of body length from females where hemipenal eversion could be induced. The larger head breadth in males, noted by Stebbins (1954), is suitable for distinguishing the sexes above 80 mm body length.

The proportions in various size classes captured during any monthly interval are relatively constant (Figure 7) until July where the disappearance of the juvenile size category is the result of the entrance of these individuals into the subadult size class. Observed adults above 110 mm body length always had broken tails and are the only size group in which multiple tail breaks appear. Tail breakage decreases in a regular fashion to 50% in the juvenile size class which suggests that breakage occurs in proportion to the length of time an individual spends in the population. Although we believe that predation is an important source of mortality, we cannot unequivocally link tail break frequencies to predatory mortality, as interaction between conspecifics may be responsible for breakage (Atsatt 1952). Females outnumber males in a ratio of 1.4:1 above the 65 mm body length where individuals could be sexed.

Diet information from the feces of two captured lizards from Ballona shows the locustid grasshopper and wasps are eaten. Cunningham (1956) summarizes the diet from the contents of 262 digestive tracts, 76 of which were empty. Arthropod food dominated the diet. In order of importance, carabid beetles, tettigoniid and locustid grasshoppers, lepidopteran larvae, spiders and ants were the groups most often encountered. However, vertebrate food was observed in 21 digestive tracts. Seventeen of these were lizards including five instances of cannibalism. Two of the lizard species reported, Sceloporus occidentalis and Uta stansburiana, occur with Gerrhonotus at Ballona. The remainder of vertebrate food items found by Cunningham were juvenile mammals and birds. Fitch (1935) reported predation on bird's eggs. The relatively low temperature tolerance of G. multicarinatus and its large size were the main factors cited by Cunningham (1956) as allowing these relatively slow-moving lizards to capture and eat swifter lizards. This agrees well with the data of Harwood (1979) who found G. multicarinatus maintained a high digestive efficiency at lower temperatures when compared to basking species.

The only record of predation on Gerrhonotus at Ballona was the finding of a 75 mm tail fragment in the stomach of a road-killed female kingsnake. Since it appeared recently swallowed, and since no other lizard remains were found in the snake, it was assumed this represented an unsuccessful attempt at predation by the snake, where it was left swallowing the tail fragment it had seized. Other suspected predators at Ballona are cats, rats, opossum, gopher snakes, which occasionally take lizard prey as juveniles (Fitch 1949), burrowing owls, sparrow hawks, and shrikes.

Western Fence Lizard - Sceloporus occidentalis

The most common lizard at Ballona and throughout much of coastal California is the Western Fence Lizard (Sceloporus occidentalis). Adults exceed 60 mm, making this species intermediate in size between two other Ballona lizards, the Southern Alligator Lizard (Gerrhonotus multicarinatus) and the Side-blotched Lizard (Uta stansburiana). Sceloporus is most often seen basking, particularly during morning hours when they are almost completely black in color. As lizards become warmed they lighten to a grey brown color, often with a series of paired dark bars down their backs. Adult males have a pair of dark, metallic-blue patches on their venter and a similarly-colored throat patch which are displayed during territorial disputes. These blue patches are the cause of the colloquial name "blue belly". Western Fence Lizards are found from central Washington state south through northwestern Baja California and from the Pacific coast east through southern Idaho and western Utah. They occur from sea level to 2700 m (Stebbins 1966).

We found S. occidentalis in all areas and all major vegetation of types at Ballona (Figure 9; Tables 1 and 2). They are abundant along the elevated dirt roads of Unit 1 with a particularly dense population among the debris at the northern edge northeast corner of the Agricultural Lands but are rare in lush growths of pickleweed (Salicornia sp.) and are probably absent from all areas flooded by saltwater. S. occidentalis are found throughout Units 2 and 3, but are particularly abundant when associated with native shrubs such as Laurel-Sumac (Rhus laurina) and California Sage (Artemisia californicum) (Table 2). No restriction of habitat selection appears for Western Fence Lizards at Ballona as reported for other populations of fence lizards occupying the same habitat with other iguanid lizards (Marcellini and Mackey 1970; Rose 1976; and Davis and Verbeek 1972).

Two age groups are distinguishable based on snout-vent length data for each sex (Figures 10 and 11). Young of the year appear in early July and grow slowly through January (mean = 0.06 mm/day for n = 7). These juveniles almost triple their growth rate during January through June (mean = .17 mm/day; n = 21). This group continues rapid growth until adult size is reached by early June for females and early to mid-July for males. Once adult size is reached little or no growth occurs (mean = 0.03 mm/day; n = 25). These data indicate that both sexes require two years to reach sexual maturity. Adult males (mean = 70.2 mm; range 60-82 mm; n = 113) are larger than adult females (mean = 67.6 mm; range 60-79 mm; n = 87). The growth pattern found at Ballona is typical of S. occidentalis in other parts of its range (Fitch 1940; Davis 1967; Rose 1976). However, lizards are larger at higher elevations (Jameson and Allison 1976) and females are larger in northern populations (Fitch 1978).

Cloacal temperature of 42 active S. occidentalis averaged 32.5°C (24.6-36.5°C), while 81 inactive lizards averaged 23.6°C (13.0 to 34.1°C). The ranges of active and inactive lizards at Ballona are similar to those reported by Brattstrom (1965) for other California S. occidentalis.

Western Fence Lizards were seen during all daylight hours at Ballona. These animals were found under surface objects during early morning hours or on cool, overcast days. Typically, lizards basked during the morning hours, remained in the shade of vegetation during the hot mid-day hours, returning to basking during evening hours. This behavior insures a rapid rise in body temperatures to a constant level that is maintained throughout as much of the day as possible.

Sceloporus occidentalis are found throughout the year at Ballona. Lowest numbers were observed from September through December. During January through March increasing numbers of lizards emerge, mostly individuals found inactive under surface objects. A sharp increase of lizards occurs in April followed by declining numbers through June (Figure 12). This contrasts with the pattern of S. occidentalis at higher elevations in California and Nevada which are inactive during winter months and show constant adult activity during spring, summer and fall (Tanner and Hopkin 1972; Jameson and Allison 1976).

Differences exist in seasonal activity between adults and juveniles, and between males and females. We found both adults and juveniles during fall and winter months but most observations were of juveniles. Juveniles were abundant from February through April after which their numbers gradually decreased (Figure 12). This decrease is due to juveniles entering adult size. Adults emerge in increasing numbers during April. Since juveniles do not reach adult size until later in the year, the April increase in adults must be due to adults that were largely inactive during the winter. Adult males appear earlier than adult females (Figure 12). These individuals are probably setting up territories in preparation for the reproductive season. These patterns are similar to other populations of S. occidentalis. Juveniles are more active than adults during winter in Monterey and Santa Barbara counties, California (Davis 1967; Davis and Verbeek 1972). Adult males emerge earlier than adult females in high elevation populations in California and Nevada (Jameson and Allison 1976; Tanner and Hopkin 1972).

During this study, several adult lizards were found dead and several others were found severely thin and emaciated. Most of the latter were found under surface objects during winter months. One emaciated female was discovered after having dropped a clutch of eggs. These data suggest that adults may sustain heavy mortality.

We observed the first visibly gravid female on May 5, 1981. By May 16, most adult females were gravid. The smallest of these was 60 mm snout-vent length. We observed the first female to have deposited eggs on May 16, 1981. We observed gravid females throughout July. However, the percentage of gravid females declined in July. The appearance of oviductal eggs during early May in lizards at Ballona is similar to the earliest date reported for lizards in other lowland areas of Los Angeles county during a wet year (Goldberg 1975). In dryer years oviductal eggs appeared by early April (Goldberg op. cit.). The three month period (May to August) over which females may be gravid is similar to that reported by Goldberg (1973) as is the size at first reproduction. We found no laying sites and did not attempt to determine clutch size. We also do not have sufficient recaptures to determine number and time between clutches. Stebbins (1954) described nests as being dug by females in loose damp, well-aerated soil. Since populations from nearby areas of Los Angeles county lay multiple clutches (1-3 clutches /year) of from three to 11 eggs (Goldberg 1973; 1974), it is likely that S. occidentalis at Ballona have a similar pattern. The variability of snout-vent length of juveniles captured from September through December indicates multiple clutches at Ballona.

We observed young of the year on July 3, 1981. The smallest of these measured 25 mm snout-vent length. Since the earliest known deposition of eggs was in mid-May, a maximum incubation time at Ballona is approximately six weeks. This is much shorter than the 13 weeks reported by Goldberg (1975) due to earlier time of deposition (early April) and later first emergence of hatchlings (mid-July). This may be an effect of drought conditions during most of Goldberg's study. An incubation time similar to that at Ballona was found by Goldberg (1974) for S. occidentalis at higher elevations. Hatchling size at Ballona is similar to other populations from a variety of habitats and elevations (Davis 1967; Goldberg 1973; Tanner and Hopkin 1972).

Scats of Western Fence Lizards at Ballona indicates that beetles (carabids and coccinelids) and orthopterans (acridids and gryllids) are common food items. These groups, along with ants, have been reported as major diet items in other populations (Davis 1967; Tanner and Hopkin 1972). We observed two cases of predation on S. occidentalis: A juvenile female was eaten by a juvenile kingsnake (see Lampropeltis account) and the remains of an adult female was impaled on a thorny bush, presumably by a Loggerhead Shrike. Southern Alligator lizards, and juvenile gopher snakes, both of which occur at Ballona, are known to feed on S. occidentalis (Cunningham 1956; Fitch 1949). Other suspected predators include dogs, cats, rats, opossum, American kestrels, white-tailed kites, burrowing owls, egrets and herons.

Side-blotched Lizard - _Uta stansburiana_

The Side-blotched Lizard (_Uta stansburiana_) is the smallest lizard found at Ballona, with adults exceeding 48 mm snout-vent length. As in _S. occidentalis_, the body of both sexes is greyish-brown with paired dark brown blotched down the middle of the back. Males possess a dark ink-colored blotch on each side near the axillae which is displayed during territorial disputes. Females may or may not possess faint axillary blotches. The scales of the Side-blotched lizard are smaller and less heavily keeled than those of _S. occidentalis_, giving a smoother appearance. _U. stansburiana_ occurs from south-central Washington; eastern Oregon and southwestern Idaho south through Baja California and northern Mexico, to western Colorado and through New Mexico to western Texas, from sea level to 2700 m (Stebbins 1966).

Side-blotched lizards are found exclusively on sandy areas at Ballona (Figure 4), common on the dune in Unit 1; and occasionally at the sandy, alluvial fan in Unit 2, the large alluvial fan along the bluff, and the sandy area at the extreme east corner end of the Agricultural Lands. In southern populations, Side-blotched lizards are typically sand-dwellers (Tinkle 1967), but northern populations are primarily rock-dwellers (Nussbaum and Diller 1976).

One age group occurs at Ballona (Figure 13). It appears that the species is annual, individuals are born, grow, reproduce and die in the span of a year. Young first appear in early July and continue hatching through mid-September. They grow at a mean rate of 0.09 mm/day (0.08-0.10 mm/day; n = 5) and reach maturity by early March. As adults, growth slows or stops (0.00-0.02 mm/day for two adult females). A few adults may live to reproduce a second season. This agrees with the pattern of growth and longevity reported for _U. stansburiana_ for Texas (Tinkle 1967) and Nevada (Turner et al. 1970). Northern and higher elevation populations live longer (Nussbaum and Diller 1976; Tinkle 1967; Tanner 1972). Males average 50.5 mm snout-vent (41.0-57.5; n = 15) and females average 46.7 mm (43.0-52.5; n = 15) at Ballona. This size dimorphism is typical for Side-blotched lizards, which is more pronounced in southern populations than northern ones (Parker and Pianka 1975).

Cloacal temperatures from six active lizards averaged 32.2°C (29.8-34.6), while eight inactive lizards averaged 21.2°C (16.0-27.8). The few basking lizards seen indicates that this species may not emerge from retreats until preferred temperatures are reached. The range of temperatures when inactive is similar to that reported by Brattstrom (1965). Our mean active temperatures is lower than that reported by Brattstrom (1965) and Tinkle (1967).

We found Side-blotched Lizards throughout all daylight hours when sunny. Activity was often restricted to areas of thick vegetation so patterns of daily activity were difficult to discern since capture was difficult. We encountered many individuals under surface objects both on cloudy or cold days and during hot, cloudless days. These retreats appeared to be used to escape both exceptionally cold and warm environmental temperatures. In Texas and Nevada, Side-blotched Lizards typically show a bimodal activity pattern with most activity occurring in morning and evening hours (Irwin 1965; Tanner 1972). It is likely that during warm summer months Side-blotched lizards at Ballona have a similar pattern.

Side-blotched lizards were found during all months of the year at Ballona, but numbers were lowest September through January with increasing numbers from February through June (Figure 14). Similar seasonal activity was reported for lizards from Texas and New Mexico (Tinkle 1967; Alexander and Whitford (1968). In Oregon, lizard activity ceases during winter (Rickard 1967; Nussbaum and Diller 1976).

During fall and winter months the population, we observed juvenile and small adult lizards (Figure 14), with approximately equal numbers of males and females encountered. During February, the population consisted of approximately equal numbers of adults and large juveniles approaching adult size. During the rest of the peak population months (March through June) the population consisted primarily of adults (Figure 14). Males predominated from February through April, whereas we found females more common from May through June. Males emerge early and set up territories before the females appear, similar to the pattern reported by Spoeker (1967) for lizards in the Mojave desert.

We first observed gravid females on April 20, 1981. By early May, nearly all adult females captured were gravid. They had bright orange to yellow patches on their throats and occasionally in the axillary region. We observed first female that appeared to have deposited eggs on June 1, 1981. Gravid females were captured throughout the month of June, but none were captured during July. The smallest female known to be gravid had 47 mm snout-vent length. Tinkle (1967) reported an earlier appearance of oviductal eggs in Texas Side-blotched lizards (early April). Since Tinkle's data are from sacrificed animals and ours from live animals in the field, it is likely that we did not recognize oviductal eggs until a much later stage of development. Egg deposition occured in mid-to-late April in Nevada (Turner et al. 1970), a month and a half earlier than at Ballona. Clutch sizes were not determined at Ballona. Mean clutch sizes from a variety of localities range from three to six eggs (Parker and Pianka 1975). U. stansburiana from southern California typically have three eggs per clutch (Goldberg 1977). In all populations clutch size increases with increase of female body size and decreases with time of year. Side-blotched lizards can lay up to five clutches per year (Turner et al. 1970), but typically lay three per year in Southern California (Goldberg 1977). Since hatchling sized lizards appeared over a long period of time (Figure 13), multiple clutches are probably laid at Ballona. The minimum adult female size found in this study is larger than any other study. Since our capture rate for Side-blotched lizards was low, this appears to be due to sampling error. Typically, female Side-blotched lizards become reproductive at about 40 mm snout-vent length in southern populations (Parker and Pianka 1975; Spoeker 1967; Tinkle 1967; Turner et al. 1970).

We first captured recently hatched juveniles on July 3, 1981. The smallest of these was 23 mm. Lizards captured in insect pitfall traps indicate hatchlings appear as late as mid-September. Since the earliest deposition date was early June, the minimum incubation at Ballona is approximately four weeks, less than half as long as the incubation time of other populations of U. stansburiana (Tinkle 1967; Goldberg 1977). The first observation of young of the year is similar to that reported for Mojave (Spoeker 1967), and mountain populations in southern California (Goldberg 1977). Later appearance of hatchlings occurred in Arizona (Parker 1974), Texas (Tinkle 1967), Nevada (Tanner 1972), Colorado (Tinkle 1967) and Oregon (Nussbaum and Diller 1976). In general, hatchlings appear later in northern populations and at higher elevations. Size at hatching in this study was similar to that of other populations (Goldberg 1977; Nussbaum and Diller 1976; Spoeker 1967; Tanner 1972; Tinkle 1967).

We have no data on feeding of Side-blotched lizards at Ballona. In other studies, they were observed to feed on beetles, termites, ants, and grasshoppers (Parker and Pianka 1975). It is likely that Ballona lizards feed on similar groups. No cases of predation on U. stansburiana were observed. Juvenile gopher snakes and common kingsnakes are known to feed on these lizards (Fitch 1949). Other suspected predators at Ballona are dogs, cats, rats, opossum, American kestrels, white-tailed kites, burrowing owls, and loggerhead shrikes.

Common Kingsnake - Lampropeltis getulus

The kingsnake is one of two snake species known to occur at Ballona. This snake is a terrestrial, non-venomous constrictor with a color pattern of alternating light and dark rings. Adults are under one meter in body length. This species is found across the continental United States north to southwestern Oregon and south to the states of Zacatecas and San Luis Potosi, Mexico (Blaney 1977). It frequents a great variety of lowland communities (Stebbins 1966). Several authors (Fitch 1949; Hayes and Cliff 1981) have commented on its tendency to aggregate around areas of persistent moisture. At Ballona, kingsnakes occur over most areas above the tidal flux (Figure 15).

Four active kingsnakes we measured had a mean body temperature of 28.6^{o}C (range 28-29.5^{o}). This value is nearly identical to that reported by Brattstrom (1965) for 17 kingsnakes. We observed a single inactive juvenile at 09:50 hours on February 6, 1981 under a wooden palate, presumably prior to warming to its preferred temperature, with a body temperature of 17^{o}C, nearly identical to adjacent air and substrate temperatures of 17 and 17.6, respectively. Brattstrom also reports the temperature of a single individual emerging from a hole as 15.1^{o}C, with air and soil temperatures of 14.8 and 15.2, respectively.

The 18 records of kingsnakes at Ballona suggest juveniles emerge first following winter hibernation, followed by adults (Figures16 and 17). There appear to be roughly four months of inactivity (October to January) at

Ballona in contrast to five months reported by Fitch (1949) in Madera county, California. Snakes observed in February through April were found under surface objects with rapid-heating capabilities (pieces of tin, boards, etc.). Peak surface activity was recorded in May (Figure 16), when snakes were frequently observed on open terrain. Summer months bring a decline in daytime activity, presumably because higher temperatures force the snakes to shift to crepuscular and nocturnal activity when temperatures are more equitable. A similar shift to nocturnal activity was also suggested by Fitch (1949) in central California.

Lampropeltis getulus is an egg-laying snake (Stebbins 1966). Reproductive information on this species is sparse. Clutch size varies from 3 to 10 (mean = 6) (Wright and Wright 1957). Egg deposition sites have not been described, but probably require loose, well-drained soil like that found in rodent burrow systems. Klauber (1931) recorded egg deposition dates in captivity for two females caught in the wild as July 19 and 30 in San Diego county. Klauber (1939) reported an incubation time period for snakes kept in captivity of 71 to 86 days, average of just under 11 weeks. The July egg deposition dates of Klauber and the June to August dates of Wright and Wright (1957), when coupled with Klauber's incubation times would produce young hatching in September, October and November. At Ballona recently-hatched individuals appeared in September.

The skeleton of a young juvenile Lampropeltis measured at 260 mm in body length was found at Ballona on September 15, 1980. Klauber's minimum juvenile sizes were 205 and 210 mm total length. It is likely that hatchling individuals are slightly over 200 mm in total length (over 170 mm snout-vent length). The only additional reproductive data from Ballona is a 703 mm road-killed female found June 15, 1981 that contained ovarian eggs, the largest of which was 9 x 5 mm. These eggs were clearly undeveloped, but it appeared yolk deposition was taking place. This size is close to the minimum we suspect required for reproduction.

Little is known of growth in Lampropeltis. Three age groups can be distinguished at Ballona (Figure 17): young of the year and first-year juveniles (250-500 mm snout-vent length), a middle size class of second-year juveniles (501-800 mm) and adults (801 mm and larger). Our impression is that juvenile Lampropeltis attain body lengths of above 500 mm at the end of their first year, and around 800 mm by the end of their second. Fitch (1949) reported slow growth (estimated at 0.0-0.1 mm/day from Fitch's table) in five adult kingsnakes. His data applied to adults well over 800 mm. Fitch has four recaptures of individuals already at this size when initially marked with six-year recapture intervals. This would give a minimum age of nine years for these snakes. The largest individual recorded at Ballona was a 1020 mm male, smaller than the largest individual recorded by Fitch (1949), also a male at 1160 mm. Size at first reproduction is unknown. Sexual dimorphism favors males (Klauber 1943).

Of 18 kingsnakes observed at Ballona, five (27%) were juveniles less than 500 mm long. This is higher than the 14% (six of 43) reported by Fitch (1949) in Madera county, California. Our impression is that young kingsnakes have a higher survivorship than young gopher snakes. Observed mortality was one of five (20%) in kingsnakes versus two of three (67%) in gopher snakes. Fitch gained the same impression from his data, but could not substantiate it conclusively. The size distribution of kingsnakes suggests that essentially all size groups are equally observable (Figure 18). It suggests equal representation if our sample has equal proportions of size groups to that found in the total population. Fitch's recapture data, noted in the discussion of growth, also suggest that adults have a high survivorship and considerable longevity. Sources of mortality are road casualties (n = 3) and unknown causes (n = 2). The two snakes listed under unknown causes included a 610 mm female whose dehydrated carcass was observed near a tidal pool fringed by pickleweed and the small juvenile mentioned under the discussion of hatchling sizes. Both snakes were fall casualities when fresh water is scarce. The sex ratio of observed snakes was essentially 1:1, of 15 individuals that could be sexed, 8 were males. A comparison of our data with Fitch's suggests that the density of kingsnakes at Ballona is higher than in Madera county, but no good density estimates for L. getulus exist.

Three records of food items for Lampropeltis exist for Ballona. A 42 mm long female Sceloporus occidentalis was palped from a 311 mm long juvenile Lampropeltis on February 19, 1981. On the night of June 15, two road-killed kingsnakes were found. One, a female, contained a Gerrhonotus tail fragment (see Gerrhonotus account) and the other, a 1020 mm male, contained the remains of an unidentified rodent. Diet items agree with the combined data of Klauber (1931), Fitch (1949), and Cunningham (1959a) who reported 31 food items eaten in a minimum of 16 predatory episodes. Reptiles were the food items in 63% (10 of 16) of the episodes, birds or their eggs in 25% (4), and mammals in the remaining 12% (2). Multiple food items in a single predatory episode are the result of juveniles or eggs being taken from nests. Fitch (1949) notes that a significant proportion of the diet may be obtained by nest robbing. When compared to other snake species (Fitch and Shirer 1970), Lampropeltis getulus is a relatively mobile predator. Fitch (1949) reported moves of ten kingsnakes varying from 45 to 553 m (mean = 260 m) over intervals from four days to over six years. Mobility may be a necessity in a foraging predatory mode where nest robbing occurs frequently. However, Fitch emphasizes that his data suggest permanent residence areas a few hundred meters at most in longest diameter.

Two records of snake predation exist for Ballona. On December 22, 1980 at 11:20, a burrowing owl was flushed from vegetation on Unit 3 carrying what appeared to be a snake. On February 6, 1980, a white-tailed kite (*Elanus leucurus*) or marsh hawk (*Circus cyaneus*) was observed carrying a snake at the west end of Unit 3. Neither snake was positively identified, but either of the two Ballona snake species were the possible food item for these predators. All three species mentioned are capable of capturing kingsnakes, particularly younger individuals. Fitch (1949) reports red-tailed hawks, great horned owls, and coyotes as kingsnake predators. Of these, only the first occurs at Ballona (C. Dock, pers. comm.). Fitch emphasized the low frequency of kingsnakes (14 occurrences) in the very large number of diet remains (7002 pellets and scats) examined over five years for the above three predators. He suggested predation on kingsnakes was infrequent. These data agree well with the previous suggestions on longevity. Other suspected potential predators at Ballona include cats, dogs, opossum, sparrow hawks and man.

Gopher Snake - *Pituophis melanoleucus*

The gopher snake is the larger of the two snake species known to occur at Ballona. Adults average somewhat over one meter in body length. Similar to the kingsnake, they are slightly stouter in build, terrestrial, non-venomous and powerful constrictors. Gopher snakes have regularly-spaced brown blotches on a tan to ochre ground color. This species ranges across the continental United States north to southern Alberta and Saskatchewan, Canada and south to central Mexico (Klauber 1947). They frequent a variety of habitats but are especially abundant in grassland and open brushland (Stebbins 1966). Frequently the most abundant terrestrial snake in many lowland communities (Klauber 1939; Sullivan 1981), they are the more numerous snake species at Ballona. Gopher snakes can be found over all areas above the tidal flux (Figure 15).

Our data for ten active gopher snakes show a mean body temperature of 28.5°C (range 22.6°C-32.2°C), similar to Brattstrom's (1965) mean for 17 active gopher snakes of 26.7 (range 16.4-34.6). Our range of body temperatures of active snakes also agrees well with Brattstrom's thermal gradient data where snakes, given a range of temperatures from 15 to 45°C, were most often found in the 22 to 31°C range.

Daily and seasonal activity patterns for adults agree well with the thermal data. The pattern is similar to that observed for kingsnakes with peak surface activity in May (Figure 16). This agrees well with Klauber's (1931) seasonal data for San Diego county. However,gopher snakes appear to use rapidly-heating surface objects less than kingsnakes, and they are diurnally active through July, while kingsnakes have undergone a shift to more nocturnal activity in June. Although still diurnal in June and July, snakes shift to activity times earlier in the day, when temperatures are more equitable.

Pituophis melanoleucus is an egg-laying species that produces clutches of three to 18 eggs (mean = 8) (Klauber 1947). We observed gravid females in June at Ballona. This agrees with Klauber's (1947) June and July egg deposition dates. Egg-laying sites have not been described but are expected to be similar to those postulated for kingsnakes (see Lampropeltis account). Klauber reports an incubation period in captivity varying from 64 to 71 days (mean = 66.5 days) and a hatchling size of 380 mm snout-vent length. At Ballona, we observed a 370 mm road-killed juvenile on September 29, 1980. Given a July egg deposition date, this agrees well with Klauber's estimates of incubation time and hatchling size.

We can distinguish two size categories in gopher snakes at Ballona (Figure 19). First-year juveniles (350-750 mm) and adults (1000 mm and up). We recorded no individuals in the 750 to 1000 mm size interval, which probably represents second-year juveniles (Figure 20). Fitch (1949) recorded only 7% (19 of 257) individuals in the 600 to 900 mm size interval, which he termed second year snakes. From the differential numbers observed in other size categories, Fitch suggested a high mortality (over 80%) of juveniles before their first hibernation as the reason a low frequency of the second year class is observed. We estimated growth rates from Fitch's size data for all size categories. Growth for juveniles and young of the year ranges from .31 mm/day to 1.99 mm/day (mean = .96 mm/day; n = 4). Growth during hibernation was estimated from a single individual at less than .005 mm/day. There are no estimates of growth during hibernation for the other size classes, but they are probably equally low. For the second year class, growth ranges from .51 mm/day to .97 mm/day; n = 2). Estimates for adult growth are only for the adult males that made the largest growth increases. Estimates range from .04 mm/day to .13 mm/day (mean = .11 mm/day). If growth is similar at Ballona, and the shorter winter period should allow more time for growth, it suggests snakes at Ballona attain the adult size range of 1000 mm midway through their second year of growth. The largest snake recorded at Ballona was a 1585 mm male, considerably smaller than the snake in excess of 1800 mm recorded by Fitch (1949). Fitch recorded two snakes recaptured after six year intervals which were already adult size, which suggests these two snakes were at minimum eight years old when recaptured. Klauber (1943) records sexual dimorphism in size in favor of males.

As previously noted, we gain the impression, concurring with Fitch (1949), that juvenile mortality is high (see Lampropeltis account). At Ballona, most (86% - 18 of 21) gopher snakes were adults. Fitch (1949) believed that adult mortality was less than the mortality of juvenile conspecifics. Sex ratios of observed snakes were not different from 1:1; of 21 snakes 11 were males.

Two records of predation by Pituophis exist for Ballona. The 370 mm juvenile mentioned under the discussion of hatchling size, a female, contained an unidentified mouse in its stomach. A 560 mm juvenile female was found basking on June 12, 1981 with a recently swallowed harvest mouse (Reithrodontomys sp.) in its stomach. A summary of the food records from Klauber (1931; 1947), Fitch (1949), and Cunningham (1959a) show that gopher snakes ate 112 food items in 57 predatory episodes. Fitch (1949) found 39% (13 of 33) of snakes with food were nest robbers. Similar to the kingsnake, it is a highly mobile predator, with moves up to 778 m recorded (mean = 138 m for n = 28) (Fitch 1949). In a telemetric study involving seven snake species, Pituophis made the longest mean movements (142 m = mean; n = 3, Fitch and Shirer 1971). Of 57 episodes summarized above, 45 (79%) were mammals, while 6 (10.5%) were birds or their eggs and the remaining six were reptiles. Reptiles in the diet were all lizards taken exclusively by juveniles except for a single report of cannibalism. Because of its size, larger mammals up to the size of a cottontail rabbit are occasionally taken. Juvenile rabbits, juvenile squirrels and adult and juvenile pocket gophers are frequent diet items. A notable feature of the gopher snake's diet is the presence of burrowing mammals that plug their burrows with dirt. The ability of gopher snakes to dig through the dirt, pushing defenses of pocket gophers, is an important reason for these snakes being major predators on these rodents (Hickman 1977). Species which occur at Ballona and have been reported as gopher snake prey include: pocket gophers (Thomomys sp.), meadow voles (Microtus sp.), house mice (Mus sp.), western fence lizards (Sceloporus sp.), side-blotched lizards (Uta sp.), and quail (Lophortyx sp.).

Two instances of potential predators on snakes are reported under the kingsnake account. Fitch (1949) reported predation on gopher snakes by red-tailed hawks, great horned owls, coyote, gray fox, barn owls, and kingsnakes. Gopher snakes represented 1-5% of the total prey items for the hawks, owls, and canids. One instance of a gopher snake eaten by a kingsnake occurred in six kingsnake food items reported. Of the reported predators, the hawk, barn owl, and kingsnake all occur at Ballona.

SUMMARY

Scope of the herpetofauna

The reptiles and amphibians known to occur on the sampled area consist of nine species: four lizards, two snakes, a frog, a toad, and a salamander. Our knowledge of habitat requirements suggest this sample represents all existing reptiles and amphibians, with the possible exceptions of the terrestrial salamander, *Ensatina eschscholtzi*, and the Western Spadefoot Toad, *Scaphiopus hammondi*, which may have been missed due to limited rainfall. Only one other study, that of Pluym et al. (1979) by Envicom Corporation, has attempted a more than cursory survey of the Ballona reptile and amphibian fauna. Unfortunately, that survey did not specify the number of hours of field observation, species' occurrences were often statements merely paraphrasing the field guide literature, and references were vague so that field observations could not be distinguished from literature records. The Envicom study reported 13 species of reptiles and amphibians, only four of which were observed in the field. These were *Bufo boreas*, *Hyla regilla*, *Sceloporus occidentalis* and *Uta stansburiana*. Four others reported were never observed by us. Three of these are probably absent from Ballona today (see historical data and changes). We caution that although the Envicom report is valuable as an initial estimate, it does not provide essential habitat and reproductive period data for species actually present. These data are needed for management decisions. We caution further that, even with rigorous sampling, certain species may be missed because of annual variability in climate.

Historical data and changes

Los Angeles County Natural History Museum (LACNHM) records suggest all species recorded were historically present. However, the greater area which includes the Ballona Marsh ecosystem has been considerably modified since the turn of the century, and changes in the herpetofauna are not reflected by confirmation that existing species were formerly present. Instead, we distinguished two types of changes: 1) elimination of species, recognized by comparing our data with historical records, and 2) gross movements and changes in population size for existing species, which we inferred from a knowledge of species' habitat requirements and differential habitat composition between historical and present-day marsh sites. Although other types of changes are certainly possible, historical data are insufficient to allow a more detailed comparison. Records indicate that the Ballona region once supported a freshwater marsh system behind today's halophytic tidal marsh. Historical records (LACNHM collections) of two reptiles, the Pacific Pond Turtle (Clemmys marmorata) and the Common Garter Snake (Thamnophis sirtalis), suggest that habitat and food resources required by these two species existed. Neither species invades halophytic marshes, but both are associated with cattail-tule vegetation in warmer, slow-moving waters of drainages to the north and south of the Ballona ecosystem (Storer 1930; Klauber 1931). Since both are common and easily collected by comparison to most reptiles and amphibians, it is not surprising they should appear in these records. However, at least two other species, the California Red-legged Frog (Rana aurora draytoni) and the Two-striped Garter Snake (Thamnophis couchi hammondi), were probably associated with this freshwater marsh system. The former is recorded as a fossil at La Brea in the Ballona drainage system (Brattstrom 1953), while the latter is observed in similar marsh systems in San Luis Obispo county (Dan C. Holland, pers. comm.).

In addition, the terrestrial herpetofauna is likely to have historically included the Red Racer (Masticophis flagellum), which is associated with coastal scrub vegetation (Bogert 1930). This scrub, which once covered the lowland Los Angeles basin that includes the Ballona region (Mooney 1977), exists in a modified form in terrestrial habitats at Ballona. The three reptiles reported by Envicom, that we did not observe, are the Coast Horned Lizard (Phrynosoma coronatum), the Yellow-bellied Racer (Coluber constrictor), and the Pacific Rattlesnake (Crotalus viridis). If any of these occurred at Ballona, they disappeared due to habitat restriction and/or removal by man. The horned lizard needs relatively level, short grassland or open brushland for foraging and reproduction (Stebbins 1966). Such habitat is found only on a small strip of dune on Unit 1. The brushland on Unit 3 was not present historically. Horned lizards are particularly sensitive to human disturbance, since their defensive behavior of remaining immobile in order to escape detection makes them very susceptible to being crushed by offroad vehicles as well as collected by humans (Stebbins 1966). This species still occurs on similar, more extensive habitat on the El Segundo dunes south of Ballona (Richard Friesen, pers. comm.). The racer requires grassland or brushland habitats (Stebbins 1966), both of which are limited at Ballona. Since large contiguous areas of such habitat are required to sustain racer populations (Fitch 1963), suitable sites at Ballona are probably too small, given the species occurred there historically. Rattlesnakes are long-lived and show rapid decline when impacted by human predation (Parker and Brown 1974; Galligan and Dunson 1978). If historically present, the Pacific rattlesnake may never have been abundant at Ballona. Since it prefers rocky sites and such sites are absent from Ballona, human influence may have eliminated any marginal rattlesnake population.

Other reptile and amphibian faunal changes at Ballona can be attributed to migration and changes in population size. Most such changes probably result from habitat modification. These appear to have been variable in their effects, at times increasing and/or decreasing population sizes of existing species. Several reptiles appear to have benefited from an increase in habitat space.

Unit 3 is dredge spoil on an area historically occupied by marsh and agricultural fields. Most reptiles and amphibians occurring there presumably migrated from adjacent populations. It is significant, however, that the two sand-dwelling species (*A. pulchra* and *U. stansburiana*) are absent despite the presence of a sandy pocket in the eastern corner of this Unit. The habitat appears both suitable and extensive enough to support both species. Since all other species found on the dredge spoil occur elsewhere in the study area, the absence of these two species suggests this is a recent habitat that neither was able to colonize since suitable access corridors do not exist.

New habitat created by access roads to gas wells, most prominent on Unit 1 but also present on Units 2 and 3, appears to have a positive impact on reptile populations. Without these access roads, which occupy a significant land area above the high tidal mark, many reptiles (*G. multicarinatus*, *L. getulus*, *P. melanoleucus* and *S. occidentalis*) would be absent from marsh areas. Reptiles require subterranean refuges and egg deposition sites above the region washed by tides. The access roads also provide important habitat for mammals that are fed upon by snakes and alligator lizards. The presence of mammals is a vital link to reptile survival for yet another reason. No Ballona reptile can burrow in dry, compacted soil. In the absence of physically-created holes, which are few and mostly unsuited to reptile use, reptiles must take refuge and lay eggs in burrows made by mammals. Access roads may also provide movement corridors for amphibians restricted by saline habitats.

New habitats have been created by extensive debris found throughout the study site, but primarily in Units 1 and 3. Utilization of different sorts of debris varied among reptiles. Light trash (paper, etc.) has a short longevity and poor heating capabilities; such objects were infrequently used. In contrast, wood, metal, and cement debris are long-lasting. Many such objects have rapid-heating capabilities and reptiles often used them to raise their body temperatures. Both lizards and snakes used such debris for thermoregulation and refuges. However, only larger debris was used consistently for the latter purpose. It is difficult to separate the positive impacts reptile populations have experienced from the combined effect of access road construction and the addition of larger debris. We believe, however, that the former is more important, though the latter is probably responsible for the high densities of Sceloporus occidentalis observed in many areas. This may secondarily influence the densities of the primarily saurophagous kingsnake (Lampropeltis getulus).

Certain changes linked to habitat alteration have probably decreased populations sizes. Freshwater habitat in the Ballona region has decreased. Changes which probably eliminated turtles (Clemmys marmorata) and garter snakes (Thamnophis sirtalis) may have simultaneously reduced populations of the two extant, aquatic-breeding amphibians (H. regilla and B. boreas).

Of the six freshwater sites found in the study site, the small drainage in the eucalyptus grove on Unit 2 and the drainage south of Jefferson Boulevard on the Agricultural Lands, appear polluted and had no successful amphibian reproduction; and the channelized drainage in the north corner of Unit 3 is probably marginal habitat because of the proximity of salt water. Successful amphibian reproduction was not observed there.

Farming activities on the Agricultural Lands also may have a negative impact on reptile and amphibian populations. Agricultural Lands were plowed at least twice a year. This activity probably restricts most reptiles to the unplowed fringes of the fields and reduces available habitat.

Exotic vegetation appears to have a negative impact. Distribution of the herpetofauna categorized by vegetative associates suggests the native vegetation is preferred (Table 1). Laurel Sumac (Rhus laurina), Bush Lupine Lupinus chamissonis), Saltgrass (Distichlis sp.), California Sage (Artemisia californicum), and Bulrush (Scirpus olneyi), all natives, have the highest relative densities of reptiles and amphibians. Eucalyptus, an exotic, has the lowest value. We believe that the observed difference between native and introduced vegetation is due to the fact that exotics harbor a poor food base (primarily insects) and are therefore less attractive to reptile and amphibian consumers.

