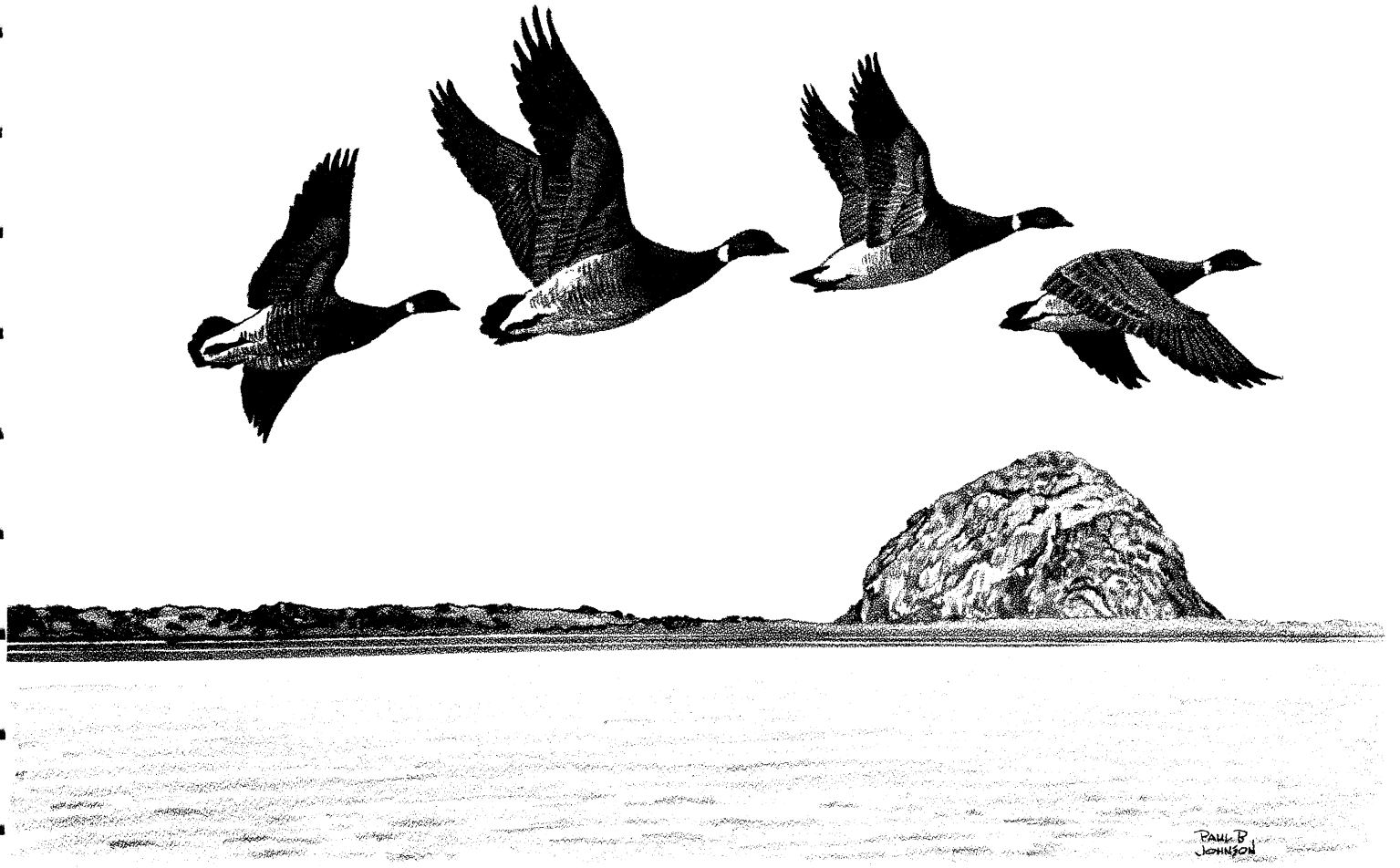
THE NATURAL RESOURCES OF MORRO BAY



State of California

DEPARTMENT OF FISH AND GAME

August 1974

Cover
by Paul Johnson

State of California

DEPARTMENT OF FISH AND GAME

NATURAL RESOURCES

OF

MORRO BAY

Their Status and Future

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MORRO BAY

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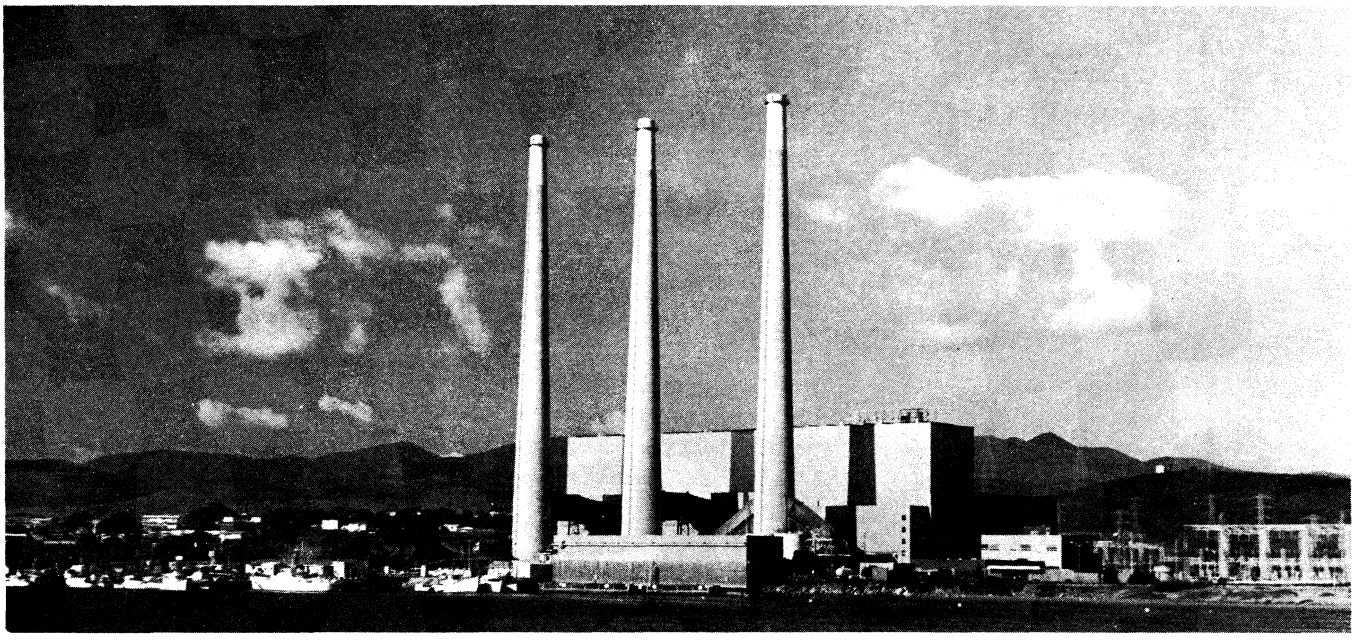
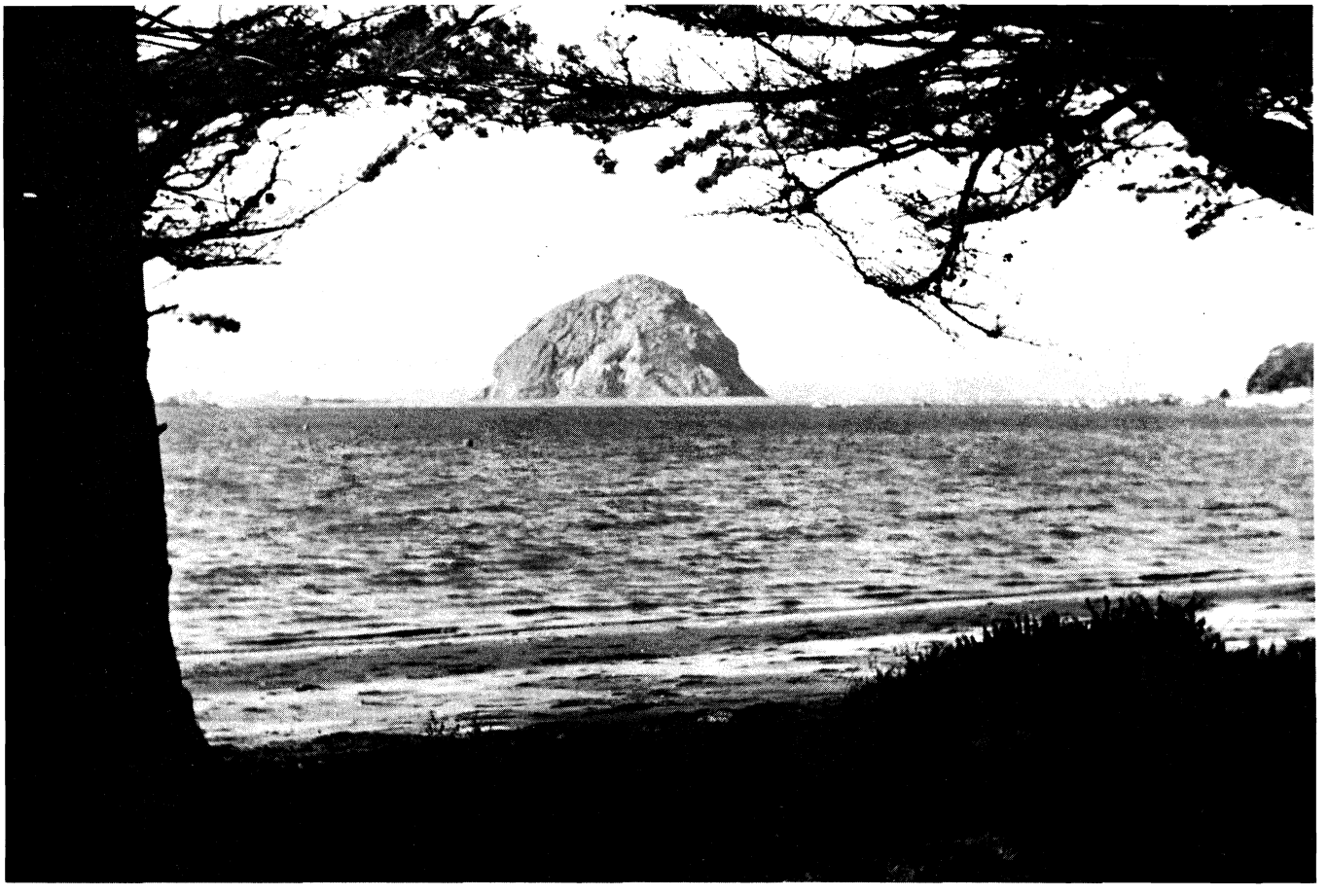


MORRO ROCK AND THE P.G.&E. POWER PLANT COOLING TOWERS DOMINATE THE LANDSCAPE AT MORRO BAY. (DEPT. FISH & GAME PHOTOS)



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INTRODUCTION

The California Department of Fish and Game is charged with the responsibility of conserving the State's fish and wildlife resources. It does not, however, always have the means at hand to ensure such conservation. The Department has few controls over much of the land that provides habitat for fish and wildlife, but an effective alternative to direct control has been to inform and point out areas of urgent concern to others. More than two-thirds of the original coastal wetlands, upon which many fish and wildlife species are vitally dependent, already have been filled-in, reclaimed, or otherwise destroyed, but Morro Bay remains relatively intact as an important element in California's wetlands ecosystem.

The primary purpose of this report, then, is to document the natural resources of Morro Bay and their values; point out significant problems regarding their use and to make recommendations for preservation of these resources to planners, administrators and interested citizens. A secondary purpose of this report is to pull together into one source, all data and references on the biological resources of Morro Bay. Up to now these data have been widely distributed amongst letters, reports, papers, etc., to which few have access.

At the request of Senate Resolution No. 176, 1966 First Extraordinary Session, the Department completed in December, 1966 a report entitled, "Report of the Natural Resources of Morro Bay and Proposal for Comprehensive Area Plan." Based largely upon the recommendations of that report, the San Luis Obispo County Board of Supervisors appointed a task force to prepare a comprehensive area plan for the Morro Bay area and its watershed. Hence, the information herein is presented in order that the natural resources of Morro Bay will be given adequate consideration, based on the best data

available, in the proposed comprehensive area plan and in other plans such as one being prepared by the Coastal Zone Conservation Commission.

This publication is one of a scheduled series. Reports already completed document the natural resources of Upper Newport Bay (Orange County), Goleta Slough (Santa Barbara County), Bolinas Lagoon (Marin County), Elkhorn Slough (Monterey County), San Diego Bay (San Diego County), Humboldt Bay (Humboldt County) and Los Penasquitos Lagoon (San Diego County).

SUMMARY

Morro Bay is located approximately halfway between Los Angeles Harbor and San Francisco Bay. Actually a lagoon, or shallow sound, rather than a true bay, it is about 4 miles long with a maximum width of approximately 1-3/4 miles. At high tide there are 2,101 acres of water surface and 472 acres of salt marsh. At low tide 1,452 acres of mudflats are exposed with the water surface reduced to 649 acres, mostly in natural and man-made channels.

Historically, Morro Bay was a true bay. Deposition of sand formed the existing sand spit, forming the lagoon now called Morro Bay. In pristine times three creeks drained into Morro Bay. Morro Creek with a drainage area of about 15,000 acres, Chorro Creek draining about 30,000 acres and Los Osos Creek with a drainage of about 18,000 acres, all originally entered the bay; but in the course of harbor development, Morro Creek was diverted to the ocean north of Morro Rock. These creeks, however, have not significantly influenced the salinity and temperature of the bay waters.

Morro Bay is rich in history from the time the Chumash Indians hunted and fished in and about the bay to the period of Spanish occupation and land grants during early California settlement. Modern history of Morro Bay began with the subdivision of the land grants. Port development began prior to the turning of the 20th century, with harboring and wharfage for lumber schooners and commercial trade steamers. In 1910 the north channel was partially closed and a new entrance created with revetments, breakwaters and channel dredging. At present, maintenance dredging of navigation channels in the harbor is done periodically by the U. S. Army Corps of Engineers.

The salt marsh, tidal mudflats, open water and upland vegetation provide rich and varied habitats which support numerous and varied assemblage of estuarine and terrestrial animals rarely exceeded in other parts of the State. Eel grass, which provides a specialized habitat for the black brant, covers 483 acres of intertidal area. Salt marsh plants make a major contribution to the primary productivity of the bay and are used as nesting and loafing areas by many water-associated birds. The tidal mudflats host abundant populations of invertebrate organisms that become food for many fish and wildlife species in the bay ecosystem.

Over 25,000 birds have been counted within Morro Bay at one time. As many as 11,800 black brant have been seen on the bay at one time. Seventy-five species of water-associated birds have been identified from the bay environs. A rookery for great blue herons and black-crowned night herons is located at Fairbanks Point. The black rail, a rare species, has been observed in the salt marsh. An additional 207 bird species, other than those sighted in the bay area, have been identified in western San Luis Obispo County, which includes the Morro Bay watershed.

Sixty-six species of finfish have been identified. Most numerous are northern anchovies, shiner perch and black perch. Eleven species are considered resident and fifteen other species apparently use the bay during some stage of their life cycle. The bay teems with invertebrates and supports a commercial oyster operation. Nineteen species of clams are present. Most abundant are Washington, gaper and geoduck clams.

Four large marine mammal species have been seen in Morro Bay: the harbor seal, California sea lion, Steller's sea lion and sea otter. The most common is the harbor seal, which is known to give birth to young in the bay.

Two endangered species receive much attention locally. The peregrine falcon nests on Morro Rock, and the Morro Bay kangaroo rat is indigenous to an area at the southern end of the bay.

Land ownership in the bay is divided among state, city and private parties. About 440 acres, including the harbor area in the northern portion, is controlled by the City of Morro Bay. Morro Bay State Park includes about 230 acres of marsh within its boundary. State tide and submerged lands cover about 1,300 acres of the bay and an additional 604 acres of tidelands are privately owned. Several small acreages of marsh along the eastern and southern shore, totaling about 100 acres, are privately owned.

Appropriative use of fish and wildlife at Morro Bay includes duck and black brant hunting. Over 3,000 hours were expended during the 1970-71 season in pursuit of waterfowl. Perch, flounder, jacksmelt, lingcod and cabezon are some of the fish caught from skiffs, piers, revetments and breakwaters. A 1958 estimate of fishing effort from piers alone was 8,000 angler-days. Crabbing and clamming also are significant appropriative use of the bay's natural resources and oysters are raised commercially, producing an average of 120,000 pounds of shucked oysters per year.

Scientific and educational use of Morro Bay is another important non-approriative use of the bay's resources. The most significant of this type of use is made by students from California State University, San Luis Obispo, but students and instructors from various other universities and colleges in California also use the bay. The University of California, at Los Angeles has conferred two Ph.D. degrees to students working on dissertations concerning the resources of the bay.

Recreational use undoubtedly accounts for the highest use of the area's total natural assets. The significance of this type of visitor-use is reflected by the estimated average attendance at Morro Bay State Park of 1,343,701, for the 5-year period 1967 through 1971. Camping facilities, boat rentals, a golf course, and the Morro Bay Museum of Natural History, which has an average attendance between 50-60,000 per year, all make the State Park attractive. The natural amenities of the bay itself are famous state-wide, if not nationally.

Bird-watching, photography, hiking and general sight-seeing are other important non-appropriative uses of the bay. Bird-watchers come from far and wide to observe the wide variety of birdlife in and about the bay. An estimated 10,000 user days is assigned to bird-watching. This attraction is underscored by the local populace that has posted signs about the city, proclaiming "Morro Bay is a Bird Sanctuary."

Other uses of the bay and its environs include industrial, commercial fishing, and, of course, residential. The population of the City of Morro Bay is a little over 7,000. Another estimated 6,000 live in the unincorporated areas on the southern perimeter of the bay. It is estimated that temporary residencies boost the population as high as 24,000 seasonally.

The Pacific, Gas and Electric Company power plant at the north end of the harbor draws 470,000 gallons of bay water per minute for cooling purposes. The heated water (15 to 23 degrees above ambient ocean temperature) is discharged directly into the ocean on the north side of Morro Rock.

Commercial and sport fishing are important industries at Morro Bay. Port facilities include 1,190 feet of public piers; 1,290 feet of privately

owned piers; 555 feet of public floating docks and 5,125 feet of private floating docks. Over 6 million pounds of commercial fish are landed annually. Catches of five leading species, perch, rockfish, albacore, lingcod and California halibut, range between 6 and 21 percent of the total California commercial catch. Total values of the catches were over $900,000 for the 5-year period 1966 through 1970. Abalone has been an important Morro Bay fisheries but now is in decline. Fourteen sportsfishing party boats use Morro Bay as a home port. An average of approximately 26,000 angler-days is expended yearly in this pursuit.

Probably the greatest threat to the natural resources of Morro Bay is the ongoing pressure for continued development of the bay and its environs. Paradoxically, it is the aesthetic and recreational appeal of the area's natural resources that creates requests and demands for further development of harbor facilities, alteration of the privately owned tidelands for recreational facilities and urbanization of the privately owned shoreline.

The Morro Bay Task Force, under the leadership of the San Luis Obispo County and Cities Area Planning Coordinating Council, and with representation from local, state and federal agencies, is in the process of creating a comprehensive area plan for Morro Bay and its watershed. The Task Force has recommended that a Citizens Advisory Committee be created to represent local communities and interest groups such as: conservation-wildlife, conservation-land, agricultural-livestock, agricultural-farmers, commercial and pleasure boating, sportsman and business organizations, and education and public information groups. The Department of Fish and Game, which was instrumental in the formation of the Task Force, commends the tremendous cooperative effort and action of all city, county, state

and federal agencies, and the local citizens' groups, in behalf of the natural resources of Morro Bay. And, the Department pledges to continue giving support to those concerned with the preservation, management and wise use of this, one of the most beautiful and significant of all of the California coastal wetlands.

RECOMMENDATIONS

Because of the high aesthetic and ecological values of the natural resources of Morro Bay; increasing recreational, scientific and educational use of the bay; and, the opportunity to preserve one of the least disturbed coastal wetlands along the coast of California, the Department of Fish and Game recommends that:

1. The comprehensive area plan being prepared for Morro Bay and its watershed include provisions for the preservation, management and wise use of the area's natural resources. The Morro Bay Task Force, comprised of representatives of interested local, state and federal agencies, guided by a local Citizens' Advisory Committee representing most local conservation, agricultural, commercial, sportsman, educational and public information interest groups, is actively preparing a comprehensive area plan for Morro Bay and its environs. Natural resources maintenance and enhancement must be an integral part of the comprehensive area plan, and the plan should provide for specific means of implementation.
2. Privately owned tidelands be placed in public ownership. Several parcels of private lands under tidal influence, including the Los Osos creek and estuarine area and the southern half of South Morro Bay (Plate 4), contain valuable fish and wildlife habitat. These privately owned tidelands comprise about 23% of the bay area under tidal influence. Placing these lands in public ownership is the most effective means of preserving them for fish and wildlife.
3. A narrow strip of undeveloped, privately owned land along the southern perimeter of Morro Bay, from the mouth of Los Osos Creek to Shark Inlet, be maintained in a natural state. This recommendation is necessary

to preserve the aesthetic quality of South Morro Bay. This strip of maritime and upland vegetation is an integral part of the Morro Bay ecosystem, providing nesting, resting and escape cover for many wildlife species, and also serving as a buffer between already developed uplands and the vital tideland habitats. Hence, undeveloped lands, within a distance of not less than 100 feet from the higher high tide line along this southern perimeter of the bay, should be preserved by zoning ordinance and/or public acquisition.

4. The legislative grant conveying title to tide and submerged lands to the County of San Luis Obispo and its successors be amended to provide for maintenance and enhancement of fish and wildlife and their habitats. The 1947 grant, as amended in 1955, 1957 and 1960, provides that the granted lands can only be used for harbor, recreation and other closely related purposes. The grantee would technically be in violation for implementing programs and projects not included in the grant provisions.

5. Any alteration of Morro Bay or its watershed be made with minimal or no adverse impact on the natural resources of the bay. Future development should be restricted to marine-related or bay-dependent industry or commerce and confined to the mainland side of the city tidelands. No dredging or filling of salt marsh or tidal flats should be permitted except dredging to maintain existing navigational works, unless such dredging or filling is beneficial to natural resource maintenance or enhancement.

6. Appropriative uses, including hunting, clamming and fishing continue as beneficial uses of the natural resources of Morro Bay. Appropriative and non-appropriative uses of natural resources are compatible

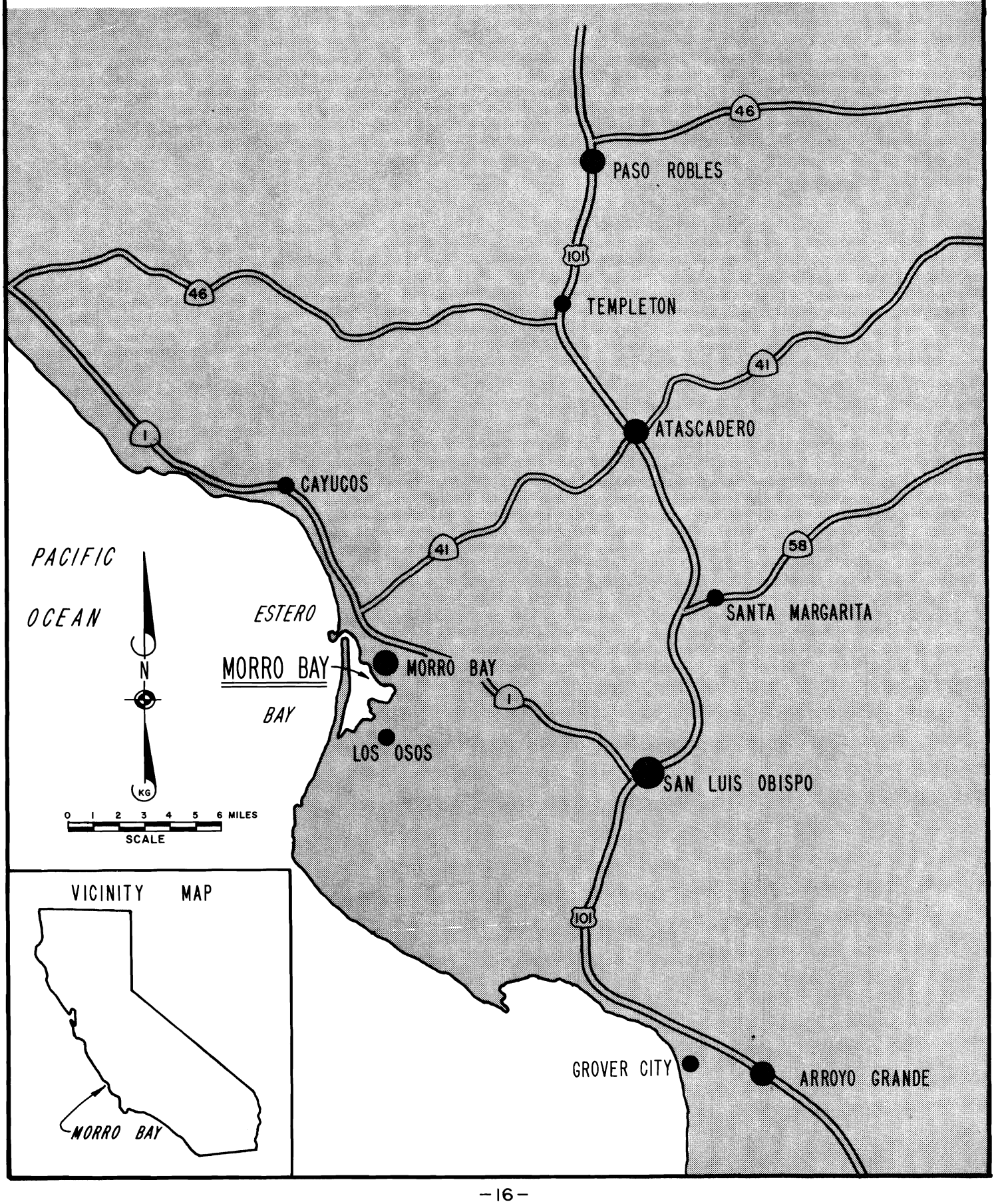
as long as both uses are carefully monitored and the ecological integrity of the bay is preserved.

7. Commercial oyster raising be allowed to continue as a beneficial use of the bay. Mariculture, carefully monitored, is a compatible use of the natural resources of Morro Bay and most coastal wetlands.

8. Water quality be maintained at shellfish production and consumption standards. Due to the efforts of state and county governmental agencies responsible for water quality and because of the support and response of the local people, Morro Bay has some of the "cleanest" water found in California coastal wetlands. However, in the face of continued demands for development and use of the bay and its watershed, the quality of the waters of Morro Bay should continue to be monitored and the requirement of high water quality standards retained.

PLATE 1

MORRO BAY AND VICINITY



MORRO BAY AND ENVIRONS

Physical Features

Location

Morro Bay is located on the coast of California approximately halfway between San Francisco Bay and Los Angeles Harbor (Plate 1). It lies 12 miles northwest of the City of San Luis Obispo in San Luis Obispo County. The Morro Bay West Breakwater Light, a navigational marker at the end of the breakwater extending from Morro Rock, fixes the location of the entrance to the bay as latitude 35° 21.8' N and longitude 120° 52.1' W (U. S. Coast and Geodetic Survey, 1968).

General Description

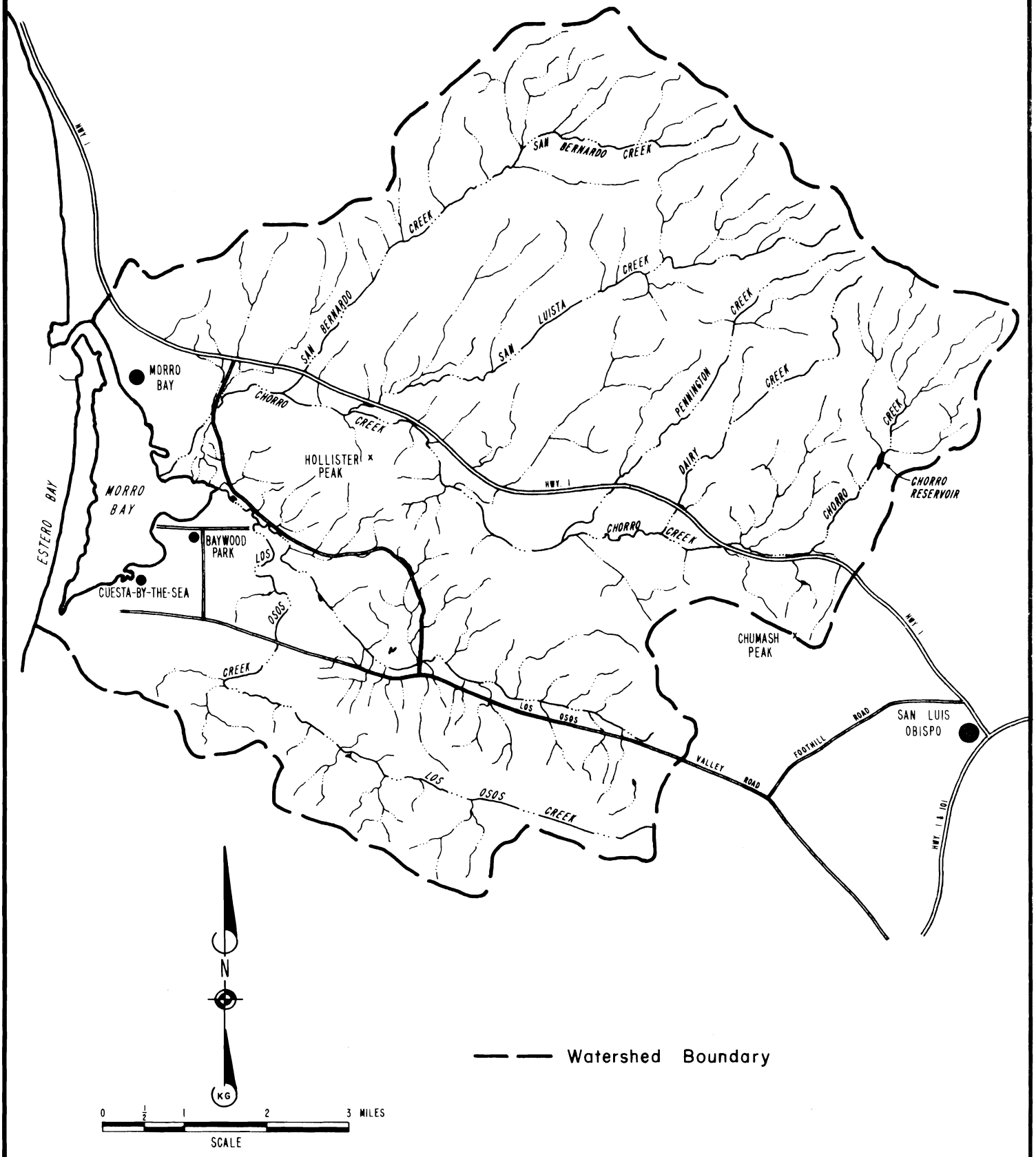
Morro Bay is not a true bay. By definition it is a lagoon (Moore, 1967; Runcorn, et al., 1967; Russel, 1968; U. S. Coast and Geodetic Survey, 1968.) The lagoon is four miles long with a maximum width of about one and 3/4 miles. The lagoon is connected to Estero Bay by a narrow channel situated approximately midway between the northern and southern terminal landmarks of Estero Bay, Point Estero and Point Buchon. This man-made channel, maintained by dredging, is constructed to about 500 feet at the entrance to the bay between Morro Rock and the tip of the sand spit.

The lagoon, called "Morro Bay" in the ensuing text, is created, and separated from Estero Bay, by a sand spit approximately four miles in length and varying from 900 to 2,150 feet in width. The sand spit is a dune of moderate height, the maximum approximately 115 feet (Cooper, 1967). A breakwater extending 1,832 feet westerly from the sand spit functions in the formation of the entrance.

Morro Rock, 578 feet high, protrudes conspicuously at the northwestern point of the channel entrance into Morro Bay. The protective influence of this famous landmark is extended by a breakwater projecting 1,800 feet

PLATE 2

WATERSHED



from the rock in south-southwesterly direction. A breakwater extending 1,832 feet westerly from the sand spit also functions in the formation of the entrance to the bay. The distance between breakwaters is 1,050 feet.

Drainage

The lagoon receives water from two streams, Chorro and Los Osos creeks. The confluence of these creeks has formed a delta encompassing an area of 438 acres of salt marsh. Chorro Creek has a perennial stream flow across 11.25 miles, and drains an area of 30,000 acres. Within this drainage is part of the Santa Lucia Range that separates Morro and Chorro creeks and the entire northern slope of Park Ridge which lies between Chorro and Los Osos creeks.