Certain exotics appear to have greatly reduced available habitat. Present distribution patterns of the two sand-dwelling species suggest that both once had continuous distributions from the dunes fringing the beach to the bluffs bordering the south boundary (Figure 4). Although some habitat has been eliminated by development (the gas company facility), a substantial portion is now covered by the exotic iceplant, Carpobrotus sp. Present-day populations of U. stansburiana and A. pulchra occur on portions of Units 1, 2, and the Agricultural Lands not covered by this exotic.

The Ballona region is used by several introduced and domestic animals which have potentially serious effects. Feral cats and rats decrease existing reptile populations directly by predation (Iverson 1978; Honegger 1981), or indirectly by removing food items normally taken by reptiles (George 1974). The access roads on Unit 1 are used daily by horseback riders from the corrals on the south corner of this unit. Despite signs warning them to avoid marsh areas, the riders frequently ignore the signs and cause visible damage to the vegetation and disturb marsh soils. Vegetation damage reduces available habitat for reptiles. Unit 3 is frequently used by local residents to run their dogs, which often harry and kill the rabbits occurring on this unit. Since juvenile rabbits are prey for gopher snakes, a negative impact similar to that suggested for feral cats may be incurred.

Finally, certain human activities have or are suspected of having negative impacts. Off-road vehicle (ORV) use has clear negative effects (Berry 1973; Busack and Bury 1974; Bury, Luckenbach and Busack 1977). ORV's cause vegetation destruction and produce soil compaction. Burrowing mammals are deterred by compacted soils, and, in turn, the available habitat for reptiles and amphibians is limited. ORV use can also eliminate individuals directly. Field observations of several crushed reptiles and amphibians suggest they were killed in this manner. Further, reptiles, especially snakes, are susceptible to collection by amateurs wishing to keep them as pets. Since snakes are frequently collected as adults, there are potential negative consequences for the reproductive population. Two encounters with snake collectors at Ballona suggest this activity may be an important influence on local populations. Lastly, groups of young boys were observed hunting rabbits on Unit 3 on two different occasions. We suspect the effect of such hunting is similar to that suggested for dogs, and the combined effect may have a negative impact on gopher snake populations.

In summary, only a portion of Ballona's original herpetofauna remains today. Extant amphibian populations are probably smaller than in the past, due to physical alteration and pollution of freshwater habitats required for reproduction. Reptile populations have been variously affected. Some have probably benefited from the increase in area above the tidal flux and the addition of debris. The sand-dwelling lizards have probably experienced declines due to habitat encroachment by exotic vegetation. Farming activities, introduced predatory mammal species and various human impacts (ORV use, horseback riding and hunting) have or are suspected of having negative impacts on reptile and amphibian populations.

Ecological characteristics of the existing herpetofauna

That reptiles and amphibians are an integral part of the Ballona ecosystem is shown by trophic and other relationships. All reptiles and amphibians are higher-order consumers. Amphibians and lizards are primarily insectivorous, whereas the two snake species prey on mammals, reptiles, and birds. In turn, larval and adult amphibians are food for wading birds; lizards are eaten by snakes, shrikes, and raptors; snakes provide food for hawks, owls, and other snakes. As previously noted, amphibians and reptiles are dependent on burrowing mammals for their subterranean refuges.

A summary of the yearly cycles of the nine sampled species based on our data and literature records is shown in Figure 21. The three amphibians deposit eggs, when water is abundant in late winter and early spring. Most juvenile frogs and toads metamorphose well before late summer and fall, when freshwater is scarce. In contrast, most reptiles begin to breed after the end of the wet season into mid-summer, when productivity of this ecosystem is highest. Critical breeding periods for amphibians are January to March and April through June for reptiles. March to July is the critical period for aquatic larvae of amphibians.

The patterns of reproductive cycling are also important determinants of a species' ecological sensitivity. Of the nine species, two are annual (Hyla and Uta), one is biennial (Sceloporus) and the rest are perennial. Perennial species take two or more years to mature and are long-lived. Such species are sensitive to impacts that eliminate the breeding population since these are slow to be replaced. It is noteworthy that populations of species extinct in the Ballona ecosystem were all long-lived perennials. In contrast, annual species mature, reproduce, and die all in the span of one year. Thus, they are particularly sensitive to disturbances that eliminate a year's reproduction, since there are no additional possibilities for reproduction the following year. At Ballona, this may be particularly crucial since annual populations exist as isolates and cannot depent on recruitment from adjacent populations in the event of a reproductive setback.

Table 1 shows the relative density of species by Unit. Uta stansburiana is most abundant on Units 1(D) and 2, which contain prime sandy habitat. Hyla regilla is most abundant on the Agricultural Lands, where the largest concentrations of freshwater exist. Sceloporus occidentalis and Gerrhonotus multicarinatus are found in all areas, but the former has the highest densities on Units L(1A) and 3, while the latter appears most abundant on Unit 1 (1A and D). The two snakes species occur on Units 1, 3, and the Agricultural Lands, with Lampropeltis getulus most abundant on Unit 1 and the Agricultural Lands, and the gopher snakes (Pituophis melanoleucus) most abundant on Units 1 and 3. These data are unequivocal: Unit 1 is the most diverse with the highest relative densities of three of the nine species recorded.

Uniqueness of the Ballona ecosystem

The Ballona region is the only significant piece of saltmarsh remaining in Los Angeles county, and it contains a valuable salt marsh ecosystem. California salt marsh ecosystems have sustained reductions in area varying from 60% to over 90% since 1880 (MacDonald 1977). Estimates in 1975 indicate that just slightly over 36,000 hectares of this ecosystem remain in California (MacDonald 1977), making it the rarest of any major vegetational association.

Unit 1 contains a viable dune habitat. Only 23% of California's 1326 km long coast is occupied by beach and dune (Cooper 1967). Multi-recreational use of a number of California's largest dune systems have made the remaining less disturbed dunes one of the rarest habitats in California (Powell 1978). Dune and alluvial fan sand habitats harbor the unique limbless lizard, Anniella pulchra, a protected species under the California Fish and Game Code. Elimination and modification of many dune systems and sandy wash environments have reduced the range of this species, whose ecology is still poorly known. Since two reptile species at Ballona are restricted due to habitats and since the dune habitats are separated by other habitats, the dunes appear to be the most sensitive habitat for the herpetofauna. Disturbance to any dune habitat may result in elimination of a reptile species which will be unable to reestablish via migration.

Although we have no absolute density figures, the field experience of one of us (Hayes) suggests that in Ballona the snake and alligator lizard densities are unusually high. We believe this system presents a unique opportunity to study these three species under unusual conditions. Densities are sufficiently high that ecological data, obtainable only with difficulty at more typical densities would be easily available at Ballona.

The fact that this is a disturbed system would enhance the value of such a study, as our knowledge of the ecology of reptiles in disturbed systems is exceedingly limited.

Management recommendations

The Ballona region is a unique, viable, albeit highly-modified ecosystem. To regard this system as non-viable ignores the reality that populations continue to maintain themselves within this system despite a history of varied impacts. Because of the small size of the area and the urban position of the ecosystem, several impacts are liable to eliminate populations of remaining species if their effects are not reduced or removed. For Ballona to maintain its present reptile and amphibian species composition over a long period of time (over the next 50 to 100 years), we feel the following suggestions should be implemented:

1) Preserve the largest possible area

Both existing snake species require large contiguous areas in which to maintain viable populations. Historical records suggest that snake species no longer occurring at Ballona required large areas of undisturbed habitat. The remaining two species can survive in a disturbed habitat, but the area size remains crucial. We predict that any parcelling of the area into smaller units would eliminate the snake species before other species. Instead of preserving small areas of different habitats, we suggest maintenance of the largest possible contiguous area as the only alternative that will maximize the number of species retained at Ballona. We further suggest that elevation of through-traffic roads (i.e. Culver Blvd.) or the addition of wide culverts that would allow water and animal movement, is a necessary part of the above suggestion. It would aid area contiguity by allowing free movement of animals between Units 1 and 2, and would reduce vehicle-caused mortality. This is especially important for snakes to which this source of mortality may be significant.

2) <u>Increase pickleweed</u>

Our data suggest that pickleweed is a primary foraging habitat for alligator lizards, and is of secondary importance for others. Enhancement of the quality or increasing the extent of pickleweed and its associated insect fauna would benefit these species. Maintenance of adequate tidal flow through open channels is vital to restore pickleweed to a healthy state. The level of flooding should be limited so as not to reduce other drier, higher habitats required by reptiles as egg-laying and refuge sites. Thus, we suggest that the access road system to the gas wells in the central marsh be retained as habitat for these species.

3) <u>Limit access</u>

Vehicles, domestic animals, and human activity all share responsibility for significant mortality in reptiles and amphibians. ORV traffic probably has the greatest impact, as it results in habitat alteration over longer periods of time than the other factors. The utilization of the area by domestic animals would conflict with efforts to maintain the marsh system in a natural state. Vehicle access should be eliminated and use by domestic animals should be excluded. Human activities (hunting and collecting) in conflict with maintenance of the marsh system should be disallowed. Because of the urban position of this marsh system, adequate fencing is a prerequisite to limiting the impacts noted above. Human foot traffic should be the only access allowed and this should be limited to sites that will least impact the system.

4) <u>Dune preservation</u>

Coastal dunes, as previously discussed, are becoming increasingly rare, Unit 1 has a significant dune remanent inhabited by the unique limbless lizard, <u>Anniella pulchra</u>. Maintenance and protection of all areas where this species occurs at Ballona is recommended. The introduced iceplant encroaching on dune habitat should be limited. Removal would be preferable if it could be done in such a way as to avoid disturbance of existing populations. Growth of native dune vegetation, such as Bush Lupine (Lupinus chamissonis), should be encouraged.

5) Preserve freshwater habitats

Amphibian eggs must be laid in freshwater, and two of the Ballona amphibians lay aquatic eggs. Freshwater habitats are limited to six small sites, three of which are not suitable for successful amphibian breeding. The continued existence of both species requires preservation of their breeding sites. The eucalyptus trees on Unit 2 should be removed. They are poor habitat (Table 1) and probably contribute to the pollution of the freshwater site associated with them.

6) Exclude dumping

Some of the Ballona region has been used for trash disposal. Although this has provided some habitat for reptiles and amphibians, it detracts from the overall aesthetic value of the area. We suggest that littering of any kind not be permitted and that existing refuse be removed. Increasing the number of native shrubs will compensate for any habitat losses resulting from trash removal (see next management suggestion).

7) Increase native shrubs

Shrubs and trees are limited at Ballona, and their scarcity limits foraging habitat, refuges and prey items available for reptiles and amphibians. Reptiles and amphibians are more abundant in association with native shrubs (Table 1). Habitat enhancement by adding more of the native shrubs, particularly Laurel-Sumac (Rhus laurina), California Sage (Artemisia californicum), and the Bush Lupine (Lupinus chamissonis) in sandy sites would benefit existing reptiles and amphibians.

8) Preservation of the central marsh

Our data show that Unit 1 is the most biologically valuable area (Table 2). We believe the best solution to retaining a manageable marsh system in view of the previous recommendations is to preserve a contiguous piece that includes: 1) all of Units 1 and 2; 2) the bluffs; and 3) sufficient buffer around those areas. We believe restoration of Unit 3 to viable marshland would require great expense without certainty of success. The Agricultural Land north of Centinela Creek drainage and west of Lincoln Boulevard has limited biological value. We emphasize, however, that access to the protected area must be limited.

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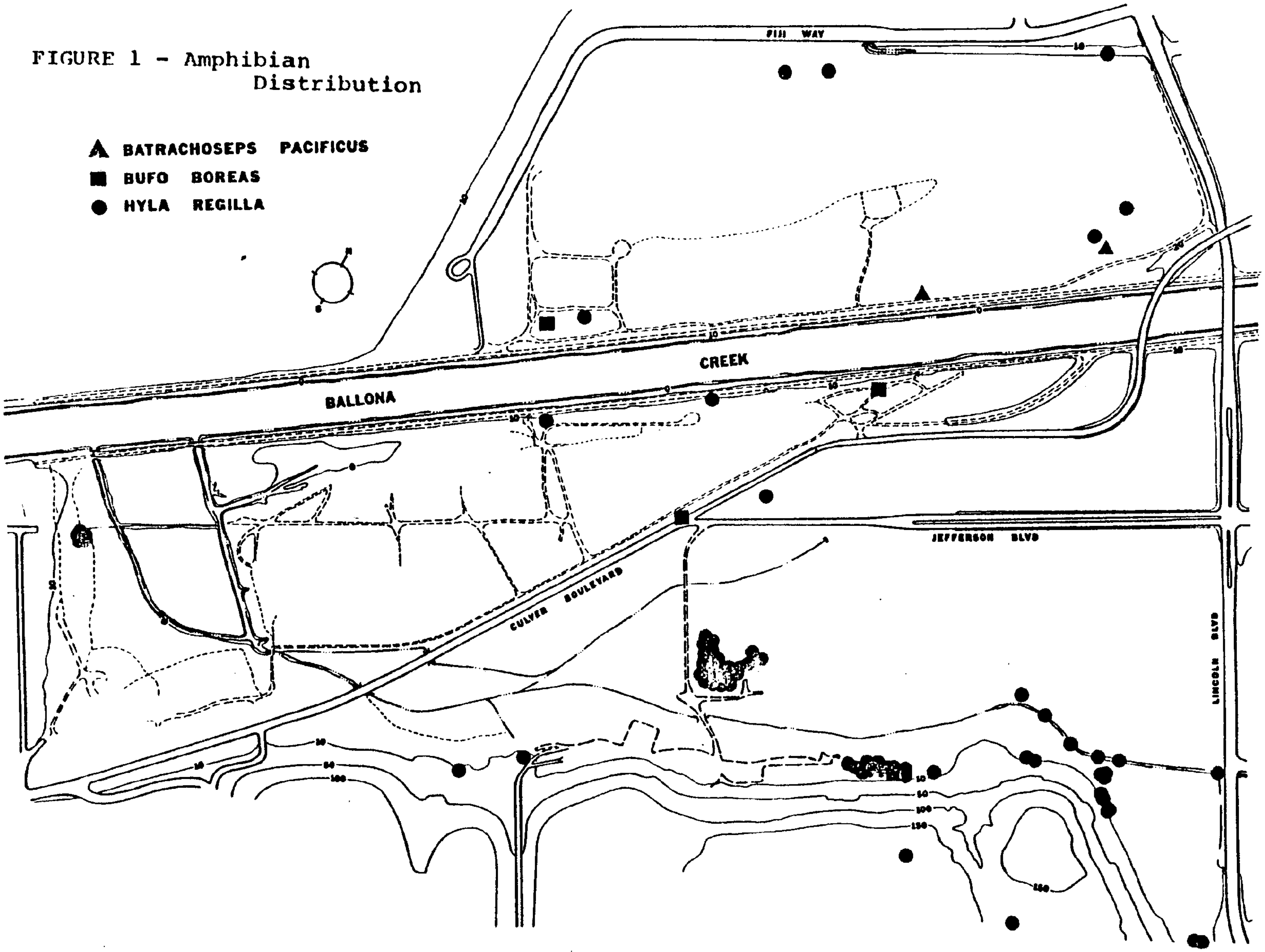
FIGURE 1 - Amphibian Distribution



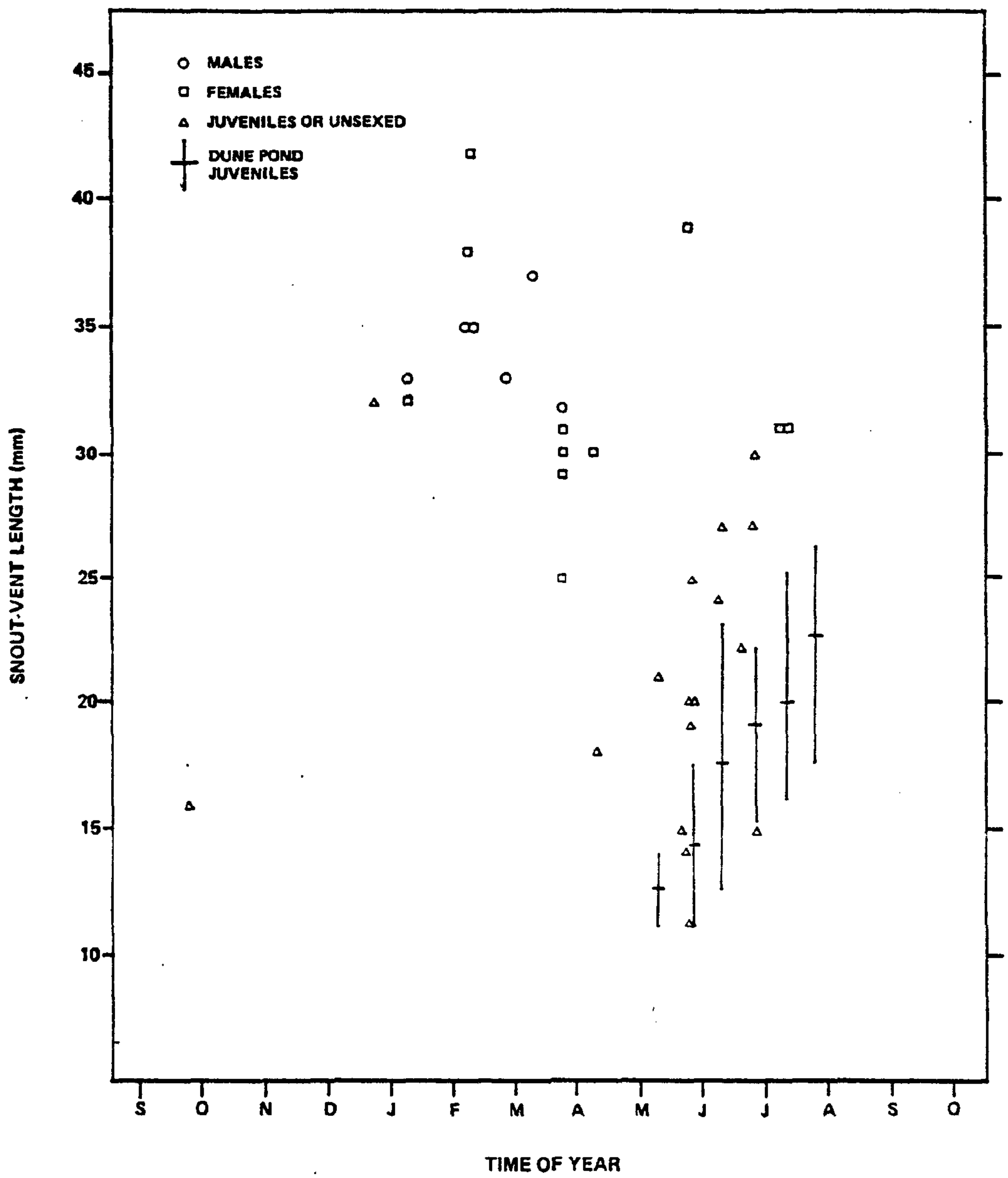


FIGURE 2 - Body lengths of *Hyla regilla* vs. time

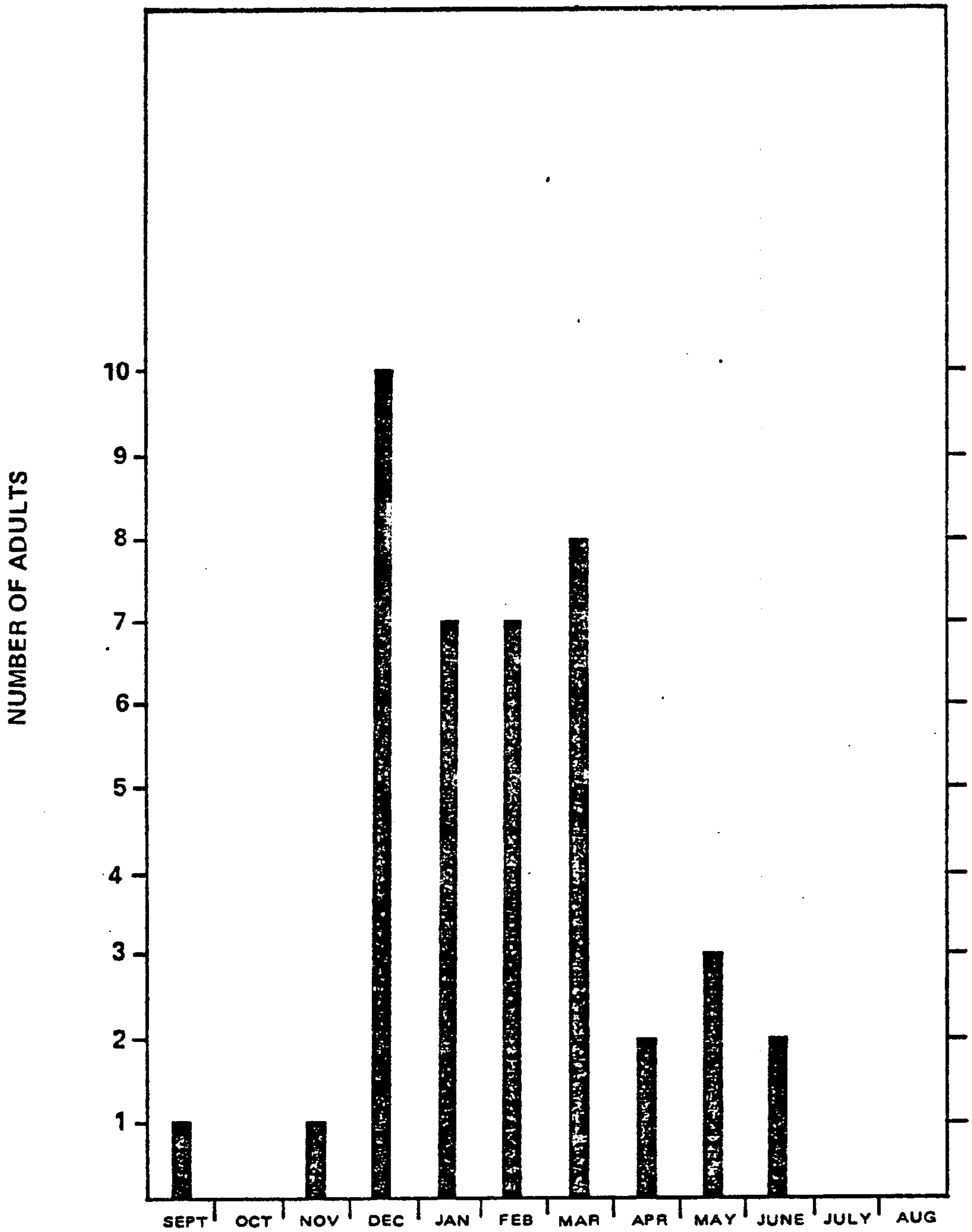
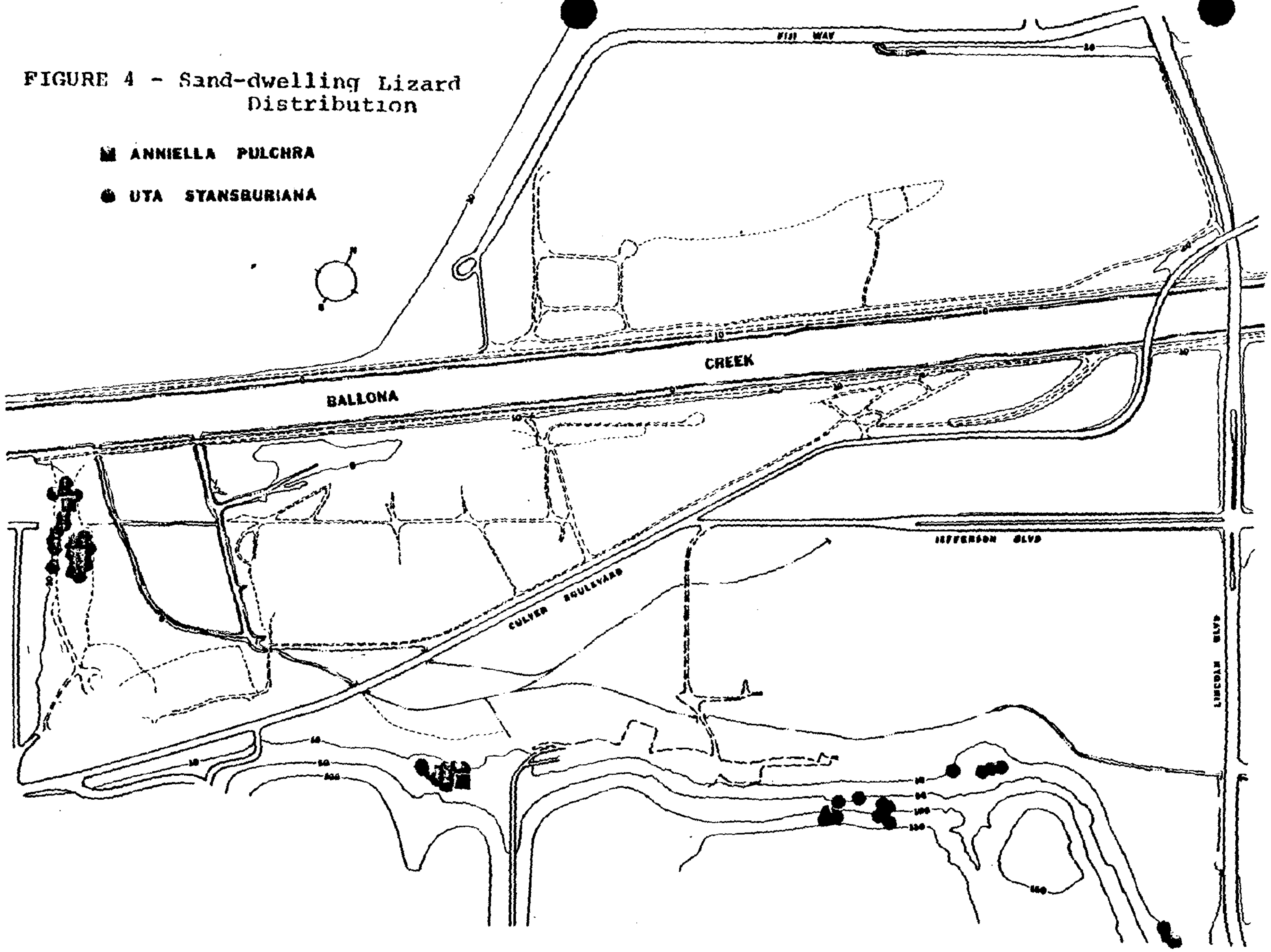


FIGURE 3 - Frequency distribution of adult treefrogs observed at Ballona by month

FIGURE 4 - Sand-dwelling Lizard Distribution



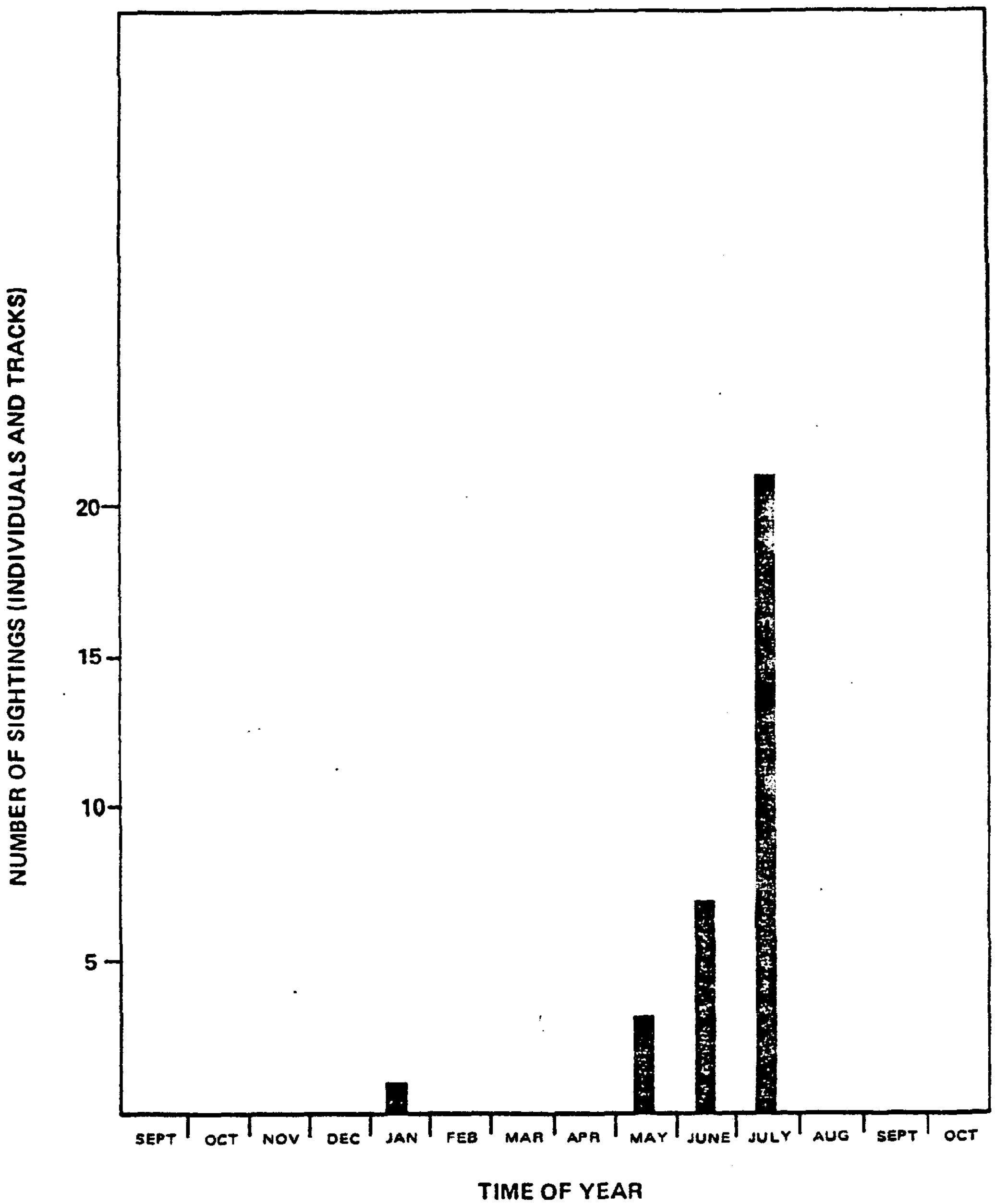
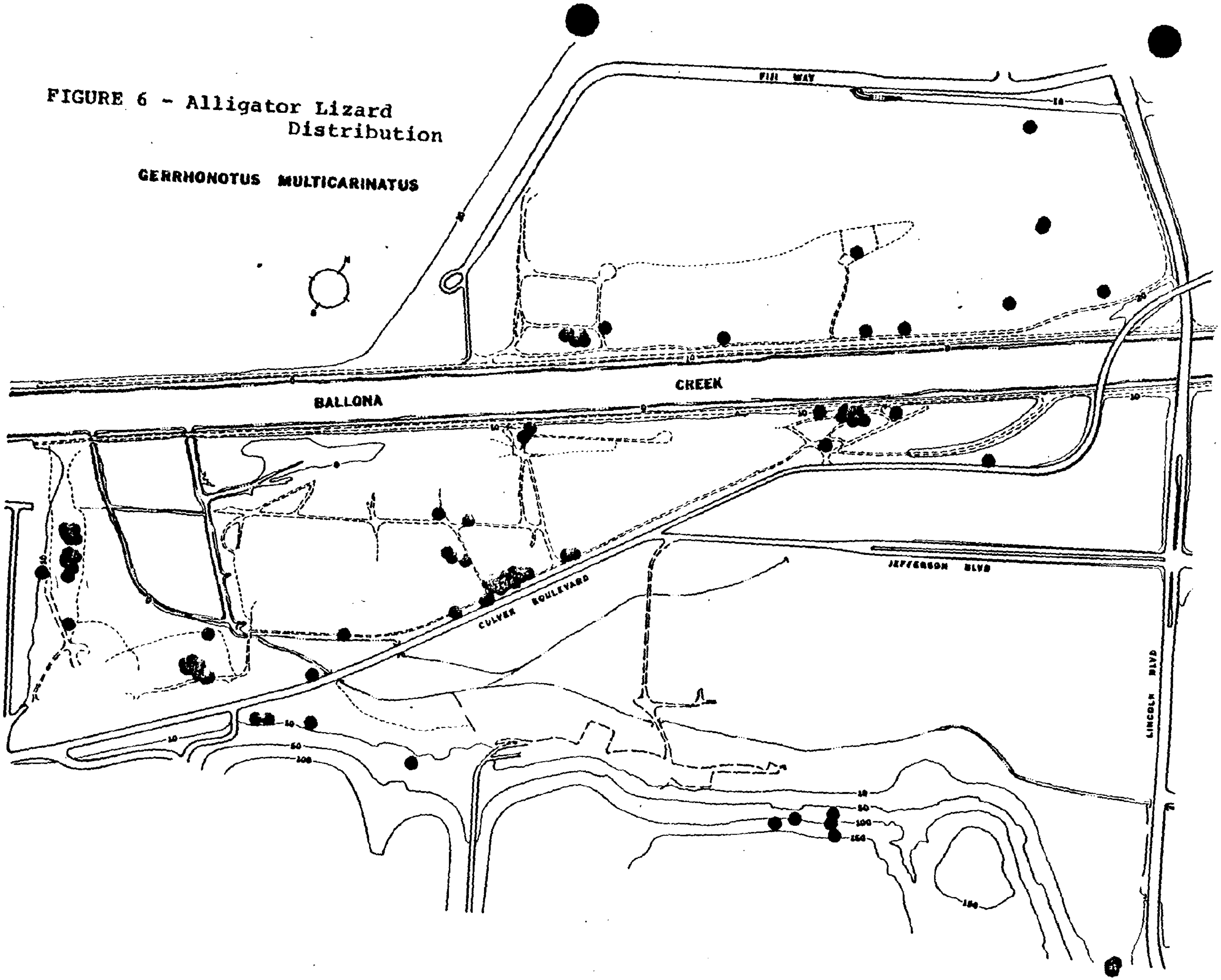