Los Osos Creek also is 11.25 miles long with a drainage of 18,000 acres. This drainage includes the southern slopes of Park Ridge and portions of the San Luis Range, some of which drain directly into the bay. The only other drainage comes from the eastern slopes of the sand spit, a drainage of 450 acres. Thus the total watershed of the lagoon is 48,450 acres (Plate 2).

At one time, Morro Creek entered the bay near the entrance. Since development of the harbor area, Morro Creek has discharged directly into Estero Bay north of Morro Rock. Morro Creek drainage area is about 15,000 acres, hence 23% of the original fresh water source no longer enters the bay.

At high tide the bay has 2,101 acres of water surface. At low tide the perimeter of the lagoon is reduced to 649 acres, leaving a tidal mud flat of 1,452 acres (Gerdes, 1970). At low tide the major part of the water in the bay is found in three channels: the Entrance Channel, Navy Channel and Morro Channel. These extend two nautical miles from the breakwaters to the area near White Point, in the order listed. At mean lower low water (mllw) the Entrance and Navy channels are both 21 feet deep; Morro Channel

is from 14 to 24 feet deep. South of Morro Channel, minor channels ranging in depths from 15 feet to 2 feet (mllw) contain most of the remaining available water at low tide (Plate 3).

The total tidal prism in the bay is estimated at 13,500 acre-feet (Koebig and Koebig, Inc. and Hahn, Wise and Associates, Inc., 1968). At spring ebb tide the outflow into Estero Bay is 54,000 cubic feet per second, a movement equal to that of a large river.

Water Characteristics

Except for the area near the mouths of Chorro and Los Osos creeks, the salinity of bay waters is remarkably uniform. Salinity at wharf installations of the town of Morro Bay and at private piers at the village of Cuesta-by-the Sea, located at the opposite end of the bay, were the same, 34.5 parts per thousand (0/00), in February 1950 (Menzies and Mohr, 1952). This observation has been verified (Reish and Barnard, 1967), and shows that the salinity of the lagoon is similar to the salinity of the adjacent ocean waters, which is 33.5 0/00 (U. S. Geological Survey, 1970). In the channel of Chorro Creek that is exposed to only the very highest tides, the salinity is only 22.4 0/00 (Menzies and Mohr, 1952). However, pools in the salt marsh, surrounded by pickleweed[1/], a dominant salt marsh plant had a consistently high salinity averaging 38.2 0/00.

The temperature of bay waters in February can range from 50 to 57°F which is within the range of winter minimum and maximum temperatures (50 and 61°F) of adjacent ocean waters (U.S. Geological Survey, 1970). In salt marsh pools a temperature of 61° has been recorded in February (Menzies and Mohr, 1952). In August bay water temperatures can range from 55° to 64° F., the lower temperatures located at the entrance and higher temperatures in creek channels in the salt marsh (Reish and Barnard, 1967). Summer temperatures

1/ Scientific names of plants are found in Appendix H.

of ocean water off Morro Bay range from a minimum of 54°F to a maximum of 68°F. A 12° temperature gradient of 52°F to 64°F has been recorded in March from the mouth of Los Osos Creek to about ½ miles upstream (Garman, 1970). The influence of the higher temperature of Los Osos Creek upon the bay water appears insignificant.

In August the dissolved oxygen of the lagoon water can range from 4.2 to 7.1 parts per million. The lowest concentration recorded is found immediately off the east side of the sand spit, an area primarily of tidal water or pools, and the highest concentration at the influx of Chorro Creek into the lagoon. A slight oxygen gradient, increasing with depth, was observed generally throughout the bay (Reish and Barnard, 1967).

Climate

Air temperatures of Morro Bay are moderately cool. The average daily temperature for 1970 was 56°F. Extremes that year ranged from a high of 101°F in September to a low of 27°F in December. The annual average precipitation is 14.6 inches, with a range from 6.6 inches to 24.1 inches. In 1970 rainfall was recorded on 28 days.

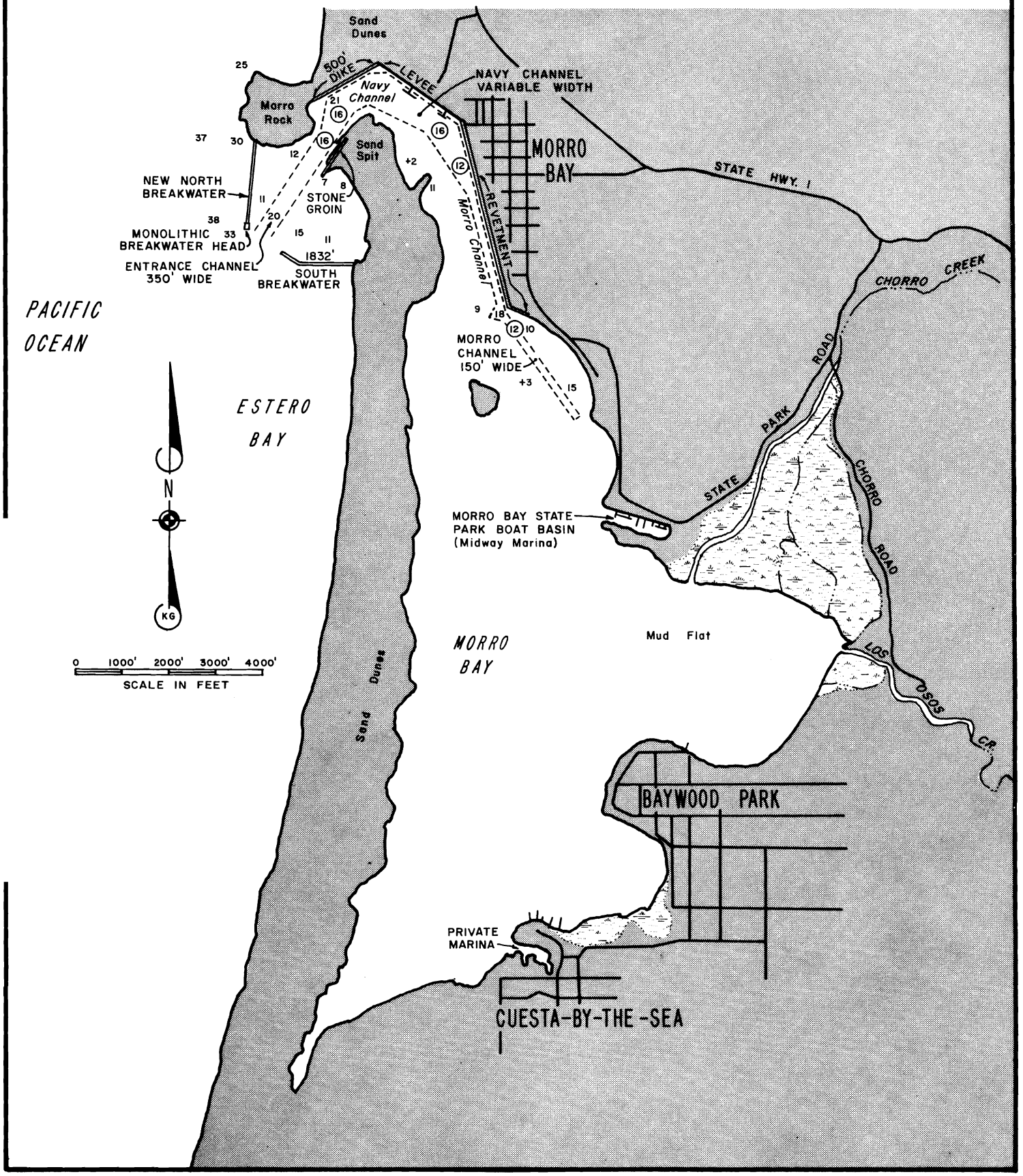
The atmosphere is often foggy, and the prevailing wind is from the northwest, from which direction come most of the offshore storms. Severe storms, however, come from the southwest.

Bottom and Shore Soil Types

From the entrance to approximately Fairbank Point the bay bottom consists of hard-packed sand (Reish and Barnard, 1967) or coarse sand (Menzies and Mohr, 1952). These bottom types continue out into Estero Bay and on into the ocean where they graduate into mud-sand-rock combination (U.S. Geological Survey, 1970). Sough of Fairbank Point, Morro Bay has a bottom of fine

PLATE 3

EXISTING NAVIGATIONAL FEATURES MORRO BAY



mud and sand, rich in organic material (Menzies and Mohr, 1952). Pools, or pans, within the salt marsh are bottomed with fine, brown silt. The Chorro Creek channels through the salt marsh are constituted primarily of gravels covered by thin layers of silts and fine sands (Reish and Barnard, 1967).

The extreme north shore connecting Morro Rock with the mainland is mostly coastal beach sand supported by a rock revetment. The eastern corner of the north shore, however, is formed from Metz loam (U.S. Department of Agriculture, 1928). The entire western side of the bay is shored, coastal beach sand with some active dunes. The only other major shore type is Baywood fine sand, found along the City of Morro Bay, Morro Bay State Park and the southern shore of the bay. Along the waterfront of the city of Morro Bay the shore is protected by a constructed rock seawall (Weigel, 1967). Between the estuaries of Chorro and Los Osos creeks, both of which are tidal marsh shore types, small areas of Los Osos fine sandy loam, Montezuma clay adobe, McClusky fine sandy loam and Clear Lake clay loam, border the bay (U.S. Department of Agriculture, 1928).

Area Geology

Morro Bay is the northern end of a depression trending southeastward through the Los Osos Valley and extending to, and including, the San Luis Valley (Cooper, 1967). This depression was an arm of the ocean at one time (Fairbanks, 1904). Morro Rock was once a part of the shore, as is indicated by the presence of waterworn pebbles up on the rock.

The only extensive lowland proximate to Morro Bay is the pre-Flandrian dune area of Baywood fine sand southeast of the Bay which slopes from a low of 49 feet to a high point of 656 feet. The upper reaches here are covered by Garey fine sand with an intermixture of Monterey shale (Cooper,

1967). The remaining bay environs is moderately steep and represents three diverse means of formation. North and northwest of Morro Bay is the Santa Lucia range, a late Mesozoic structure, partly of marine origin (Bailey, 1966). The section of this range in the bay area is included within the Franciscan formation (Division of Mines and Geology, 1958), which implies that the prevalent rock type is sandstone (Graywacke) accompanied by masses of serpentine. The soil type generally is a loam - Los Osos, fine sand, Clear Lake and Yolo (U.S. Department of Agriculture, 1928).

East of Morro Bay is a series of buttes, the San Luis Buttes, 14 in number, extending from Morro Rock to Islay Hill (Division of Mines and Geology, 1958). These buttes are volcanic intrusions of andesite-dacide composition of the Miocene epoch (Hall, Turner and Surdan, 1966). Many stand as conspicuous landmarks of the bay area, especially Morro Rock, Black Hill and Hollister Peak.

South of Morro Bay, beyond and adjoining the lowland, is the San Luis range, a structure with a marine origin of the Miocene epoch and described as rough mountainous terrain. This area is part of the Monterey formation, which is characterized by siliceous shales and chert beds (Oakeshott, 1971), the soil type being a loam - Los Osos or Arnold sand (U.S. Department of Agriculture, 1928).

Special Topography

An island, commonly referred to as Grassy Island, is located in the bay immediately south of the City of Morro Bay (Plate 1). The island is comprised of ten acres of sand (Gerdes, 1970) which supports halophytes or salt-loving plants, chiefly pickleweed (Munro, 1957).

A narrow inlet, called Shark Inlet or the Bright, marks the extreme southwestern point of the bay. Having a bottom mire this inlet is bordered by clumps of spiny rush, not commonly found north of Santa Barbara (Mason, 1957).

History

Three eras of California history--Indian, Hispanic and Modern--are clearly definable in records of Morro Bay. While the three eras are distinct socially and economically, the natural resources have always played an important role in the settlement and development of the Morro Bay area.

Indian

The native Indians that inhabited the Morro Bay area belonged to the Chumash group (Department of Parks and Recreation, 1971). Morro Bay represented the northern extremity of the southern cultural territory that was distinguished from the central cultural territory by a greater reliance on the sea for food. Although plant life was utilized by the Chumash, fishing from canoes on the open sea was their major preoccupation and livelihood. The canoes, made of fastened planks and payed with bitumen, the prow and stern elevated above the center, were propelled by long double-bladed paddles (Bancroft, 1886). Fish were taken with seines made of bark or with spears formed from bone. In trade with the Portola expedition of 1769 Indians offered fish and shells (Jespersen, 1939). The bartered shells probably were those of abalone (Frey, 1971).

Fishing was supplemented by hunting mammals and birds. Superstition generally excluded bear meat from the diet. Deer were hunted with bow while the hunter wore an artifice of deer's head and antlers. Wild fowl were caught in nets woven from tules (Bancroft, 1886).

Hispanic

Cabrillo was recorded as the first explorer of Morro Bay in the year 1542 (Morrison and Haydon, 1917). However, it is disputed whether Cabrillo ever landed in any part of San Luis Obispo County (W. W. Robinson,

1957). It is generally accepted, however, that Pedro de Unamuno entered Morro Bay in 1587 and landed with 12 soldiers, a Franciscan friar and a few Luzon Indians (Robinson, 1957; Salitore, 1971).

At the time of the actual Spanish occupation of California, Gaspar de Portola, the first governor of Alta California, led a land expedition from San Diego to rediscover Monterey during 1769, an expedition including Miguel Constanso, an engineer, and Father Crespi. This expedition named Los Osos Valley in commemoration of the "troop of bears" which was sighted and hunted in this pass to Morro Bay. They camped on 8 September 1769 at Morro Creek, where they were visited by friendly Indians (Jespersen, 1969). Subsequent to these explorations neither the establishment of missions by the Spaniards nor the large land grants of the Mexicans were conducive to change at Morro Bay lagoon. As late as 1872 large land grants permitted only a small population and insignificant trade and commerce The only trader at Morro Bay in 1872, E. B. Stocking, recorded exports primarily in dairy products (butter, cheese and eggs), grains (barley and wheat), vegetables (beans, potatoes and corn), lumber imports and copper ore (U. S. Army Chief of Engineers, 1873).

Modern

The beginning of the modern era is marked at Morro Bay by subdivision of the land grants, development of towns and the building of wharves. The Rancho Moro y Cayucos, a large land grant extending from Morro Bay to Cayucos, was subdivided into small farms in 1877 by the owner Don Domingo Pujol with the advice of C. H. Phillips, a real estate promoter. Cereals, vegetables and cattle were raised on the farms (Thompson, 1966).

In 1870, Franklin Riley founded the town of Morro Bay, originally called El Morro, by subdividing 160 acres along the waterfront into town lots. Riley in partnership with Williams, a captain of the schooner Alexina, also built the first wharf and warehouse, which encouraged the building of a second wharf in 1873, and promoted development of a town with a population of 148 in 1880 (Jespersen, 1939). The steamer Coquille and several schooners made stops at these wharves (Thompson, 1966). Other small steamers ran regularly between Morro Bay and San Francisco (Wiegel, 1967).

By 1894, although lumber schooners still made three or four landings at Morro Bay, the grain and dairy exports which previously left from Riley's wharf were now shipped from Cayucos. The diversion of traffic from Morro Bay to Cayucos in the north and to Port Harford (Port San Luis) in the south, the latter served by a railroad, was encouraged by the hazardous narrow channels abutting Morro Rock. One schooner, the Don George, ran aground in 1891. In the same year the third wharf was completed at the Town of Morro, and in the southern part of the bay the Town of El Morro was established (U. S. House of Representatives, 1895).

As early as 1910 the fishing port and recreational potentials of Morro Bay were realized (Wiegel, 1967), and in 1917 efforts were made to construct a year-round resort area (Morrison and Haydon, 1917). In spite of these early occupational developments, the population of Morro Bay in the first decades of this century increased but slightly, the 1930 census showing only 800 inhabitants.

A harbor was constructed by the U. S. Army Corps of Engineers between 1941 and 1946 (Wiegel, 1967). Subsequent to the completion of the harbor, at a cost of $2,612,000, the fishing industry at Morro Bay became economically

significant. In the 1950's 20 to 30 boats were regularly headquartered in the bay, and 12 purse seiners unloaded sardines, 11,000,000 pounds in the peak year of 1950, for transport to the canneries of San Francisco, Monterey and San Pedro (Scofield, 1954).

Morro Bay also assumed the role as an abalone fishery center after the harbor was completed. Between 1960 and 1967 an annual average of 1.25 million pounds was harvested (Frey, 1971). Sport fishing also assumed importance as early as 1952 when nine party boats were operating from the port (Scofield, 1954). Although commercial enterprises were established at Morro Bay soon after experimental plantings of 1932, large-scale oyster operations did not develop until the mid 1950's (Barrett, 1963).

Coincidental to the industrial growth, the population of Morro Bay increased more than twofold between 1950 and 1960, from 1,659 to 3,692 inhabitants (U. S. Bureau of the Census, 1961), and approximately doubled again in the following decade.

Quarrying Morro Rock

Before 1936 man-made modifications of Morro Bay were undertaken principally to assist in shipping stone quarried from Morro Rock. Quarrying began as early as 1880 for construction of the lighthouse on the rock, and in 1889 for construction of the breakwater at Port Harford, now called Port San Luis (U. S. House of Representatives, 1965). In 1910, quarried rock was used on the jetty at Morro Bay (Wiegel, 1967). Quarrying continued intermittently until 1965, when the State of California received unconditional title to Morro Rock (U. S. Statutes at Large, 1966). Over the years, 1,200,000 tons of stone were removed, and by 1965 the base perimeter apparently reduced from about 45 to the 36 acres (U. S. House of Representatives, 1965).

HISTORICALLY, MORRO ROCK WAS AN ISLAND AND THE BAY ENTRANCE WAS A CHANNEL ON THE NORTH SIDE OF THE ROCK. (PHOTO (ABOUT 1900) - FROM WIEGEL, 1967)

Closing the North Channel

In its natural state Morro Rock was a peak 1,000 feet off shore. Father Crespi in 1769 described it as a "round morro [Spanish geographical term for crown-shaped rock (Gudde, 1965)], which at high tide is isolated and separated from the coast by a little less than a gunshot" (Robinson, 1957). Navigational channels passed both north and south of the rock.

Since the shoaling and decreasing width of one channel had been associated with the deepening and increasing width of the other (U. S. House of Representatives, 1895), closing south channel was recommended in 1872 by the U. S. Army Corps of Engineers (U.S.A.C.E., 1873). But it was the north channel that was partially closed with a revetment by the San Francisco Bridge Company on the recommendation of the Corps. However, after 1913 the revetment was not maintained and by 1919 was badly in need of repair.

The revetment was rebuilt in 1935-36 and extended by the County of San Luis Obispo to the length of 1,700 feet and to the height of 12 feet above MLLW. Shoaling in the south channel subsequently decreased but variation in the width of the south channel continued (U. S. House of Representative, 1941). The Corps of Engineers again reconstructed the revetment in 1943 and improved it by a fill of heavy gravel deposited seaward (Wiegel, 1967). Further strengthening and stabilization of the embankment occurred by the formation of a coastal sand beach north of the revetment, the formation being an accretion of sand carried by southward currents (House of Representatives, 1941), and the north channel was finally closed.

In spite of the modifications that have been effected in the entrance area of the lagoon during the past century, the total area of high water has remained remarkably constant. In 1872, the rough estimate of high water was 2,500 acres (U.S. Army Chief of Engineers, 1873), an estimate reduced to 2,250 acres in 1894 (U.S. House of Representatives, 1895). In 1919 an estimate of 2,240 acres was given (Wiegel, 1967); the same estimate given in 1941 (U.S. House of Representatives, 1941). A recent estimate is 2,573 acres, including 472 acres of marsh (Gerdes, 1970).

Harbor Development

In 1941 the need for a coastal defense harbor by the Navy Department was given as justification for further federal work in the bay (U. S. House of Representatives, 1941). Additional impetus for development came from the Board of Supervisors of San Luis Obispo County and the local chamber of commerce. The latter agencies wanted access and facilities for small pleasure and commercial craft. The development was to include: (a) construction of breakwaters west from the sand spit and south from Morro Rock, (b) dredging of channels approximately two miles into the lagoon, (c) construction of a seawall 6,930 feet along the waterfront of the town of Morro Bay, and (d) the filling of a 200-foot strip between the town channel and the high tide line.

Prior to 1900, the channel into the lagoon forked into two segments at Stockings Wharf at the town of Morro. One continued south along the waterfront of the town of Morro Bay (the east channel), and the other continued south along the shore of the sand spit (the west channel). The latter rejoined the east segment north of White Point. Associated with the construction of the partial revetment from Morro Rock to the mainland in 1910 and the closing of the north entrance, was the shoaling

BY 1938, A REVETMENT AND SUBSEQUENT ACCRETION OF SAND BEHIND IT FINALLY CLOSED THE OLD NORTH CHANNEL. NOTE THE SHOALING ALONG THE FRONT OF THE TOWN OF MORRO BAY. (PHOTO (ABOUT 1938) - FROM WIEGAL, 1967)

BY 1946 THE SOUTH AND MORRO ROCK BREAKWATERS WERE CONSTRUCTED AND BY 1956 THE NAVIGATION CHANNELS DREDGED, BY THE U. S. ARMY CORPS OF ENGINEERS, FORMING THE PRESENT ENTRANCE TO MORRO BAY. NOTE THE PACIFIC GAS AND ELECTRIC CO. PLANT, THE WATER INTAKE AREA (A) AND THE WATER DISCHARGE CANAL (B). (PHOTO BY THE U. S. GEOLOGICAL SURVEY - JUNE, 1963)

of the channel along the waterfront of the town of Morro Bay. The first edition of the U. S. Coast and Geodetic Survey (1938) shows only one channel, along the sand spit. The serial construction of partial and complete barriers across the entrance north of Morro Rock is considered the cause of the east channel shoaling (Wiegel, 1967).

Harbor development began in 1941 with the restoration by dredging of the channel along the town of Morro Bay and the closing of the channel along the sand spit. In 1942 the South breakwater and reconstruction of the Morro Rock revetment were completed, and in 1944 the retaining seawall, marginal fill along the Morro Bay waterfront and dredging of the channel to the lower bay were finished. The Morro Rock breakwater was done by 1946 and the dredging of navigational channels by 1956 (U. S. Army Chief of Engineers, 1967). By 1945, a channel had been dredged laterally to the town of Morro Bay along the spoil sand fill, now called the Embarcadero, but the west channel along the sand spit remained largely unaffected by the development. The northern tip of the sand spit has been prominently widened leeside by the deposits of spoil sand from dredging operations.

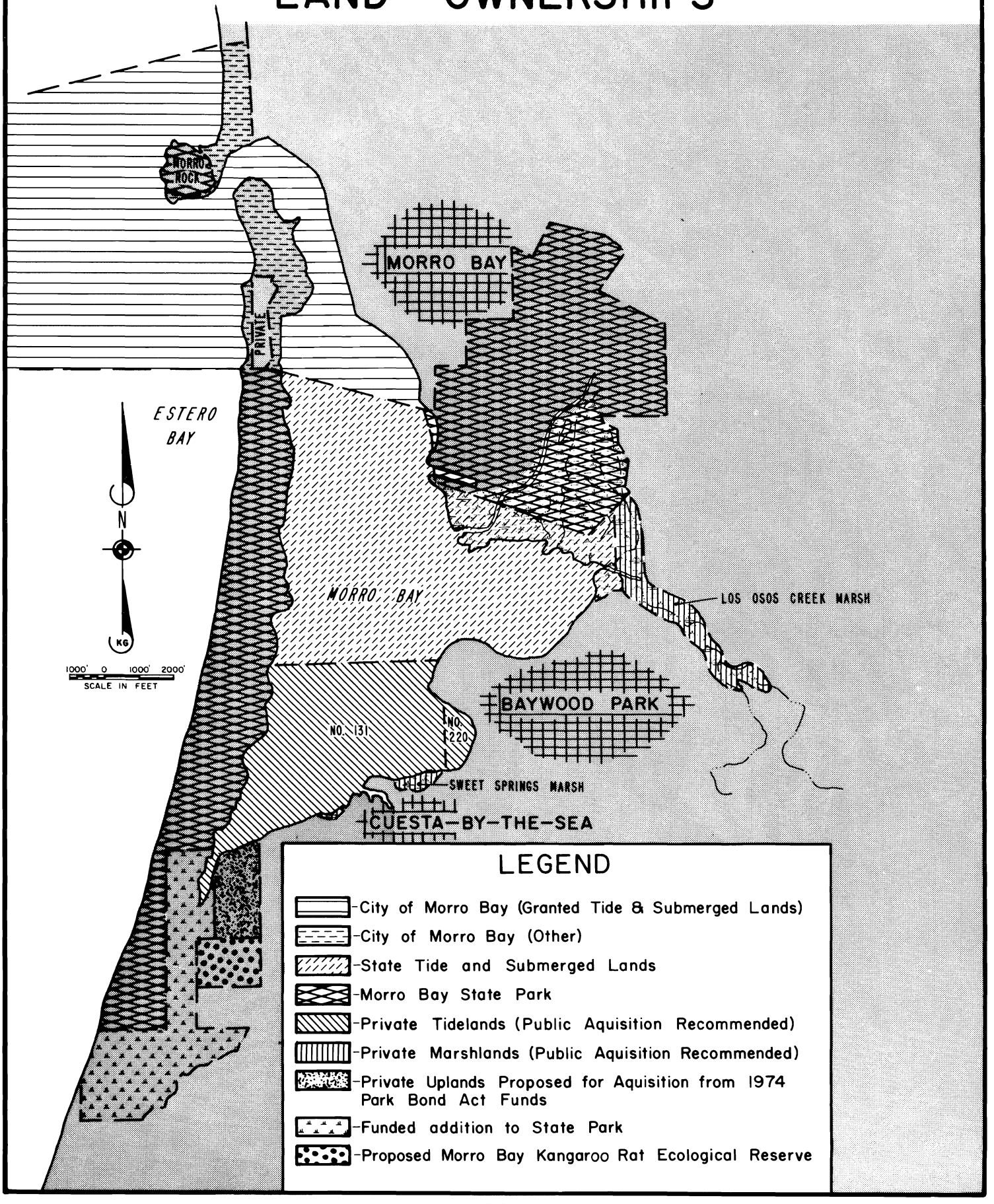
Since 1957 the work on Morro Bay has been confined to reconstruction of the Morro breakwater, completed in 1964. The existing Corps project (Plate 3) consists of maintenance dredging, performed every two years, removing 300,000 cubic yards of sand spoil which usually is deposited on the sand spit (John Wood, pers. comm.). Authorization for this continuing work is cited as the 1945 River and Harbor Act (U. S. Statutes at Large, 1945).

Land Ownership

Land ownership in and around Morro Bay is largely in public trust, the State of California being the major landowner (Plate 4). Morro

PLATE 4

LAND OWNERSHIPS



Bay State Park, under the jurisdiction of the Department of Parks and Recreation, embraces nearly 1,500 acres in and adjacent to the bay. The State Lands Commission holds in public trust approximately 64% of "tide and submerged lands" in mid-bay. By virtue of a 1947 legislative grant the County of San Luis Obispo received title to the northern portion of the bay and subsequent to incorporation on July 17, 1964 transferred the tidelands under their jurisdiction to the City of Morro Bay. The City also owns most of the northern end of the sand spit and the beach lands between Morro Rock (State Preserve) and Atascadero State Beach.

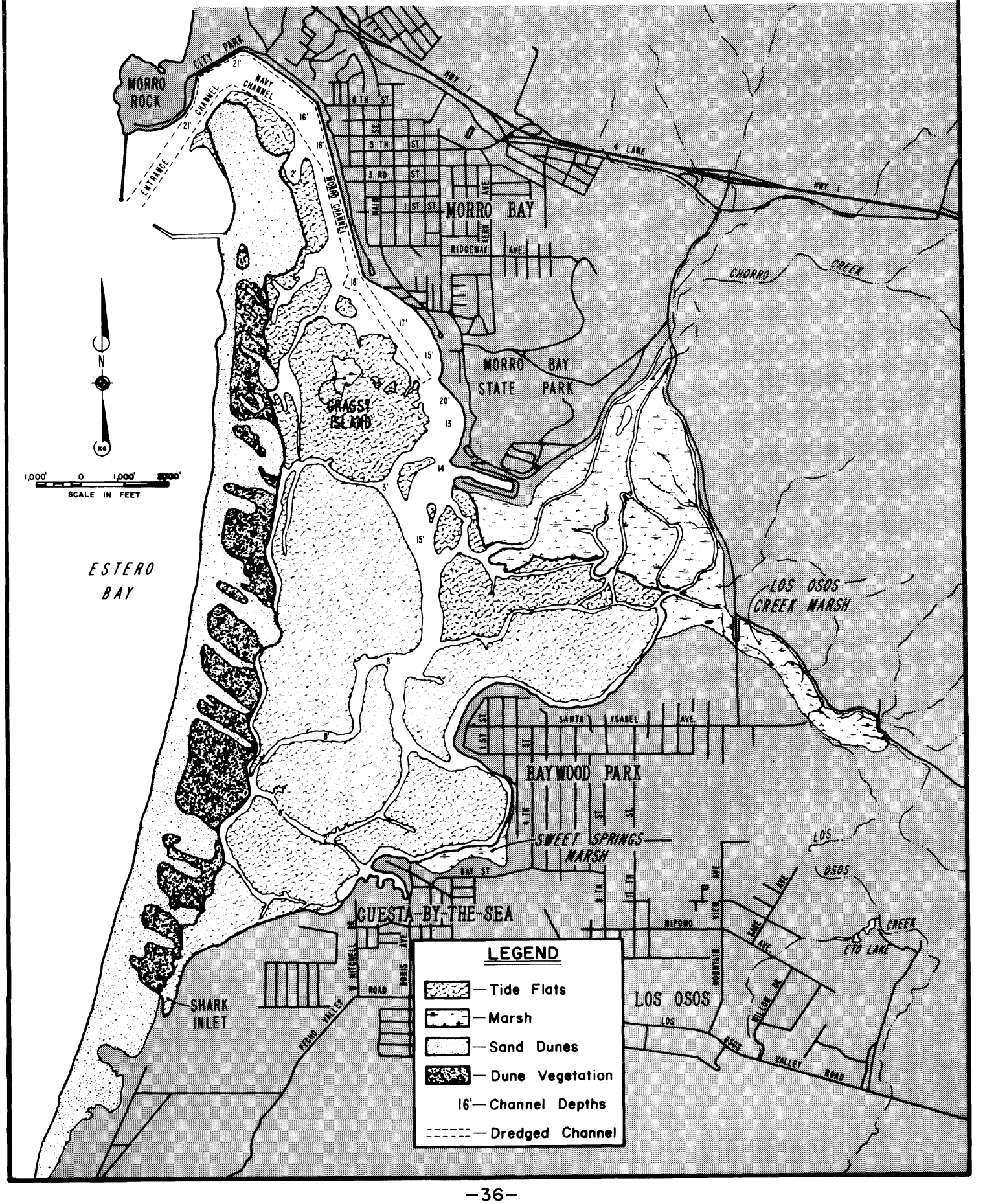
Approximately 566 acres of tidelands in the bay are privately owned. In the early 1900's "tideland location" #131 (538 acres) and "tideland location" #220 (28 acres), both in the southern part of the bay, were sold by the State to private parties. Other tideland parcels in the bay were also sold, but some were forfeited back to the State. The Department of Parks and Recreation acquired two such tideland locations which now comprise much of the salt marsh area of Morro Bay State Park. Only "tidelands locations" #220 and #131 (Plate 4) remain in private ownership.

A considerable part of the bay's shoreline also lies within the State Park and hence is in public trust. The City controls much of the bay frontage in the harbor area. The shoreline from Los Osos Creek to Shark Inlet, however, is privately owned; but, as yet, sparsely developed.

Morro Rock now in the Department of Parks and Recreation system was originally owned by the United States and utilized as a lighthouse reservation from 1867 to 1935. To protect the aesthetic, historic and tourist values of the landmark the State was given absolute title to Morro Rock in 1966 (U. S. Statutes at Large, 1966).

PLATE 5

MORRO BAY HABITATS



RESOURCES

Habitat and Ecology

Habitat is the key to the abundance, well-being and survival of fish and wildlife resources. The term "habitat" has been used for many years by biologists and means "where the organism lives" and implies "living requirements." Basically these requirements are food, water, cover and space. Morro Bay provides habitats and, hence, fulfills these requirements for numerous and varied fish and wildlife species, some of which migrate to the area to spend a short time, and others that are year-long residents.