FIGURE 5 - Observed activity in Anniella pulchra

FIGURE 6 - Alligator Lizard Distribution

GERRHONOTUS MULTICARINATUS



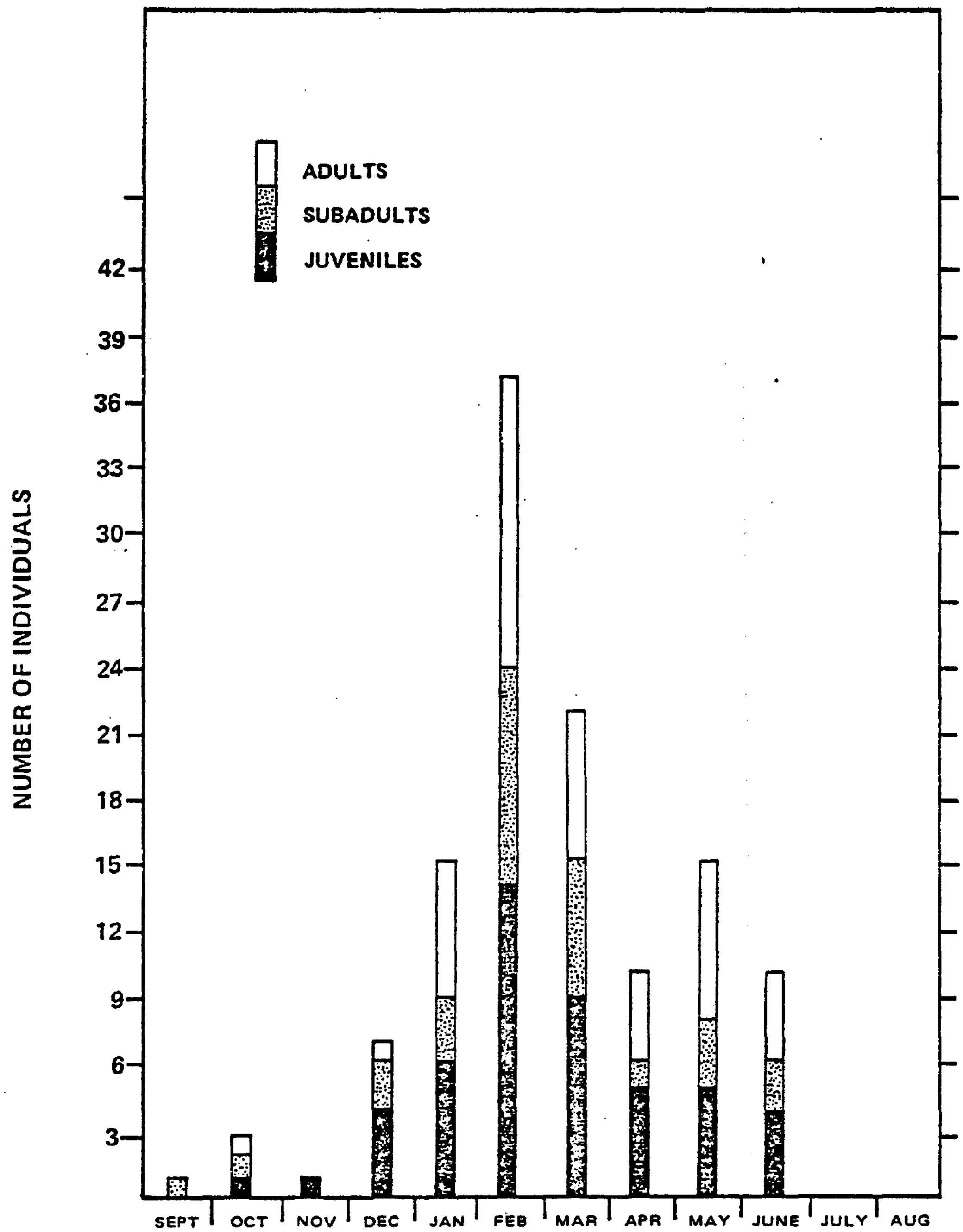


FIGURE 7 - Observed Activity in Gerrhonotus multicarinatus

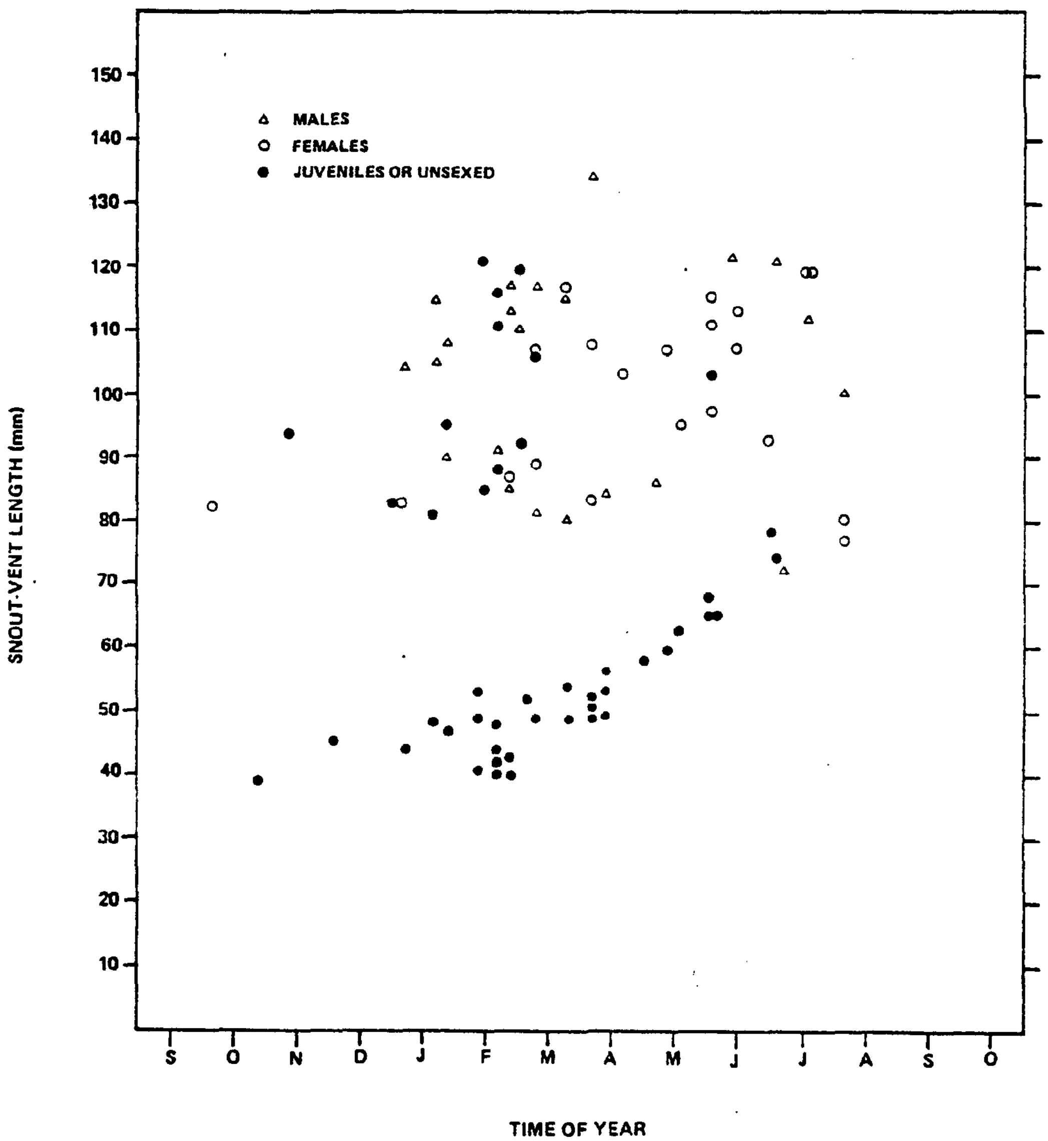
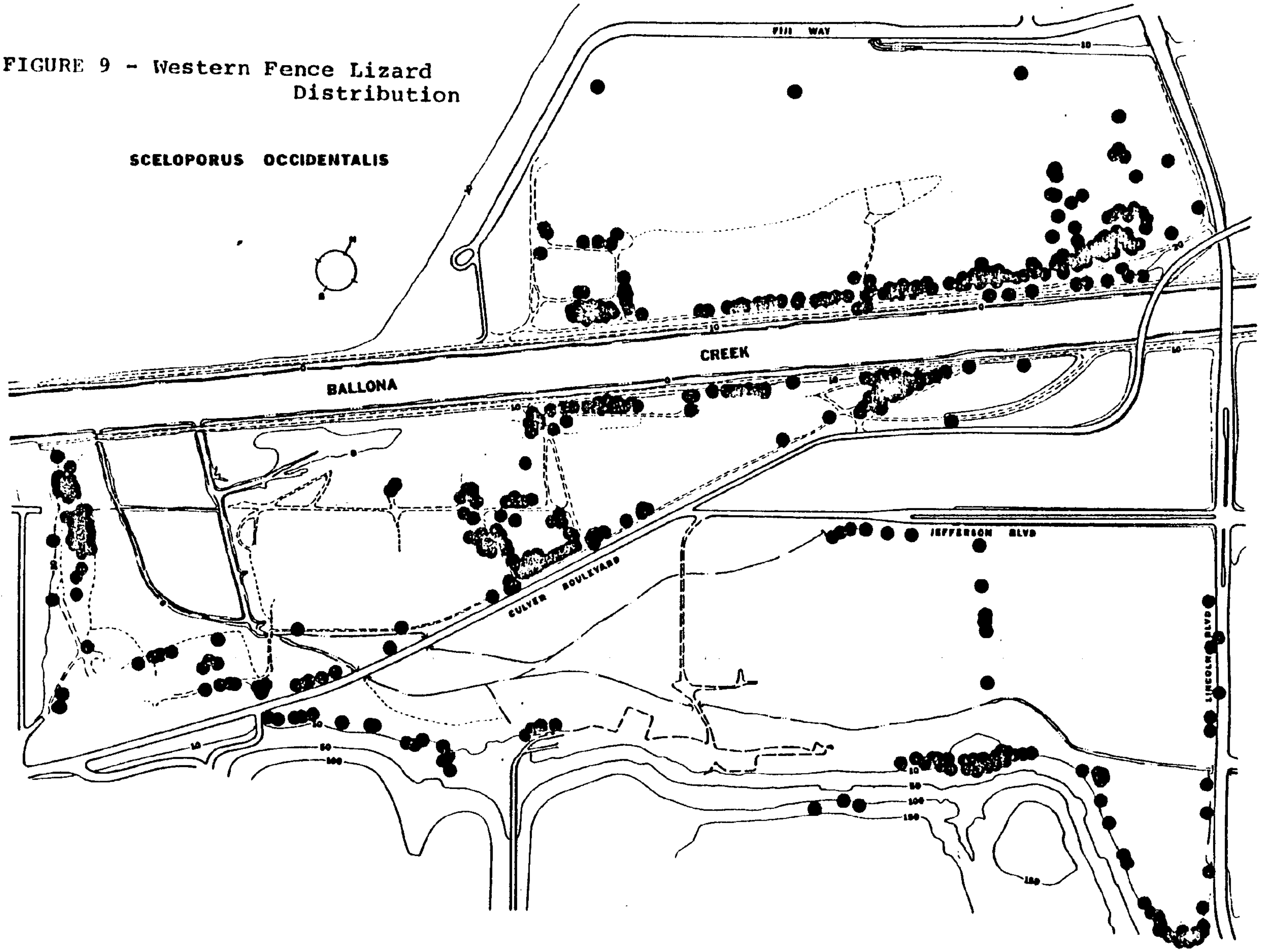


FIGURE 8 - Body lengths of Gerrhonotus multicarinatus vs. time showing growth

FIGURE 9 - Western Fence Lizard Distribution

SCELOPORUS OCCIDENTALIS



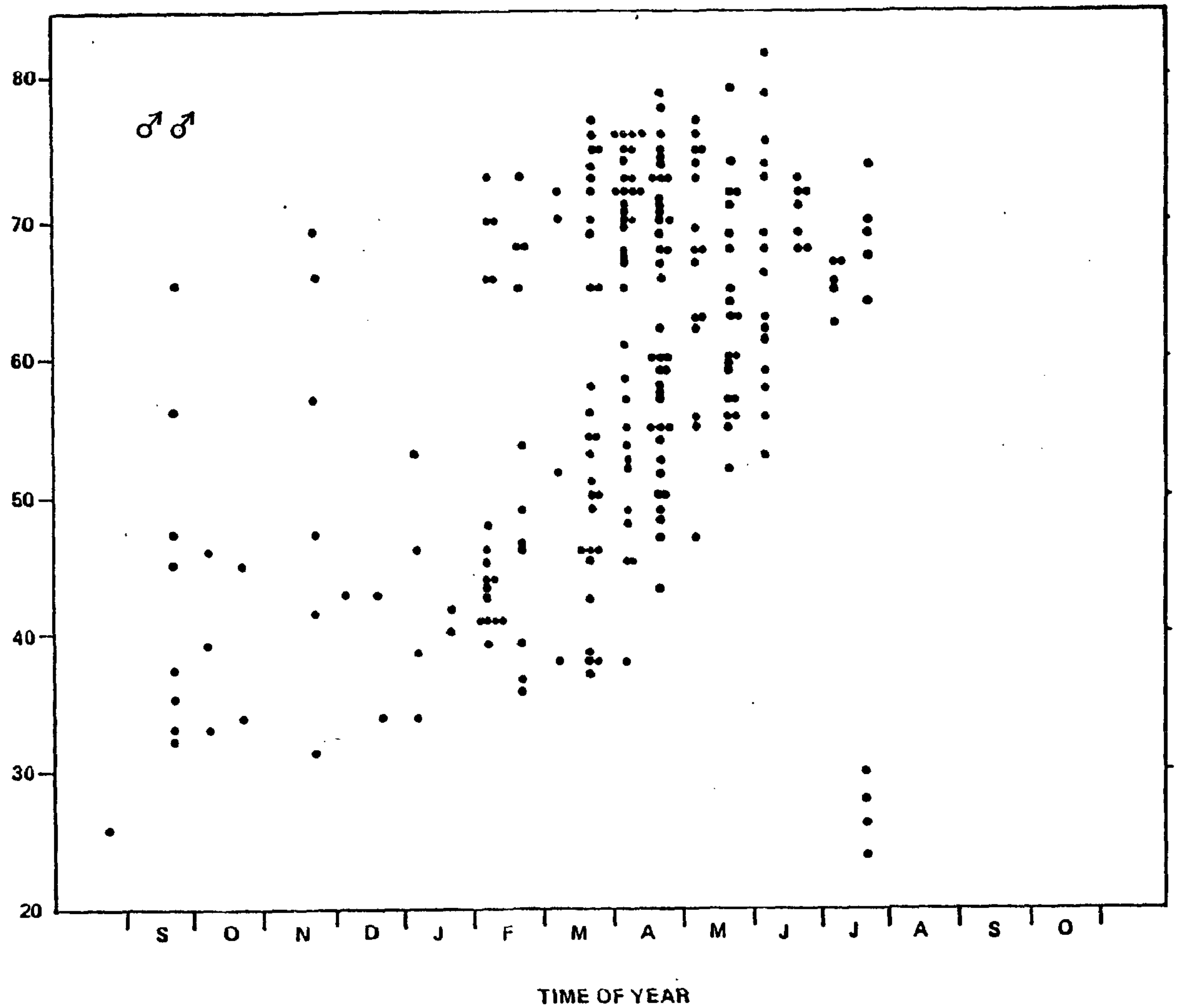


Figure 10 - Snout-vent lengths (mm) of male Sceloporus occidentalis vs. time showing seasonal growth

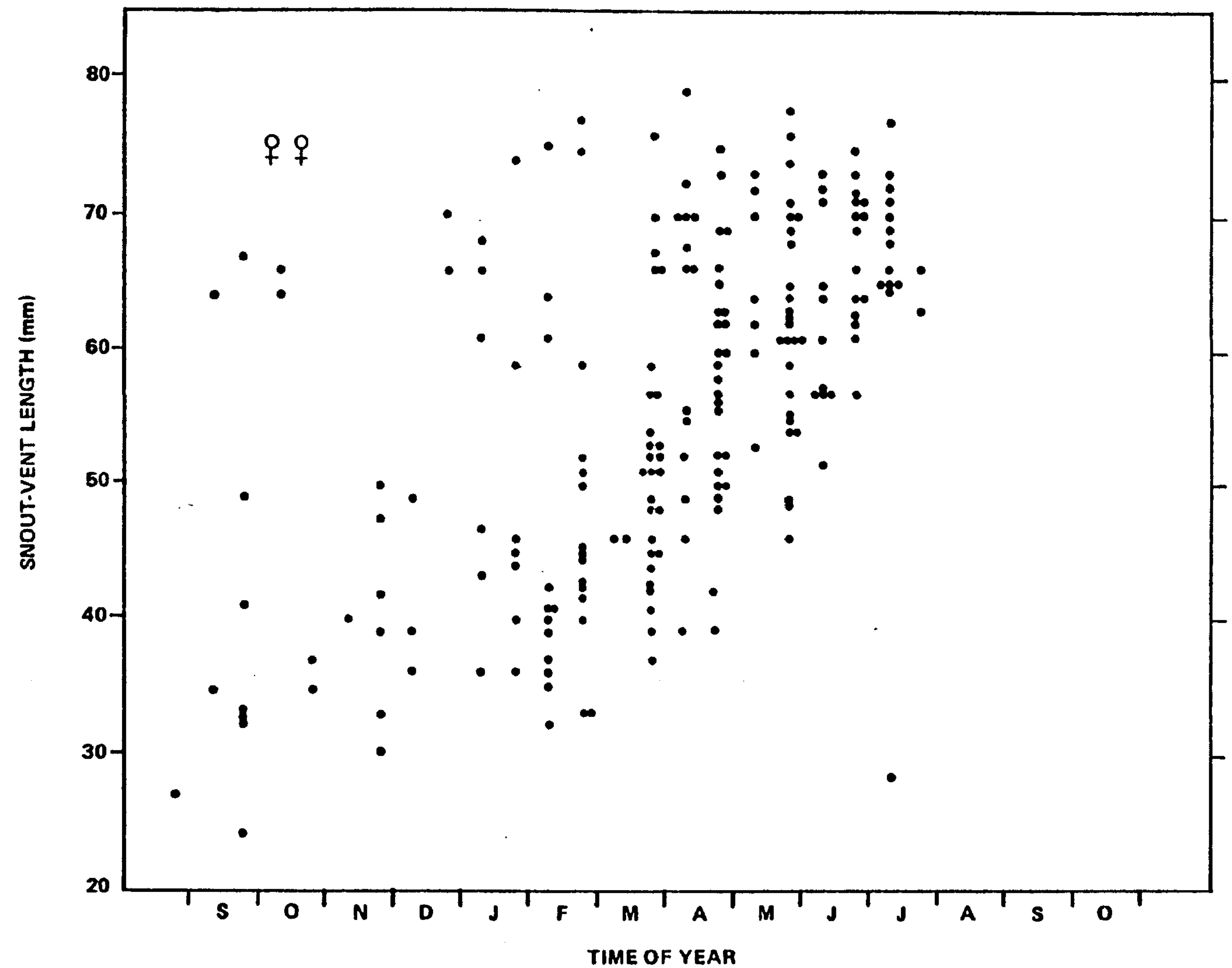


FIGURE 11 - Body lengths of female *Sceloporus occidentalis* vs. time showing seasonal growth

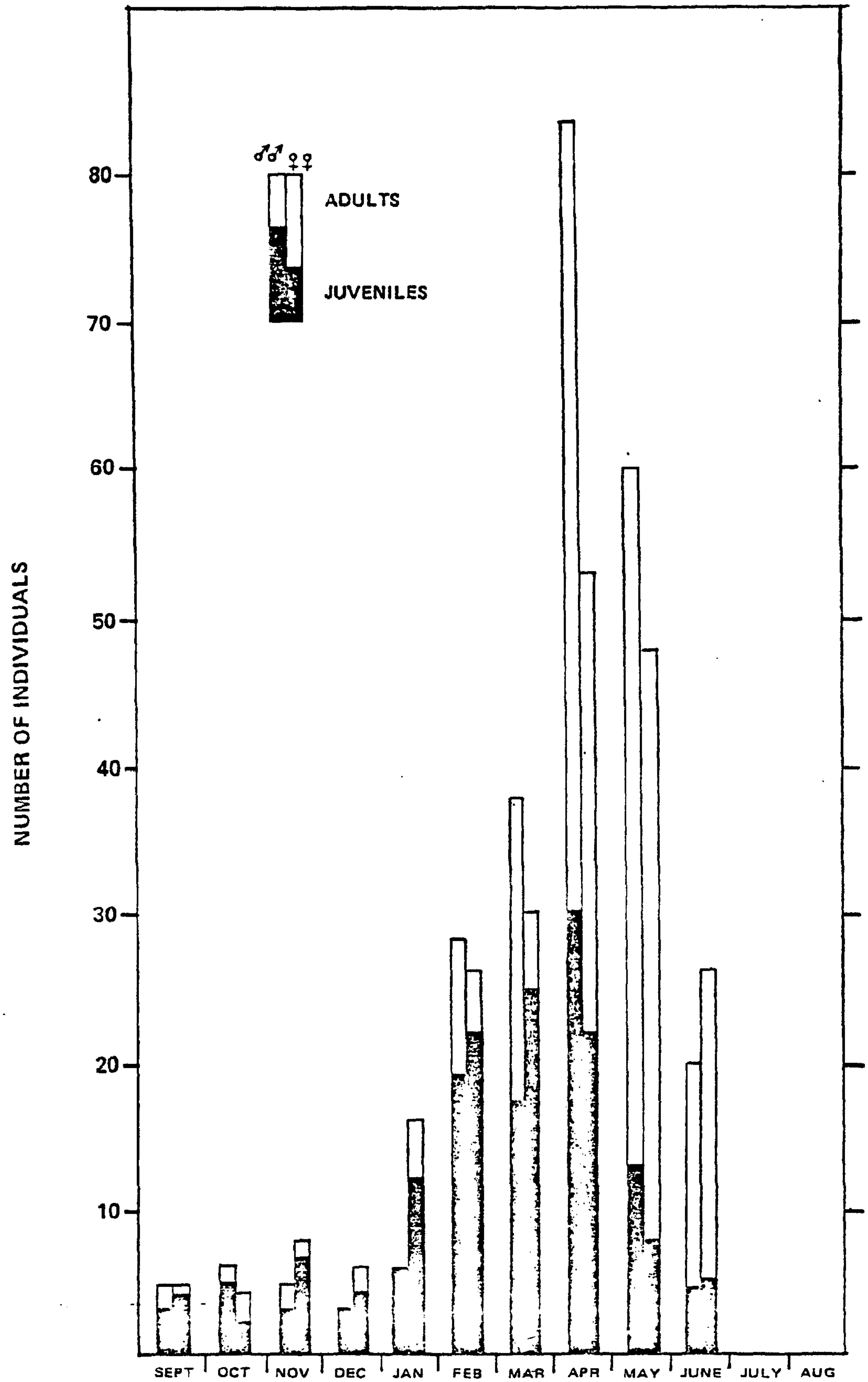


FIGURE 12 - Seasonal Activity in <u>Sceloporus</u> <u>occidentalis</u>

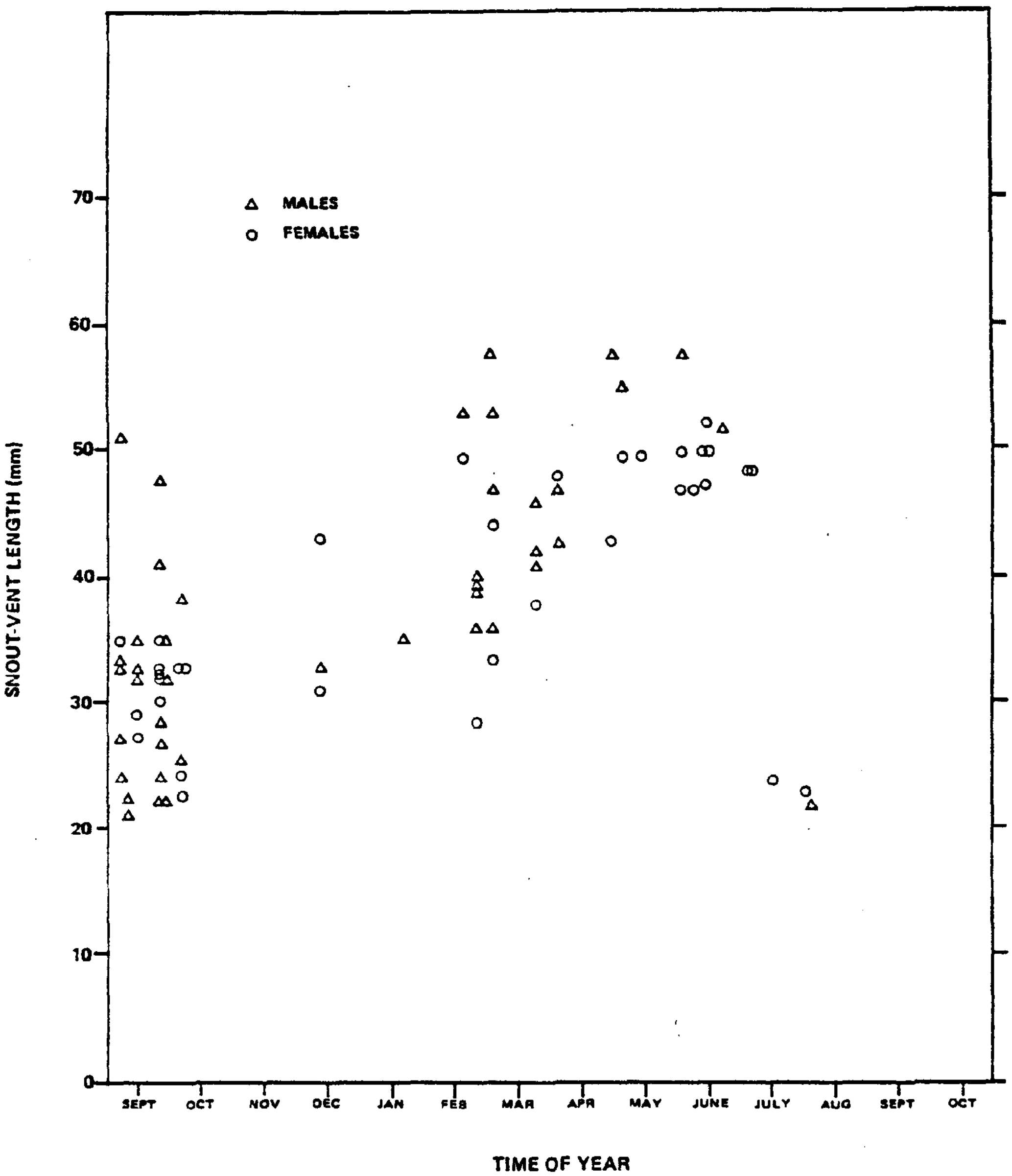


FIGURE 13 - Body lengths of *Uta stansburiana* vs. time showing growth

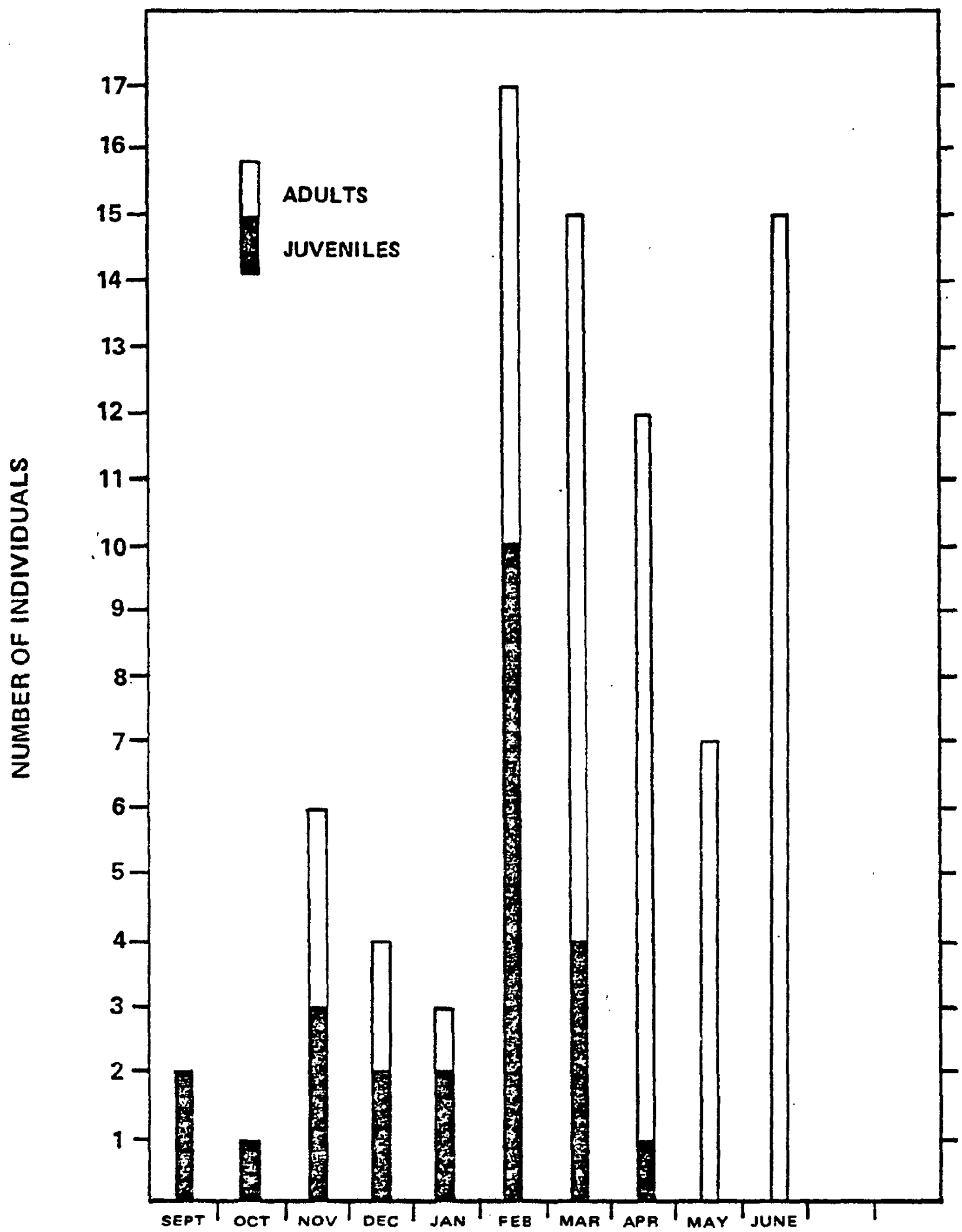
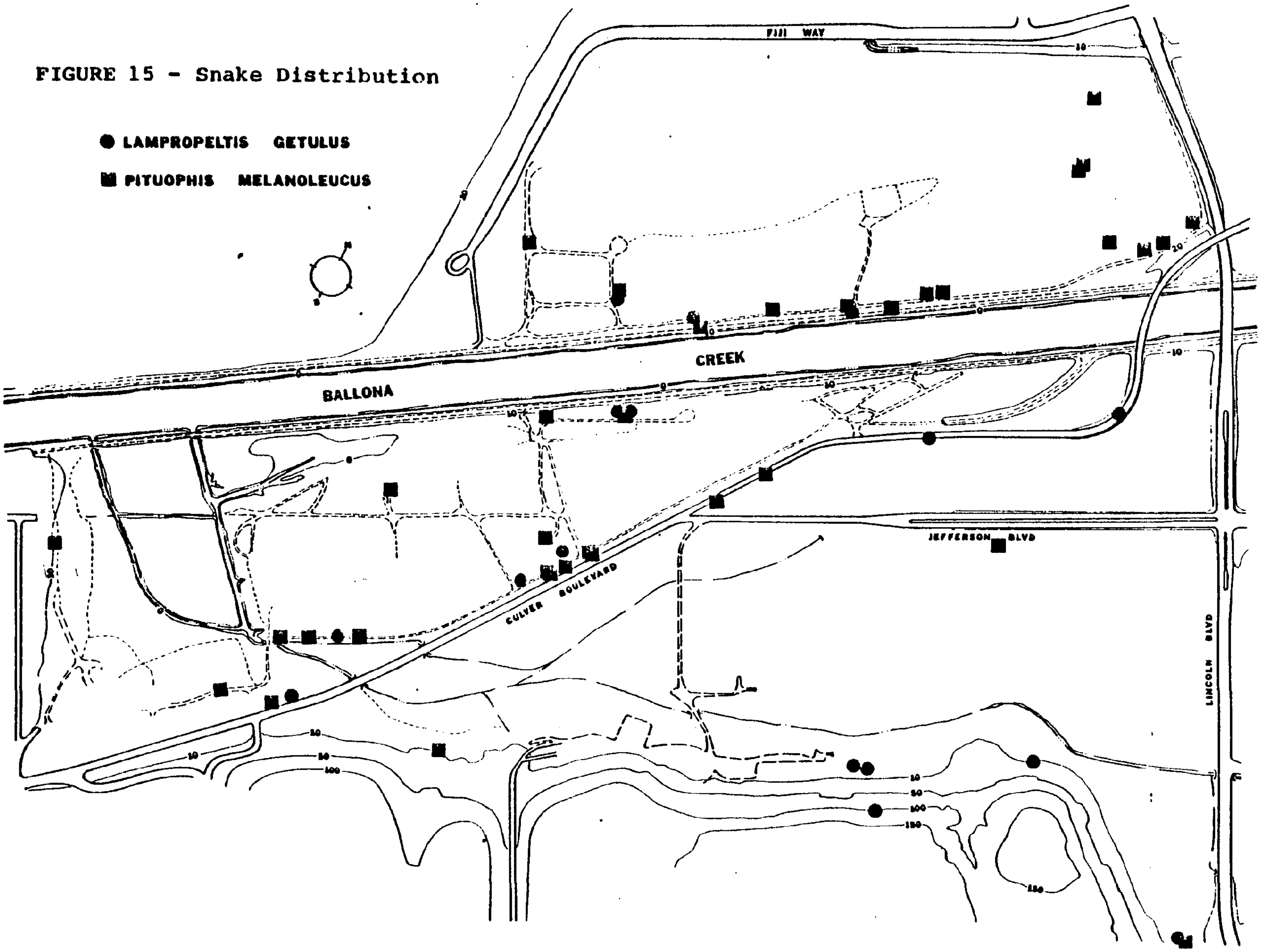


FIGURE 14 - Seasonal Activity in Uta stansburiana

FIGURE 15 - Snake Distribution

● LAMPROPELTIS GETULUS

■ PITUOPHIS MELANOLEUCUS



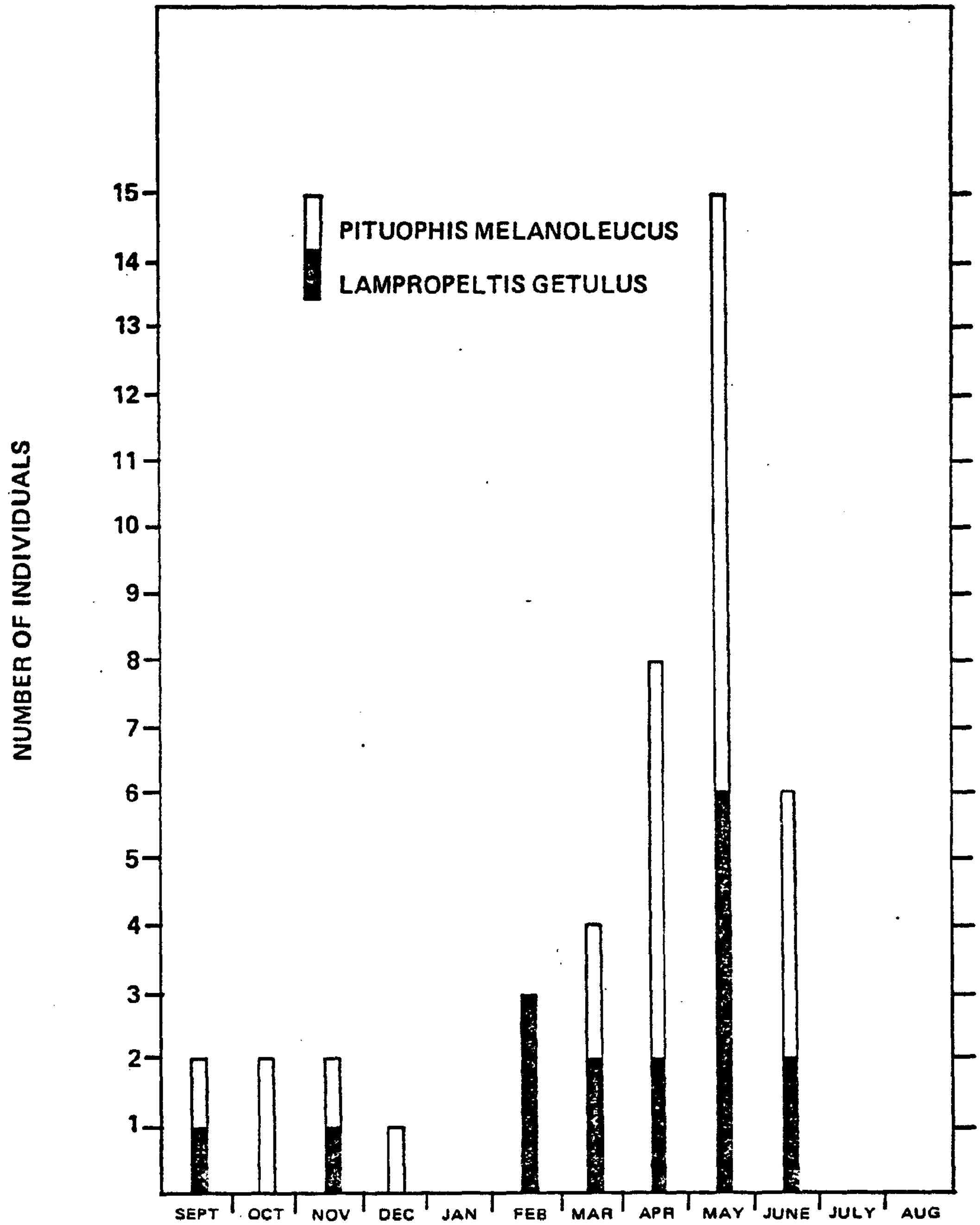


FIGURE 16 - Frequency distribution of the two snakes observed at Ballona by month

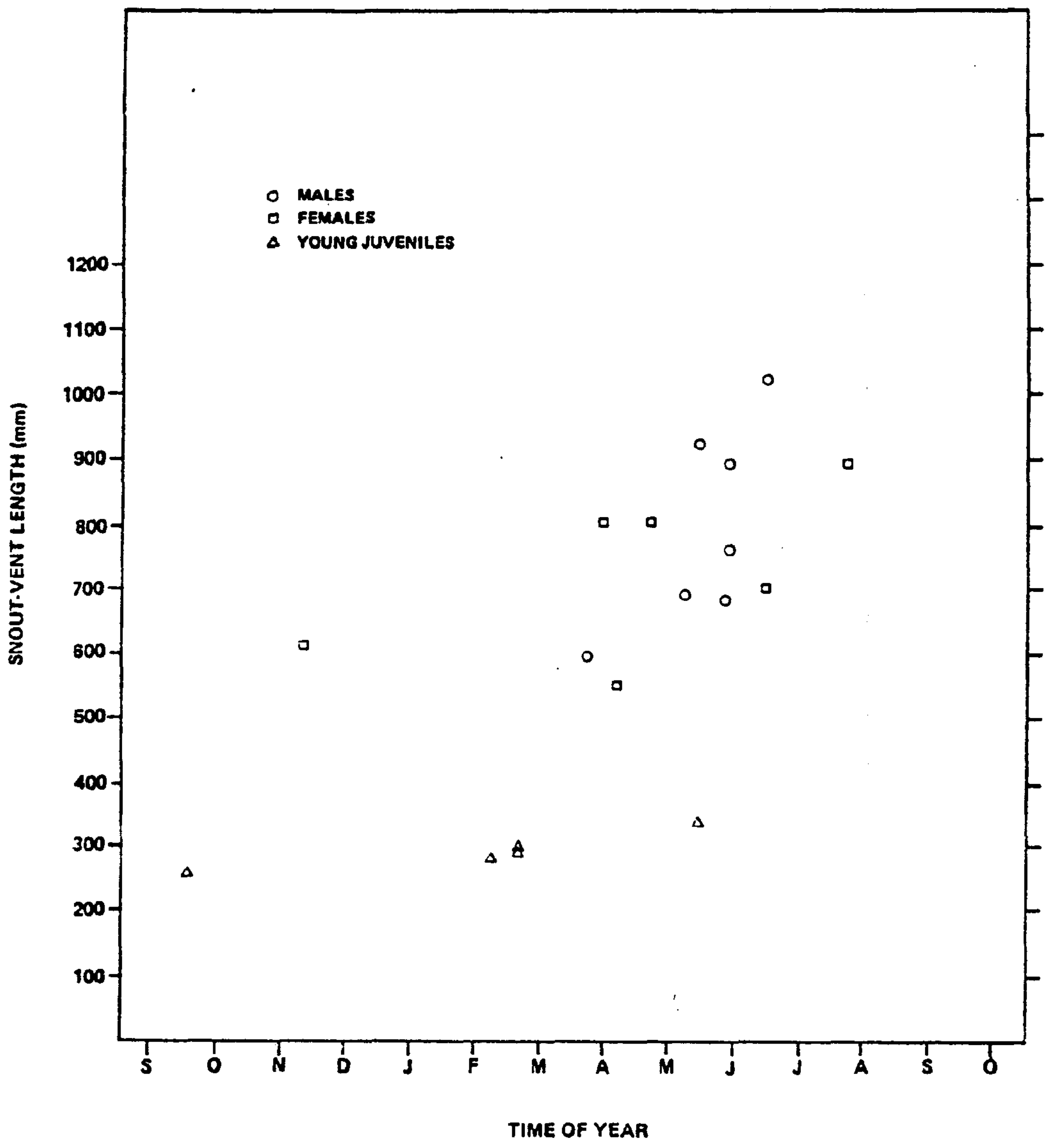


FIGURE 17 - Body lengths of <u>Lampropeltis getulus</u> vs. time

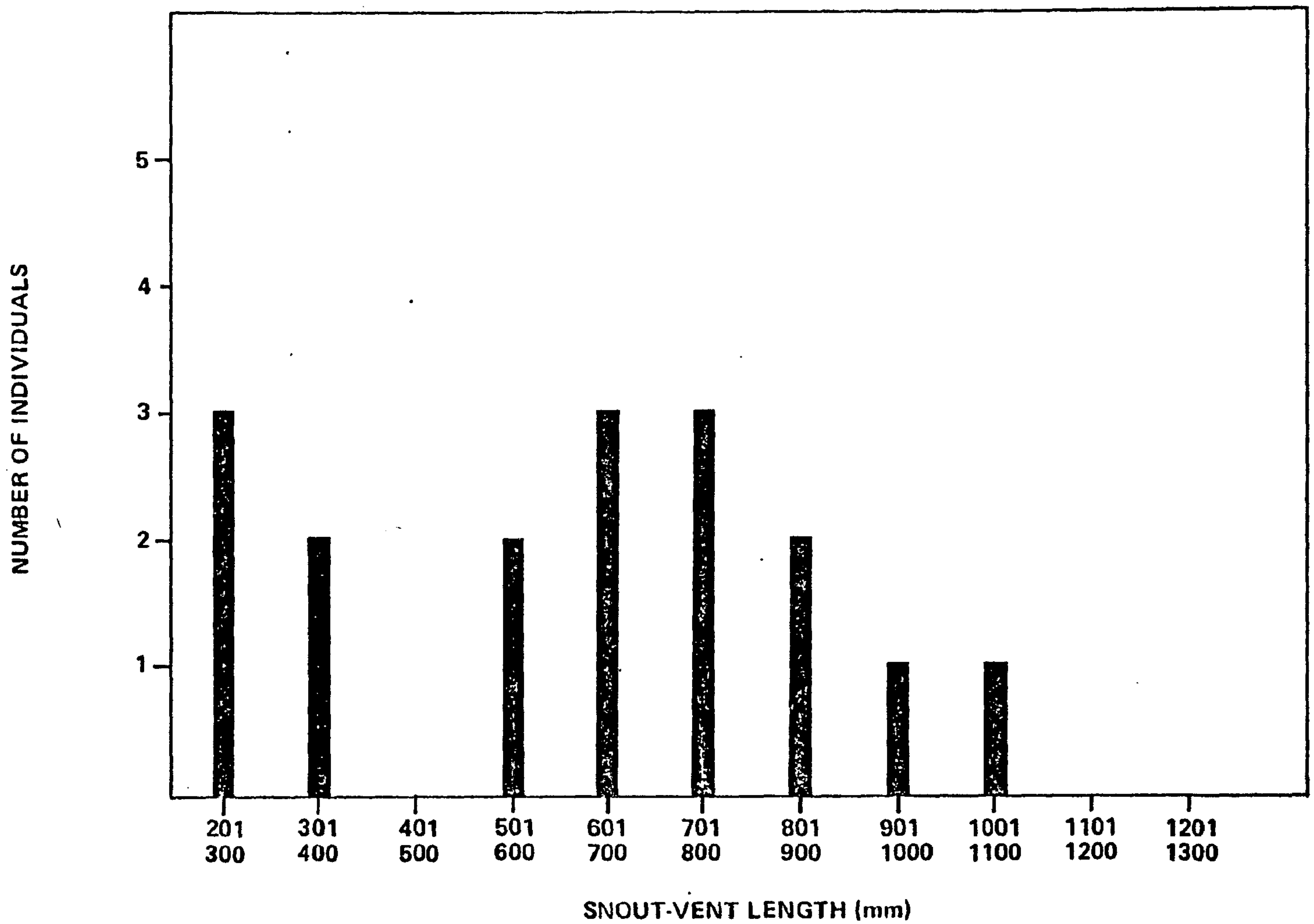


FIGURE 18 - Frequency distribution by 100 mm size intervals for *Lampropeltis getulus*

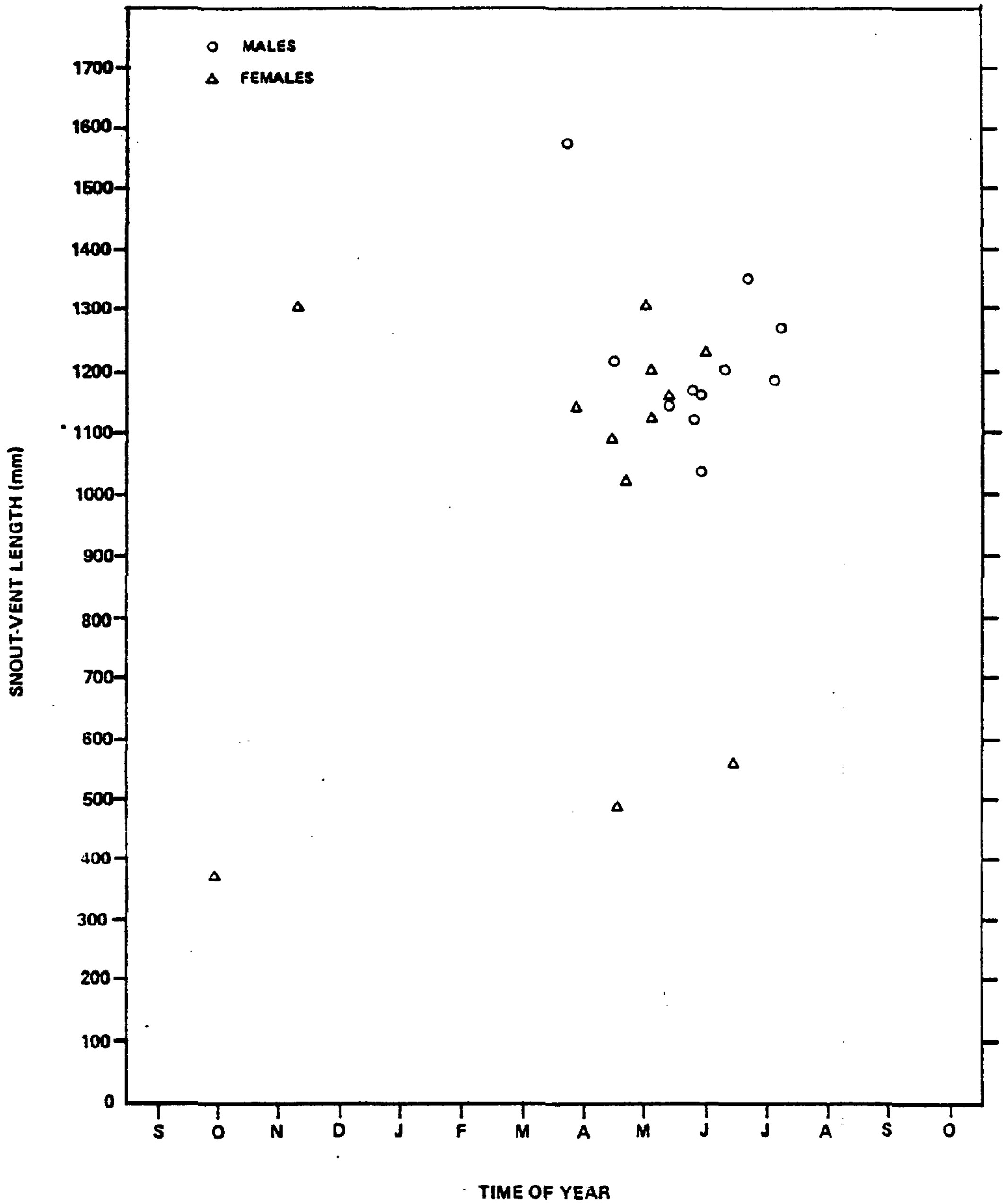


FIGURE 19 - Body lengths of Pituophis melanoleucus vs. time

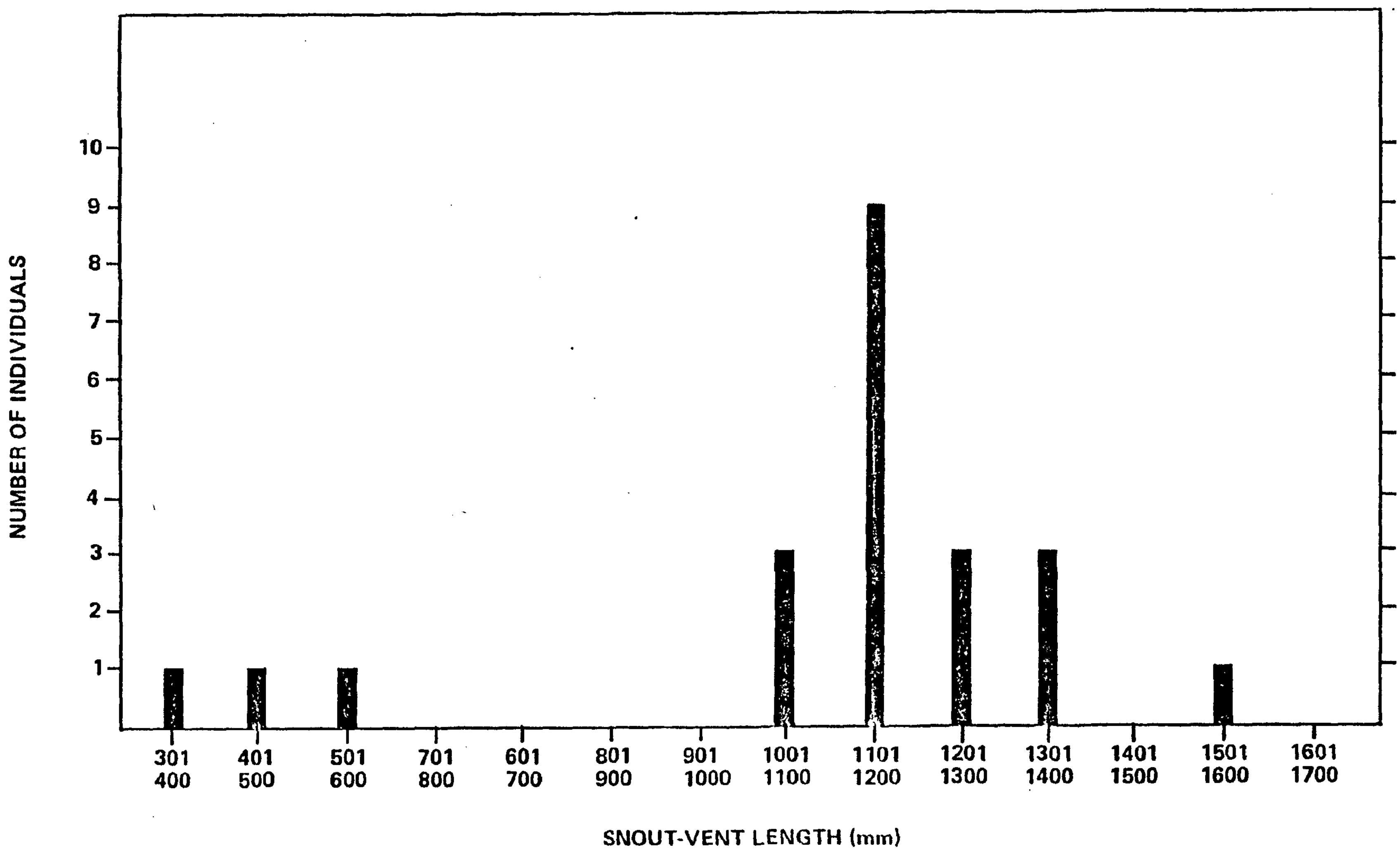


FIGURE 20 - Frequency distribution by 100 mm size intervals for _Pituophis melanoleucus_

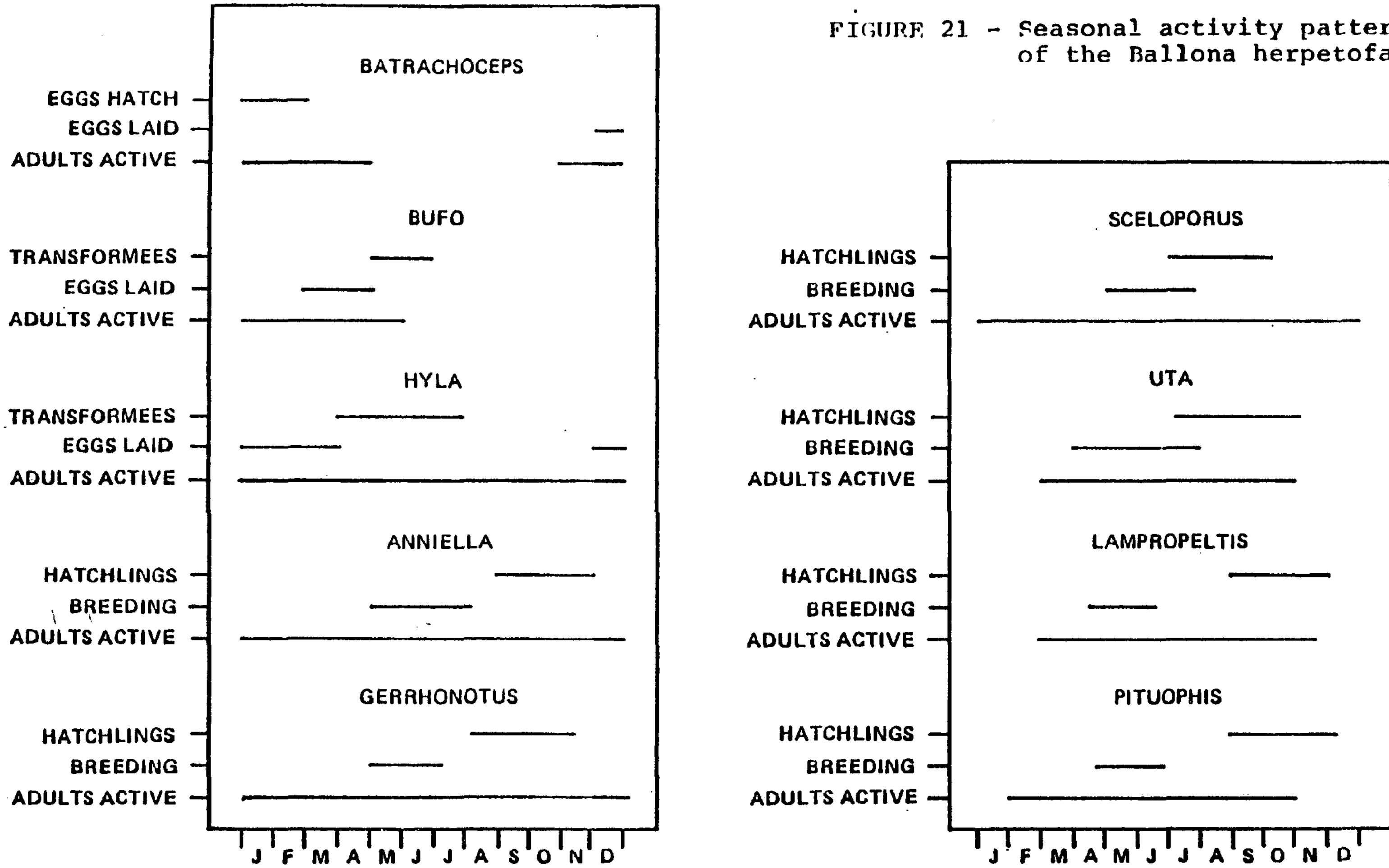


FIGURE 21 - Seasonal activity patterns of the Ballona herpetofauna

Table 1

Ballona herpetofauna relative abundance by unit and sample area

Unit	1		2	Ag Land	3	T*	N**
Sample Area	D	1A	2	Ag Land	3		
Batrachoseps	-	-	-	-	.05***	.01	2
Bufo	-	.01	-	-	.02	.01	2
Hyla	****	.03	.15	.70	.05	.19	49
Anniella	.03	-	.05	-	-	.01	2
Gerrhonotus	.49	.98	.39	.16	.32	.47	123
Sceloporus	2.20	6.81	1.80	2.69	6.14	4.93	1293
Uta	1.33	-	.93	.20	-	.32	84
Lampropeltis	-	.08	-	.12	.03	.05	14
Pituophis	-	.15	-	.12	.14	.11	29
Totals (Sample) N =	4.06 140	8.07 577	3.32 68	4.46 183	6.52 620	6.09	1598
Totals (Unit) N =	6.76 717						

*Total by species
**Number of sightings by species
***Estimates in number of individuals per sample hour
****No estimate

	Pickleweed	Castor bean	Iceplant	Lupine	Willow	Eucalyptus	Laurel-Sumac	Calif. Sage	Coyote Brush-Pampas Grass	Fennel	Cattail	Bulrush	Saltgrass	Weeds
<u>Batrachoseps</u>	-	-	-	-	-	-	.238	-	-	-	-	-	-	.013
<u>Bufo</u>	-	-	-	-	-	-	-	-	-	-	-	-	-	.030
<u>Hyla</u>	.003	.021	-	-	.180	-	.240	-	.140	-	.110	3.160	-	.070
<u>Anniella</u>	-	-	-	-	.090	-	-	-	-	-	-	-	-	.010
<u>Gerrhonotus</u>	.915	.104	1.060	-	-	-	-	-	.138	.028	-	-	1.170	.645
<u>Sceloporus</u>	1.450	4.610	2.880	2.920	2.840	.120	9.760	7.500	2.220	2.310	-	3.160	8.330	4.620
<u>Uta</u>	-	.104	1.590	.141	.367	-	-	-	-	.028	-	-	-	.161
<u>Lampropeltis</u>	-	.052	-	-	.092	-	-	-	-	.028	-	1.050	-	.134
<u>Pituophis</u>	-	.050	.060	-	-	-	-	-	.140	.080	-	-	.170	.080
Totals	2.390	5.130	5.290	10.00	3.580	.119	10.20	7.500	4.520	2.480	.108	7.370	10.00	5.770

All estimates are in numbers of individuals per sample hour

Table 2 - Ballona herpetofauna relative density estimates by habitat based on vegetative dominants

THE BIRDS OF BALLONA

Charles F. Dock and Ralph W. Schreiber

THE BIRDS OF BALLONA

LIST OF FIGURES

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THE BIRDS OF BALLONA

THE BIRDS OF BALLONA

Charles F. Dock and Ralph W. Schreiber

INTRODUCTION

In general, bird distribution of the United States, and California in particular, is well known (A.O.U., 1975; Robbins et al., 1966; Garrett and Dunn, 1981). However, the details of species distribution and population sizes along with habitat usage are poorly documented. Specific locations such as the Ballona Creek region are essentially unknown. While some sightings of birds of this region have been made over the years, no systematic survey has been carried out prior to 1979. The study reported here provides data on the bird populations of the Ballona region.

METHODS

We conducted weekly censuses at each study unit from the first week of February 1979, through June 1981. Survey efforts on all areas were not begun at exactly the same time, as some initial reconnaissance was necessary to establish separate study sites and census routes. Work at Ballona Lagoon was not part of the original project and commenced later than studies of the other areas, beginning March 1979 and extending through February 1980. No formal surveys were conducted on Unit 3 or the Agricultural Fields during late summer 1980. We thought at the time that this phase of the project was at an end and would no longer be funded. We did make spot checks during this interval in an effort to detect any unusual species or concentrations of individuals on the region as a whole.

Surveys consisted of counting birds along established transect routes (Fig. 1) on each unit, supplemented by additional non-systematic investigation of habitats not adequately sampled by the transect method. Transect routes were chosen to maximize coverage of the entire study site, rather than to intensively study a particular habitat type. In some cases, the choice of a transect route was influenced by consideration of potential damage to delicate habitat, disturbance of nesting birds or traversibility of habitat. Wet season counts on the Agricultural Fields were conducted from the periphery, as these areas were essentially impassable. The relatively simple nature of the habitat rendered this approach reasonably effective. We walked a transect route and recorded each individual bird detected, either visually or aurally. We recorded only birds detected in front of the observer to avoid counting individuals more than once. The transect route was traversed at a leisurely pace, with stops made only for purposes of identifying birds. Each transect survey required approximately one hour. With few exceptions, surveys were conducted between 0530 and 0930 PST. This time frame corresponds to the maximum activity period of birds and during the two and a half years of our study allowed adequate sampling of all species at all stages of the tide cycle. Spot surveys were conducted at other times of day for comparative purposes. All species identifications were made with the aid of 9 x 35 binoculars and/or a 10x -50x spotting telescope.

Supplementary observations were conducted in specific habitats of Units 1, 2 and 3, particularly during periods when migrant species that could potentially be missed by the transect method might be present. These specific habitats included the willow thicket at the west end of Unit 1, the copse of trees on Unit 2, and the scrubland on the north side of Unit 3. Additional ~~observations~~ observations were also made on the Agricultural Land during the winter rainy season, when large numbers of waterbirds were present. The field was skirted in an attempt to record all birds present on the flats and temporary ponds. The expanse and inaccessibility of the Agricultural Fields made the complete elucidation of total bird numbers difficult. Totals for this area should be treated as minimum estimates (particularly for the smaller shorebirds). Numbers recorded in the Agricultural Fields in particular should be considered as measures of relative seasonal abundance and not as measures of absolute abundance.

Ballona Lagoon was censused from various points along the shoreline that allowed complete coverage of all surface waters. The Venice canals were surveyed from the sidewalk surrounding the canal system.

In the following sections the terms waterbird and shorebird are frequently used. Waterbird is used as a general term referring to any species whose presence is influenced by the availability of aquatic or semiaquatic habitats. Shorebird refers to members of the Order Charadriiformes that typically feed and roost along the water's edge.

Data summarized in the figures are means of the weekly censuses for each unit. While some detail is lost in this method of presentation, the seasonal and annual patterns became explicit. We present the mean number of birds per visit for each species in appendices.

Scientific names for all species are given in the Species Accounts.

RESULTS AND DISCUSSION

OVERALL REGION

All species recorded during this study and the units in which they were seen are listed in Appendix 1.

Seasonal patterns in bird utilization of the various sites are shown in figures 2 and 3. Numbers were greatest in mid-winter (January and February) and lowest in late spring and early summer (May and June). These data reflect the regional pattern of bird use in lowland southern California, where winter numbers are predictably increased by an influx of species that breed at higher altitudes or latitudes. Most species found in the region in summer are year-round residents and breed in the general vicinity.

The most notable shifts in bird abundance occurred in Unit 1 and the Agricultural Fields during mid-winter, when numbers increased drastically. This period of peak abundance coincides with the winter rains characteristic of coastal southern California. Usually arid habitats are temporarily wet and were utilized by large numbers of wintering waterbirds. Numbers declined drastically in March and April as flats dry up and most of the species begin migration to summer breeding grounds. Another peak of abundance occurred on Unit 1 in late summer. This increase is due to a temporary influx of migrants (especially waterbirds) moving through to wintering grounds further south. Total bird numbers on Units 2, 3 and Ballona Lagoon were relatively stable in comparison with Unit 1 and the Agricultural Lands, although the previously mentioned general pattern of seasonal change is apparent.

Seasonal variance was great at Ballona Lagoon, where many waterfowl and shorebirds were found during the winter months, but virtually none were present in summer. A greater proportion of the total species inhabiting Units 2 and 3 were resident land birds. Those migrants and winter visitors that utilize these two sites did so in comparatively small numbers. In Unit 3 particularly, the number of species showed more striking seasonal variation than did the total number of individuals.

UNIT 1

More species of birds occurred in Unit 1 in late fall and winter than in other seasons (Fig. 4). The low point in species abundance occurred in late spring and early summer. These seasonal differences were due primarily to changes in the number of shorebird species, as can be seen by examining the lower lines of figure 4. Most shorebirds are migratory and are on the northern breeding grounds in late spring and early summer. Most of the terrestrial bird species recorded on Unit 1 were residents, consequently species numbers did not fluctuate drastically with the seasons.

More species were observed in 1980 and 1981 than during the first year of the study. While some of this variation may be attributed to the increasing familiarity of the investigators with the complexities of the habitats, it certainly also reflects changing environmental conditions. The number of species present (and number of individuals) is strongly dependent upon the relative amounts of dry ground, standing water and moist mudflats. High percentages of standing water favor gulls, terns, ducks and certain wading birds, while large expanses of mudflats attract large numbers of many shorebirds. Dry ground obviously limits utilization by any of these groups.

The pattern of changes in total numbers of individuals (Fig. 5) was similar to that shown by species numbers, but the range of variation was considerably greater. Total numbers of individuals increased markedly during the rainy season in late winter and early spring. Primary differences in abundance of total individuals are attributable to changes in shorebird abundance (Fig. 6). Shorebird numbers were very high in mid-late winter, and dropped to essentially none in early summer. Numbers increased again in late summer as birds began to return from breeding. Shorebird numbers appear to be sensitive to the total amount of mudflat available, as mentioned previously. Numbers are greatest when mud/saltflats are partially flooded, providing softened substrate for foraging, as occurs in late winter.

The seasonal pattern in numbers of gulls and terns (Fig. 7) that emerged was rather complex, with at least two and possibly three peaks of abundance. As in other waterbirds, numbers were generally lowest in late spring and early summer, but another low point occurred in fall. Numbers increased in late summer with an influx of migrant birds moving through the area. The fall decrease indicates the passage of this wave of migrants, before the bulk of wintering birds has arrived. Gulls and terns that overwinter here increase the census figures for mid-winter. Bonaparte's Gulls and Forster's Terns were particularly abundant at this time of year. The data suggest a late-winter decrease followed by another increase in numbers in early-spring. This possibly indicates migratory movements much like those mentioned above, with wintering birds moving out before spring migrants move through, but these results may be illusory (see 1981). The gas company was conducting maintenance operations on Unit 1 in late winter 1980. These operations inhibited censusing activities, and very likely also affected the number of gulls and terns present. Movement of birds out of Unit 1 may have contributed to the high numbers recorded in the Agricultural Fields at this time. Under normal circumstances, numbers may remain high on Unit 1 through early spring, and then decline as migrants move northward and inland.

Belding's Savannah Sparrows and California Least Terns, both endangered subspecies, nested in Unit 1. Belding's Savannah Sparrows are permanent residents of the region, while California Least Terns are a summer visitor. Belding's Sparrows were recorded on Unit 1 in varying numbers throughout the year. Least Terns were present for about four months, from late April to August or September, with most individuals leaving the area by late July (Fig. 8). Numbers of Belding's Sparrows appear to decline markedly in mid-summer, at the close of the breeding season (Fig. 9). These numbers reflect two phenomena. Belding's Sparrows are secretive at this time of year, singing very little and remaining concealed in the low vegetation. Also, many birds disperse to semi-arid habitats of other sites, including Unit 2 and the Agricultural Fields. Birds become easier to census in fall, and more birds were recorded during this time period. Numbers of terns using Unit 1 appear to be lower in 1980 than in 1979. This difference is correlated with a change in water level on the mud/saltflats between the two years. In 1980 these flats, which have been used for breeding in the past, were largely flooded throughout the spring. Little or no reproduction appears to have occurred on the tern colony in 1980. Numbers of Least Terns were initially fairly high again in 1981, but declined following flooding of the breeding site. Some Least Terns that have used this breeding site in the past may have moved to the colony on the beach north of the Marina, although this is not certain (J. Atwater, pers. comm.).

A complete list of birds censused on Unit 1 is given in Appendix 2.

UNIT 2

In Unit 2 species numbers were greatest in fall and lowest during summer, although the differences were rather small (Fig. 10). Changes in total species number are primarily due to the increased incidence of waterbirds during the fall.

Largest numbers of individuals were recorded in fall and the smallest numbers in summer (Fig. 11). Unlike species numbers, the greatest differences in numbers of individuals was attributable to changes in land bird populations, particularly in the number of House Finches recorded. House Finch flocks foraged over the area, after the breeding season, feeding on seeds of annual plants both along the canals and in the drier portions of the study site. A significant contribution to the fall increase in numbers was made by Belding's Savannah Sparrows that dispersed into the area after the breeding season (Fig. 9).

Belding's Sparrows fed regularly in the same portions of the habitat as the House Finches and probably also utilized the temporarily abundant seed resources. Terrestrial birds were the dominant components of the bird fauna in Unit 2. Particularly common species included the House Finch, Mourning Dove, Meadowlark and Song Sparrow. Song Sparrows were more abundant in this study site than any other unit within the region, and were particularly common in the stand of pampas grass bordering the south side of the tidal channel.

A complete list of birds censused in Unit 2 is given in Appendix 3.

UNIT 3

In Unit 3 species diversity was greatest in spring and lowest in summer (Fig. 12). The peak of diversity corresponded with the time when part of the area was flooded. Lower portions of Unit 3 collected runoff from the winter rains and remained wet through April well after the heavy rains have ceased. This area retained standing water longer than Unit 2 or the Agricultural Fields, and as a consequence, was used by a larger number of waterfowl and wading birds later in the spring during 1979 and 1980.

The peak of waterbird abundance coincided with the peak in species number (Figs. 12 and 13). Total numbers of all birds, however, were as high or higher in the fall, as a notable influx of land birds on migration or, in some cases, dispersing in from surrounding areas occurred. These were primarily seed-eating species making use of the temporary abundance of weed and grass seed available in the drier portions of the habitat. The most abundant species on the area at this time are White-crowned Sparrows, Meadowlarks, Mourning Doves and House Finches.

Belding's Savannah Sparrows resided on this unit (Fig. 14). They primarily inhabited those portions of the study site covered by stands of pickleweed (Salicornia), but also used drier areas in the non-breeding season.

The number of sparrows using the study site declined markedly in mid-summer. They may regularly disperse entirely to other portions of the region as Unit 3 becomes particularly hot and dry. This point warrants further investigation. Numbers increased during the fall months, when seed-eating species in general became particularly abundant.

An apparent decrease in the number of Belding's Sparrows occurred on the site during the breeding seasons of 1980 and 1981, as compared to 1979. This may have been a random fluctuation in numbers more or less typical of small populations, or it may be a direct reflection of changing environmental conditions. Our subjective observations suggest that the "quality" of the *Salicornia* on Unit 3 declined during this study. This site is not subject to tidal flux, and the only source of water is fresh-water runoff. *Salicornia* is usually restricted to salt water or brackish water intertidal habitats. Its presence on Unit 3 is due to residual salt in dredge spoils left from the construction of the Marina. It appears this salt is gradually leaching from the soil, thus negatively impacting the *Salicornia*. Elimination of *Salicornia* would effectively eliminate the unit as a breeding site for Belding's Sparrows, although they might continue to be present outside the nesting season.

A complete list of birds censused on Unit 3 is given in Appendix 3.

AGRICULTURAL FIELDS

Data presented in this section are derived primarily from the region south of Jefferson Blvd. and west of Lincoln Blvd., bounded on the west side by the road leading to the gas company facility.

Species numbers were considerably greater from mid- to late winter than at any other time of the year (Fig. 15). At that time of year, the area is usually at least partially flooded with a fairly extensive temporary pond formed along the western border of the study area. Another, smaller pond may form approximately 100 meters west of Lincoln Blvd. in wet years. During particularly heavy rains in January and February 1980, the entire study area was submerged. During most of January and February, extensive wet mud areas surrounded the temporary pond nearest to the gas company facility. These areas were used regularly by shorebirds for both feeding and loafing. Waterfowl (particularly Cinnamon Teal) utilize the standing water, as do several species of gulls. Waterfowl were concentrated on the temporary pond nearest the western border of the study site, while gulls used both of the ponds as resting areas. Early in the rainy season, Bonaparte's Gulls foraged extensively over the area, apparently feeding on insects trapped by the rising waters.

Plowed portions of Agricultural Fields away from the immediate vicinity of temporary ponds were used as foraging sites by shorebirds, as long as the soil remained wet and easily penetrable. These sites were used most extensively when the extent of available foraging sites on Unit 1 were reduced by high water levels.

Most of the Agricultural Area dried out rapidly after the winter rains, and waterbirds moved to other locations. The temporary pond near the gas company remained for some time after the remainder of the field was dry, and supported fairly large numbers of birds. In 1980 and 1981, this spot continued to be used by shorebirds into April.

The seasonal pattern in numbers of individuals was the same as shown by species numbers, but monthly differences were even more pronounced (Fig. 16). More than a hundred-fold difference in numbers was recorded between mid-summer and certain periods during the wet season. This difference was due entirely to the great influx of waterbirds (Figs. 15 and 16). Among shorebird species, only small numbers of Killdeer were present during most of the year, but large numbers of several species were present in wet winters.

These differences in species and numbers are responses to environmental change and not simply to the obvious large-scale seasonal shifts in shorebird distribution, as can be seen by comparing 1979 with 1980 and 1981. The initial 1979 surveys were begun after the peak winter rains, when the area was relatively dry, and comparatively small numbers of birds were recorded. In the second year of the study, rains lasted somewhat longer, and the area remained wet much later. Considerably greater numbers of birds were observed during late February and March in this second year of study than were recorded in the first year, a result probably more representative of the typical winter situation as suggested by 1981 data. These data clearly illustrate the importance of and need for long-term environmental studies as basis for valid conclusions.

A complete list of birds censused on the Agricultural Lands is given in Appendix 5.

BALLONA LAGOON

Seasonal patterns in bird use of Ballona Lagoon generally mirrored those of the Ballona Region as a whole; numbers of species reached a maximum in mid-late winter and early spring, and minimum in summer (Fig. 17). Seasonal differences were due primarily to changes in the waterbird population. Very few shorebirds and virtually no migratory waterfowl were present during the summer months (figures do not include "domestic" ducks and geese which are resident on the canals). Throughout the summer, a few non-breeding Willets, Marbled Godwits and Black-bellied Plovers were present. Killdeer, which are resident in the region probably breed in higher elevation habitats surrounding the lagoon itself. Other species of migratory shorebirds moved into the area in fall, and many remained in the general vicinity throughout the winter. Migratory waterfowl, such as Scaup and Red-breasted Mergansers, began moving onto the lagoon in late fall and remained through the winter. Several species of shorebirds (i.e. loons, grebes) occasionally used the protected waters of the lagoon for resting and feeding in winter. Virtually all terrestrial bird species recorded during this study were residents and were consequently observed in all seasons.

Numbers of individuals of all waterbirds largely paralleled the pattern shown by species numbers, in that maxima occurred in fall and winter and minima in summer (Fig. 18). The range of values was, however, considerably greater. This general pattern holds for both shorebirds and waterfowl (Fig. 19). Differences between the patterns of abundance of shorebirds and waterfowl did exist, however. Shorebirds showed peaks of abundance in late fall and late winter-early spring, corresponding to periods of migratory movement, when birds that winter elsewhere were passing through the region. While many birds probably remained in the vicinity throughout the winter, many spend mid-winter months further south. The waterfowl population peaked in mid-winter and reamined at a maximum until early spring, suggesting that most of these are wintering birds, and not migrants passing through the lagoon site. The most abundant waterfowl species during the winter were scoters, Lesser Scaup and Red-breasted Mergansers. Virtually no waterfowl were present on the lagoon from late-April to November.

Numbers of individuals of terrestrial bird species using higher elevation habitats around the lagoon were not recorded.

A complete list of birds censused at Ballona Lagoon is given in Appendix 6.

REMARKS

The species accounts presented below deal only with birds observed during the course of this study. A few birds that seemingly should occur in these types of habitat were not observed, and some of these will be discussed below. Few data are available for this region but Dial (1978) did find 3 species (Savannah and Song Sparrows and Western Meadowlarks) nesting in Unit 1 and noted winter bird species there. A notable lack of published information exists for the birds of similar marshland situations in southern California, but Kiff and Nakamura (1979) compiled bird sighting records at Malibu Lagoon, a smaller but somewhat similar coastal location 12 km northwest of the Ballona region. Malibu Lagoon and the Los Cerritos wetlands are the only other sites where remnants of a *Salicornia* marsh are found in southern Los Angeles County. The extent of pickleweed habitat at Malibu is extremely limited, and Malibu Lagoon differs from Ballona in significant ways, being situated directly on the coast and having riparian woodland and chaparral habitats immediately adjacent. Despite these differences, the bird species composition of the two locations is generally similar. The important differences in bird faunas of the two locations will be addressed below, along with additional remarks concerning the status of some birds recorded in this study.

Malibu Lagoon appears, superficially at least, to harbor a greater diversity of bird species than the Ballona region. Kiff and Nakamura (1979) report records of 262 species, versus 129 species recorded in this study. This is attributable in part to the occurrence of many species at Malibu that normally occur offshore, and probably rarely if ever come far enough inland to be recorded at Ballona. In addition, many more terrestrial birds were recorded at Malibu due to the close proximity of large areas of riparian and chaparral habitats. Most important, the Malibu study includes records of birds sighted over a span of several decades by avid "bird listers," and consequently includes a higher percentage of rare or uncommon species. These factors withstanding, certain anomalies exist between the two studies.

The Common Loon, Gavia immer, Arctic Loon, Gavia arctica, Horned Grebe, Podiceps auritus and Hooded Merganser, Lophodytes cucullatus, are waterbird species which have been recorded on several occasions as migrants or winter visitors at Malibu Lagoon but were not observed at Ballona. All of these species might reasonably be expected occasionally at Ballona Lagoon, although its relatively protected location away from the coastline may lessen the chance of their occurrence. The Hooded Merganser also may be unlikely to frequent an area subject to such a high level of human activity.

Soras, Porzana carolina, are listed as fairly common migrants at Malibu but were never seen in the present study. This small rail frequents dense reed beds, which are scarce at Ballona, and this may account for their absence. Their secretive nature makes it possible that their occurrence may have been missed during this investigation.

The Glaucus-winged Gull, Larus glaucescens, Mew Gull, Larus canis and Black-legged Kittiwake, Rissa tridactyla, are at least fairly common wintering gull species at Malibu and occur offshore near Ballona. They apparently do not regularly venture inland, probably accounting for their virtual absence in this study, although their occasional occurrence should not be considered particularly exceptional.

Common Terns, Sterna hirundo, and Royal Terns, Sterna maxima, are listed as fairly common to common migrants in the area of Malibu Lagoon, while neither was recorded during this study at Ballona. Their absence is rather perplexing. The superficial similarity of Royal Terns to Caspian Terns may have led to errors in identification at a distance, but even Caspian Terns were rather uncommon at Ballona.