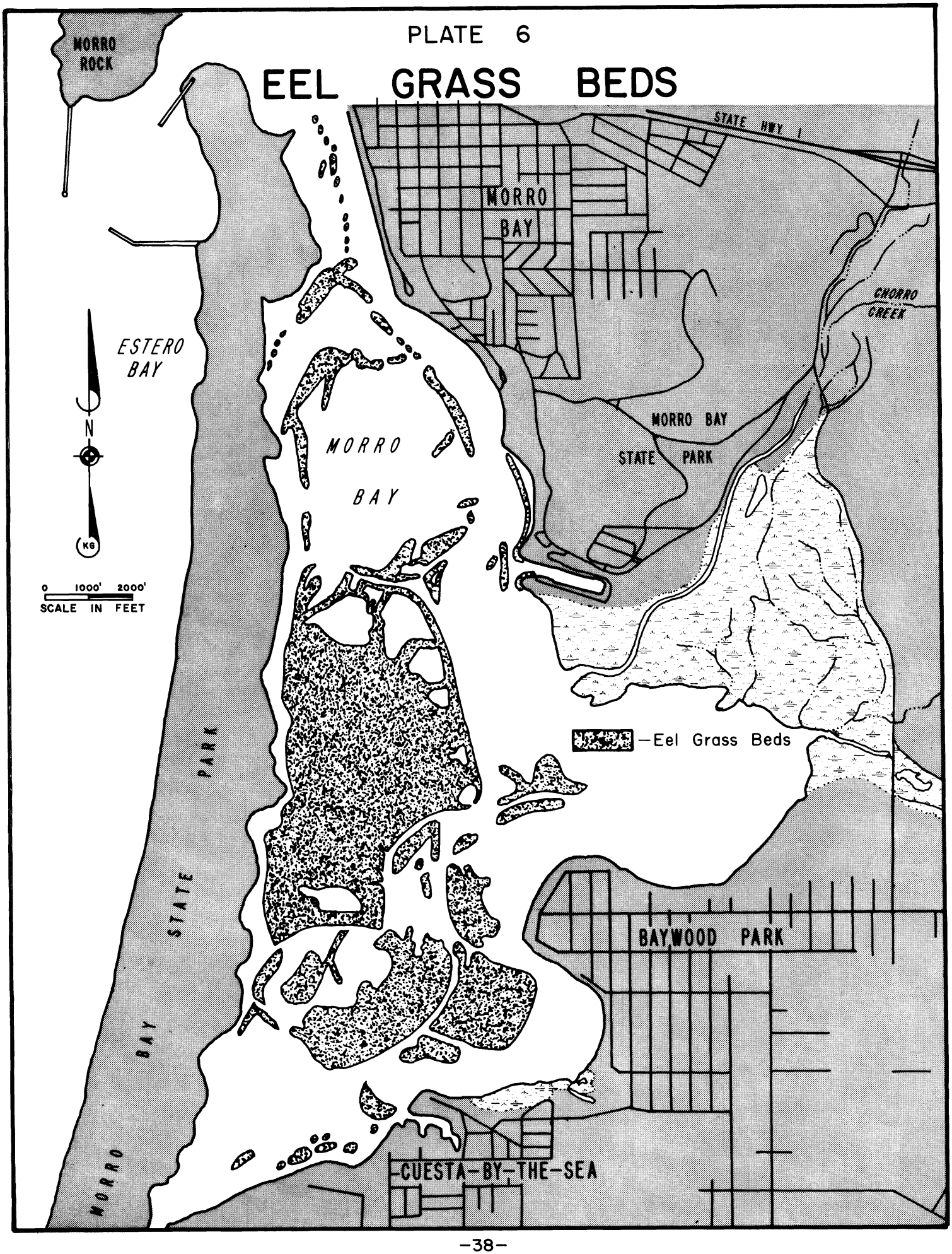
To better understand tidal habitat, scientists have delineated three zones: *marine*, that area continually under water; *littoral*, that area subject to tidal influence; and *maritime*, that area between the upper edge of the littoral zone and the upland vegetation. All three of these zones provide different habitats and are represented in Morro Bay (Plate 5).

Eel grass, ecologically an important food and cover plant, grows principally in the marine zone (Plate 6). Surveys show that eel grass is increasing. Initial surveys (Haydock, 1960) showed 335 acres of eel grass; 1972 Department surveys, 483 acres.

Most other significant aquatic plants of the marine zone are algae (Appendix A). Bellin (1970) collected and identified 30 species of macroscopic algae; nine were green algae, sixteen red, and five brown. Also identified from the marine zone were two diatom species. Green algae species are also found in the higher intertidal zone (littoral) and in areas of low salinity, while reds and browns are restricted to lower areas with greater salinity. In addition to being a food source, algae serve as a place for attachment for the eggs of many estuarine animals.

PLATE 6

EEL GRASS BEDS



The littoral zone has two distinct features, the tidal mudflat and the salt marsh (Plate 5). Tidal flats occupy 1,452 acres and salt marsh, 472 acres (Gerdes). Eel grass and green algae species are found over lower tidal flats as well as in the marine zone. The upper edges of the tidal flats generally are barren of vegetation due to constant exposure and then periodic innundation due to tidal influence. Although appearing sterile, tidal mudflats provide habitat for very large numbers of invertebrate species. It is the mudflats that are so attractive to shorebirds and supply much of their food.

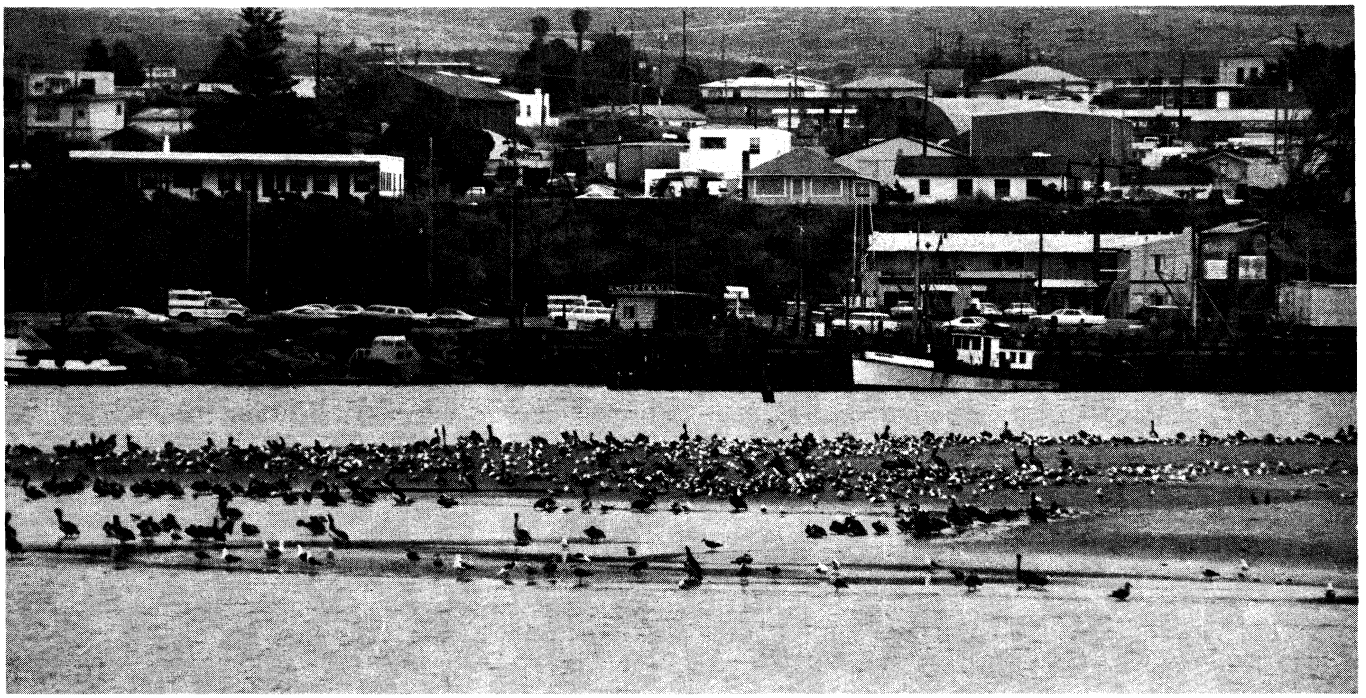
Ninety-four percent of the salt marsh in the bay is located at the mouths of Chorro and Los Osos creeks. The remainder is scattered along the edges of the bay and on Grassy Island. Salt marsh plants, by means of photosynthetic activity and nutrient storage make a major contribution to the primary reproductivity of the bay.

Some herbivores feed directly upon the vegetation. However a considerable portion of littoral vegetation is converted to detritis which forms a substrate for bacteria. It is both the bacteria and the detritus that begins the complex food chain that holds the cycle of life in the coastal wetlands together. And, salt marsh also is used by some species for nesting and as a loafing (resting) area by many water-associated birds during high tides.

The vegetative composition of the salt marsh is largely dominated by pickleweed. In some areas of slightly higher ground, the pickleweed is mixed with patches of saltgrass, Jaumea and alkali heath. At lower soil and water salinities, at the approaches to the creek mouths, changes in the vegetation composition are observed and the presence of cattails, tules and willows indicates a freshwater influence. Los Osos creek and

THE SALT MARSH LYING SOUTH AND EAST OF THE STATE PARK IS IMPORTANT RESTING, NESTING AND ESCAPE HABITAT FOR MANY BAY WILDLIFE. (DEPT. FISH & GAME PHOTO)

TIDELANDS ARE VERY ATTRACTIVE TO COASTAL WATER-ASSOCIATED BIRDS AND SUPPLY MUCH OF THEIR FOOD. (DEPT. FISH & GAME PHOTO BY JOHN SPETH - JUNE, 1974)



estuarine area east of Baywood Road is a good example of an admixture of both fresh and saltwater vegetative associations. Ground bars and salt pans throughout the salt marsh and not flooded constantly by tidal water often support stands of different plants such as brassbuttons and saline pools and ditches in the marsh support ditch grass, an important waterfowl food plant. Morro Bay State Park has an excellent account of the plants and ecology of the intertidal and estuarine area of the bay (Barnes, 1964).

The maritime zone borders almost all of the bay with the exception of the developed harbor areas. For the most part, this zone occurs as a narrow band between the pickleweed salt marsh and the upland vegetation, which consists largely of grassland or chaparral. Sea blite, statice, saltwort, and annual saltbush are plants characteristic of the maritime zone.

The maritime zone also includes the sand dunes that separate the bay from the ocean. From the southern end of the northern extremity of the spit, dunes and beach, in combination, cover 735 acres. Active tongues of sand are invading the intertidal zone of the bay along the west side of the spit wherever there is an absence of stabilizing vegetation (Cooper, 1967). The dunes are vegetated over most of the southern two-thirds of the spit. Dominant shrubs are silvery lupine and mock heather, coyote brush and lizard tail; other common plants are live-forever, four species of sand verbena, beach primrose and sea rocket, the latter is a primary dunes invader on the spit (Lloyd Dunkel, Morro Bay Museum of Natural History, pers. comm.).

Maritime habitats and their characteristic vegetation furnish important escape, nesting and loafing cover for many estuarine birds and

animals. The dune areas on the spit also comprise specialized habitat for a few wildlife species.

The upland vegetation surrounding the bay is principally chaparral, dominated by California sage, and interspersed with some woodland, residential areas and grasslands. The California sage scrub includes plants such as deer weed, black sage, buckwheat and bush lupine. The grasslands are characterized as pasture lands and scattered grassy openings in the chaparral scrub. The California sage chaparral areas constitute the bulk of the remaining habitat of the indigenous Morro Bay kangaroo rat (Stewart and Roest, 1960).

Water-associated Birds

During the winter the bay abounds with birdlife. Morro Bay is an integral part of the Pacific Flyway, the migratory pathway that myriads of waterfowl, shorebirds and other water-associated birds follow from their northern breeding grounds to the wintering grounds. It is the migratory species that account for most of the wealth of birdlife that occurs in the winter months; some of the birds stopping briefly, some spending the entire winter. The bay area is not without birdlife during the late spring and summer months, however, as the bay also provides nesting requirements for some interesting species (Appendix B).

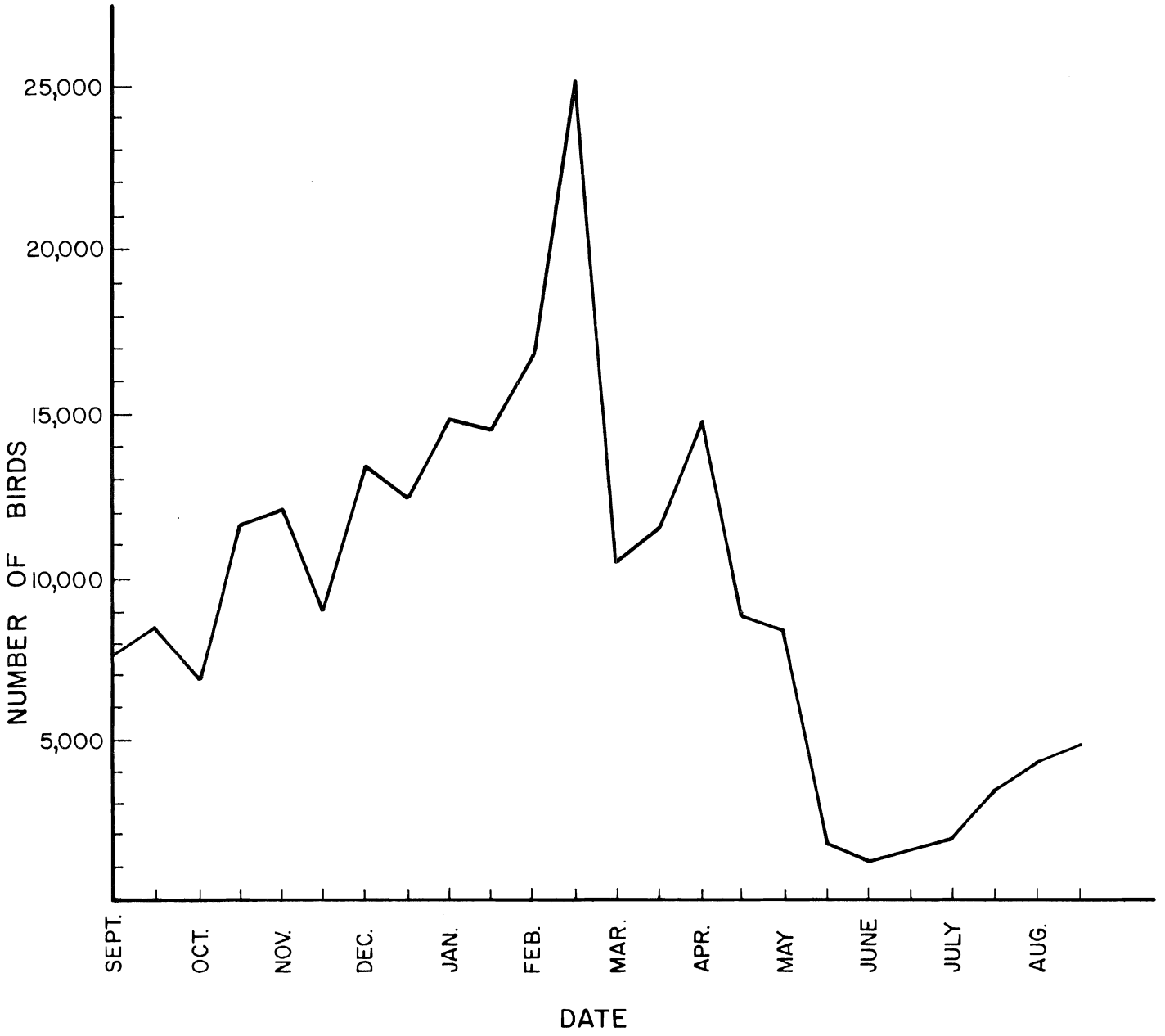
Seventy-five species were identified during a bi-monthly Department count from September 1, 1966 to August 15, 1967 (Appendix B). Over 25,000 birds were counted on the bay on February 15, 1967; and only 941 on June 1, 1967 (Appendix C). Migration into the bay area appears to start about mid-June and peaks late in the winter (Plate 7). Total numbers of birds migrating to and through Morro Bay are comparable to those recorded in Elkhorn Slough in Monterey County (Browning, 1972), a wetlands of about the same size.