Most of the differences in occurrence of terrestrial bird species may be to the upper littoral zone, dominated by dense stands of pickleweed (*Salicornia* spp.). Massey (1977) found only one population in California nesting outside of a *Salicornia* marsh, that being on Beacon Island in San Diego County. Even this site contained *Salicornia*, but not in typical dense homogeneous stands. Breeding at Ballona is restricted to those portions of Units 1 and 3 obviously dominated by pickleweed. Belding's Sparrows begin to exhibit territorial behavior by mid- to late winter at Ballona. Relatively small territories are defended by the breeding males. Massey (1977) found territories as small as 225 m^2, with maximum territory sizes of roughly 4,000 m^2. Territory sizes at Ballona appear quite variable but are definitely closer to the lower end of this range. Nests are placed on the ground among the *Salicornia* or on the lower branches of the plants themselves, always well concealed. The nesting season extends roughly from early April through June. Male singing declines through the spring, and by late June the birds are generally quiet, inconspicuous in most of their activities and difficult to census. Counts made early in the breeding season indicated a population on Unit 1 of approximately 21 pairs in 1979, 18 pairs in 1980, and 13 pairs in 1981. Estimates for Unit 3 were 18 pairs in 1979, 10 pairs in 1980 and 10-13 pairs in 1981. These estimates suggest a decline in sparrow numbers in the region. Habitat changes on Unit 3 have been mentioned previously as a possible explanation of these differences in sparrow numbers. If there was an actual decline in numbers on Unit 1, it may have been related to the increase in standing water on the area in 1980 and 1981. Increased amounts of standing water undoubtedly reduce the number of potential nest sites, at least to some degree.

Following the breeding season, sparrows do not actively defend territories, but may return to the general vicinity of the breeding territory to roost. During this time of the year, Belding's Sparrows are frequently observed foraging together in small flocks. Birds may be observed some distance from the breeding grounds in fall and winter. It is during this period that Belding's Sparrows were regularly recorded in mixed Salicornia and semi-arid habitats of Unit 2 and along the margins of the agricultural site. The diet of Belding's Sparrows is quite varied, and it is probable that seeds are the most important component of their diet in fall and winter. The ready availability of seeds in these higher elevations is probably an important factor in this seasonal dispersal.

California Least Tern

The Least Tern nested only on Unit 1. Least Terns were frequently observed in flight over other study sites but were never seen either on the ground or actively feeding.

Historically, the Least Tern nested on the upper portions of sandy beaches along the California coast. As this habitat has come under increasing pressure from human activities, the terns have tended to make use of alternative nesting sites, such as mudflats and landfills away from the immediate coastline. Within the study area, terns nest only on the saltflats of Unit 1, although another larger Least Tern colony exists on nearby Venice Beach.

Least Terns arrived on the study area during the first week of May in 1979, and during the last week of April in 1980 and 1981. Once the birds arrive on the breeding grounds, courtship and nesting commence very quickly. Least Terns nest in shallow depressions or scrapes in the ground. Birds may excavate their own scrapes where the substrate is soft, but at Ballona they tend to utilize ready-made depressions. On Unit 1 these depressions appear to be the hardened hoofprints of horses from the adjacent riding stables. The nesting cycle of Least Terns typically extends into early August (Bent, 1921), but at least in 1979, very few birds remained on the nesting grounds by late July. The terns do not remain in the vicinity for any length of time once breeding has concluded. No birds were seen after mid-August.

No systematic effort was made to accurately census the actual number of breeding Least Terns, but simple counts suggest approximately 17 pairs nested on Unit 1 in 1979. Breeding activities were greatly reduced in 1980 and 1981, almost certainly due to flooding of the breeding colony. It is possible that no successful reproduction occurred in those years.

During the time the terns were on the breeding colony, they foraged in open waters nearby. The principal foraging area appeared to be the Ballona Creek Flood Control Channel, but birds were regularly observed feeding at Ballona Lagoon and in Marina del Rey. Terns were also observed foraging in the central channel of Unit 1. Least Terns may occasionally move offshore to feed in the open ocean, but apparently prefer shallow, quiet water.

AVIAN HABITAT

Habitats may be classified in a variety of ways, depending on the object of the classification. Most classifications are based on the composition or structure of vegetation and/or topographic features of a region. The following habitat classification is a hybrid of these approaches and is an attempt to reflect differences in the environment as perceived by birds.

The following habitat types are recognized in this study:

1) pickleweed (Salicornia)
2) Mixed pickleweed and herbaceous vegetation
3) Semi-arid habitat
4) Agricultural fields
5) Trees and shrubs
6) Mud and saltflats
7) Open water

At various points in this report, subhabitats within these categories are mentioned (e.g. undergrowth--referring to low-growing plants sheltered by trees). It is hoped that any such terms will be self-explanatory and their relationship to the overall system clear.

Pickleweed

The real heart of the region is the area covered by relatively homogeneous stands of pickleweed. This characteristic salt marsh plant contributes substantially to the high levels of biological productivity recorded for salt marsh and estuarine communities. Pickleweed occurs in the upper littoral zone, areas that are subject to regular wetting by high spring tides and are inundated by storm tides. Solid stands of Salicornia are characteristically low in avian diversity (see Dial, 1978). The vegetation structure and salinity of these habitats apparently make them unsuitable nesting sites for most species, and the density of the vegetation (and perhaps other factors) limits its use as foraging habitat. Pickleweed is, however, crucial habitat for Belding's Savannah Sparrows, Passerculus sandwichensis beldingi, since this endangered subspecies typically breeds only in relatively homogeneous stands of Salicornia. This bird's decline in numbers in recent decades can be correlated directly with the destruction of pickleweed habitat along the Pacfiic coast (Massey, 1977).

The most extensive stand of pickleweed in the Ballona region occurs in western Unit 1. Much of this section is virtually pure Salicornia, although some slightly higher elevation portions of the study area support mixed Salicornia and herbaceous vegetation. The eastern portion of Unit 1 supports substantial amounts of pickleweed, but the habitat is broken up into relatively small segments, separated by expanses of mudflats and saltflats. It is, however, used regularly by Belding's Savannah Sparrows, both for foraging and nesting.

Relatively narrow bands of *Salicornia* are found along the banks of tidal channels in Units 2 and 3. The main channel of Unit 1 extends on into and through Unit 2 and is bordered by thick stands of pickleweed, but these stands are not sufficiently extensive to support a breeding population of sparrows. Most of this site is at a slightly higher elevation and supports mixed *Salicornia* and herbaceous vegetation or grasses and herbs. Dense *Salicornia* occurs along the channel bordering the north side of Unit 3, but this vegetation is not sufficiently widespread to support Belding's Sparrows. Pickleweed also occurs along the banks of Ballona Lagoon, but the slopes along the lagoon are quite steep, and this greatly restricts the extent of *Salicornia* at that site. The only reasonably large stand of *Salicornia* occurs at the north end of the lagoon proper, where small islands are exposed at low tide. These islands are apparently insufficient in size or are subject to such extensive immersion as to preclude their use by Belding's Sparrows, as none were recorded during this study.

The stand of pickleweed in the east-central portion of Unit 3 is worth special note. This area is not subject to tidal flux, and the *Salicornia* apparently survives only due to a unique combination of periodic inundation following heavy rains and residual soil salinity from dredge spoils used as landfill when the adjacent marina was constructed in the late 1950s and early 1960s. As the area continues to dry out, we expect the *Salicornia* will continue to deteriorate and no longer provide suitable habitat for the sparrows.

Mixed Pickleweed and Herbaceous Vegetation

This habitat type occurs in areas that are covered by salt water only at especially high tide. This habitat is characterized by pickleweed interspersed with a variety of species of herbs and occasional patches of grasses.

This habitat generally occurs just above the pickleweed habitat and is found in some abundance on Units 1, 2 and to a lesser extent along the Agricultural Fields. Mixed pickleweed habitat is primarily important as foraging grounds for a variety of granivorous species that utilize seeds produced by the herbs and grasses. Some nesting may occur within this habitat type. Song Sparrow territories frequently encompassed large segments of mixed pickleweed vegetation in regions where large herbs provided singing perches. Yellowthroats possibly occasionally nest in locations supporting large herbs.

Old field Habitat

Old field habitat is distinguished from the previous category by the prevalence of grasses and herbs and the lack of pickleweed. Old field habitat occurs above areas that are periodically inundated and is usually quite dry. A variety of seed-producing plants, many of which are usually considered "weeds," is usually found in this habitat, which supports populations of small mammals and reptiles. Old field habitat is found on all study areas within the wetlands ecosystem, being most extensive on Unit 3 and least extensive on Unit 1. In Unit 1, old field habitat is largely restricted to the periphery, being prominent only in the transition zone between Unit 1 and the adjacent Agricultural Field. Old field habitat is used extensively by several of the common bird species of the region, including seed-eating forms such as House Finches, Mourning Doves, Meadowlarks and California Quail. Raptorial species such as the Red-tailed Hawk, American Kestrel and Burrowing Owl hunt above the open old field habitat. This is the principal nesting habitat for the Western Meadowlark, one of the most common and obvious birds of the region.

Agricultural Fields

The Agricultural Fields might be considered as special cases of the above habitat type, but they cover such a large proportion of the area under consideration as to merit a separate category. Except for times immediately following plowing, or presumably when being actively cultivated, these Agricultural Fields support scattered grasses, with occasional herbs interspersed, particularly along the margins. Sizable portions of the Agricultural Fields between Lincoln Blvd. and the gas company facility apparently support characteristic salt marsh plants such as Saltgrass and Bulrush when they are not in active cultivation (P. Kelley & J. Schular, pers. comm.). During most of the year, these fields are used by birds in much the same manner as previously described for semi-arid habitat, although the lack of tall vegetation limits their use by some species (e.g. Loggerhead Shrikes, which require lookout perches). Killdeer apparently nest in the more open agricultural areas, while Meadowlarks nest on sites supporting a greater coverage of grasses. Some portions of the Agricultural Fields are inundated by runoff during the winter rains and change rather radically in character. These areas will be treated below.

Trees and Shrubs

Trees and shrubs are rather widely scattered over old field habitats throughout the region. Unit 1 supports a stand of willows along its western margin, and scattered shrubs along the central canal. Unit 2 contains a fairly large eucalyptus copse, surrounded by a number of individual pampas grass plants. A small stand of Baccharis also occurs near the southwestern boundary of Unit 2. Unit 3 contains a sizable stand of Baccharis in the northcentral portion of the study site, scattered pampas grass throughout the semi-arid habitat and a number of large Rhus plants along the southern and eastern margins. Trees and shrubs are used as perch sites by a variety of bird species, including raptors, Loggerhead Shrikes and Mockingbirds.

They also provide nesting sites for several species, including Song Sparrows, Anna's Hummingbirds, House Finches, Shrikes, Mockingbirds and probably Mourning Doves. Their primary importance in the region is probably as resting and foraging habitat for migrating songbirds. A number of species recorded during this study were observed only in areas supporting trees and/or shrubs, as can be seen by an examination of the species accounts.

Mudflats and Saltflats

For the purposes of this study, mudflats are considered to be any area generally devoid of vegetation that is periodically or regularly covered with water, providing a moist substrate. Saltflats differ from the above only in the notable saline nature of the soil. They are in many ways functionally equivalent from the standpoint of avian utilization, although it is probable that mudflats support a greater diversity of invertebrates and provide better foraging substrate for shorebirds. In general, saltflats are not as regularly flooded as mudflats. The saltflats of Unit 1 provide the only nesting habitat for the California Least Tern within the Ballona region, probably due in part to the fact that this spot is usually dry during the tern breeding season. Both mudflats and saltflats are found on the eastern half of Unit 1. Unit 2 contains only a small segment of habitat which could be called mudflats, along its northern boundary. Unit 3 has sizable areas of saltflat habitat near its center. For reasons that are not immediately apparent to us, this area has not been utilized by the California Least Tern. Small patches of mudflats are exposed at low tide along Ballona Lagoon. The most extensive mudflats at the lagoon are at the extreme north and south ends. During the winter rains, large portions of the agricultural study site become flooded and are used extensively by waterbirds and shorebirds.

Flats are the most important habitat type to the functioning of the wetlands bird community. A large percentage of the total number of birds observed during this study were observed in this habitat. The mudflats and saltflats are used extensively by gulls and terns as roosting sites and by shorebirds for both roosting and feeding, during the winter months. Most of these species are limited to this habitat type and would be lost to the region if the mudflats and saltflats were eliminated.

Open Water

This habitat type is largely self descriptive. Important areas of open water occur at Ballona Lagoon and the central channel of Unit 1. Of lesser importance are the water channels of Units 2 and 3. During heavy rains or after particularly high tides, these areas are augmented by large temporary ponds on Units 1, 3 and the Agricultural Lands. Open water is used by several species of ducks for resting and feeding, gulls and terns for feeding and certain other waterbirds (e.g., grebes) for resting and feeding. Least Terns which nest on Unit 1 move to open water for foraging. While much of their activity centers around Ballona Channel, they were frequently observed feeding at Ballona Lagoon. The larger wading birds such as herons and egrets forage along the margins of open water areas, and kingfishers are restricted to this habitat type for feeding. The temporary ponds which are largely devoid of fish may be used as foraging sites by some species under certain circumstances. Large flocks of Bonaparte's Gulls and Forster's Terns were observed feeding at the large temporary pond on the Agricultural Site after the first heavy winter rains, where they were apparently picking insects off the water surface.

Ballona Lagoon and Venice Canals

Ballona Lagoon plays a dual role in the overall scheme of bird use in the vicinity. It is frequently used by birds spending the bulk of their time on other portions of the wetland, but it is also frequented by some birds that do not otherwise occur in the region. At low tide, mudflats are exposed along the margins of the lagoon, with particularly sizable areas at the mouth and the northern end. During the fall and winter, these habitats are used by varying numbers of shorebirds as feeding and resting grounds, and by gulls as loafing areas. These are at least primarily birds that also utilize other habitats in the surrounding wetlands. Birds were frequently observed flying into the lagoon from across the marina channel on Unit 1. Some of these shorebirds were probably migrants moving north or south along the Pacific flyway. During the Least Tern breeding season, a few individual terns were commonly seen foraging in the lagoon. Terns would fly from one end of the lagoon to the other, periodically diving to capture fish. Some terns were definitely from the breeding colony on Unit 1, while others may have come from the Venice Beach nesting grounds. Forster's Terns, a common wintering species of the wetlands, also forage at the lagoon. A variety of waterbirds that normally occur offshore use the open water of the lagoon as a resting and/or feeding area. This group includes several species of waterfowl, grebes and others (see Appendix 6). The lagoon supports no major concentrations of these birds but may be important as a quiet refuge, particularly during inclement weather.

The Venice canals are primarily used by "domestic" waterfowl, Domestic Geese, Domestic Ducks and tame Mallards which frequently interbreed with the Domestic Ducks. Sizable numbers of American Coots are also found here, particularly in the winter. These birds primarily subsist on handouts from people living along the canals. Very few migrant and wintering birds move northward from the lagoon into the canals. A few gulls (usually ring-billed) were regularly seen along the canals, and occasional small flocks of ducks (esp. scaup) were recorded, but other waterbirds and shorebirds were almost totally absent. The canals are apparently too confined by the surrounding residential area. There is no natural vegetation along the canals to provide protection from human disturbance. There also appears to be insufficient food to support significant numbers of wild birds. The canals lack any mud-flats to provide invertebrate food and resting areas for shorebirds, nor do any rocky margins exist to provide habitat for species such as Willets that are frequently found in this type of area.

Any alterations of the canals should probably be undertaken for aesthetic rather than ornithological reasons. It is unlikely that any reasonable changes would significantly increase their use by wild birds. The Venice residents appear to generally enjoy the domestic birds that live on the canals, and they are likely to remain there unless actively removed. The lagoon, on the other hand provides useful habitat for a variety of wild bird species. It would be preferable to maintain access to the lagoon for migrant and wintering species. To this end, the mouth of the lagoon should be kept free of obstructions as much as possible, as most birds appear to enter the lagoon from the marina channel or Unit 1. Tall buildings immediately surrounding the mouth of the lagoon might well discourage entrance to the lagoon, just as large structures around the entrance to the Venice canal system appear to inhibit its use. The mudflats at either end of the lagoon should be maintained, and tidal flow should be largely unrestricted. This combination would insure the maintenance of foraging and resting grounds for shorebirds, and the survival of their invertebrate and vertebrate prey. Sufficient buffer zones should be maintained along the banks of the lagoon. The west bank is somewhat buffered already by the presence of Pacific Ave. An approximately qual zone on the east bank would probably lessen the impact of further construction, although it is impossible to predict with certainty. Limiting the heights of buildings immediately adjacent to the lagoon would also be preferable. Tall buildings along the banks would create an artificial "canyon effect" and would be likely to discourage bird use, much as it appears to do in the canal system. Multi-story structures in the immediate vicinity are probably an important factor in limiting water and shorebird use of the Los Angeles County Bird Conservation Area, as was discussed elsewhere. The buffer zone along the lagoon could be landscaped in such a way to improve its aesthetic appeal and also provide some protection from human disturbance for the birds. Plantings of shrubs along the upper banks on both sides could achieve these desired effects. If consideration were taken as to the plant species chosen for this sort of project, an additional benefit might be to attract larger numbers of migrant song birds as well as providing additional habitat for those resident species recorded in this study.

It is uncertain that these measures would be completely effective in mitigating effects of further construction but would at the very least provide an invaluable experiment in wildlife conservation. Since data exist on the status of birds in the area prior to construction, it should be possible to evaluate the effects of these different conservation measures, providing invaluable information which could be used in future planning.

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SPECIES ACCOUNTS

The status of individual species observed during this study is presented below. For each species, the general pattern of occurrence in southern California is given first, followed by a brief account of its status in the Ballona region based on observations made during the course of this investigation.

ORDER GAVIIFORMES

FAMILY GAVIIDAE

RED-THROATED LOON <u>Gavia stellata</u>. Fairly common winter visitor and migrant offshore. Less common in lagoons and inlets. Two individuals observed on Ballona Lagoon from late January to late February 1980.

ORDER PODICIPEDIFORMES

FAMILY PODICIPEDIDAE

EARED GREBE <u>Podiceps nigricollis</u>. Common migrant and winter visitor on protected coastal waters. Individuals observed at Ballona Lagoon and Unit 1 on several occasions in the winter, spring and early summer.

WESTERN GREBE <u>Aechmophorus occidentalis</u>. Common migrant and winter visitor offshore and occasionally on quiet inshore waters. Several individuals observed during winter and spring on Ballona Lagoon. Observed occasionally during this period on canals of Unit 1.

PIED-BILLED GREBE <u>Podilymbus podiceps</u>. Fairly common migrant and winter visitor to protected bodies of both fresh and salt water. Individuals may occasionally be observed in summer. Individual birds occasionally seen at Ballona Lagoon and on the major canal of Units 1 and 2 from late summer to early spring.

ORDER PELECANIFORMES

FAMILY PELECANIDAE

BROWN PELICAN Pelecanus occidentalis. Common resident in offshore waters but uncommonly seen inshore. Isolated individuals observed soaring above Unit 2 on two occasions during the summer months.

FAMILY FRIGATIDAE

MAGNIFICENT FRIGATEBIRD Fregata magnificens. Occasionally observed as stragglers along the coast in late summer. Single individuals were observed above Unit 1 and Ballona Lagoon in early August 1979.

FAMILY PHALACROCORACIDAE

DOUBLE-CRESTED CORMORANT Phalacrocorax auritus. Common offshore species in all seasons, but less numerous in summer. Most local adults breed on the Channel Islands. Occasional vagrants observed in the fall and winter, resting on open water at Ballona Lagoon.

ORDER CICONIIFORMES

FAMILY ARDEIDAE

GREAT BLUE HERON Ardea herodias. Commonly observed in all seasons in coastal marshes and along water courses. Observed regularly on Unit 1, with numbers increasing in fall and winter. Smaller numbers observed on Units 2 and 3 and Ballona Lagoon. Several individuals recorded in Agricultural Fields during particularly wet periods.

GREEN HERON Butorides striatus. Common resident around shallow water containing vertebrate and/or invertebrate prey. Breed in a variety of locations in southern California. Individuals commonly observed in all seasons around Ballona Lagoon and along water courses on Units 1, 2 and 3. A few fall and winter records from Agricultural Fields.

GREAT EGRET Casmerodius albus. May be seen in all seasons on mudflats and in marshes along coast, but not a common bird in the Los Angeles area. Observed along water channels of Units 1 and 2 in November and March.

SNOWY EGRET Egretta thula. Common transient and winter visitor around fresh and salt water. Individuals regularly seen along water channels in all study sites. Observed from late summer through early spring, with numbers greatest in winter.

BLACK-CROWNED NIGHT HERON Nycticorax nycticorax. Uncommon transient and winter visitor in southern California and local resident in coastal district. Scattered observations along water courses of Units 1 and 2.

ORDER ANSERIFORMES

FAMILY ANATIDAE

BRANT Branta bernicla. Fairly common migrant and occasional winter visitor onoffshore coastal waters. Less common inland. Single individuals observed in December 1979 and April 1980 on mudflats of Unit 1.

DOMESTIC GOOSE Anser answer. Birds on the area probably are intentionally released. Several birds are resident on the Venice canals.

MALLARD Anas platyrhynchos. Wild birds are common southern California residents, with numbers increasing in winter with influx of migrants. Common residents on Venice canals. Commonly hybridize with domestic ducks. Occasional wild birds seen on all study sites in winter.

GADWALL Anas strepera. Fairly common winter visitor on quieter coastal waters in southern California. Several individuals observed on Ballona Lagoon through winter 1979, but none seen in 1980. One flock observed on Unit 1 in winter 1981.

PINTAIL Anas acuta. Fairly common winter visitor in marshes and wet agricultural fields of southern California, but primarily inland. Flock of 15 birds seen on flooded agricultural fields in January 1980.

GREEN-WINGED TEAL Anas crecca. Fairly common migrant and winter visitor, especially in fresh water streams, ponds and marshes. Small flocks observed along canals of Unit 1 and in agricultural fields.

BLUE-WINGED TEAL Anas discors. Uncommon winter visitor, primarily in freshwater habitats. A male and two females were observed on several occasions during winter 1981 on Unit 1.

CINNAMON TEAL Anas cyanoptera. Common migrant and winter visitor in coastal southern California, particularly in fresh water and wet agricultural fields. Regularly observed along canals and in flooded portions of Units 1, 2, 3 and Agricultural Fields during winter months. The most commonly seen surface-feeding duck in the Ballona region.

AMERICAN WIDGEON Anas americana. Common migrant and winter visitor on protected fresh and saltwater situations in southern California. A few individuals observed in winter on Unit 1 and on wet agricultural fields.

NORTHERN SHOVELER Anas clypeata. Common winter visitor to freshwater and estuarine habitats. A single male was seen on Unit 1 in winter 1981.

GREATER SCAUP Aythya marila. Uncommon winter visitor in southern California. Small flocks observed on Ballona Lagoon in winter.

LESSER SCAUP Aythya affinis. Common winter visitor and migrant on quiet water. Small flocks observed regularly from December through March on Ballona Lagoon.

BUFFLEHEAD Bucephala albeola. Regularly seen in small numbers during winter in southern California. Single individuals observed in early December on Unit 1 and March and April at Ballona Lagoon.

OLDSQUAW Clangula hyemalis. Rare winter visitor to coastal waters of southern California. A single individual was observed on Ballona Lagoon in mid-March 1979.

WHITE-WINGED SCOTER Melanitta deglandi. Common winter visitor in some years, rare to absent in others. Usually observed offshore or in larger bays and estuaries. Small flocks observed regularly in winter and spring of 1979 on Ballona Lagoon, but absent in 1980. Single individuals seen on canals of Unit 1 in November and December 1979.

SURF SCOTER Melanitta perspicillata. Common migrant and winter visitor in coastal waters, primarily offshore. Commonly observed in small flocks from mid-November through early May on Ballona Lagoon and Marina del Rey channel. Numbers greatest from mid- to late winter. The most common diving duck in the area.

RUDDY DUCK Oxyura jamaicensis. Common migrant and winter visitor along coast and on fresh-water ponds. Small numbers observed on canals of Unit 1 in February 1979.

RED-BREASTED MERGANSER Mergus serrator. Common migrant and winter visitor on both coastal and inland waterways. Observed regularly from mid-November through April on Ballona Lagoon. Single individuals were seen in March, May and December 1980 on the canals of Unit 1.

DOMESTIC DUCK Anas platyrhynchos. Common "pets," also raised commercially. Common residents on Venice Canals.

ORDER FALCONIFORMES

FAMILY CATHARTIDAE

TURKEY VULTURE Cathartes aura. Fairly common migrant in spring and fall. Some individuals resident in mountains and foothills. Forages widely over open areas. Sporadically observed soaring above Units 1 and 3 and the Agricultural Fields.

FAMILY ACCIPITRIDAE

WHITE-TAILED KITE Elanus leucurus. Uncommon to locally fairly common resident. A single individual was observed foraging on Unit 1 in mid-December 1979. Regularly observed on all units in winter 1980-81.

SHARP-SHINNED HAWK Accipiter striatus. Uncommon migrant and winter visitor to wooded areas. One bird observed on Unit 2 in November 1979.

COOPER'S HAWK Accipiter cooperi. Fairly common resident and migrant in open or scattered woodland. Occasionally observed on Units 1 and 3.

RED-TAILED HAWK Buteo jamaicensis. Common resident in foothills of Los Angeles basin. Regularly forage over open areas. Single individuals observed irregularly throughout the year on all study units.

MARSH HAWK Circus cyaneus. Sporadic in occurrence in the Los Angeles basin but usually seen in winter around marshes or fields. Observed fairly regularly in open habitats of all study sites in winter 1980-81 but absent in other years.

FAMILY PANDIONIDAE

OSPREY Pandion haliaetus. Uncommon migrant, primarily in the fall. Single individuals observed soaring above Units 1, 3 and the Agricultural Fields in February, March and August 1979.

FAMILY FALCONIDAE

AMERICAN KESTREL Falco sparverius. Common resident in open areas with natural or man-made perch sites. Observed commonly on all units and in all seasons.

ORDER GALLIFORMES

FAMILY PHASIANIDAE

CALIFORNIA QUAIL Lophortyx californicus. Common resident in brushlands, agricultural edges and dense riparian woodland. Small covey observed regularly throughout year on Unit 3. Also recorded sporadically on Units 1 and 2.

ORDER GRUIFORMES

FAMILY RALLIDAE

VIRGINIA RAIL Rallus limicola. Uncommon migrant, but some individuals probably winter in the area. Found in both fresh- and saltwater marshes. The secretive nature of this species makes its status difficult to determine. Single individuals flushed from emergent vegetation along canals of Unit 2 in February 1979 and 1981 and the Agricultural Fields in September 1979.

AMERICAN COOT *Fulica americana*. Common resident in freshwater marshes, pond and slower-moving streams and canals. Year-round resident on Venice canals, but numbers greatly increase in winter. Occasionally observed on standing water in other units.

ORDER CHARADRIIFORMES

FAMILY CHARADRIIDAE

SEMI-PALMATED PLOVER *Charadrius semipalmatus*. Common fall and spring transient and winter visitor to coastal mudflats. Observed regularly in small numbers from September through April, primarily on wet saltflats of Unit 1. Also observed occasionally along Ballona Lagoon and along flooded portions of the Agricultural Area.

SNOWY PLOVER *Charadrius alexandrinus*. Fairly common resident of sandy sea beaches. Much less common inland. Observed rarely on mudflats of Unit 1.

KILLDEER *Charadrius vociferus*. Common resident near fresh and salt water and in wet fields and meadows. Observed regularly in all seasons on all study units. Breed in Ballona area, at least in Agricultural Fields.

AMERICAN GOLDEN PLOVER *Pluvialis dominica*. Uncommon to rare transient and winter visitor to tidal flats and wet agricultural fields. Single individuals seen on wet saltflats of Unit 1 in winter 1979, 1980 and 1981.

BLACK-BELLIED PLOVER *Pluvialis squatarola*. Common winter visitor and migrant on mudflats along coast. Found in large numbers (several hundred) in mid-winter on wet saltflats of Unit 1 and on flooded Agricultural Fields. Numbers gradually diminish through spring, then build up again from mid-July on Unit 1. Samller numbers also found on mudflats of Ballona Lagoon and flooded portions of Unit 3.

Ruddy
~~RUDDY~~ TURNSTONE Arenaria interpres. Common migrant and winter visitor on mudflats, beaches and rocky shores. Found fairly regularly in small numbers on wet saltflats of Unit 1 from mid-summer through early spring. Also found along flooded portions of agricultural fields in mid-winter.

BLACK TURNSTONE Arenaria melanocephala. Common migrant and winter visitor on mudflats, beaches and rocky shores. Observed in small numbers on wet saltflats of Unit 1 from late July through early fall. Apparently not as common in the region as the Ruddy Turnstone.

FAMILY SCOLOPACIDAE

COMMON SNIPE Capella gallinago. Common migrant and uncommon winter visitor in fresh- and saltwater marshes and wet grassy areas. Several individuals observed sporadically in emergent vegetation of canals in Units 1, 2, 3 and the Agricultural Fields from mid-fall to mid-spring.

LONG-BILLED CURLEW Numenius americanus. Relatively uncommon transient and winter visitor to mudflats, marshes and wet fields. Within study area, observed on mudflats of Unit 1 in fall 1980.

WHIMBREL Numenius phaeopus. Common spring and fall transient and winter visitor to mudflats, beaches and wet fields. Observed in small numbers on saltflats, mudflats and along canals at all sites. Some individuals seen in all seasons except early summer. Numbers peak in fall and early winter.

SPOTTED SANDPIPER Aetitis macularia. Fairly common spring and fall transient and winter visitor, primarily around fresh water. Individuals observed sporadically from September to May, primarily along water's edge at Ballona Lagoon.

WILLET _Catoptrophorus semipalmatus_. Common visitor in all seasons on mudflats, beaches and marshes but does not breed in region. Observed commonly foraging and loafing along canals and on mud or saltflats of all study sites. Numbers greatest from late summer through the winter, and least in early summer.

GREATER YELLOWLEGS _Tringa melanoleuca_. Fairly common as migrant, less common as winter visitor at marshes, mudflats and shores of ponds. Observed irregularly on mudflats and wet saltflats of all sites. Most common on Unit 1 and most abundant in late winter.

LESSER YELLOWLEGS _Tringa flavipes_. Uncommon migrant through general area along marshes, mudflats and pond margins. Single individuals observed rarely on mudflats of Units 1, 3 and the Agricultural Fields in spring and late summer.

RED KNOT _Calidris canutus_. Rare fall migrant in salt marshes and mudflats. Observed twice in late July 1980 on mudflats of Unit 1.

BAIRD'S SANDPIPER _Calidris bairdi_. Rare fall migrant on upland portions of marshes and areas of scattered short grass. One individual observed on mudflats of Unit 1 on November 1, 1979.

LEAST SANDPIPER _Calidris minutilla_. Common migrant and fairly common winter visitor to marshes, mudflats and margins of ponds. Small flocks observed sporadically in fall and winter on mudflats of Unit 1. Also observed in late winter and spring on flooded Agricultural Fields and along Ballona Lagoon.

DUNLIN _Calidris alpina_. Fairly common migrant and winter visitor to mudflats and salt marshes along coast. Small numbers observed in winter on mudflats of Unit 1 and the Agricultural Fields.

SHORT-BILLED DOWITCHER *Limnodromus griseus*. Fairly common migrant along coast. Rarely seen in winter. Usually observed on mudflats and beaches near water. Scattered flocks seen around water on all sites from late summer through spring. Difficult to separate from the following species.

LONG-BILLED DOWITCHER *Limnodromus scolopaceus*. Fairly common migrant and occasional winter visitor in marshes, on beaches and mudflats along coast. Observed in small flocks at water margins on all sites from late summer to early spring. Numbers peak in late winter. Particularly common on Unit 1 and the Agricultural Fields when the latter are flooded. Most dowitchers observed in the region appear to be this species.

WESTERN SANDPIPER *Calidris mauri*. Common spring and fall transient and fairly common winter visitor on mudflats or moist shores of both fresh and salt water. Observed regularly on mudflats and wet saltflats of Unit 1 from late summer through mid-spring. Numbers greatest in late fall and late winter. Also fairly abundant on flooded areas of Agricultural Area in late winter. Observed sporadically on all other sites.

MARBLED GODWIT *Limosa fedoa*. Common winter visitor and migrant on mudflats, beaches and marshland along coast. Occasionally seen in wet areas further inland. Observed regularly on mudflats and along canals from late summer to mid-spring, with numbers peaking in late fall and late winter. Individuals observed at all sites, but particularly abundant on Unit 1 and along Ballona Lagoon.

SANDERLING *Calidris alba*. Common migrant and winter visitor along beaches of coast. Somewhat less common on mudflats. Observed on mudflats of Unit 1 from late fall to early spring, with numbers greatest in mid-late winter. Small flocks present on flooded agricultural fields in winter.

FAMILY RECURVIROSTRIDAE

AMERICAN AVOCET *Recurvirostra americana*. Fairly common transient on mudflats along coast. Small numbers observed sporadically on mudflats of Unit 1 in late summer and fall, and again in early spring. Also observed on wet agricultural fields.

BLACK-NECKED STILT *Himantopus mexicanus*. Fairly common migrant and winter visitor on mudflats along southern California coast. Observed commonly on wet mudflats of Unit 1 from late fall through early spring. Also seen occasionally on mudflats and temporary pools of Units 2 and 3 during the same period. Forage in standing water on agricultural fields during mid-winter.

FAMILY PHALAROPODIDAE

RED PHALAROPE *Phalaropus fulicarius*. Uncommon spring and fall migrant and occasional winter visitor to beaches and mudflats in coastal southern California. Observed on flooded mudflats of Unit 1 in spring and summer 1980.

WILSON'S PHALAROPE *Steganopus tricolor*. Uncommon spring and fall migrant on mudflats and beaches along coast. Individuals observed on mudflats of Unit 1 and along canal of Unit 2 in spring and summer.

NORTHERN PHALAROPE *Lobipes lobatus*. Fairly common migrant along coast. Largely restricted to quiet bays and lagoons, but sometimes seen far at sea. Regularly seen in late summer and early fall 1980 on standing water of Unit 1, but absent in 1979.

FAMILY STERCORARIIDAE

POMARINE JAEGER *Stercorarius pomarinus*. Unusual fall transient along coast in southern California. One individual observed resting on mudflats of Unit 1 in early December 1979.

FAMILY LARIDAE

GLAUCOUS-WINGED GULL *Larus glaucescens*. Relatively uncommon winter visitor along coast of southern California. Seldom seen inland. One individual observed on Unit 1 in winter 1981.

WESTERN GULL *Larus occidentalis*. Common resident in coastal southern California, but restricted to offshore islands for breeding, south of San Luis Obispo County. Observed irregularly from early fall through spring loafing on mudflats of Unit 1 and Ballona Lagoon. One sighting in March on Unit 3.

CALIFORNIA GULL *Larus californicus*. Common spring and fall transient and winter ~~inter~~ visitor. May be found in virtually any open area with nearby water but more common along coast. Observed on all but Unit 2 but most common on Unit 1 and the flooded Agricultural Fields. Primarily observed in winter months.

RING-BILLED GULL *Larus delawarensis*. Common visitor in all seasons. Numbers diminish appreciably in summer. May be found in variety of habitats where some moist ground is available for foraging. This species may be observed in all seasons soaring over all study sites. Particularly utilize wet mudflats for loafing whenever available.

BONAPARTE'S GULL *Larus philadelphia*. Very common migrant and winter visitor around protected waters and wet agricultural fields along coast. Seen in large numbers on mudflats of Unit 1 from mid-fall to mid-spring. Observed in smaller numbers on Ballona Lagoon, Unit 3 and overflying Unit 2. Very abundant on agricultural fields when these sites are flooded in winter.

HEERMAN'S GULL Larus heermanni. Primarily late summer and fall visitor. Some individuals present in all seasons. Restricted to coastal areas. Occasional vagrants observed loafing on mudflats of Units 1, 3 and Ballona Lagoon during fall and winter.

FORSTER'S TERN Sterna forsteri. Common migrant and winter visitor around bays, lagoons and other protected waters along coast. Commonly observed in varying numbers on mudflats of Units 1, 3, Ballona Lagoon and the Agricultural Fields from late summer through early spring. Most common in late fall and winter on Unit 1 and the Agricultural Area, when these habitats are wet. Some individuals seen even during late spring and summer.

LEAST TERN Sterna albifrons. Uncommon summer visitor, from late April to September or October along protected portion of coast. Formerly nested on upper beaches at a number of locations along California coast. Breeding now limited to a small number of managed sites in southern California and around San Francisco Bay. Least Terns nest and roost on the salt/mudflats of Unit 1 from late April to August. Terns feed in the marina, Ballona Creek, Ballona Lagoon and the large canal of Unit 1. Single individuals were observed on several occasions in spring 1980 foraging in the waters of the Los Angeles County Bird Conservation Area. Terns were observed in flight over all study sites within the wetlands. Breeding appeared to be inhibited on Unit 1 in 1980 and 1981, as most of the mud/saltflats were flooded.

ELEGANT TERN Sterna elegans. Fairly common fall migrant and occasional winter visitor along southern California coast. A few individuals observed on mudflats of Unit 1 in late summer.

CASPIAN
~~CASPIAN~~ TERN Sterna caspia. Common migrant along coastal southern California in both spring and fall. One to a few individuals observed in late summer on mudflats of Unit 1 and Ballona Lagoon and flying over Units 2 and 3.

ORDER COLUMBIFORMES

FAMILY COLUMBIDAE

ROCK DOVE Columba livia. Common resident in urban, suburban and agricultural areas. Resident in urban areas surrounding Ballona region. Regularly observed in open, grassy upland habitats in all study areas. Large flocks forage in the agricultural fields.

MOURNING DOVE Zenaida macroura. Common resident in open woodlands, agricultural areas, parks, residential areas. Numbers increase in winter. Regularly seen througout the year in dry upland habitat everywhere in region. Roosts in trees and shrubs but forages on ground in open, grassy areas.

SPOTTED DOVE Streptopelia chinensis. Common resident in urban areas of coastal southern California, which comprises its entire North American range. Introduced. Resident in urban areas surrounding the region. Regularly observed in all seasons at Ballona Lagoon.

ORDER STRIGIFORMES

FAMILY STRIGIDAE

BURROWING OWL Athene cunicularia. Fairly common resident in dry agricultural lands and bare open areas with soft banks or bluffs for nest burrows. Two pairs apparently nest in banks adjacent to Ballona Creek on Unit 3. Owls were occasionally observed on Units 1 and 2 and along bluffs south of the agricultural area, where they probably nest.

LONG-EARED OWL *Asio otus*. Fairly common but widely scattered resident and transient. Usually found in riparian or oak woodland. One or two individuals flushed from trees along Unit 3 in fall 1980.

SHORT-EARED OWL *Asio flammeus*. Uncommon transient in fresh- and saltwater marshes and agricultural lands. Formerly bred at least occasionally in basin (Grinnell & Miller, 1944), but there apparently are not recent records. One bird was seen on Unit 3 in February of 1979.

ORDER APODIFORMES

FAMILY APODIDAE

VAUX'S SWIFT *Chaetura vauxi*. Fairly common spring and fall migrant along the southern California coastline. A single individual was observed soaring along the main canal of Unit 1 in early May 1980.

FAMILY TROCHILIDAE

ANNA'S HUMMINGBIRD *Calypte anna*. Common resident in open woodland, shrubland, parks and residential areas with appropriate vegetation. Observed in all seasons and in every study site within the Ballona region. Generally restricted to drier habitats with open shrubs providing perch sites.

ORDER CORACIIFORMES

FAMILY ALCEDINIDAE

BELTED KINGFISHER *Megaceryle alcyon*. Fairly common resident near waters containing fish. Observed regularly near water on all study sites within the region.

ORDER PICIFORMES

FAMILY PICIDAE

COMMON FLICKER Colaptes auratus. Common resident in open woodlands and parks throughout basin. Observed irregularly throughout the year in wooded portions of the Ballona region.

ORDER PASSERIFORMES

FAMILY TYRANNIDAE

WESTERN KINGBIRD Tyrannus verticalis. Fairly common migrant in open lowland habitats with scattered trees. Observed sporadically in grassy upland habitats of Units 2, 3 and the Agricultural Fields in the spring and fall.

ASH-THROATED FLYCATCHER Myiarchis cinerascens. Fairly common migrant and occasional summer resident in lowlands and foothills. Nests in mountain woodlands ~~bedlands~~ around basin. Single individuals were observed on several occasions foraging over upland habitats of Units 1, 2, 3 and the Agricultural Fields from late July through September. A single individual was observed in May 1980 on Unit 3.

BLACK PHOEBE Sayornis nigricans. Common permanent resident in agricultural areas, brushlands, woodlands and suburbs near water. Require moderately elevated perch sites. Single individuals observed along canals of Units 1, 2, 3 and the Agricultural Fields during the fall and winter.

SAY'S PHOEBE Sayornis saya. Fairly common migrant and occasional winter visitor to open, grassy habitats such as fallow agricultural fields. Scattered individuals observed in upland habitats of Units 1, 2, 3 and the Agricultural Fields from late summer to early spring. Numbers greatest in fall.

WESTERN WOOD PEWEE Contopus sordidulus. Common spring and fall migrant and transient in wooded areas, usually near water. Nests in riparian woodlands of nearby mountains. A single individual was observed foraging around trees on Unit 2 in May 1979.

FAMILY HIRUNDINIDAE

VIOLET-GREEN SWALLOW Tachycineta thalassina. Common spring and fall migrant in open habitats over or near water. Nests in mountains surrounding Los Angeles basin. Occasional flocks observed over open areas of Units 1, 2, 3 and the Agricultural Fields in late winter and early spring.

BANK SWALLOW Riparia riparia. Uncommon transient in open areas near water in lowland southern California. A small flock was observed over Unit 3 in September 1980.

ROUGH-WINGED SWALLOW Stelgidopteryx ruficollis. Fairly common migrant and summer resident near water. Require soft banks for nesting tunnels. Single flock observed over Unit 1 and Agricultural Fields in early spring 1979.

BARN SWALLOW Hirundo rustica. Fairly common migrant and occasional summer resident in open areas near water. Requires mud for nest construction. Small numbers observed foraging over open areas of Units 1, 2, 3, Ballona Lagoon and the Agricultural Fields from late winter through late summer.

CLIFF SWALLOW Petrochelidon pyrrhonota. Common summer resident in open habitats near water. Require natural or man-made cliffs (concrete bridges, etc.) for nesting. Large flocks regularly observed over Units 1 and 3 from early spring to late summer. Less commonly seen over Agricultural Fields and Unit 2 during same time period.

FAMILY CORVIDAE

SCRUB JAY Aphelocoma coerulescens. Common resident in woodland, chaparral and urban areas with trees. A common resident of wooded urban areas surrounding the Ballona region. Observed commonly around trees of Unit 2 and in willow thicket of Unit 1.

COMMON RAVEN Corvus corax. Common resident in rocky areas of the foothills and mountains around the Los Angeles basin. Less common within the city than the Common Crow. Ravens were seen in April and June 1980 soaring above Unit 1, and in June 1980 over Unit 2.

FAMILY PARIDAE

COMMON BUSHTIT Psaltriparus minimus. Common resident of chaparral and coastal sage habitats in basin foothills. Flocks disperse widely outside breeding season. Occasional flocks observed foraging in lower canopy of trees on Unit 2 in fall and winter.

FAMILY TROGLODYTIDAE

LONG-BILLED MARSH WREN Cistothorus palustris. Fairly common migrant and winter visitor around fresh and brackish water marshes, with tall emergent vegetation. Probably formerly a breeding species in the Ballona region (Grinnell & Miller, 1944). Commonly recorded around clumps of pampas grass on Units 2 and 3 and in mixed stands of tall annuals and Salicornia on Unit 1 from mid-fall to early spring.

FAMILY MIMIDAE

MOCKINGBIRD Mimus polyglottos. Common resident in urban areas and along edges of brushlands and woodlands. Resident in urban areas surrounding Ballona.

Commonly observed in trees and shrublands of upland habitats throughout region in every season.

FAMILY SYLVIIDAE

BLUE-GRAY GNATCATCHER Polioptila caerulea. Common resident and transient in brushland and wooded chaparral. Observed in fall in trees bordering Unit 3.

RUBY-CROWNED KINGLET Regulus calendula. Common winter visitor in riparian woodlands or brush thickets (esp. willow) near water. Recorded in mid-winter in willow thickets of Unit 1.

FAMILY MOTACILLIDAE

WATER PIPIT Anthus spinoletta. Fairly common winter visitor in agricultural areas, grasslands and sandy beaches. Observed in small flocks on wet, plowed portions of agricultural fields in late winter. Several spring records from Unit 3 in open moist habitat.

FAMILY LANIIDAE

LOGGERHEAD SHRIKE Lanius leudovicianus. Common resident in areas with look-out perches and open areas for foraging. Resident on all study sites within region. Forage over both wet and dry open habitats.

FAMILY STURNIDAE

STARLING Sturnus vulgaris. Common resident around human habitation. Regularly observed in open habitats throughout region in all seasons. Large flocks frequently forage in the agricultural fields.

FAMILY PARULIDAE

YELLOW-RUMPED WARBLER *Dendroica coronata*. Common migrant and winter visitor; breed at higher elevations. Regularly observed in trees, shrubs and tall annuals throughout the region from October to early April.

COMMON YELLOWTHROAT *Geothlypis trichas*. Fairly common resident in wet habitats with reeds or cattails. Seen sporadically in all seasons among tall annuals and stands of pampas grass near canals on Units 2, 3 and the Agricultural Fields. Most common on Unit 2.

WILSON'S WARBLER *Wilsonia pusilla*. Common spring and fall migrant, most commonly in brushland (esp. willow thickets) near water. Surprisingly few individuals were recorded during the study.

FAMILY PLOCEIDAE

HOUSE SPARROW *Passer domesticus*. Common resident around human habitation. Introduced. Small flocks may be observed foraging in dry habitats around periphery of study sites in all seasons. Nest in palms and man-made structures all around the Ballona vicinity.

FAMILY ICTERIDAE

WESTERN MEADOWLARK *Sturnella neglecta*. Common resident in grasslands, agricultural areas and very open brushland habitat. Common resident of dry habitat throughout the wetlands. May forage over wetter portions of the study areas but return to drier marginal habitats for nesting and roosting.

YELLOW-HEADED BLACKBIRD *Xanthocephalus xanthocephalus*. Fairly unusual transient around marshes or wet agricultural fields. One to a few individuals were recorded on several occasions in April and May 1979 flying above Units 1, 2 and 3.

RED-WINGED BLACKBIRD *Agelaius phoeniceus*. Common resident in marshes, along ponds and in wet fields with some taller reeds, grasses, etc., for nesting. Seen in all seasons around canals and wetter habitats of Units 1, 2, 3 and the Agricultural Fields.

BREWER'S BLACKBIRD *Euphagus cyanocephalus*. Common resident in parks, agricultural fields, suburbs and other open areas with nearby trees. Only one record in Ballona Lagoon in late August 1980.

FAMILY THRAUPIDAE

WESTERN TANAGER *Piranga leudoviciana*. Common spring and fall migrant. Breed in higher life zones. Single individual observed in April 1979 on Unit 3.

FAMILY FRINGILLIDAE

HOUSE FINCH *Carpodacus mexicanus*. Common resident in open woodland and shrubland, both inside and outside of urban areas. Flocks move around in non-breeding season. Regularly observed in all seasons on all study sites within the study area. Frequents trees, shrubs and tall annuals in drier habitats. Numbers peak in fall.

LESSER GOLDFINCH *Carduelis psaltria*. Common resident in areas with scattered trees and/or large shrubs. Transient in non-breeding season. Observed in small numbers in willow thickets of Unit 1 and around margins of Unit 3.

BROWN TOWHEE *Pipilo fuscus*. Common resident in drier upland habitats with a combination of dense brush cover and open areas with grasses and annuals providing seeds. Apparently fairly common on hillsides above Unit 2 and the Agricultural Lands but rarely appear on study areas themselves. Recorded only from Units 2 and 3.

SAVANNAH SPARROW Passerculus sandwichensis. Uncommon local resident and fairly uncommon winter visitor in salt-water marshes and grassy habitats, usually near water. All of the Savannah Sparrows in the Ballona region are apparently resident members of the beldingi subspecies. Small breeding populations occur within Salicornia stands of Units 1 and 3. Sparrows were observed along canals bordered with Salicornia and in adjacent weedy habitats on Unit 2 and the Agricultural Fields from late summer through mid-winter but not during the breeding season. Basically homogeneous stands of Salicornia appear to be necessary for breeding of P. sandwichensis beldingi.

WHITE-CROWNED SPARROW Zonotrichia leucophrys. Resident within southern California area. Generally restricted to "natural" areas of variety of habitat types for breeding. Common winter visitor in brushy habitats of all study areas within the Ballona region. Present from early October to mid-April.

LINCOLN'S SPARROW Melospiza lincolnii. Fairly common migrant and winter visitor, usually in wet areas or near streams with available brush cover. Single individuals were seen in September 1980 in Unit 1 and in November 1980 on Unit 2.

LARK SPARROW Chondestes grammacus. Uncommon to fairly common breeder in most of its winter range along coast, usually near agricultural lands with some nearby brush cover. A single individual was observed on Unit 1 in April 1980.

SONG SPARROW Melospiza melodia. Common resident in appropriate habitat. Numbers increase somewhat in fall and winter. Observed in all seasons along canals, around clumps of pampas grass and areas with tall annuals providing singing perches. Resident in Units 1, 2, 3 and along canals in Agricultural Fields. Attain greatest density on Unit 2.

SOME CONCLUDING THOUGHTS

A total of 129 species of birds were recorded within the confines of our study areas during the course of this study. While this is an impressive number, it is not overwhelming, and as explained previously, is probably an underestimate of the total that use the region from time to time. Most of the species total is comprised of relatively uncommon species, which is typical of most biological communities. A relatively few species contributed heavily to the overall numbers of individuals recorded during our investigation.

The totals recorded here include two endangered subspecies, the California Least Tern and Belding's Savannah Sparrow, both of which breed at Ballona.

Most of the birds observed, both in terms of species and numbers, were migrants and wintering waterbirds. Relatively few birds utilize this area as a breeding ground. The reasons for this are diverse, and include various factors of human disturbance, but primarily relate to limiated habitat diversity. Pickleweed, perhaps the most "dominant" habitat within the region, is never diverse in terms of birds it can support. Other habitats within the region are rather simple also, lacking vertical complexity, and frequently are of introduced plant species which support few birds. Increasing the littoral zone and management for native plants in areas of higher elevation might enhanse the land bird population status of this region.

Since waterbirds make up the bulk of the total numbers of birds within the region, those units most heavily used by waterbirds show the greatest seasonal variability in numbers. While the total birds present on those units are at times impressive, more individuals actually use the region than even the high numbers indicate: many of these birds are probably transients, indicating that the individuals observed one week are probably not the same ones seen previously. The Ballona area may provide a crucial "way station" in terms of foraging and resting space for many of these transients. Preservation and enhancement of these resting and foraging grounds is critical.

In our view, the principal management concerns for the avian populations in the region should relate to endangered species and waterbirds. Maximum effort should be made to preserve and enhance the habitat value of Unit 1 for the sparrow and tern that nest in the area. In addition, appropriate habitat for migrating and wintering waterbirds should not be compromised. A secondary, yet critical, consideration involves enhancement of habitat diversity to actually increase the number of species that are found within the region. This primarily involves increasing the diversity of native shrub and tree plants present surrounding the wetlands. These are the principal concerns that motivate our specific recommendations incorporated in the overview of this study.

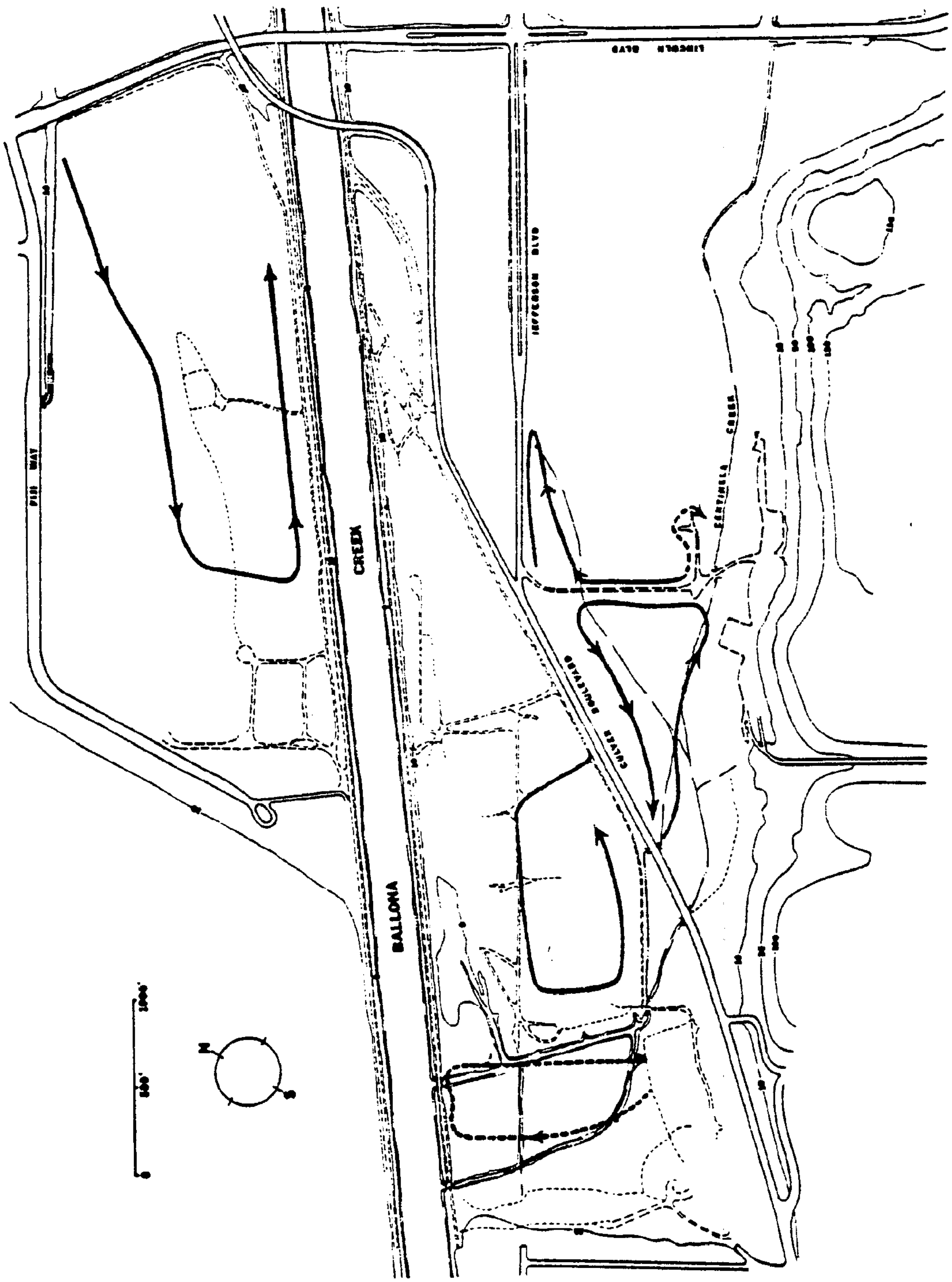

Figure 1. Transect routes used to study bird populations. Solid lines indicate regular routes, broken lines indicate alternate routes.

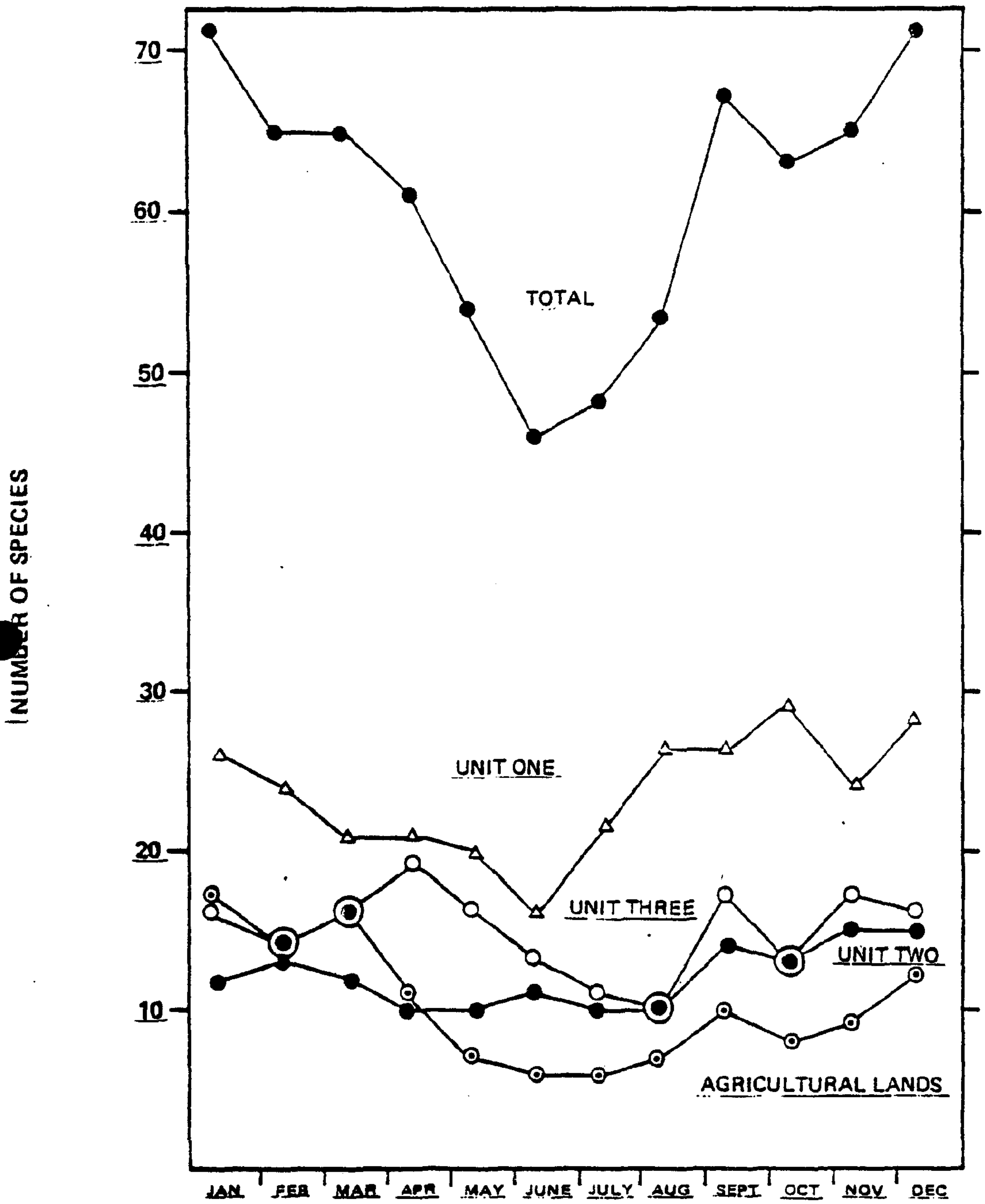

Figure 2. Numbers of species of birds by units and total region.

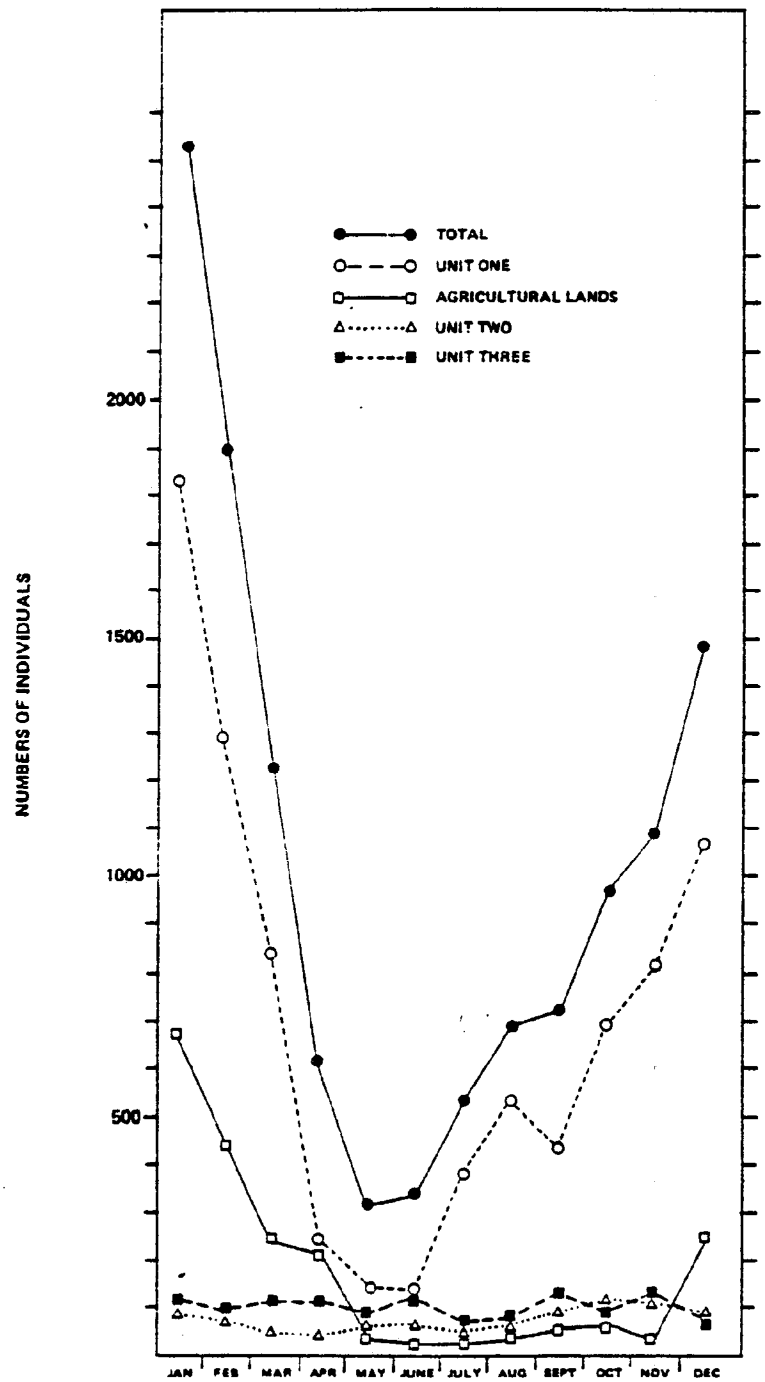

Figure 3. Numbers of individual birds by units and total region.

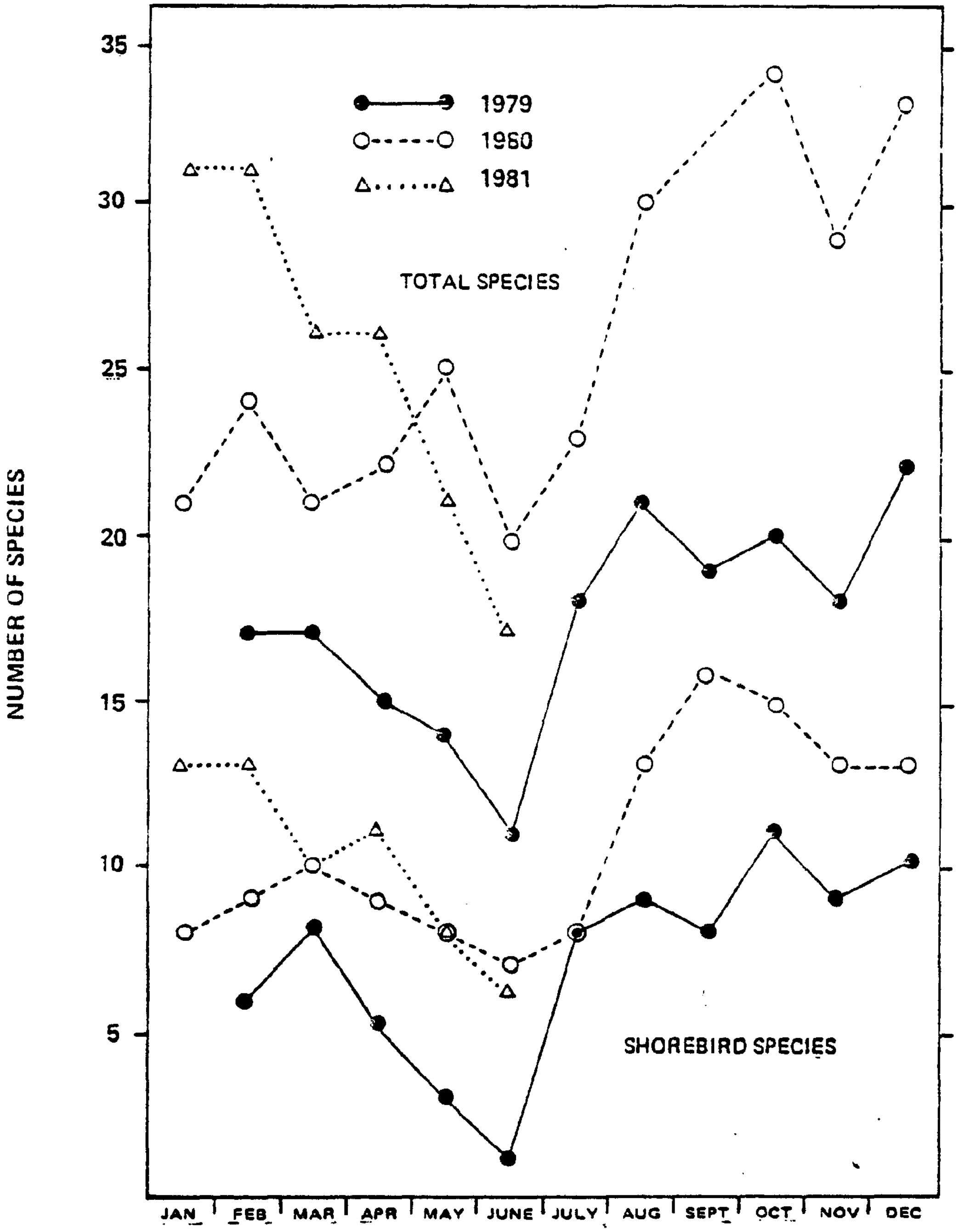

Figure 4. Total species of birds and shorebird species, Unit 1.

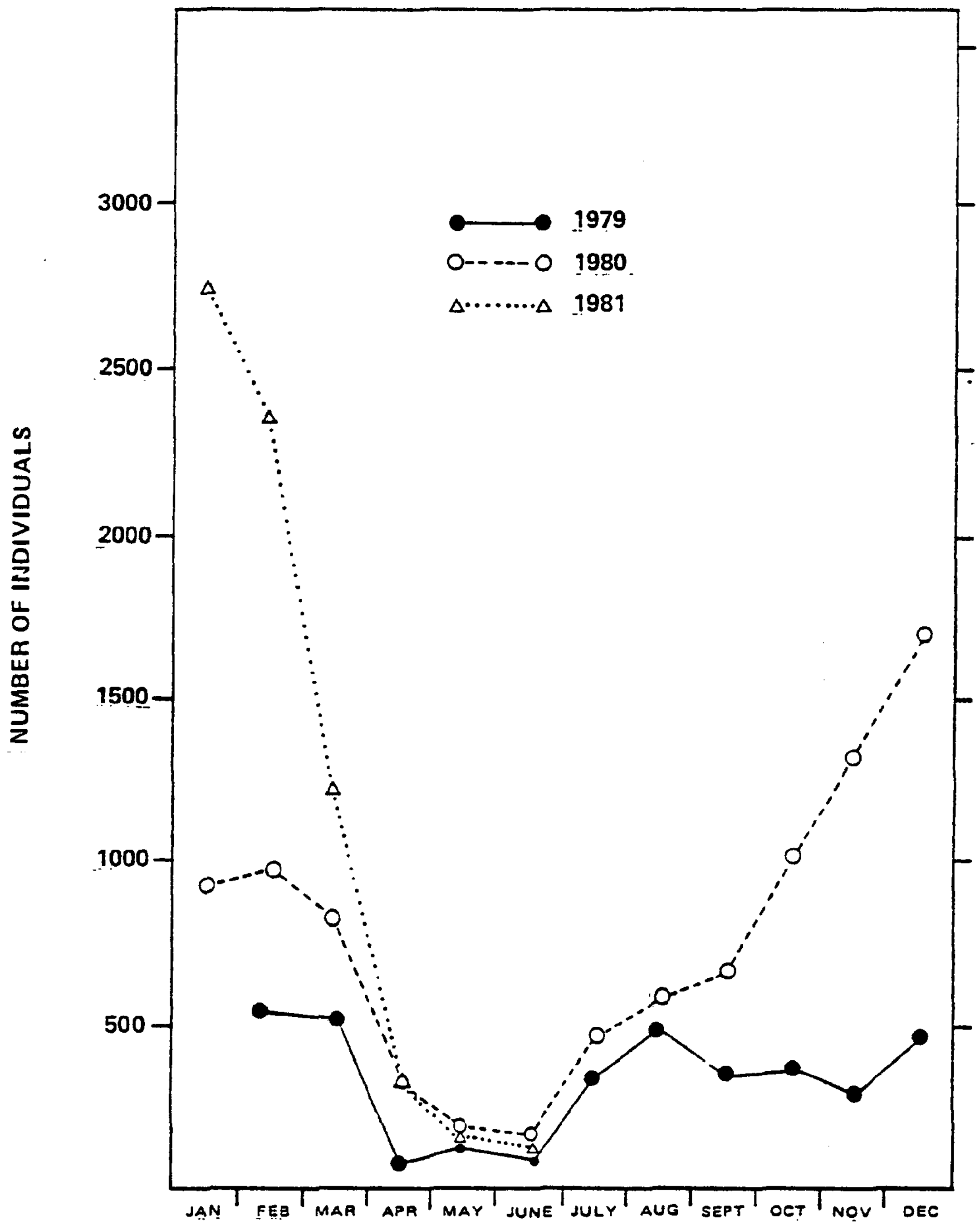

Figure 5. Numbers of individual birds, Unit 1.

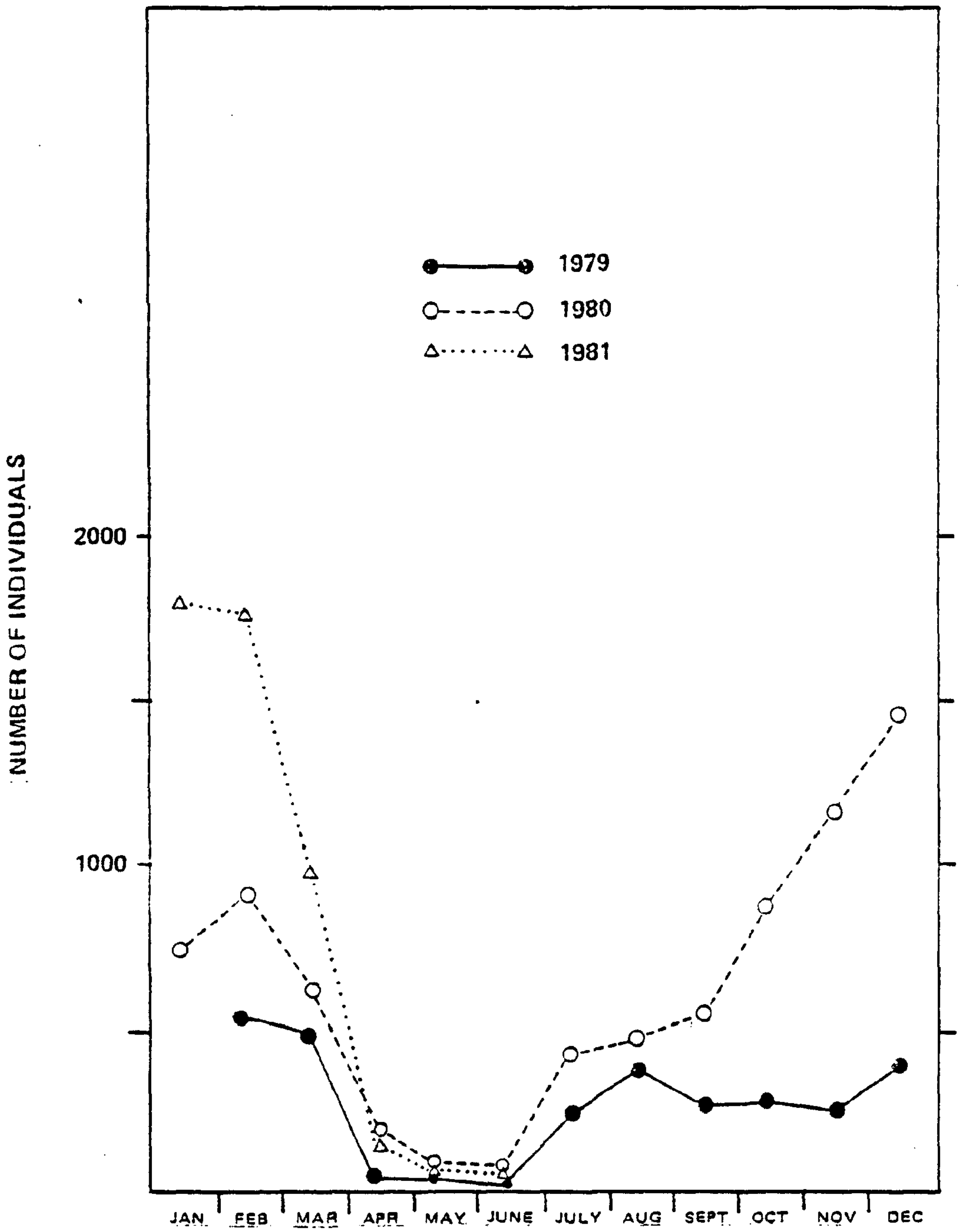

Figure 6. Numbers of shorebirds, Unit 1.

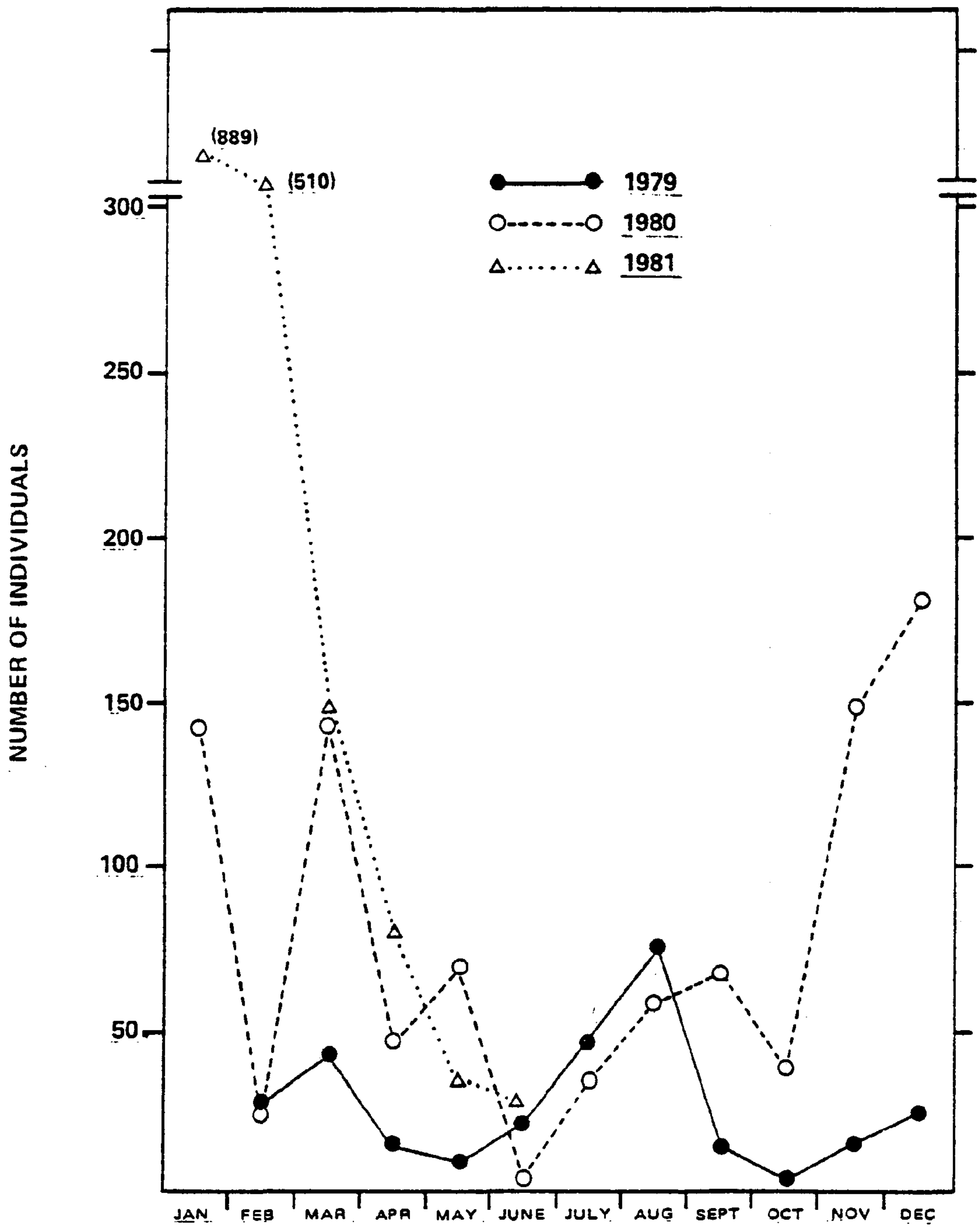

Figure 7. Numbers of gulls and terns, Unit 1.