PLATE 7

WATERBIRD ABUNDANCE

D.F.G. BIMONTHLY CENSUS

SEPT. 1, 1966 – AUGUST 15, 1967



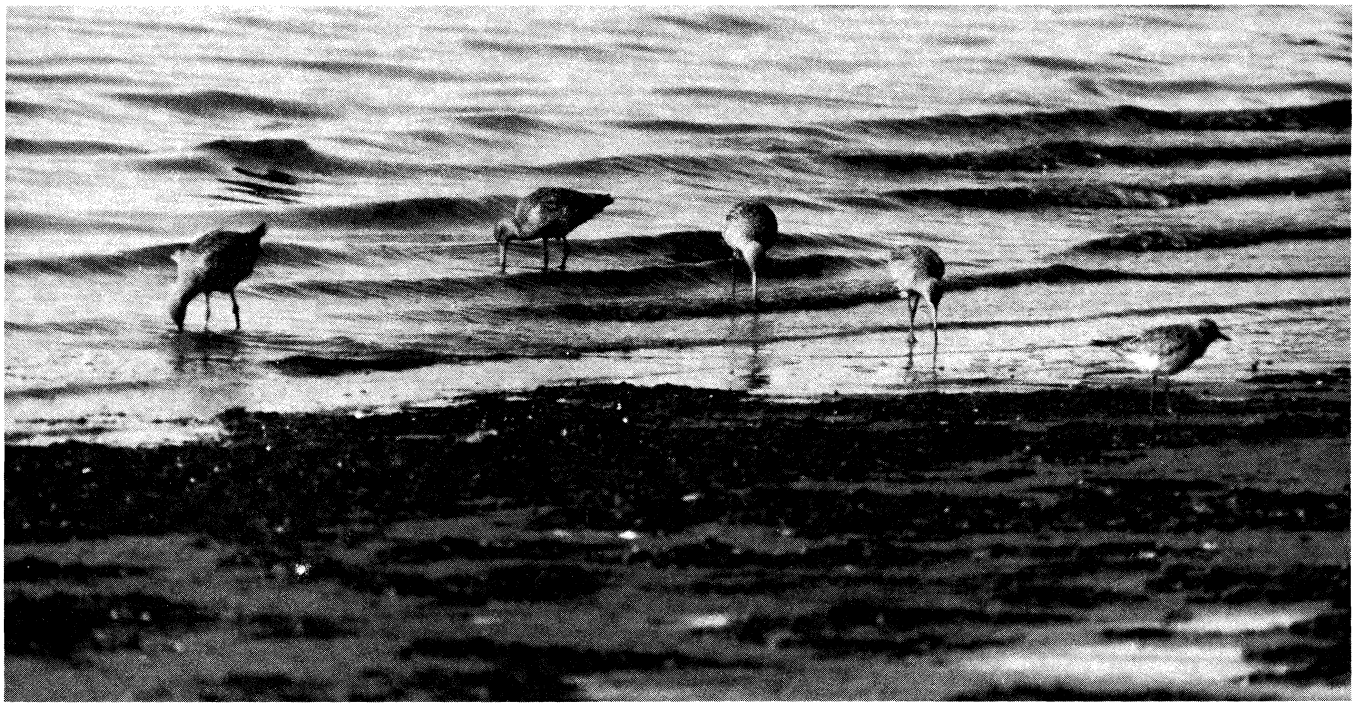
K.G

Early surveys show that Morro Bay has long been an important link in the coastal migratory flyway. In the fall of 1918 Grinnel and Hunt recorded 59 bird species. Munro (1957) recorded 89 species over a seven-year period. Both early accounts included observations along the beaches and adjacent areas to the bay. The 1966-67 Department count of 75 species was confined to the bay alone.

Shorebirds are more abundant than any other group of birds. The 1966-67 Department survey recorded 4,169 marbled godwits, 3,070 willets and over 7,000 sandpipers, predominantly least and western sandpipers. Other common shorebirds seen at Morro Bay are the curlew, dunlin, dowitcher and sanderling.

Waterfowl are second in abundance in Morro Bay during their annual migration. Pintail, green-winged teal, lesser scaup, widgeon, ruddy ducks and bufflehead are fairly common winter visitants. But, the most significant in total numbers is the black brant, a goose generally restricted to coastal bays, lagoons and estuaries. During the 1966 - 67 census over 8,000 brant were observed; in fact the highest number recorded by the Department for any one bird species using the bay was recorded for the black brant (11,800 in 1955).

Wading birds are a significant group of birds at Morro Bay. Great blue herons, black-crowned night herons, snowy and common egrets are all seen about the bay. An important heron rookery is located at Fairbank Point and has been active since 1948 (C.D.F.&G., 1966). Studies during the 1971 breeding season recorded 74 active great blue heron nests; 132 chicks hatched and 11 fledged. Black-crowned night herons occupied 100 nests at the Fairbank Point rookery during the 1972 breeding season. The rookery is posted against irresponsible trespass. Night herons may



SHOREBIRDS ARE AMONG THE MOST NUMEROUS WINTER MIGRANTS
TO MORRO BAY. (DEPT. FISH & GAME PHOTO)

BLACK BRANT HAVE BEEN RECORDED AS THE MOST NUMEROUS BIRD ON THE BAY
AT ANY ONE TIME AND ARE HIGHLY PRIZED BY A SMALL COTERIE OF
TRADITIONAL HUNTERS.
(DEPT. FISH & GAME PHOTO BY GEORGE TIDWELL - 1972)

also be observed commonly roosting in the eucalyptus grove east of the State Park marina. A similar rookery at Cuesta-by-the-Sea has not been active the last few years and appears to be abandoned.

Gulls, of course, are another common group of birds observed in the bay area. Ten species are recorded, the most common are the Heermann's, California, Western and ring-billed gulls. Six species of tern are also noted at Morro Bay, including a rare observation of a least tern which is considered a rare species in California (C.D.F.&G., 1972).

The white and brown pelicans, 5 species of grebe including the uncommon red-necked grebe, and 3 species of loon are also found as winter visitants to the bay, although a few brown pelicans may be observed all year round.

The black rail, also classified as rare (C.D.F.&G., 1972) has been observed in the salt marsh area of the bay and there are past reports of nesting success there (A.I. Roest, pers. comm.). Other species of water-associated birds besides the herons and the rail nest in Morro Bay. Although no specific studies have been made, observations by wildlife managers and conservationist groups indicate that at least another dozen species nest locally.

Finfish

Fishes are an important resource in Morro Bay, both in variety of species and number. Sixty-six species (Appendix D) have been collected from the bay and from about one mile of Los Osos Creek (Firestine, Kline and Garman, 1973). Only three species comprised 50% of the total individuals collected (excluding freshwater species): the northern anchovy, 21%; shiner perch, 17%; and the black perch, 12%.

THE EUCALYPTUS GROVE AT FAIRBANKS POINT IS THE LAST SIGNIFICANT GREAT BLUE HERON ROOKERY ON THE CALIFORNIA COAST SOUTH OF SAN FRANCISCO. (DEPT. FISH & GAME PHOTOS BY JOHN SPETH - JUNE, 1974 AND CLYDE EDON - JUNE, 1972)

The distribution of northern and southern ranging fish overlaps at Morro Bay and, depending on oceanographic conditions (warm or cold water trends), the fish using the bay tend to be predominantly those that range to the south. Eleven species, captured during six months or more of the year, probably are annual residents. Twenty-nine species were collected only during a single month and probably are seasonal or occasional visitors.

The bay is used as a nursery or spawning ground by several fish (Firestine, Kline and Garman, 1973). The bay also is important as a migration route and nursery for steelhead, which utilize the tributary streams (M. Johnson, pers. comm.).

Morro Bay supports a significant sport fishery. California halibut, starry flounder, sand sole, jacksmelt, four species of perch, leopard shark, horn shark, skates and rays are the chief contributors to the sport fishery within the bay (Calif. Dept. of Fish and Game, 1966).

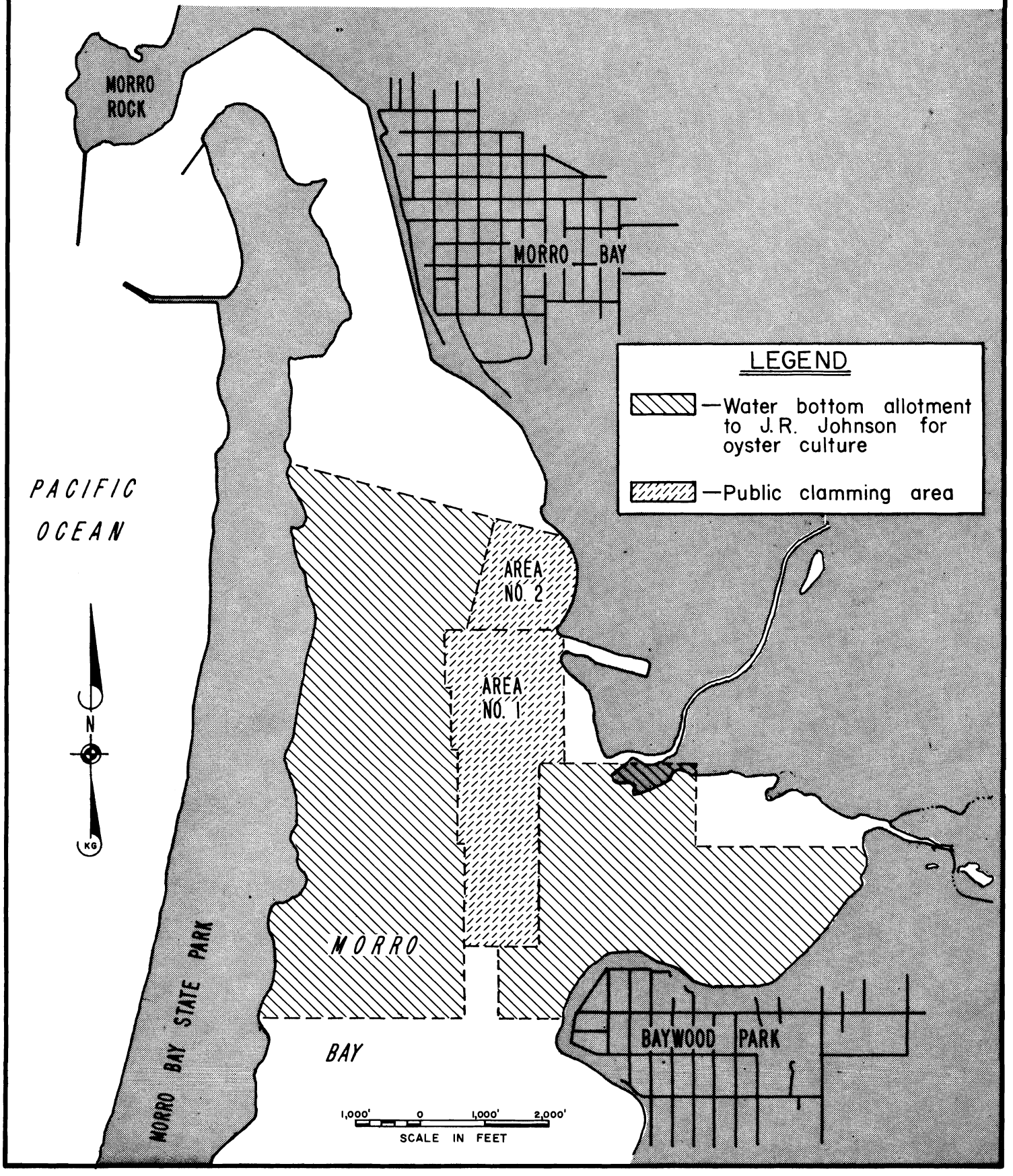
Shellfish

There are 19 species of clams found in the Morro Bay area (Appendix E). The most abundant are the Washington gaper and geoduck clam. All these species are important to the recreational use of the area. Clam preserves No. 1 & 2 (Plate 8) both support healthy populations of these principal species (Dahlstrom and Modin, 1966). Numerous gapers and geoducks are found near the mouth of the bay opposite the P.G.&E. powerhouse. Geoduck clams appear to be abundant and distributed from the entrance to the bay and along the main channels to the mudflats on the south end near Baywood Park (Dahlstrom and Modin, 1966).

Some clams have very low populations in the Morro Bay area, and one, the Pismo clam, appears to be at a dangerously low population level.

PLATE 8

STATE WATER BOTTOM ALLOTMENTS AND PUBLIC CLAMMING AREAS



Formerly quite numerous in the area, Pismo clams have exhibited little recruitment of any consequence since 1944 (Carlisle, 1966). Reproduction was good in 1966, 1967 and 1972 but there has been little survival of 1966 and 1967 year classes (J.G. Carlisle, pers. comm.). Because the Pismo clam requires surf to survive (Ricketts and Calvin, 1948), it is found only on the beaches that face the surf, and on the sand spit and north of the Rock.

Other clams in scarce supply in the Morro Bay area are on the extreme limits of their habitats or ranges, and are more numerous elsewhere. Littleneck clams are an example and are only found on the rocks at White Point and at the mouth of the bay (Dahlstrom and Modin, 1966).

Morro Bay is the most southerly area in California where commercial oystering is significant (Barrett, 1963). The oyster industry in California does not exploit a native marine resource, but is based on mariculture (Frey, 1971). The Pacific oyster (or giant Pacific oyster) is the only oyster being cultivated in large numbers in California at the present time.

All Pacific oysters are grown from "seed" (small oysters, 0.1 to 0.5 inches in length) imported from Japan, British Columbia or the State of Washington, and put into oyster beds in California. Water temperatures in California's oyster growing areas are too low to permit successful spawning and survival of the larvae (Barrett, 1963).

Oysters in Morro Bay are generally free of the pests and parasites that attack other oyster growing areas. The bat stingray is the only serious predator, and they attack only young oysters; older oysters have too thick a shell for the ray to crush. Morro Bay sometimes becomes choked with a green filamentous algae during the summer. Large algae blooms inhibit oyster feeding and make working oyster beds difficult (Barrett, 1963).

Other Invertebrates

Morro Bay is extraordinarily rich in invertebrate life. Numerous species of invertebrates, including the clams, oysters and mussels, occupy various niches in the lagoon's complex food web. Marine worms ingest mud and extract nutrients from it. Barnacles filter out nutrients from plankton rich water. Crabs, isopods and amphipods are active scavengers. All in turn become prey for birds, fishes, marine mammals, and man himself, through the food chain.

Some definitive work has been done locally on various groups of invertebrates. Reish and Barnard (1967) found 34 species of polychaete worms and 20 species of amphipod crustaceans. Curtis (1965) identified four species of sea anemones and noted their locations. Barnes (1963-64) listed invertebrates found throughout the intertidal zone and Menzies and Mohr (1952) surveyed distribution of wood-boring crustaceans. Over 160 invertebrates are listed from the bay (Appendix E).

Four species *(Capitella capitata, Strebloospis benedicti, Heteromastus filiformis* and *Exogone lourei)* comprised over 70% of the polychaete worms (Reish and Barnard, 1967). Most were found in the central part of the bay and in Los Osos and Chorro creeks. Amphipods are found in the same areas. Most of these latter animals are closely associated with plant life such as eel grass, algae and pickleweed.

Curtis (1965) found anemones distributed from the marina at White Point out to the harbor mouth. Lack of attachment sites and very swift currents probably preclude establishment of these animals in most areas of the bay.

Ghost shrimp are commercially important and are dug from sand and mud flats for bait by sport and commercial fishermen (D. Burge, pers. comm.).

Marine Mammals

Four marine mammal species are seen at times in Morro Bay. The most common is the harbor seal. Less abundant are the California sea lion and Stellar's sea lion (L. Dunkel, pers. comm.). Very recently a sea otter was observed in the area, which probably makes Morro Bay the southern limit of the otter's present distribution.

As many as 15 harbor seals have been seen at one time on the mudflats south of White Point (Schultz, pers. comm.). The total population is estimated at about 30 animals (A. I. Roest, pers. comm.). The harbor seal has been noted to give birth to young on the mudflats of the bay (A. I. Roest, pers. comm.).