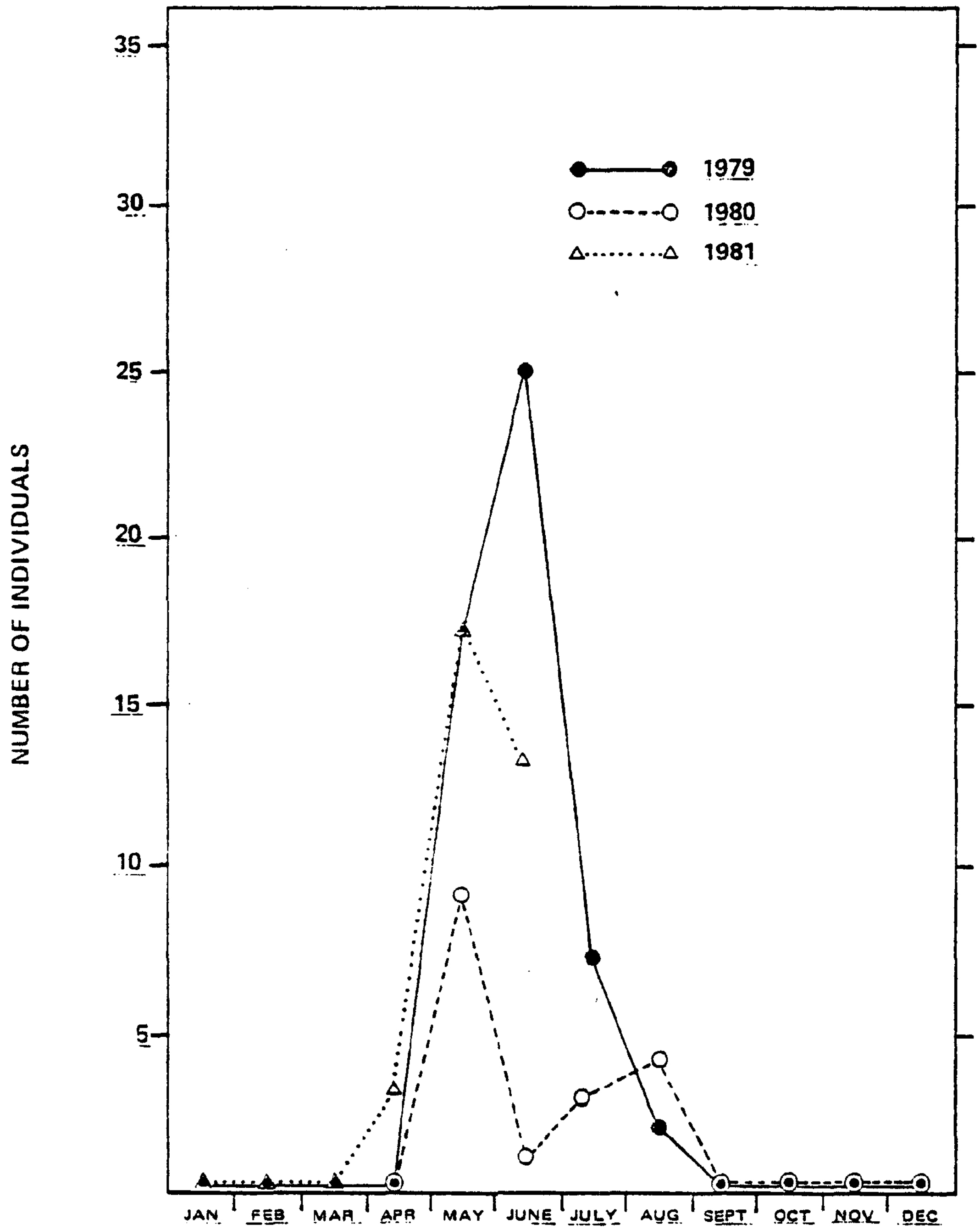

Figure 8. Numbers of Least Terns, Unit 1.

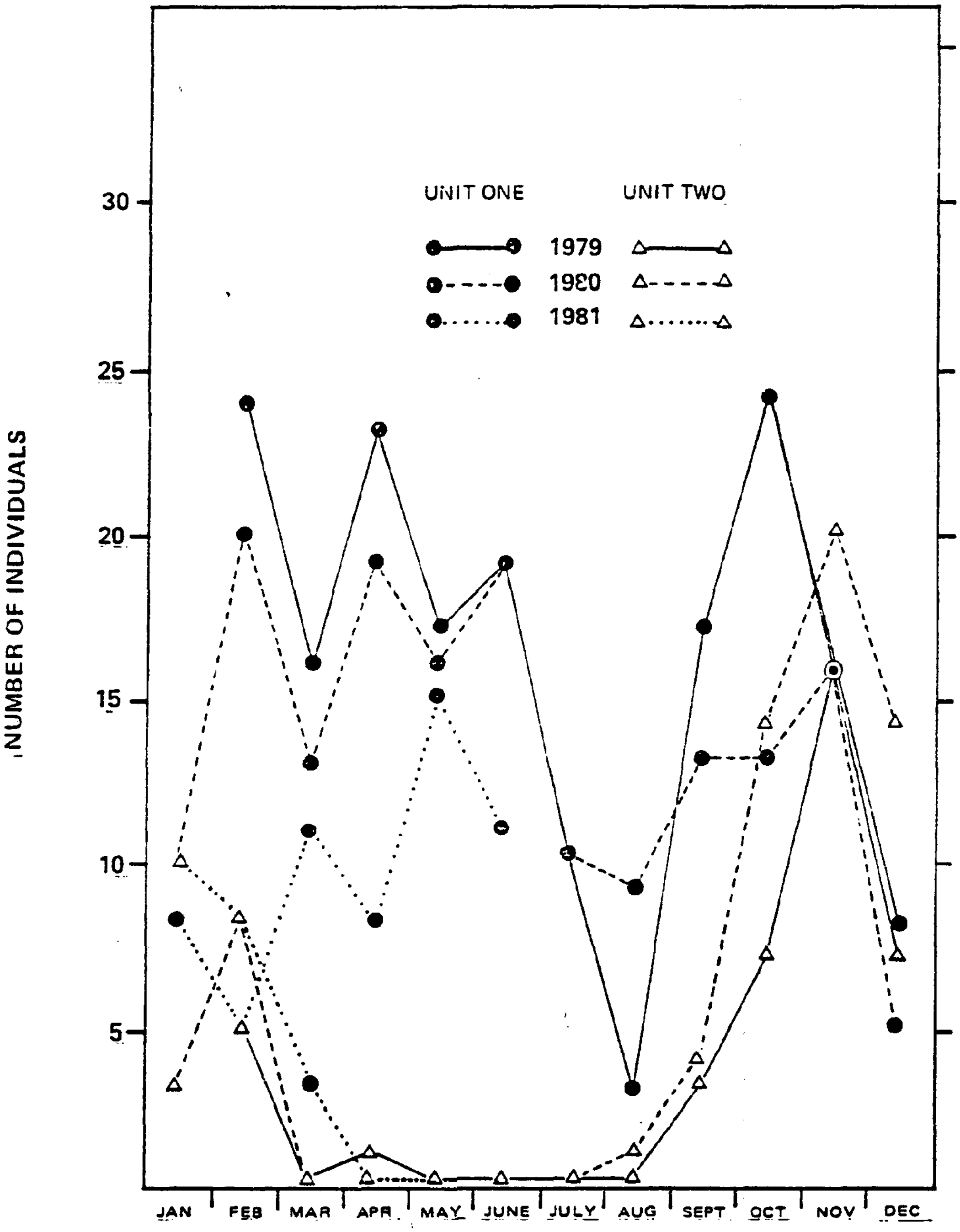

Figure 9. Numbers of Belding's Savannah Sparrows, Units 1 and 2.

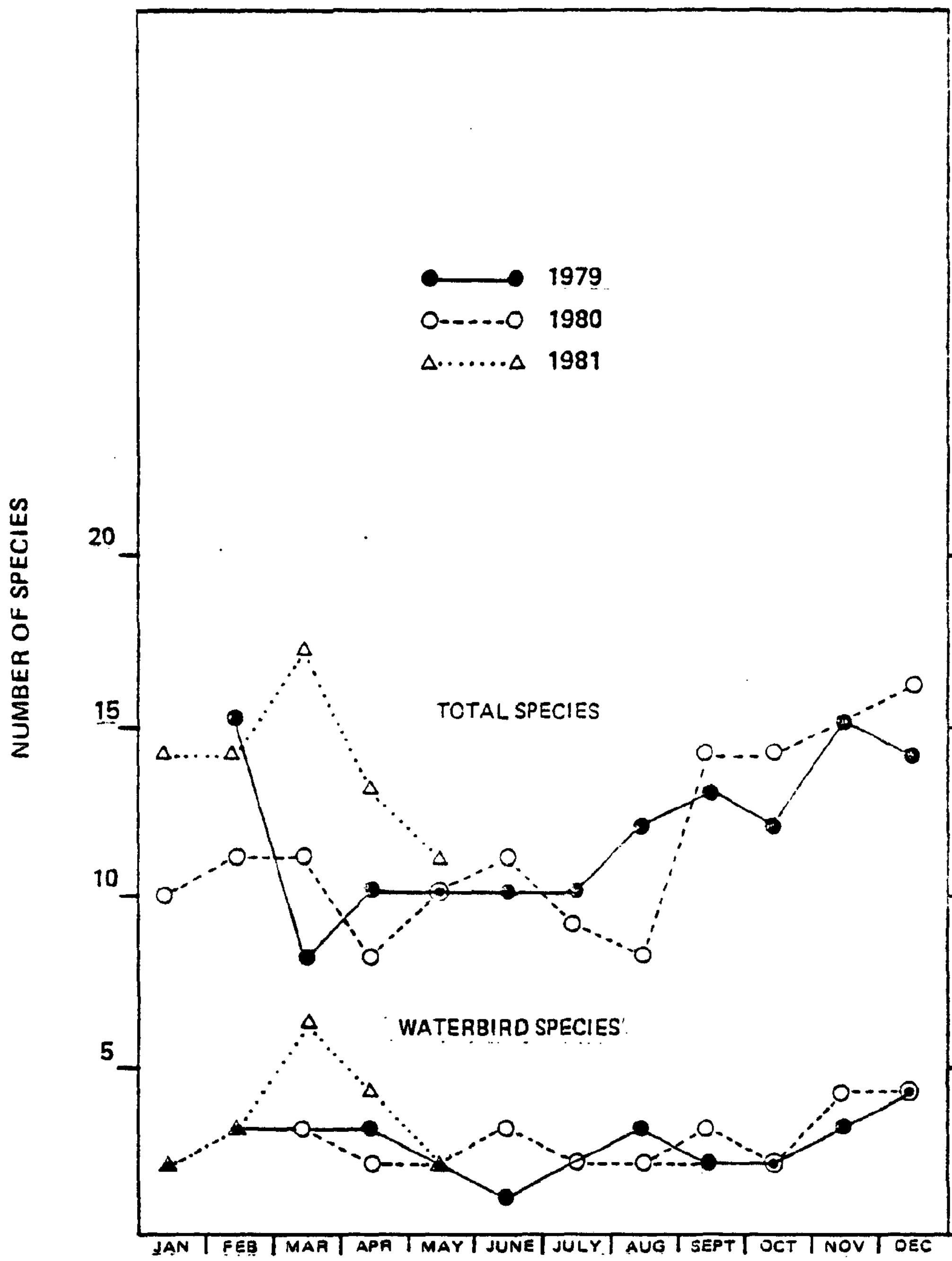

Figure 10. Numbers of species of birds and waterbird species, Unit 2.

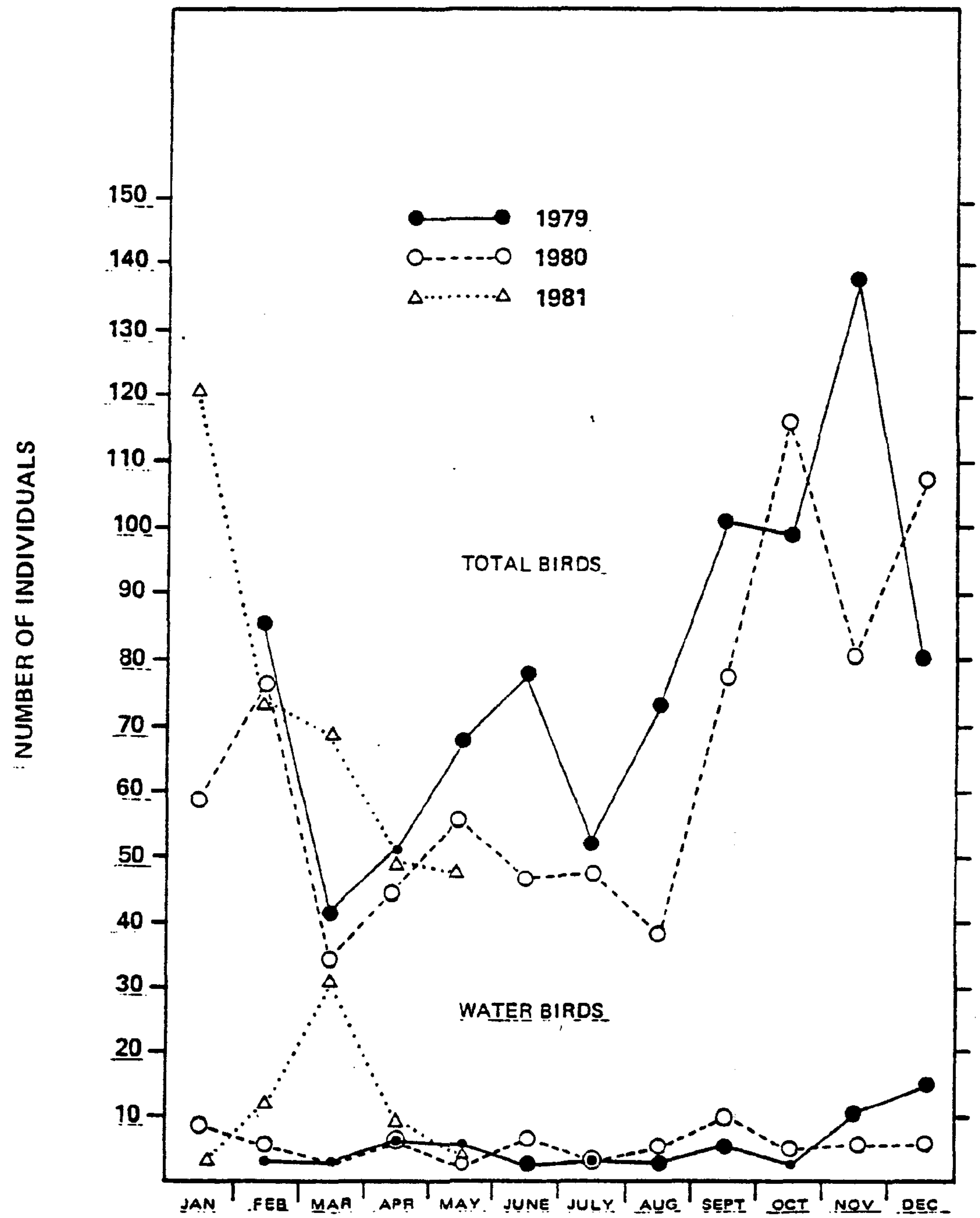

Figure 11. Numbers of individuals of all birds and waterbirds, Unit 2.

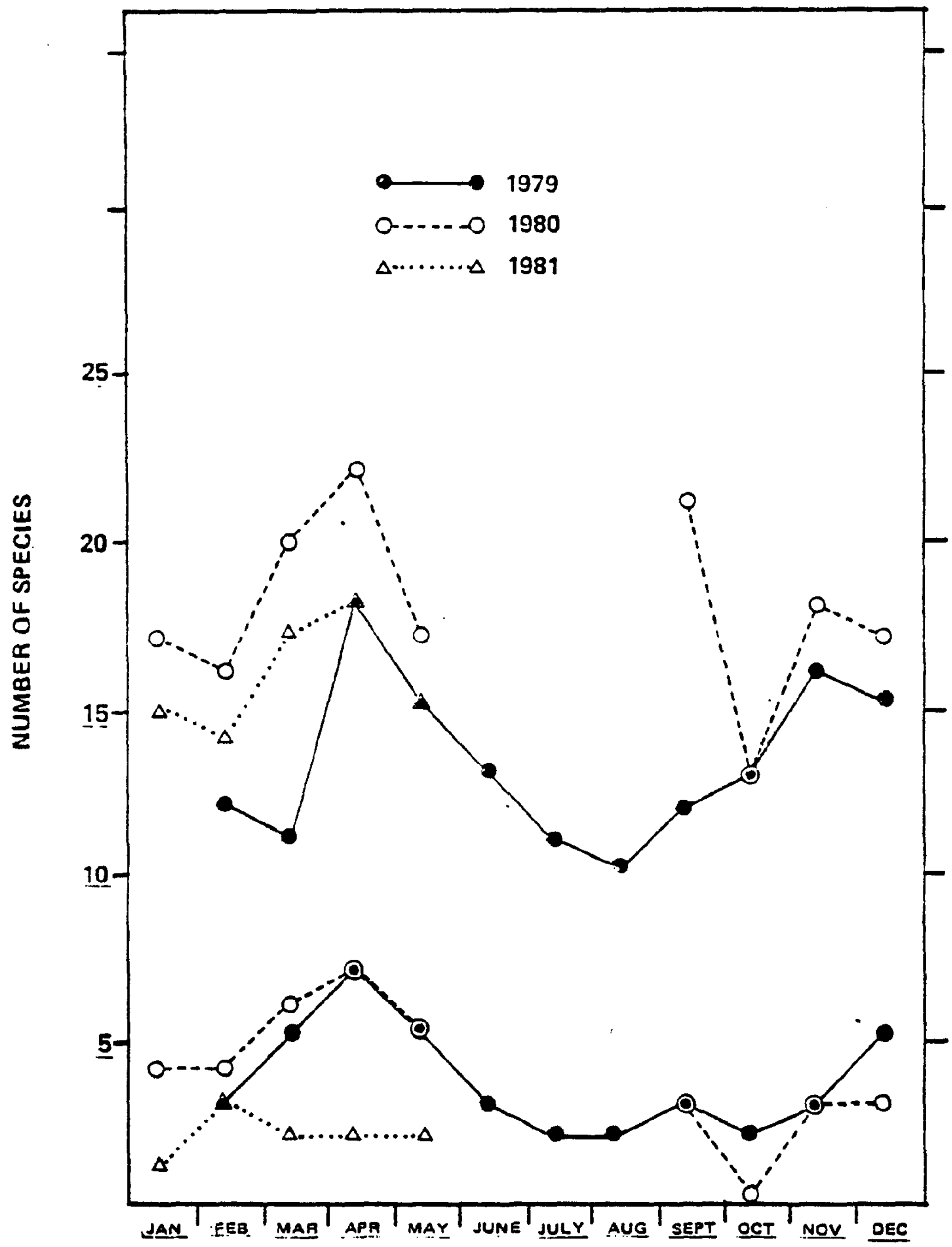

Figure 12. Numbers of bird species and waterbird species, Unit 3.

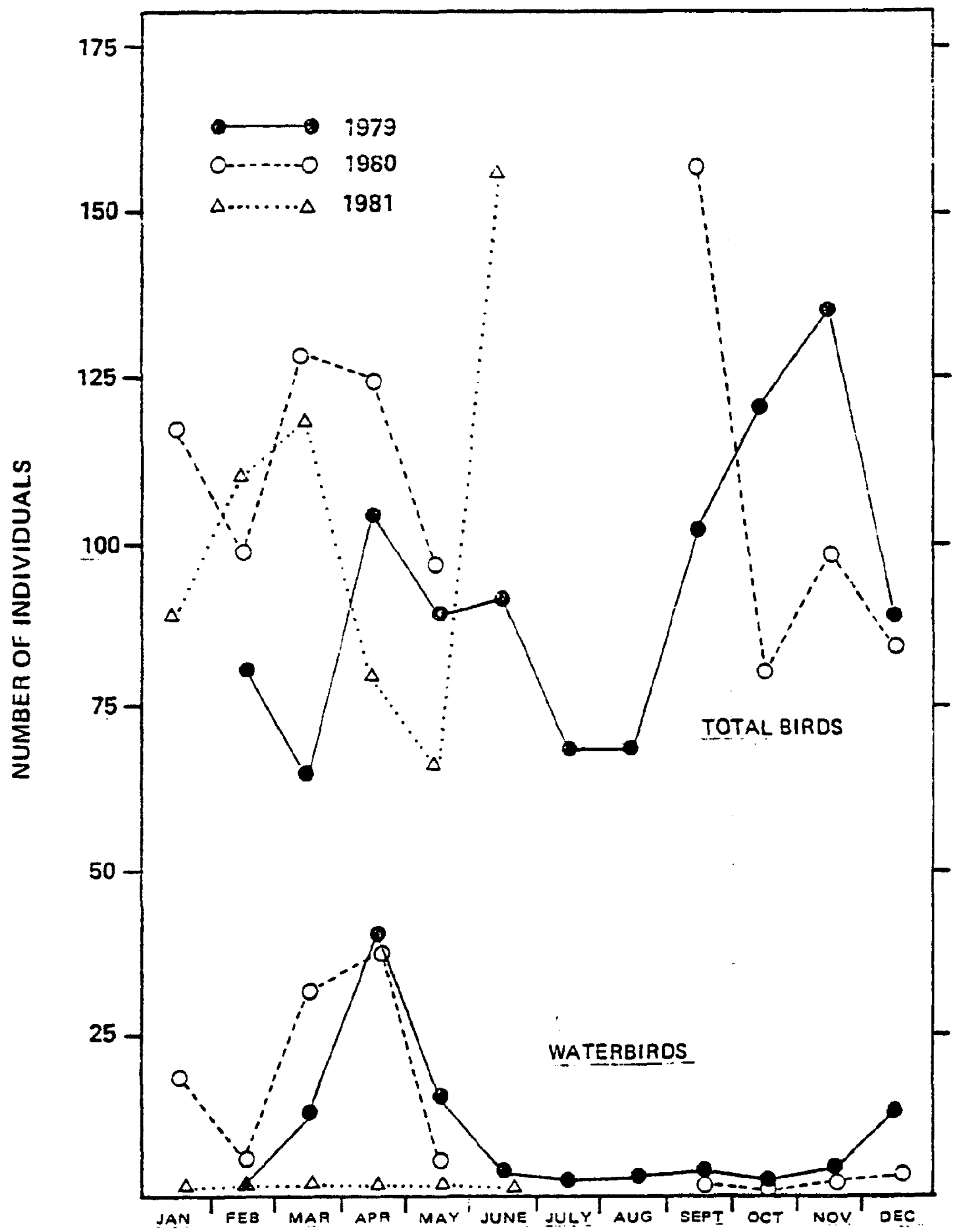

Figure 13. Numbers of individuals of all birds and waterbirds, Unit 3.

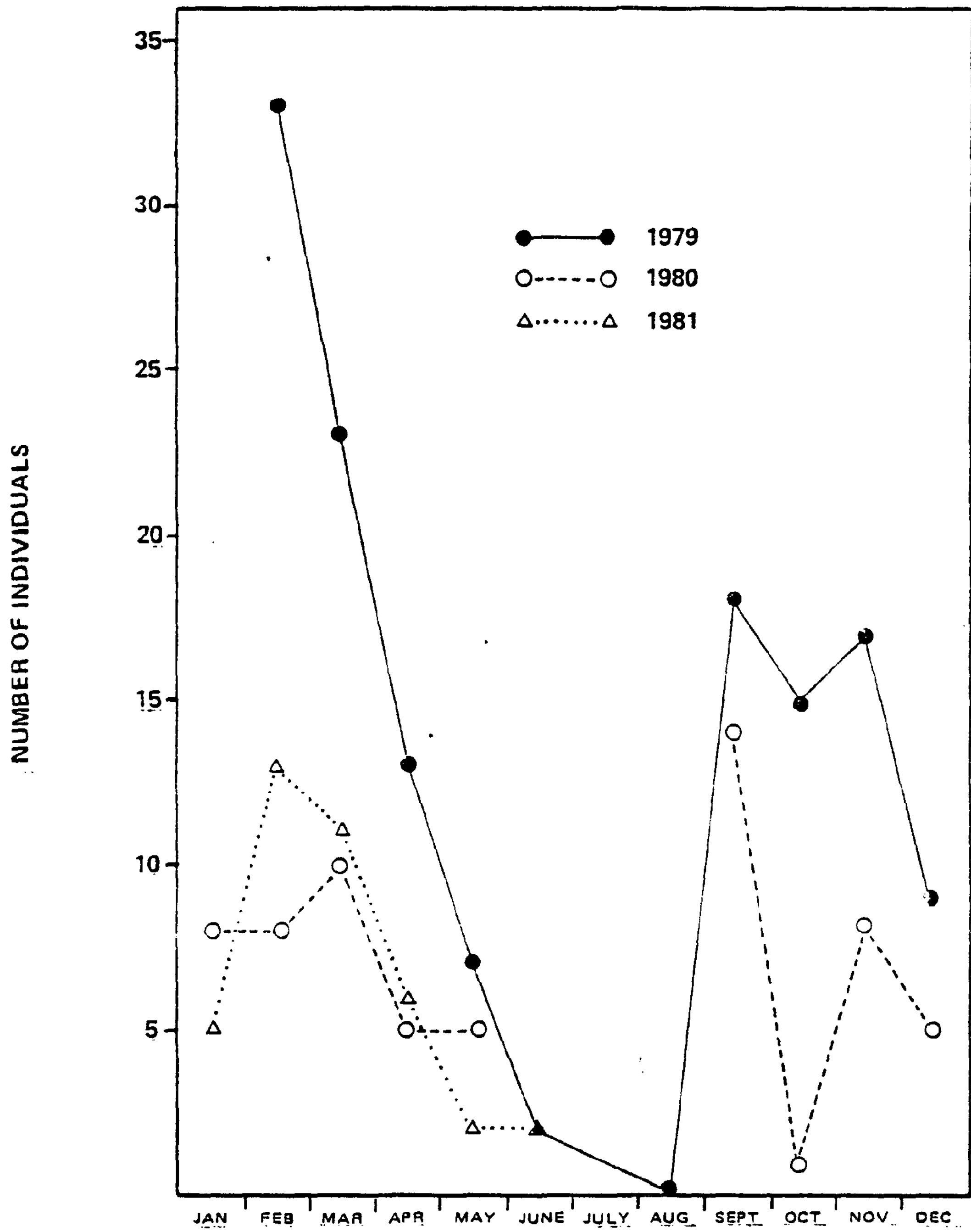

Figure 14. Numbers of Belding's Savannah Sparrows, Unit 3.

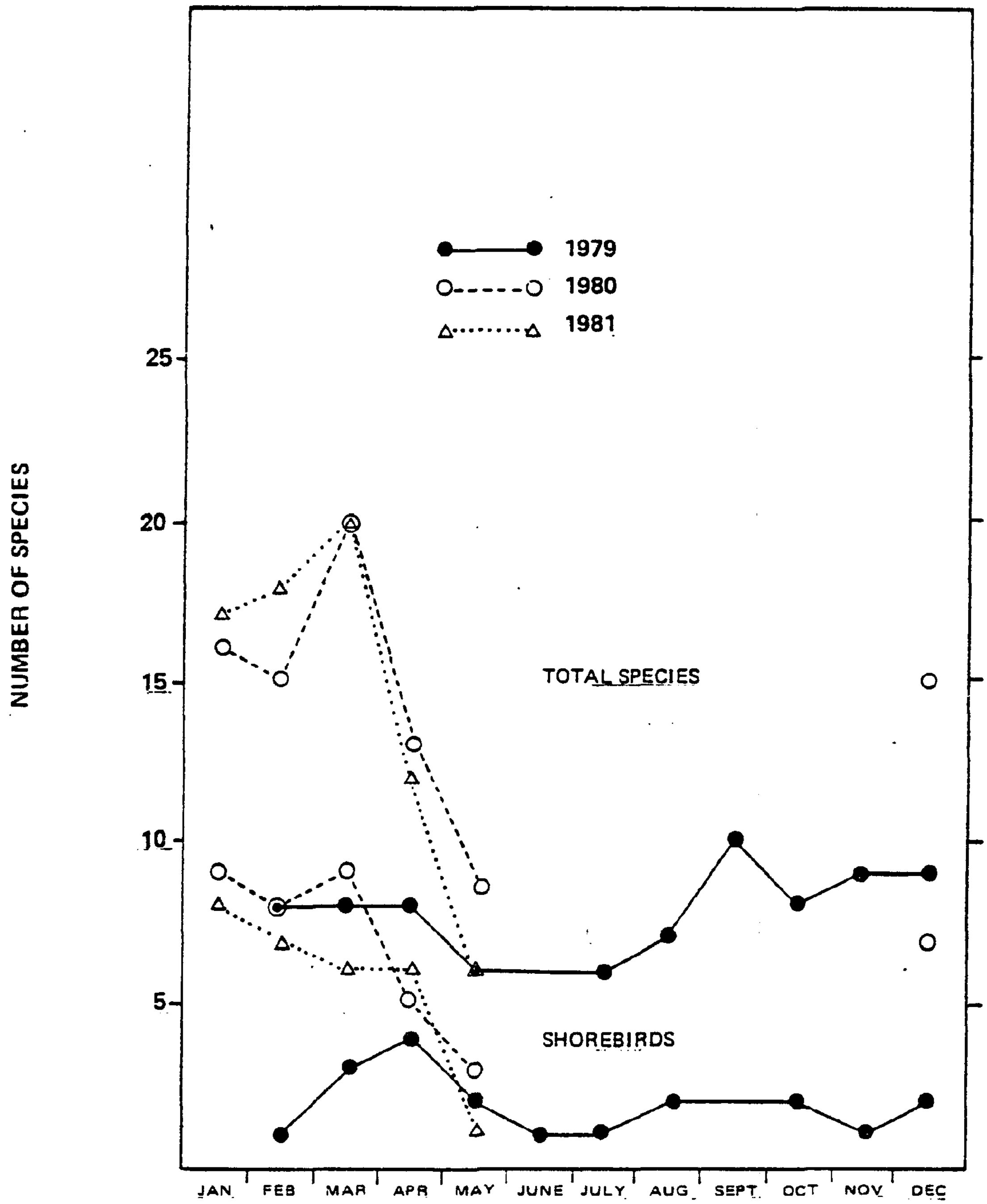

Figure 15. Numbers of species of birds and shorebirds, Agricultural Areas.

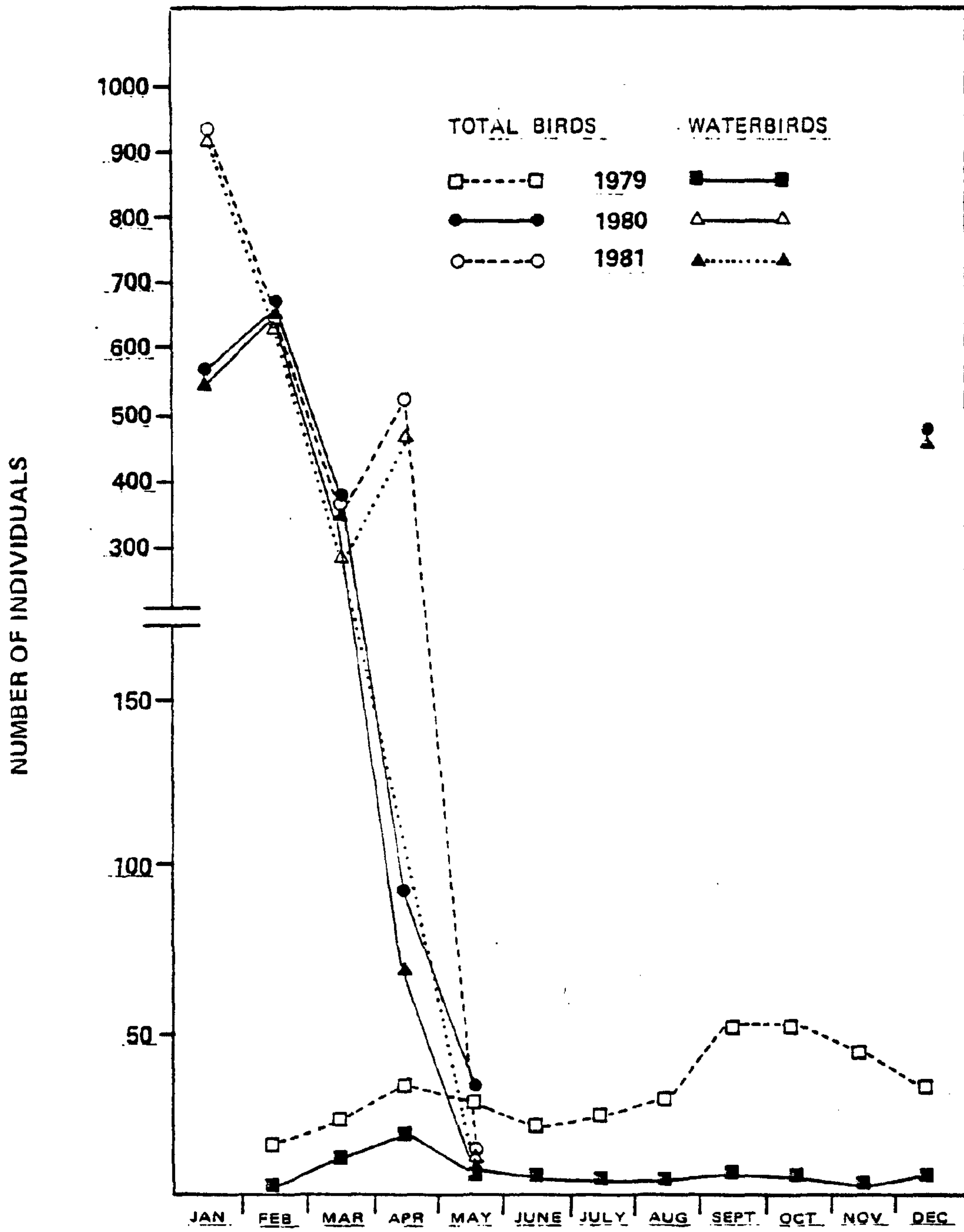

Figure 16. Numbers of individuals of all birds and waterbirds, Agricultural Areas.

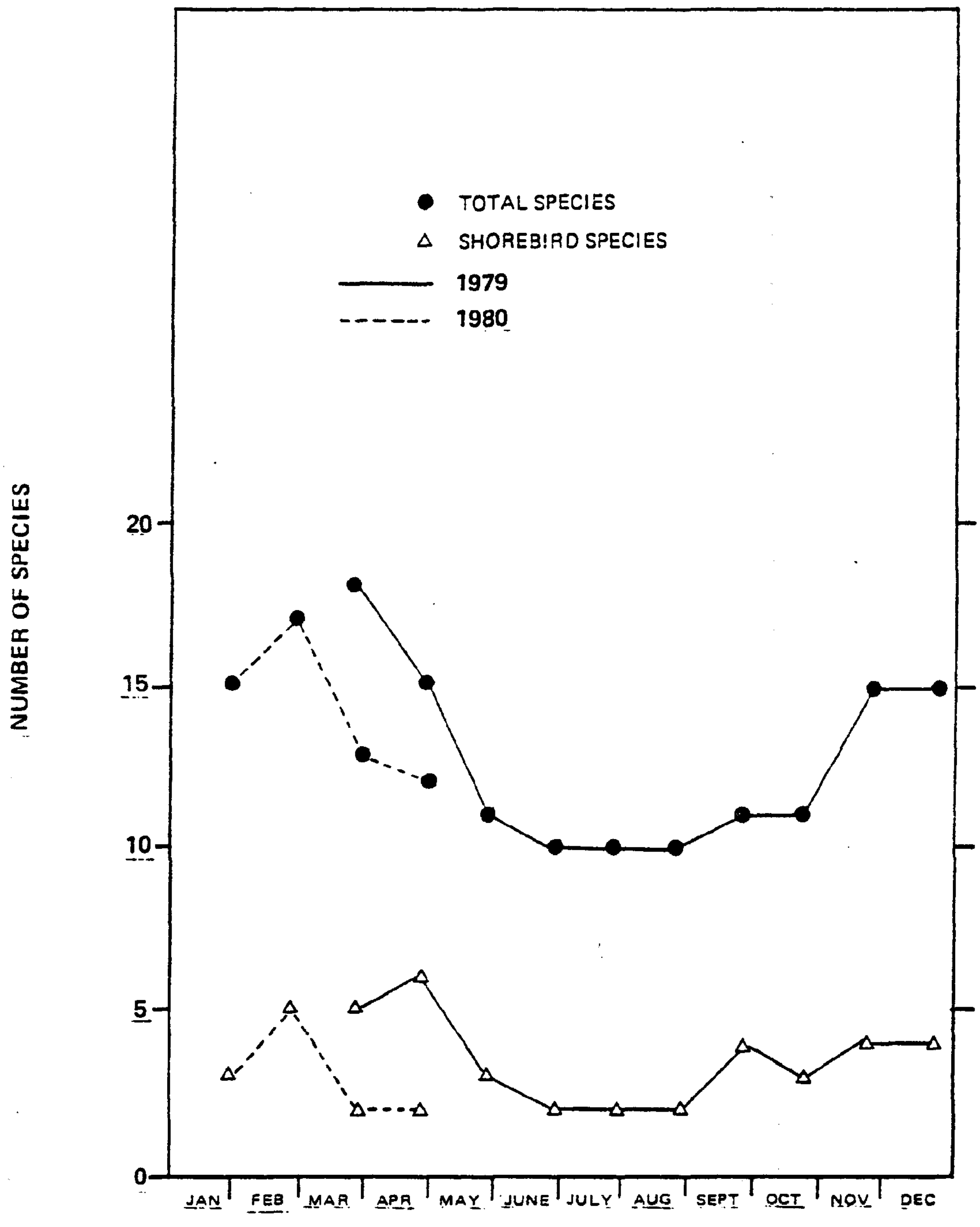

Figure 17. Numbers of species of birds and shorebird species, Ballona Lagoon.