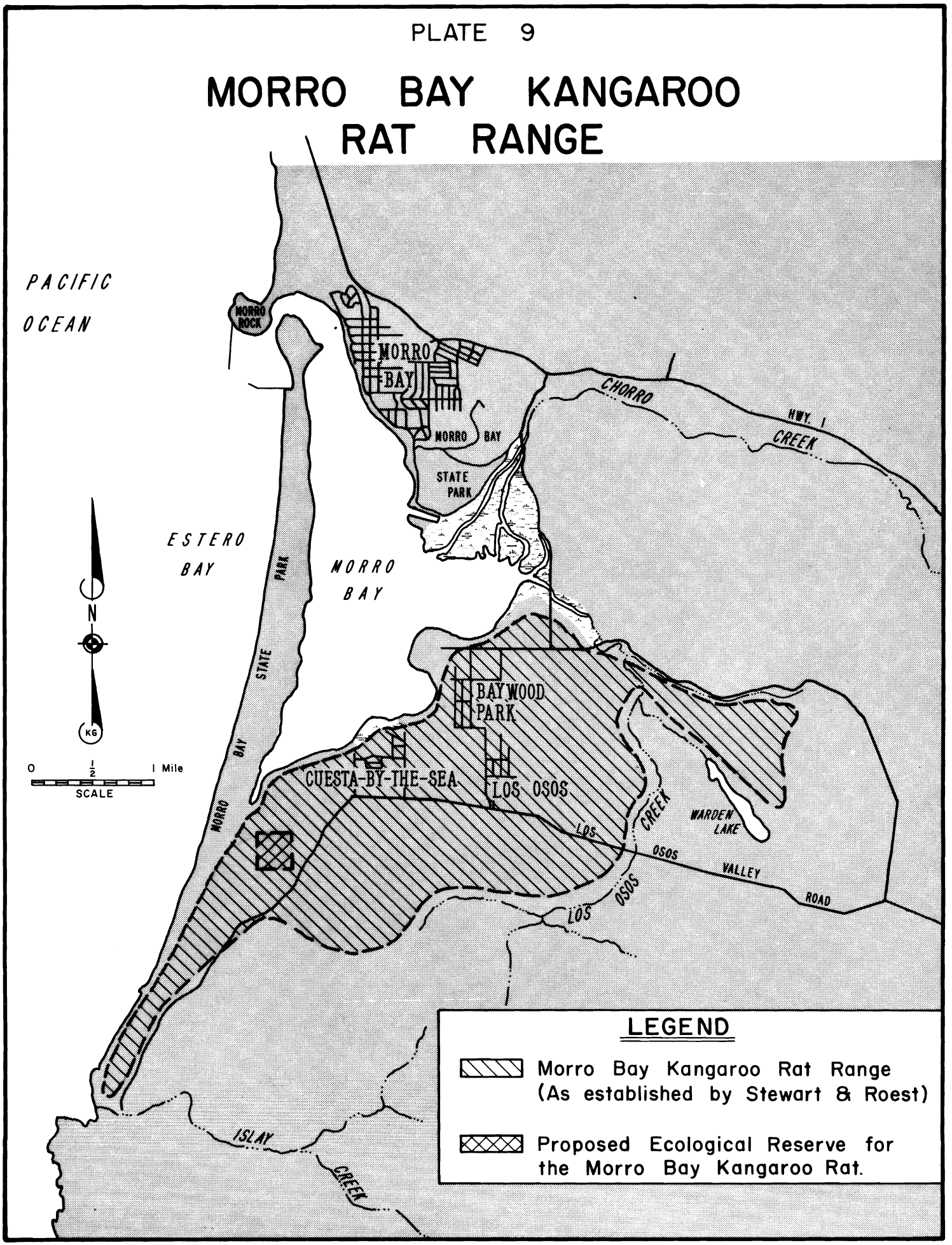
Upland Wildlife

Approximately 30 mammal species (Appendix G), including the 4 marine mammals, are found in the Morro Bay area (A. I. Roest, pers. comm.). Many of these are found in upland habitat surrounding the bay and several use the littoral area in search of food.

The Morro Bay kangaroo rat, an endangered species (Calif. Dept. of Fish and Game, 1972) is known only from the south side of Morro Bay (Stewart and Roest, 1960 (Plate 9). In 1958, the population was estimated at 8,000 and in 1971, 3,000 (Congdon, 1971). Maturation of plant cover, destruction of suitable habitat by urbanization, high populations of predatory feral house cats, and the possibility that early estimates were made during peak populations and later estimates when populations were low are possible explanations for the difference in population estimates of these cyclic animals (Congdon, 1971). Habitat destruction, however, is one of the most significant factors affecting wildlife populations today;

PLATE 9

MORRO BAY KANGAROO RAT RANGE



and is a factor influencing this endangered species at Morro Bay. Suitable habitat now occupies 1.75 square miles (Congdon, 1971) compared to 2.5 square miles in 1958 (Stewart and Roest, 1960).

The peregrine falcon, another endangered species (Calif. Dept. of Fish and Game, 1972), nests on Morro Rock, one of the few remaining active peregrine nest sites in California. Reproduction at Morro Rock in the 1972 breeding season was unseccessful because of nest robbing by unknown persons. The survival of this species is precarious. Herman (1970) states "the small remnant population is especially sensitive, and the loss of a single peregrine might well reduce the survival potential of a population."

Besides the 75 species of water-associated birds counted on the bay, another 207 species of birds (Appendix F) have been recorded in western San Luis Obispo County (Roest, 1970). Some of these species can be found occasionally in the bay, and a few more species are pelagic; but most (85%) are upland associated birds.

Three reptiles have been recorded from the sand spit: the fence lizard (*Sceloporous occidentalis*), western skink *(Eumeces skiltonianus)* and garter snake *(Thamnophis sirtalis)*. The northern pacific rattlesnake *(Crotulus viridus oreganus)* has been reported as present on Morro Rock (Klauber, 1956).

RESOURCE AND LAND USE

Use of Biological Resources

Hunting

The taking of wildlife at Morro Bay includes both duck and goose hunting. Six species of ducks are taken on the bay (De Grood, 1971). These ducks listed in order of decreasing frequency of hunter possession on weekends and holidays during the 1970-71 season, are widgeon (0.3 ducks per hunter), pintail (0.2), ruddy (0.2), scoter (0.1) and teal (0.1); the merganser was recorded in weekday hunting with a take of 0.04 ducks per hunter. Over the entire 1970-71 hunting season teal followed widgeon in frequency of hunter possession. On a selected 291 acres (23%), of the total 1,285 acres of hunting area, duck hunters, during 1970-71, spent 3,013 hours to take a total of 211 ducks (De Grood, 1971).

Goose hunting in San Luis Obispo County is generally limited to hunting of the black brant at Morro Bay lagoon. An estimated average of 300 brant a season are taken from Morro Bay. Brant hunting is traditional and very important to a limited number of hunters at Morro Bay.

Clamming and Harvesting of Other Mollusks

Section 6523, Article 5, of the Fish and Game Code (1971) prohibits allotment for oyster cultivation in tidewaters designated for clamming by the public. Two such areas have been designated in Morro Bay (Plate 8): clam area No. 1, encompassing approximately 60 acres, and clam area No. 2, south and adjacent to area No. 1, encompassing 156 acres. In addition to these areas reserved for the public by the Fish and Game Commission, the southern extremity of the bay that is in private ownership, and the northern extremity of the bay, which is held in trust by the City of Morro Bay, are popular with clam diggers.

Since the area within and between the breakwaters is considered to be part of Morro Bay, sport clamming in Morro Bay includes some open coast and sandy beach where pismo and razor clams are taken. On the tidal mudflats of the bay, geoduck, Washington and gaper clams are dug, and rocky shores yield a harvest of piddock and littleneck clams. In a 1966 survey (Dahlstrom and Modin, 1966), three diggers obtained 30 clams in approximately one hour. Although the survey was taken in February, clamming is a year-round sport in Morro Bay.

Bay Fishing and Crabbing

Sport fishing in Morro Bay is done from shore as well as from skiff. The breakwaters are considered unsafe and not utilized. Fishing from piers, the revetment, and rocks often results in catches of perch or flounder and less often in catches of jacksmelt, lingcod or cabezon (Sunset, 1957, 1960). The sand sole also is reported as numerous (Miller and Gotshall, 1965).

A limited survey of fishing on the City of Morro Bay's "T" Pier (McLeod, 1969), during the first five months of 1969, showed that 107 fishermen used the pier to spend 228 hours catching 161 fish (0.701 fish per hour per fisherman). Fish caught represented 11 species and 4 families: shiner perch (53% of the catch), black perch (23%), jacksmelt (11%), other perch (10%), lingcod (2%) and rockfish (1%). Average size of the fish caught was 6.5 inches and ranged from 3 inches for shiner perch to 16 inches for jacksmelt and lingcod. Total linear fishing space on piers at Morro Bay covers 650 feet and in 1958 had an estimated use of 8,000 angler-days (Miller and Gotshall, 1965).

Fishing by skiff is primarily for California halibut, which is 17% of the total catch by the skiffs operating in the bay (Miller and

Gotshall, 1965). However, the starry flounder (41%) and jacksmelt (20%) compose an important element of the skiff fishery. Striped bass are also caught but in numbers that indicate a small population.

Crabbing with nets is an important sport activity from piers along the waterfront. Divers take many crabs in the entrance channel (D. Burge, pers. comm.).

Scientific and Educational Use

California Polytechnic State University at San Luis Obispo uses Morro Bay for numerous and diverse studies by both graduate and undergraduate students. Studies results are permanently filed at that university[1/] In conjunction with a course in marine resources, four experimental oyster fields, 100 square feet, are actively utilized for mariculture research. These fields are located within the oyster allotments, two fields in the northern and two in the southern sections (Richards, 1972). Staff members of California Polytechnic State University have published reports on the biology of Morro Bay, e.g., on the extant fish population within the lagoon (Fierstine, Kline and Garman, 1972); the distribution and habits of the indigenous species of kangaroo rat at Morro Bay (Stewart and Roest, 1960), and a study of an estuarine ecosystem (Los Osos Creek and Marsh) (Richards, 1972).

The University of California, Santa Barbara, utilizes Morro Bay for scientific and educational field trips. The University of California, Los Angeles, has found in the bay material for two Ph.D. dissertations (Russell, 1960; and Brandman, 1972). Other academic institutions using the bay are the University of California, Irvine and Pomona College, Claremont. Local elementary and secondary schools also make field trips to the bay area. And, independent of any California institution, one

1/ Several of these papers may be found in the Reference Section.

scholar has come all the way from Canada to study the birds of the bay (Munro, 1957).

The Department of Parks and Recreation maintains a museum of natural history at White Point, which commands an extensive view of the bay, its wildlife and other natural resources. Exhibits, movies, lectures, slide programs and nature walks at this museum inform tourists and school children of the biological value of the area. The mean average annual attendance from 1965 to 1971 at the museum was 27,197 (Marshall, 1972). In 1972 and 1973, however, the visitor-use has jumped to 62,464 and 75,435 people, respectively.

The Department's Marine Resource Region maintains a laboratory at Morro Bay. Research on the life history and biology of the red abalone is presently the major emphasis of that laboratory.

Birdwatching

Observation and identification of the large winter population of birds is a hobby not only for many residents, some of whom have mounted telescopes in their homes, but also for the many birdwatchers and tourists with binoculars and spotting scopes in hand. This activity is well-emphasized in typical lists of diversions for visitors to Morro Bay (Sunset, 1960). It is estimated that about 10,000 man days are expended annually for this activity.

The National Audubon Society has an established branch, the Morro Coast Audubon Society, in the bay area. This branch initiates field trips, lectures, bird study groups, and an annual bird census. A monthly newsletter, *Pacific Flyway*, distributed by the branch, publicizes scheduled events and news notes relating to birdlife and conservation.

Utilization of Land and Water

With the exception of the Pacific Gas and Electric Company's fossil fuel power plant, the water of Morro Bay and the land adjoining it have in general one of three main uses: commercial fishing harborage, recreational and residential (Smith, 1964).

Harbor Facilities

Port facilities are comprised of 1,190 feet of public piers, 1,290 feet of privately-owned piers, 555 feet of public floating docks and 5,125 feet of privately-owned floating docks (U.S. Army Chief of Engineers, 1967). There are two T-piers, the northern one belongs to the City; the other, the "fish pier," is private. Both piers have a depth of 16 feet alongside. Special anchorage areas for small craft, with depths of two to twenty feet, are located one and two miles from the lagoon entrance (U.S. Coast and Geodetic Survey, 1968). The Morro Bay State Park boat basin (Midway Marina) has a depth of eight feet and a capacity of 110 boats, the use in August 1972 being 106 boats (Marshall, 1972). A wildlife conservation launching facility is available at the end of the Embarcadero in the City of Morro Bay. This ramp constructed by the State and maintained by the County is available to the general public free of charge. Other launching sites are at the Morro Bay State Park boat basin and in the commercial waterfront area of Morro Bay.

The harbor is served by law enforcement and rescue vessels. A Coast Guard rescue vessel, Department of Fish and Game law enforcement vessel and a harbor police boat all operate from the city pier. A boat maintenance yard in the harbor can hoist craft up to 45 tons and 65 feet in length (U. S. Coast and Geodetic Survey, 1968).

TABLE 1

FIVE YEAR MEAN COMMERCIAL

MARINE FISH CATCH FOR MORRO BAY[1]/

1966-1970

	Value*	Pounds	Percent of Total California Catch
Fish			
Albacore	$492,217	2,260,103	11
Rockfish	84,356	1,376,343	14
Petrale sole	14,014	102,641	3
English sole	4,389	56,481	1
Lingcod	5,118	54,554	6
Salmon	25,678	34,731	1
California halibut	9,785	32,319	6
Perch	5,770	23,458	21
White seabass	6,393	20,540	2
All other fish species	53,702	1,313,939	-
Shellfish			
Abalone	184,156	822,149	20
Rock crab	5,426	63,505	17
Spiny lobster	4,939	4,295	1
All other shellfish species	12,115	1,041	-
Port Totals	908,052	6,166,099	

1/Calif. Dept. Fish and Game, 1970.

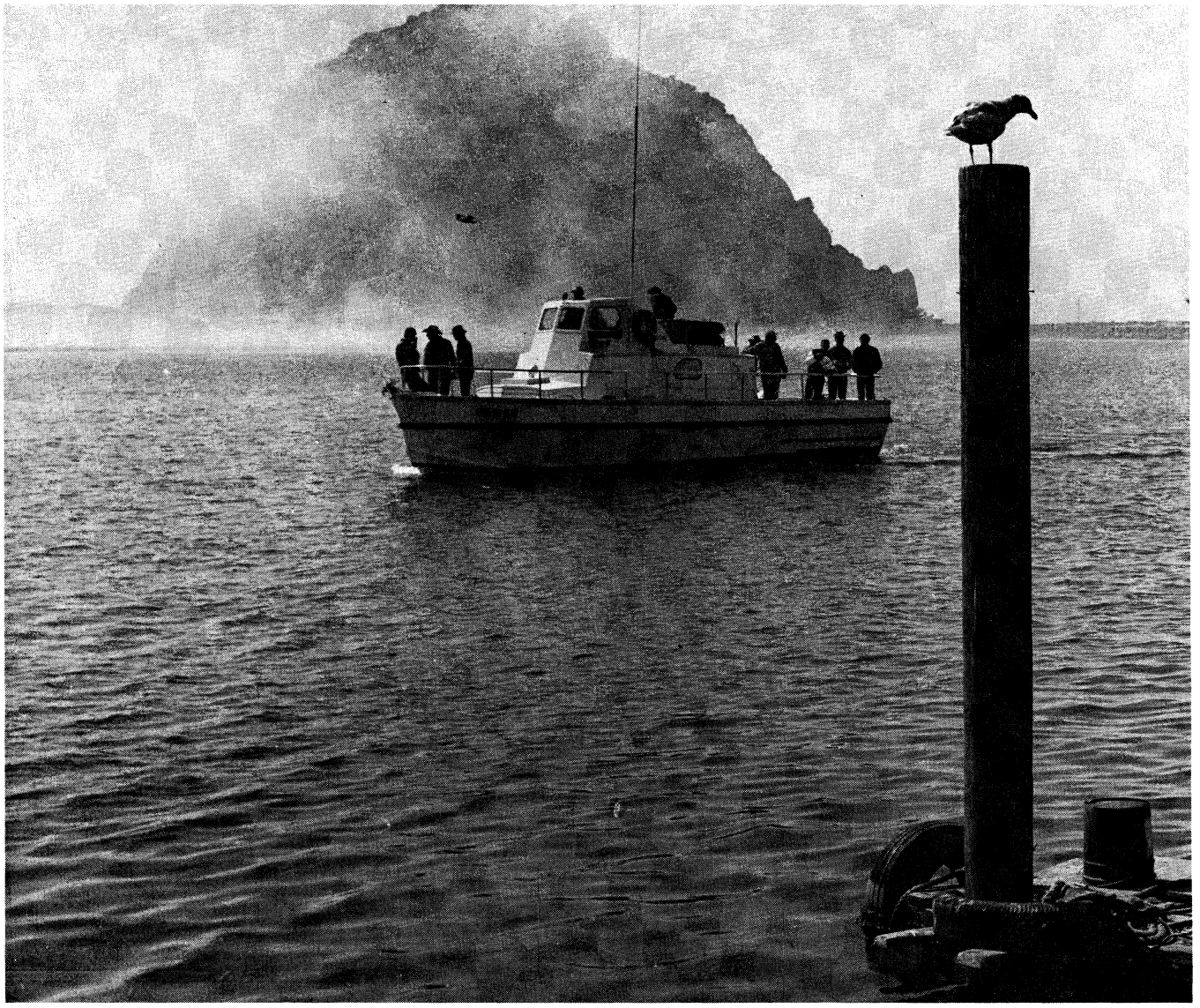
* Paid to fisherman.