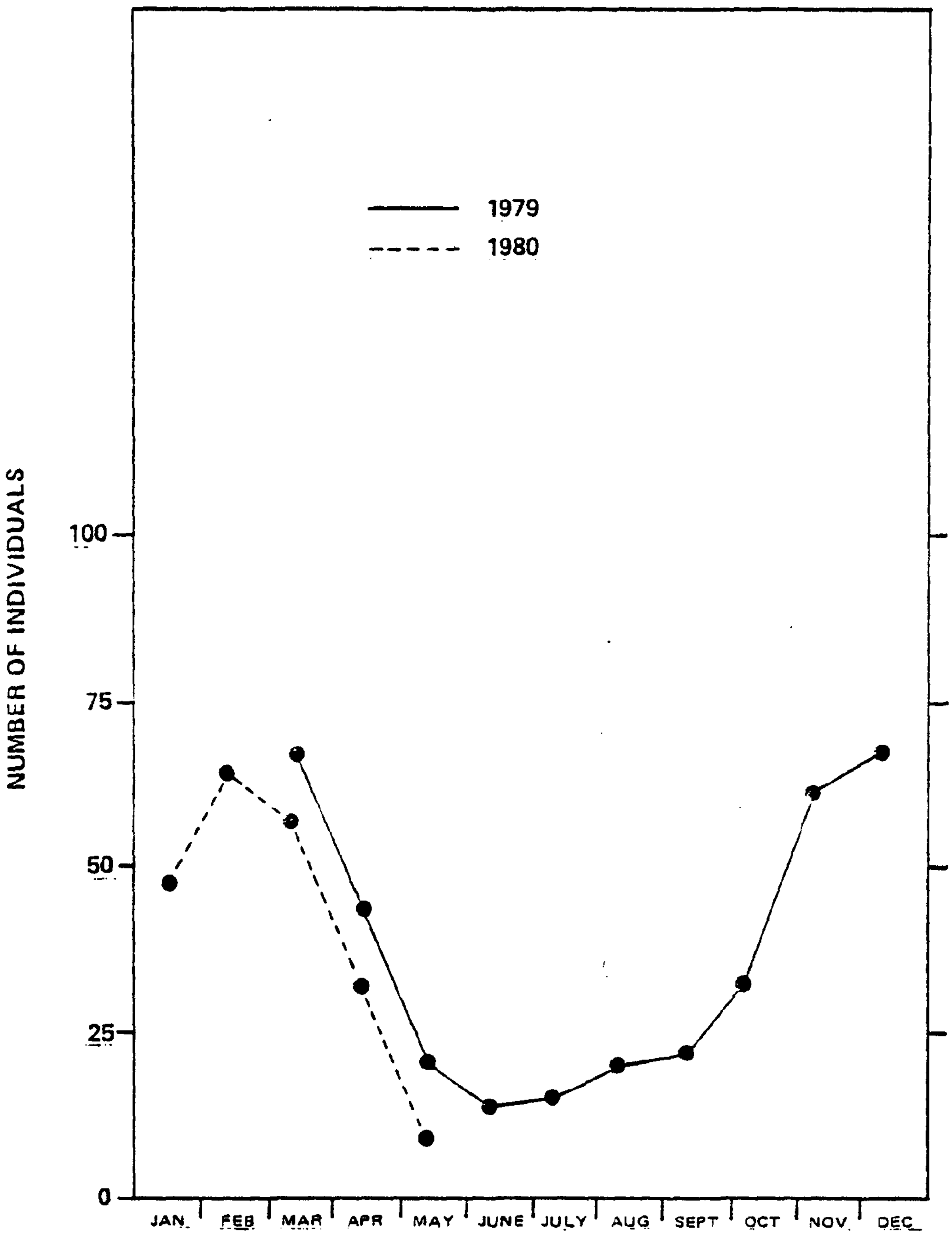

Figure 18. Numbers of individual waterbirds, Ballona Lagoon.

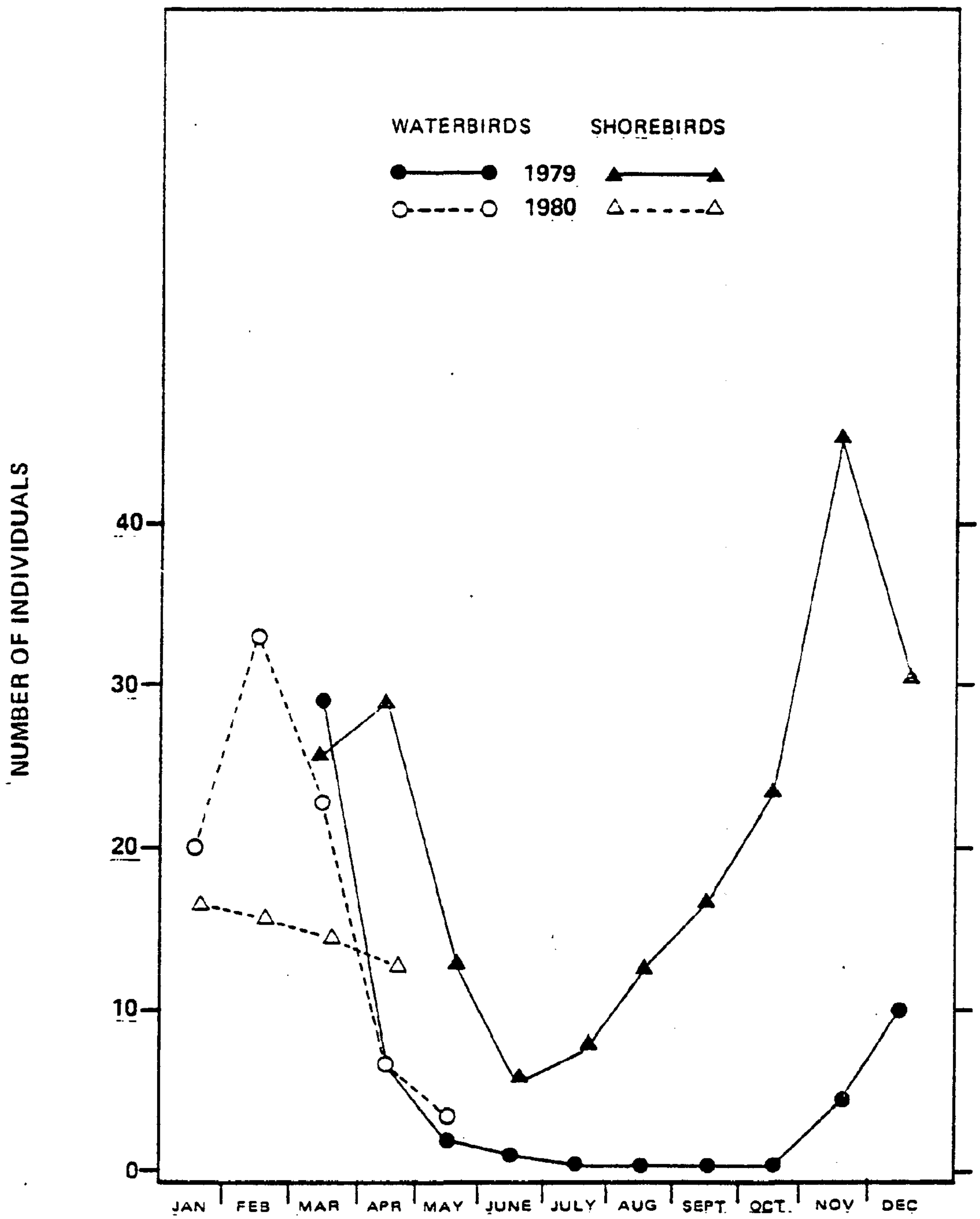

Figure 19. Numbers of individuals of shorebirds and waterfowl, Ballona Lagoon.

APPENDIX ONE

BIRD SPECIES OBSERVED AND STUDY AREAS OF OCCURRENCE

1, 2, 3 = Units Ag = Agricultural L = Ballona Lagoon

	1	2	3	Ag	L
<u>Gaviaformes</u>					
Red-throated Loon					x
<u>Podicipediformes</u>					
Eared Grebe	x				x
Western Grebe	x				x
Pied-billed Grebe	x	x			x
<u>Pelecaniformes</u>					
Brown Pelican	x				
Double-crested Cormorant	x				x
Magnificent Frigatebird	x				x
<u>Ciconiiformes</u>					
Great Blue Heron	x	x	x	x	x
Green Heron	x	x	x	x	x
Great Egret	x	x			
Snowy Egret	x	x	x	x	x
Black-crowned Night Heron	x	x			
<u>Anseriformes</u>					
Brandt	x				
Domestic Goose					x
Mallard	x	x	x	x	x
Domestic Duck					x
Gadwall	x				x
Pintail				x	
Blue-winged Teal	x				
Green-winged Teal	x			x	
Cinnamon Teal	x	x	x	x	x
American Widgeon	x			x	
Greater Scaup					x
Lesser Scaup					x

	1	2	3	Ag	L
Bufflehead	x				x
Oldsquaw					x
White-winged Scoter	x				x
Surf Scoter					x
Ruddy Duck	x				
Red-breasted Merganser	x				x
Shoveler	x				
<u>Falconiformes</u>					
Turkey Vulture	x		x	x	
White-tailed Kite	x	x	x	x	
Sharp-shinned Hawk		x			
Cooper's Hawk	x		x		
Red-tailed Hawk	x	x	x	x	
Marsh Hawk	x	x	x	x	
Osprey	x		x	x	
American Kestrel	x	x	x	x	x
<u>Galliformes</u>					
California Quail	x	x	x		
<u>Gruiformes</u>					
Virginia Rail		x		x	
American Coot	x	x		x	x
<u>Charadriiformes</u>					
Semi-palmated Plover	x			x	x
Killdeer	x	x	x	x	x
American Golden Plover	x				
Black-bellied Plover	x		x	x	x
Snowy Plover	x				
Ruddy Turnstone	x			x	
Black Turnstone	x				

	1	2	3	Ag	L
Common Snipe	x	x	x	x	
Long-billed Curlew	x				
Whimbrel	x	x	x	x	x
Spotted Sandpiper	x	x			x
Willet	x	x	x	x	x
Greater Yellowlegs	x	x	x	x	x
Lesser Yellowlegs	x		x	x	
Red Knot	x				
Baird's Sandpiper	x				
Least Sandpiper	x	x		x	x
UNID Sandpiper	x		x	x	
Dunlin	x			x	
Dowticher sp.	x	x	x	x	x
Western Sandpiper	x	x	x	x	x
Marbled Godwit	x	x	x	x	x
Sanderling	x			x	
American Avocet	x			x	
Black-necked Stilt	x	x	x	x	
Red Phalarope	x				
Wilson's Phalarope	x	x			
Northern Phalarope	x				
Pomarine Jaeger	x				
Glaucous-winged Gull	x				
Western Gull	x		x		x
California Gull	x		x	x	x
Ring-billed Gull	x	x	x	x	x
Bonaparte's Gull	x	x	x	x	x
Heermann's Gull	x		x		x
Forster's Tern	x	x	x	x	x
Least Tern	x	x	x	x	x
Elegant Tern	x				
Caspian Tern	x	x	x		x
Columbiformes					
Rock Dove	x	x	x	x	x
Mourning Dove	x	x	x	x	x
Spotted Dove					x
Strigiformes					
Burrowing Owl	x	x	x	x	
Short-eared Owl			x		
Long-eared Owl			x		
Apodiformes					
Vaux's Swift	x				
Anna's Hummingbird	x	x	x	x	x
Coraciiformes					
Belted Kingfisher	x	x	x	x	x
Piciformes					
Common Flicker	x		x		
Passeriformes					
Western Kingbird		x	x	x	
Ash-throated Flycatcher	x	x	x	x	
Black Phoebe	x	x	x	x	
Say's Phoebe	x	x	x	x	
Western Wood Pewee		x			
Violet-green Swallow	x	x	x	x	
Bank Swallow			x		
Rough-winged Swallow	x				
Barn Swallow	x	x	x	x	x
Cliff Swallow	x	x	x	x	x
Scrub Jay	x	x	x		
Common Raven	x	x			
Common Crow	x	x	x	x	x
Bushtit		x			
Long-billed Marsh Wren	x	x	x		
Mockingbird	x	x	x		x
Blue-gray Gnatcatcher			x		
Ruby-crowned Kinglet	x				
Water Pipit			x	x	
Loggerhead Shrike	x	x	x	x	x

	1	2	3	Ag	l		1	2	3	Ag	L
Starling	x	x	x	x	x	Western Tanager			x		
Yellow-rumped Warbler	x	x	x		x	House Finch	x	x	x	x	x
Yellowthroat		x	x	x		Lesser Goldfinch	x		x		
Wilson's Warbler		x				Brown Towhee		x	x		
House Sparrow	x		x		x	Savannah Sparrow	x	x	x	x	
Western Meadowlark	x	x	x	x	x	Lark Sparrow	x				
Yellow-headed Blackbird	x	x	x			White-crowned Sparrow	x	x	x	x	
Red-winged Blackbird	x	x	x	x		Lincoln's Sparrow	x	x			
Brewer's Blackbird					x	Song Sparrow	x	x	x	x	

APPENDIX TWO

UNIT 1 - 1979-1981 MONTHLY OBSERVATIONS OF BIRDS (MEAN NUMBERS PER VISIT)

	1979 Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Western Grebe											
Eared Grebe											
Pied-billed Grebe	1										
Brown Pelican	1				1			1			
Double-crested Cormorant	1		1	1							
Magnificent Frigatebird							1				
Great Blue Heron	1	1	2	1		1	3	3	6	10	8
Green Heron	1	1									
Great Egret										1	
Snowy Egret									1		
Black-crowned Night Heron											
Brandt											1
Mallard											
Gadwall											
Green-winged Teal	1										
Blue-winged Teal											
Cinnamon Teal	3							1			
American Widgeon	1										
Bufflehead											1
White-winged Scoter										1	1
Ruddy Duck	1										

	1980 Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	1981 Jan	Feb	Mar	Apr	May	Jun
Western Grebe										1								
Eared Grebe									1	1								
Pied-billed Grebe											1	2	1		1			
Brown Pelican										1								
Double-crested Cormorant										1		1		1				
Magnificent Frigatebird																		
Great Blue Heron	6	1	6	1	1			4	7	13	8	13	18	11	3	2		
Green Heron			1		1		1	1	1	1	1	1	1			1		
Great Egret			1						1	1			1			1		
Snowy Egret			1		1			1	7	1	2	2	2	3	2	3		
Black-crowned Night Heron												1			1			
Brandt				1														
Mallard					1	1		1	1									
Gadwall												1	1					
Green-winged Teal	.2								1	2	1	10						
Blue-winged Teal													1	1	1			
Cinnamon Teal	6			4				2	4	1		2		2	3	1	1	
American Widgeon										1			1					
Bufflehead												1						
White-winged Scoter																		
Ruddy Duck																		

	1979											1980												1981					
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Red-breasted Merganser														1		1													
Shoveler																				1									
Turkey Vulture																							1				1		
White-tailed Kite											1										1	1	1	1					1
Cooper's Hawk																							1	1					
Red-tailed Hawk									1	1	1		1					1				1	1	1	1				
Marsh Hawk																						1	1		1				
Osprey		1					1																						
American Kestrel	1				1	1	1	1	1	1							1				1	1				1	1		
California Quail						1																							
American Coot				1																			12	1		1			
Semi-palmated Plover					1			1	4	4	9			2		1			5	5	8	1	8	3	3	4	3	1	1
Killdeer	2	1	3	2	2	2	4	5	4	4	3	27	6	9	6	5	10	6	5	13	12	7	11	15	11	8	5	7	8
American Golden Plover		1									1													1	1				
Black-bellied Plover	333	350	29	3		105	210	142	203	81	173	550	708	192	27	16	45	109	148	250	381	492	616	814	994	428	25	12	32
Snowy Plover																				1	1						1		
Ruddy Turnstone							2	1	5	1				1		3	4	2	1	8	2		3	15			2	1	1
Black Turnstone						1	2	3	1									2	1	5	19	1	1	5	2	1			
Common Snipe																									1				
Long-billed Curlew																				1	1							1	
Whimbrel	1	1		1		26	13	2	3	2	3	1		1				36	24	7	1	1	2	1	1		1	2	1
Spotted Sandpiper																										1	1	1	
Willet	3	9	7	4	1	61	116	53	43	74	75	40	101	32	7	13	9	179	215	103	111	96	75	12	65	40	28	7	15

	1979											1980												1981					
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Greater Yellowlegs	1									1	1	1		2	1			1	2	2	3	3	2	1	2	1	1		
Lesser Yellowlegs		1				1												1											
Red Knot						2													1					1					
Sharp-tailed Sandpiper																			1										
Baird's Sandpiper										1																			
Least Sandpiper											9									2	7	8	3	38	5			1	
Dunlin						1													1	1	10	2	2	1		1			
Western Sandpiper			1	1			1	5	17	35	76	30	68	165	66	3		8	6	32	56	169	47	112	27	4	12		
UNID Sandpiper	1	10				14	4											37	9	10	141	82	510	555	548	394	80	13	1
Sanderling	1	2	1								2	2	41	22	6	7			5	4	13	1	12	3	4	17	2		
Dowitcher sp.		1	2			2		1	7	3	6	14	15	6	6	3	1	6	10	36	86	102	99	109	66	80	27	1	
Marbled Godwit	3	2	2	1		2	14	5	9	12	20	6	10	10	1	4		9	23	15	15	13	11	19	19	7	5	1	
American Avocet														1				1	1	3	6	7	24	24	9	5			
Black-necked Stilt	1	1		2				1	3	1		3		2	1	1	7	6	4	8	9	12	13	13	9	1	9	7	6
Red Phalarope																1		3	1										
Wilson's Phalarope							1	1							1				2	2									
Northern Phalarope																	1		11	16								1	
Pomarine Jaeger											1																		
Glaucous-winged Gull																							1						
*Western Gull							1							1		1		4	3	1	1			1				1	1
California Gull											1	50		5	3	3		2	5	1		1	6	10	8	3			1
Ring-billed Gull	+	+	+	+	+	20	25	5	+	9	+	70	11	78	17	17	1	6	13	10	6	5	45	130	22	7	4	7	7
Bonaparte's Gull	+	61								2	19	41	39	61	6	18		1			7	9	68	639	418	107	10	1	
Heermann's Gull						10	1												1										

Appendix 2 (continued)

	1979											1980												1981					
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Forster's Tern	+	+	6			8	41	6				30	39	48	11	22		15	29	55	25	40	60	109	62	29	62	10	5
Least Tern				13	16	8	2									9	1	3	4						3	17	11		
Royal Tern																													
Elegant Tern							1	1											1	2									
Caspian Tern							1	1										2	2			1	1	1	1				
Rock Dove	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+								
Mourning Dove	+	3	4	8	6	7	8	11	26	4	4	+	5	4	7	4	2	3	5	6	14	1	1	1	7	5	4	5	9
Burrowing Owl																					1								
Vaux's Swift															1	1													
White-throated Swift																	2												
Anna's Hummingbird	1		1	1			1	1	1	1	1	1	1	1	1	1			1	1	1	1	2	1	1	1	1	1	
Belted Kingfisher	1	1				1	1		1		1				1							1		1	1				
Common Flicker									1		1																		
Western Kingbird																		1									1	1	
Ash-throated Flycatcher						1	1																						
Black Phoebe							1													1		1	1						
Say's Phoebe								1	1	1	1	1	1							1	1	1	2	1	1				
Violet-green Swallow		+												1															
Rough-winged Swallow																				1									
Barn Swallow			1	1			1	1			1				1	1		2	5	3	1						1	1	2
Cliff Swallow			1	3	2	1		1							5	3	30	3	6	1						1	2	1	2
Scrub Jay																													
Common Raven					1										1														
Common Crow	+	1	1			1					1						1							1		1			

	1979											1980												1981					
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Long-billed Marsh Wren		1								1	2		3	1							1		1						
Mockingbird	1	1	1																										
Ruby-crowned Kinglet											1																		
Loggerhead Shrike	+	+	1	1	2	3	4	2	2	2	2	1		1	1	1	1	2	2	2	1	1	2	2	1	2	2	1	1
Starling	+	+	+	+	+	+	+	+	+				+	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+
Yellow-rumped Warbler		+									2		2		1						1								
Common Yellowthroat																													
House Sparrow	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+														
Western Meadowlark	+	9	6	7	4	4	8	6	8	4	2	4	9	8	3	4	3	1	1	4	5	2	3	8	6	4	6	4	1
Yellow-headed Blackbird				1																									
Red-winged Blackbird		1	1					1	5				4	2	1	2			3				1					1	1
House Finch	2	+	6	17	25	11	21	21	45	19	10	8	11	1	6	13	22	12	20	8	23	16	13	21	11	1	7	6	4
Lesser Goldfinch																											1		
Savannah Sparrow	+	16	23	17	19	10	2	13	33	16	8	+	21	16	13	16	19	10	9	13	13	9	5	8	5	11	8	15	11
Lark Sparrow								1																					
White-crowned Sparrow											2		1										3	1	2		1		
Lincoln's Sparrow							1																						
Song Sparrow		5	3	3	2		1	1		1	1	1	4	1	2	2							1		1	1	1	1	

Appendix 2 (continued)

APPENDIX THREE

UNIT 2 - 1979-1981 MONTHLY BIRD OBSERVATIONS (MEAN NUMBERS PER VISIT)

1979

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pied-billed Grebe											
Great Blue Heron	+	+	1	1			1				
Green Heron		1									1
Great Egret											
Snowy Egret			1						1		
Black-crowned Night Heron											
Mallard											
Cinnamon Teal		1									
White-tailed Kite											
Sharp-shinned Hawk										1	
Red-tailed Hawk	1								1		1
Marsh Hawk											
American Kestrel	1		1	1	1	2	2	1		1	1
California Quail											
Virginia Rail	1										
American Coot											
Killdeer		1	1	4	3	2	1	2	4	2	1
Common Snipe										3	4
Whimbrel			+								
Spotted Sandpiper				1							
Greater Yellowlegs						1	1				1

1980

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pied-billed Grebe												1
Great Blue Heron				1	1			2		1	1	2
Green Heron		1					1		1	1	1	1
Great Egret												
Snowy Egret				1								
Black-crowned Night Heron							1					
Mallard						2						
Cinnamon Teal												
White-tailed Kite										1		
Sharp-shinned Hawk												
Red-tailed Hawk										1	1	1
Marsh Hawk												
American Kestrel			1		1					1	1	
California Quail				1	+							
Virginia Rail												
American Coot												1
Killdeer		2	1	1	1	3	1	1	2	1	1	
Common Snipe		2										
Whimbrel												
Spotted Sandpiper					1							
Greater Yellowlegs											1	

1981

	Jan	Feb	Mar	Apr	May	Jun
Pied-billed Grebe						
Great Blue Heron		1	1			
Green Heron	1	1	1	1		
Great Egret	1					
Snowy Egret			2	1		
Black-crowned Night Heron					1	
Mallard						
Cinnamon Teal				2		
White-tailed Kite	2	1				
Sharp-shinned Hawk						
Red-tailed Hawk	1				1	
Marsh Hawk			1			
American Kestrel		1	1	2	2	
California Quail						
Virginia Rail		1				
American Coot						
Killdeer	1		1	2		
Common Snipe	1		2			
Whimbrel						
Spotted Sandpiper						
Greater Yellowlegs			1			

	1979											1980												1981					
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Willet		1	6	1			1	2		5	1			1	1				2	2	2		1		1	4	3		
Least Sandpiper											1																1		
Western Sandpiper																										2			
Dowitcher sp.		+	+							1	7				2										9	18	2		
Black necked stilt														1															
Wilson's Phalarope																													
Ring-billed Gull	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+					+								
Bonaparte's Gull		+										7																	
Caspian Tern						1	1																						
Forsters Tern																										2			
Least Tern																	1											1	
Mourning Dove	6	5	12	10	13	12	19	9	7	14	5	+	+	3	4	8	6	11	18	8	24	9	2	2	12	4	6	8	
Burrowing Owl																					1								
Anna's Hummingbird	1	1	2	2	1	1	2	1	3	3	2	+	+	1	1	1	1	1	1	1	1	2	2	2	2	2	2	2	
Belted Kingfisher	1						1	1	1		1			1	1				1	1	1	1	1	1	1	1			
Western Kingbird							2																						
Ash-throated Flycatcher							1																						
Black Phoebe									3	1									1	1	1								
Say's Phoebe	2								2	1	1	2									1	1	2	1	1				
Western Wood Pewee				1																									
Violet-green Swallow		2																											
Barn Swallow							1									1		1		2									
Cliff Swallow				2	1										3	3		7								3			
Scrub Jay			1			1	1	1			1								1		1								

	1979											1980												1981					
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Common Raven					1																								
Common Crow	+	+		+	+		+									1							1		1	3	1		
Bushtit											2										2								
Long-billed Marsh Wren									1	1	1										1	1	2						
Mockingbird						1				1							2	1			1			1		1	1		
Loggerhead Shrike	3	1	1	1	4	3	4	2	4	2	2	+	3	2	+	1	1	2	3	1	2	2	1	2	1	1	1		
Starling	+		+	+	+	+	+	+	+					+	+	+	+	+	+	+	+	+	+		+		+		
Yellow-rumped Warbler										3	1			1	2							1		2		3			
Common Yellowthroat				1		1			1	1	1				1	1				1	1	1	1						
Wilson's Warbler					1																								
Western Meadowlark	10	11	13	8	4	5	4	4	8	7	1	+	+	7	7	6	4	3	3	2	13	5	2	5	6	7	8		
Yellow headed Blackbird			1																										
Red-winged Blackbird	2	1		1						1				1	4	1		1	1	1						3	4		
House Finch	29	+	11	19	43	20	26	49	96	56	31	15	37	8	12	25	20	17	9	16	43	25	49	73	17	4	11		
Brown Towhee										1						1													
Savannah Sparrow	5		1					2	10	16	7	3	8						1	4	14	20	14	11	8	3			
White-crested Sparrow	+									9	2		3		1						3		15	13	5				
Lincoln's Sparrow										1													2						
Song Sparrow	18	16	22	18	11	6	7	6	11	11	9	+	+	7	13	7	5	2	1	4	5	7	9	5	8	7	9		

Appendix 3 (continued)

APPENDIX FOUR

UNIT 3 - 1979-1981 MONTHLY BIRD OVSERVATIONS (MEAN NUMBERS PER VISIT)

	1979											1980												1981					
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Great Blue Heron	1	1	1	1		1			1			1		2								1							
Green Heron				1						1	1	1			1					1		1							
Snowy Egret				1					1		1																		
Mallard														1															
Cinnamon Teal		6	2	1		1							1	10	11														
Turkey Vulture			1																		1	1	1	1		1		1	
White-tailed Kite																				1	1	1	2					1	
Cooper's Hawk										1					1						2			1	1		1		
Red-tailed Hawk																								1					
Marsh Hawk																						1	1	1	2	1			
Osprey							1																						
American Kestrel		1	1		1	1	1	1	1	1	+	1	1							1		1							
California Quail				1	2	3			3	2				3	+	1				6		+					3	2	
Killdeer	+	2	6	2	2	1		3	1	1		2	5	4	4	3								1	1	1	2	2	1
Black-bellied Plover	+															1						1							
Common Snipe		1								1			1	1									1						
Whimbrel			1		1			1						2															
Willet	+	1	11	4	1		1		1	1	1	1	1	7	4					1			1		1	1			
Greater Yellowlegs		1	1																										
Lesser Yellowlegs															1														
Dowitcher sp.		1	4	2										5	4														
Western Sandpiper			11																										
UNID Sandpiper															4														
Marbled Godwit		1													1														
Black-necked Stilt			1																										
Western Gull														1															

	1979											1980												1981					
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
California Gull											5	1				1													
Ring-billed Gull	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•				•		•	•	•					
Bonaparte's Gull		1									2	1		1															
Heermann's Gull								1	1																				
Forster's Tern			2	4	1																								
Least Tern				1	1																								
Caspian Tern					1	·	1																						
Mourning Dove	•	3	14	15	12	12	23	40	49	27	29	15	76	9	13	24				52	36	18	3	8	4	8	7	13	9
Burrowing Owl									1			1			1	2				2						1	2	1	1
Long-eared Owl																					1								
Short-eared Owl	1																												
Anna's Hummingbird	2	1	1	1		1	1	2	2	3	2	1	3	2	1	1				1	1	3	4	2	1	2	2		
Belted Kingfisher	1						1		1				1												1				
Common Flicker	2	1							1	1	1	1		1							1								
Western Kingbird				1		1								1	3											2	5		
Ash-throated Flycatcher						1										1													
Black Phoebe										1	1	1	1							1		1	1	1	1				
Say's Phoebe	1								1	2		1		1						1	1	2	2	1	2				
Violet-green swallow	•		•								1			1								1				2			
Bank Swallow								1	1																				
Barn Swallow			1	2	3	2								1	5	3										1	4	2	2
Cliff Swallow		2	2	5	5	1								7	11	5										1			2
Scrub Jay																											1		
Common Crow	1	1	1	1	1	1	4	5	1	5		1		2			1			2						1	3		
Long-billed Marsh Wren										1	2	1										1							
Mockingbird			1	1	1	2	2	1				1			2	1				1						2	3	1	1
Blue-gray Gnatcatcher																				1									

	1979											1980												1981					
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Water Pipit															1											19	8		
Loggerhead Shrike	2		1	1	3	8	3	1	2	2	1	2	3	2	1	2				1	3	2	2	3	1	1	3	4	2
Starling	•	•	•	•	•	•	•	•	•	•		•	•	•	•	•				•	•	•	•	•	•	•	•	•	•
Yellow-rumped Warbler									2	2	1	1	1									10	9	6	6	2			
Yellowthroat													1	3															
House Sparrow	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•								•	•	•	•	•	•
Western Meadowlark	34	19	18	21	12	8	14	13	16	17	26	33	19	27	10	14				12	14	9	12	25	39	18	11	19	13
Yellow-headed Blackbird				2																									
Red-winged Blackbird		1	1	3	1		2	3				1	•	6	9	9										23	5		
Western Tanager			1																								1		
House Finch	•	•	2	13	46	28	15	12	19	19	11	9	17	14	6	14				54	17	29	19	22	19	17	10	8	119
Lesser Goldfinch																											1		
Brown Towhee																												2	
Savannah Sparrow	33	23	13	7	2	1		18	16	17	9	8	13	10	5	5				14	1	8	5	5	13	11	6	2	2
White-crowned Sparrow									5	29	•	12	13	8	1					1		12	20	9	15	5	1		
Song Sparrow		1	1	2	1			1	1	1	2	3	4	3	5	5				2		1.	2	4	6	4	5	6	2

Appendix 4 (continued)

APPENDIX FIVE

AGRICULTURAL FIELDS - 1979-1981 MONTHLY BIRD OBSERVATIONS (MEAN NUMBERS PER VISIT)

	1979											1980												1981					
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Great Blue Heron	1	1	1										4		1											6	1		
Green Heron									1														1	1					
Snowy Egret																								1		1	1		
Mallard																										1			
Pintail												5																	
Green-winged Teal																							4	10	6	2			
Cinnamon Teal			1									11	24	46	4										16	45	4		
American Wigeon														1										2	3				
Turkey Vulture																								1					
White-tailed Kite																								1					
Red-tailed Hawk	1								1		1												1	1	1	1			
Marsh Hawk																							1			1			
Osprey	1																												
American Kestrel	1						1	1	1	1	1					1								1					
Virginia Rail								1																					
American Coot																							7	2					
Semipalmated Plover												4		1	1									1					
Killdeer	4	3	4	7	4	2	1	3	7	1	2	69	37	19	8	2							34	32	7	3	2		
Black-bellied Plover		1	1	3								108	241	79	11	2							53	23					
Ruddy Turnstone												1												1					
Common Snipe		1								1	2	5	9	3										3	2	1			
Whimbrel			2	1										1	3	2													
Great Yellowlegs		1										2		2									1	1					
Lesser Yellowlegs														1	1														

	1979											1980												1981					
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Willet	+	2	7	1			1	1	1	1	1	24	26	39	2	1							13	11	12	14	2		
Least Sandpiper												5	2	6															
Dunlin												2	2	2															
Western Sandpiper												63	31	98	24								13						
Marbled Godwit	+							1				18	2	7	1														
Sanderling												5	2	7	1									1	2		5		
Dowitcher sp.			3									4	18	39	3								10	214	97	100	33		
UNID Sandpiper		5		1								3	6	4									155	383	163	68	136		
American Avocet																										1			
Black-necked Stilt												2	1	1	1								4	2	3	17	2	1	
California Gull												31	47	8									18	5	8	15	3		
Ring-billed Gull	+	+						+		+		46	60	21	5	+							90	28	147	9	20		
Bonaparte's Gull												143	169	4									47	19	161	13	260		
Forster's Tern												23	1	1											2	1	1		
Least Tern															+	1													
Rock Dove	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+							+	+	+	+	+	+	
Mourning Dove	4	1	2	5	7	12	13	20	21	21	5	1	3	2	5	5							+	2	1	3	+		
Burrowing Owl																									1				
Anna's Hummingbird								1				1																	
Belted Kingfisher											1		1	1															
Western Kingbird			1	1																									
Ash-throated Flycatcher								1																					
Black Phoebe										1																			
Say's Phoebe								3	1	1	1																		
Violet-green Swallow														3															
Barn Swallow								3						1		1									1				
Cliff Swallow				1			1								1	6										2	5		
Common Crow		+	+																								1	+	

	1979											1980												1981					
	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Water Pipit											1			2															
Loggerhead Shrike	1				1	1	2	1	1	1	1	1	1	1												1			
Starling	+				+	+		+				+	+	+	+	+								+					
Common Yellowthroat	+														+	1													
Western Meadowlark	4	4	4	4	4	4	5	4	1	2	1	1	1	5	5	7							+	1	7	8	+	+	
Red-winged Blackbird	1	3	2	4	3	4	1					2	1	7	9	17								3	12	28	32	+	
House Finch							1	4	17	6	3	6	1	1	4	1							2		5	1		+	
Savannah Sparrow								5	16	8	9		1	3	3									1	2				
White-crowned Sparrow											2																		
Song Sparrow	2	2	3	4	5	3	3	3	6	4	5	1	1	2	2	5							1		1	+	+	+	

Appendix 5 (continued)

APPENDIX SIX

BALLONA LAGOON & VENICE CANALS MONTHLY BIRD OBSERVATIONS (MEAN NUMBERS PER VISIT)

	3/79	4/79	5/79	6/79	7/79	8/79	9/79	10/79	11/79	12/79	1/80	2/80	3/80	4/80
Red-throated Loon											1	1		
Eared Grebe	1	1	1	1	1	1					1	1		
Western Grebe	1								1		1	2	5	1
Pied-billed Grebe								1	1	2	1	1	1	
Double-crested Cormorant	1													
Magnificent Frigatebird						1								
Great Blue Heron								1						
Green Heron	1	1	1	1					1		1	1		
Snowy Egret	1	1									1	1	1	
Domestic Goose	3	3	2	2	3	3	3	3	3	3	4	5	4	3
Mallard	149	153	168	155	160	145	143	148	150	153	127	197	155	151
Domestic Duck	53	48	46	49	55	53	50	45	48	58	44	70	48	50
Gadwall	+													
Cinnamon Teal												7		
Greater Scaup										2				
Lesser Scaup	1										5	4		
Bufflehead	1	1						1			1			
Oldsquaw	1													
White-winged Scoter	7	2	1	1										
Surf Scoter	10	4	1						2	3	13	18	18	6
Red-breasted Merganser	4	1							2	5	3	4	5	1
American Kestrel	+	+	+			+	+	+	+	+	+	+	+	+

	3/79	4/79	5/79	6/79	7/79	8/79	9/79	10/79	11/79	12/79	1/80	2/80	3/80	4/80
American Coot	18	15	5	3	1	1	3	4	9	20	18	30	20	14
Semi-palmated Plover													1	
Killdeer	1	2	2	1	1	1	1	10	16	4	1	3	1	1
Black-bellied Plover	+	1	1	2	1	2	1	1	3	4	1	1	1	1
Whimbrel	2	1	1		2	1	1	1						1
Spotted Sandpiper											1	1		
Willet	10	11	6	3	4	8	11	11	14	13	8	4	6	3
Greater Yellowlegs									1					
Least Sandpiper													5	
Dowitcher sp.		1								1	2		4	3
Western Sandpiper		3							1	4		2		1
Marbled Godwit	8	10	3			1	3	2	10	8	4	3	3	4
Western Gull									1				1	
California Gull										1	1	1	1	1
Ring-billed Gull	+	+	+	+	+	+	+	2	4	9	11	5	7	4
Bonaparte's Gull													1	
Heermann's Gull				1		1								
Forster's Tern	2	1				1			1	1	1	1	1	
Least Tern			2	3	2									
Caspian Tern							1							
Rock Dove	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Mourning Dove	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Spotted Dove							+							
Anna's Hummingbird								+				+		
Belted Kingfisher	1				1	1	1	1	1	1	1	1	1	

	3/79	4/79	5/79	6/79	7/79	8/79	9/79	10/79	11/79	12/79	1/80	2/80	3/80	4/80
Barn Swallow		+	+											
Cliff Swallow			+		+									
Common Crow	+	+			+	+		+	+			+		+
Mockingbird		+	+	+	+	+	+	+		+		+		+
Loggerhead Shrike	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Starling	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Yellow-rumped Warbler										+				
House Sparrow	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Western Meadowlark	+	+	+	+				+	+	+	+	+	+	+
Brewer's Blackbird						+								
House Finch	+	+	+	+	+	+	+	+	+	+	+	+	+	+