Althouth Morro Bay often is characterized as the only "land locked" harbor between San Francisco and Los Angeles (Webster's Geographical Dictionary, 1965), boat berthing and maneuverability are difficult. Stress on lines, floats and piling occurs because of the velocity of the current (Koebig and Koebig, Inc. and Hahn, Wise and Associates, Inc., 1968). Commercial fishing boats, sport fishing boats and recreational craft all use the port facilities. For current and future predicted demand the available port facilities have been rated as inadequate and underdeveloped (Koebig and Koebig, Inc. and Hahn, Wise and Associates, Inc., 1968).

Commercial and Sport Ocean Fishing

Morro Bay lagoon serves as the port for a commercial fishing fleet which annually lands an average of over six million pounds of fish with a value of $900,000. Perch, rockfish and albacore caught out of Morro Bay comprise 21, 14 and 11 percent, respectively of the total California catch of those species and abalone and rock crab 17 and 20 percent of the California total (Table 1).

Three docks are available in Morro Bay for unloading commercial catches. Each dock has two crane hoists to handle two boats at a time. Ice, equipment, fuel, parts and repair facilities also are readily available and compose an important part of the commercial area along the waterfront. Both the Bumblebee Canning Company and the Starkist Company purchase fish at Morro Bay that is transported by truck to canneries in southern areas (The Morro Bay Bulletin, (2), 1971). Transportation costs increase the price of albacore by approximately six percent (The Sun Bulletin (2), 1972).



THE MORRO BAY HARBOR IS THE HOME PORT OF MANY PARTY BOATS AND OTHER COMMERCIAL FISHING VESSELS. (DEPT. FISH & GAME PHOTOS BY JOHN SPETH - 1974)

Only two abalone processors remain out of seven that were in operation in 1967, and these supply only the local market. The decline reflects the depletion of abalone beds between Morro Bay and Monterey. As a supplement to abalone processing, the two operating companies also prepare crab, lobster and smoked fish for local use (The Morro Bay Bulletin, (3), 1971). A new wholesale fish packing plant with headquarters in Seattle will begin processing for statewide restaurant trade in the near future (The Sun-Bulletin, (3), 1972).

Morro Bay also serves as port for a sport fishing fleet, composed of independent sport fishing boats and 14 commercially-owned party boats, the latter operated by seven companies. Although the party boat fishery operates all year, major activity is between June and August (Heimann and Miller, 1960). For one week in August, 1972, three party boat companies, which operate 10 of the 14 boats available, reported that 1,824 anglers caught 12,733 rock fish, 1,710 albacore and 549 lingcod. Small numbers of sole, halibut, cabezon and salmon also were reported in the catches (The Sun-Bulletin, (4), 1972). In 1963, 13 of the 14 party boats out of Morro Bay completed 1,290 trips (Young, 1969).

The independent sport fishery leaving from Morro Bay generally includes blue and gopher rockfish, with some California halibut, cabezon lingcod, salmon, Pacific bonito, California barracuda and California yellowtail in the catch. This fishery also is seasonal, 88% of the effort occurring between March and November (Miller and Gotshall, 1965).

Oyster Culture

A commercial company, the J. R. Johnson Morro Bay Oyster Company is allotted 846 acres of the State of California's tidelands, allotment

No. 614-01, for the purpose of cultivating and commercially harvesting the Pacific oyster (Plate 8). From 1966 to 1970, this oyster industry in Morro Bay produced an average of 120,069 pounds of shucked oysters a year. This is 3% of the total production of California. During the same 5-year period production in Morro Bay had an average value of $57,270.00 a year (Calif. Dept. of Fish and Game, 1966-70).

At the end of 1971 there were 8,000 cases of oyster seed planted in Morro Bay - 5,000 cases from the State of Washington and 3,000 from Japan (The Morro Bay Bulletin, 1971). During the spring of 1972 an additional 3,000 cases were planted and another 3,000 cases ordered under contract for the next spring (Richards, 1972). Such seeding requires planning three years in advance. The oysters harvested are shucked, bottled in 10 oz. jars in Morro Bay and sold on the wholesale market throughout California (The Morro Bay Bulletin, 1971). An oyster festival is celebrated annually in Morro Bay, at which time the public is encouraged to view the oyster beds in the bay.

Residence

Residences on the northern shore of the bay, north of the State Park are within the City of Morro Bay. The City was incorporated in July, 1964, and has a population of about 7,000. The age-group composition of this population differs from that of the County of San Luis Obispo and the State of California in that there is a larger percentage of individuals over the age of 65 (19%) and a smaller percentage of individuals in the age group under 14 (24%) (Koebig and Koebig, Inc., and Hahn, Wise and Associates, Inc., 1968). Projections indicate that by 1985 the City of Morro Bay will have an estimated population of 20,000.

Residence on the southern shore of Morro Bay, south of the State Park, is distributed among numerous unincorporated communities and subdivision residential tracts. These include the town of El Moro (Baywood Park), Cuesta-by-the-Sea, Los Osos, Bayview Heights, Redfield Woods, Martin Tract and Cabrillo Estates. Within this area, referred to generally as the "South Bay," the 1970 census was approximately 3,500 people. In two years this population nearly doubled to an estimated 6,000 people due to the current active building in this district (The Sun-Bulletin (5), 1972).

The number of visitors to the Morro Bay Area is significant as indicated by State Park annual attendance of over one million people and by the number of public and private temporary accommodations available. In the communities bordering the bay there are 40 motels and 17 private trailer parks. This temporary type of residence may partially account for the Morro Bay Chamber of Commerce estimate of 24,000 individuals within the banking and shopping area of the city.

State Parks

Morro Bay State Park encompasses about 1,485 acres abutting the bay (Plate 4). Within this area there are 135 campsites, 20 with trailer hook-ups, and a group-camping area that can accommodate as many as 150 people. Picnic sites also are available. A golf course is situated in the park and is managed by San Luis Obispo County. The State Park Museum of Natural History at White Point provides additional recreational opportunity. The sand beach on the ocean side of the sandspit, most of which lies within the State Park, is rated as suitable for swimming (Department of Parks and Recreation, 1971). Boats, with or without motors, may be rented from a concessionaire at the boat basin within the park. The

FISHING AND BAIT COLLECTING ARE POPULAR IN MORRO BAY.
(DEPT. FISH & GAME PHOTO BY JOHN SPETH - JUNE 1974)

NATURE STUDY, SIGHTSEEING AND BIRDWATCHING ARE SOME OF THE MOST SIGNIFICANT USES OF THE BAY'S NATURAL RESOURCES. THE STATE PARK MUSEUM OF NATURAL HISTORY OVERLOOKING MORRO BAY HOSTS UP TO 60,000 VISITORS PER YEAR.
(DEPT. FISH & GAME PHOTO BY JOHN SPETH - JUNE, 1974)

mean annual average attendance (by automobile talley) for the five year period 1967 to 1971 is an astounding 1,343,701 (Marshall, 1972).

Approximately five miles south of Morro Bay is Montana de Oro State Park, which extends over 6,956 acres. Fifty campsites are available within this park. Numerous trails and access paths to the ocean shore provide opportunities for hiking and skin diving. The mean annual average attendance for the five-year period 1967 to 1971 is 240,834 (Marshall, 1972).

Pacific Gas and Electric Company

The P.G.&E. fossil fuel electricity generating plant at Morro Bay uses water from the bay. The water, 470,000 gallons per minute, is removed from the Navy Channel of Morro Bay, immediately north of the city's T-pier to eliminate waste heat by passing sea water through a network of condenser tubes on the exhaust side of the turbines (North, 1969). The water, at maximum power generation, is heated above the temperature of the bay, and is discharged into the ocean on the north side of Morro Rock by way of a canal that is approximately 33 feet wide, 192 feet long and 14 feet deep (North, 1969). The highest reported temperature of the water in the discharge canal, observed on 12 September 1963, was 81°F (Adams, 1969); but, generally, the increase is between 15°F and 23°F above that of the natural ocean temperatures (Adams, 1972).

The plant with its attendant facilities for oil and water storage, switches and parking area, occupies approximately 58 acres in the harbor area. Three 450-foot power plant stacks, which are visible from far offshore, are perhaps a more conspicuous landmark than Morro Rock itself. The northwest stack is charted and utilized for ocean navigation (U.S. Coast and Geodetic Survey, 1968). Built in 1956, the plant has a

maximum production of 1030 megawatts, which is approximately six percent of the total production of electrical power produced by thermal plants in California (Adams, 1969).

At one time primary fuel of the P.G.&E. plant was natural gas, but the use of oil has increased 16-fold. In 1970 six million barrel-equivalents of gas and only 14 thousand barrels of oil were burned; in 1971 six million barrel-equivalents of gas were again burned, but 225 thousand barrels of oil were also used (De Bord, 1972). Currently, the Morro Bay operation has five fuel oil tanks with a capacity of 168,000 barrels each, but plans construction of two more tanks with a capacity of 500,000 barrels each. Oil-loading terminals are located 0.8 miles offshore in Estero Bay from a point three miles north of Morro Rock (U.S. Coast and Geodetic Survey, 1968).

PROBLEMS AND CONFLICTS

Development

Probably the greatest potential threat to the natural resources of Morro Bay is the ongoing pressure for continued development of the bay and its environs. A population of 20,000 permanent inhabitants for the City of Morro Bay is predicted by the 1985 (Koebig and Koebig, Inc., 1968; Hahn, Wise and Assoc., Inc., 1968). In addition to residential and industrial growth, tourism and State Park use will continue to expand. A prediction has also been made for 1,000 additional boat berths in Morro Bay by 1985.

Paradoxically it is the aesthetic and recreational appeal of the area's natural resources that produces requests and demands for further development of harbor facilities, alteration of the privately-owned tidelands for recreational facilities and urbanization of the privately-owned shoreline. If the natural resources of Morro Bay are to be preserved and maintained, development will have to be well planned; curtailed to a large degree; and, some private tidelands placed into public ownership.

Harbor Development

At present the only active project in the harbor is maintenance dredging by the U. S. Army Corps of Engineers. Every two years the Corps dredges about 300,000 cubic yards of sand from the harbor channels and dumps it on the sand spit. However, several development plans and studies past and present have been prepared in response to the desires of local interests. Improvements to the entrance channel to provide greater protection to boats entering and leaving the harbor, enlargement of channels to relieve boat traffic congestion, provision for more boating and sailing

areas and extensive marine development have been planned and constitute the most pressing requests.

In 1959 the San Luis Obispo County Planning Department together with private financial interests employed the firm of Moffat and Nichol, Engineers, to prepare a feasibility study for the development of Morro Bay. This study integrated the development goals of the private interests with the development plans of the County and incorporated a lease proposal involving 90 acres on the end of the sand spit. Subsequently the interested corporations were awarded the bid for the lease. The Moffatt and Nichol Plan stressed recreational use of the bay as a beneficial factor in local economics, and encouraged dredging and filling of the private tidelands in the south bay for camping and boating. This plan also called for additional basins for marinas, but did designate the salt marsh delta of Los Osos and Chorro creeks and tidal flats along the east side of the spit as "wildlife" sanctuaries (Plate 10).

However, there was much local discontent with the Moffat and Nichol Plan and the leasing of tideland properties (City of Morro Bay, 1971). Discontent led to the initiation of a "massive" tidelands litigation against the County by the upland property owners, which in effect stopped any further development on lease lands within the harbor, including the large sand spit lease still in its planning stages.

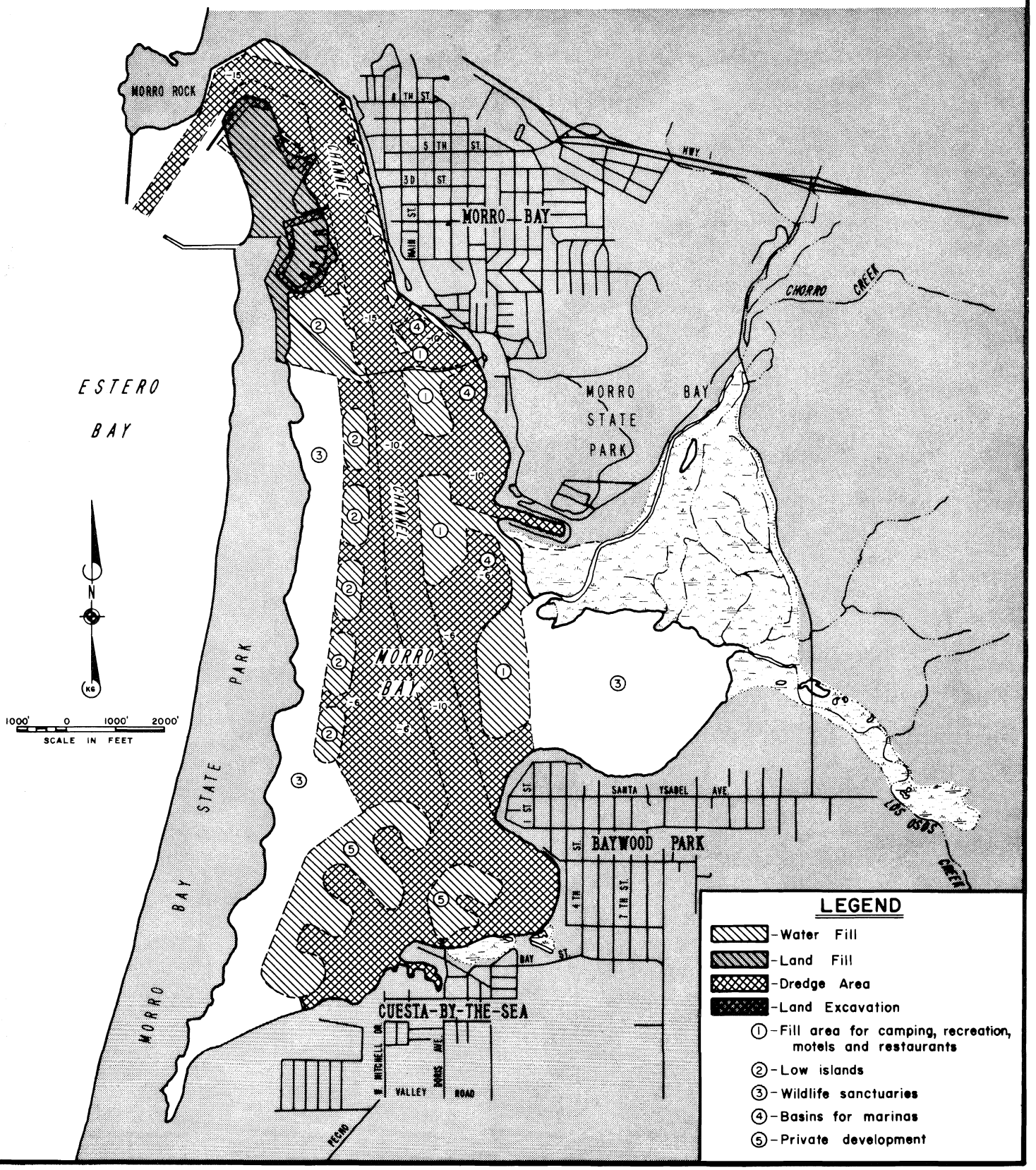
In 1965 the City of Morro Bay became incorporated before any of the litigation had been resolved. Jurisdictional disputes evolved between the City and the County which further stalled harbor development for several years (City of Morro Bay, 1971).

In July, 1967, the City of Morro Bay submitted to the Corps of Engineers a plan, assembled by the consultant firms of Koebig and Koebig,

PLATE 10

PROPOSED BAY DEVELOPMENT PLAN

FROM MOFFATT & NICHOL ENGINEERS SUGGESTED MASTER PLAN" 11-9-62
PREPARED FOR COUNTY OF SAN LUIS OBISPO



and Hahn and Wise, Inc., that envisioned extensive modifications in the city-owned tidelands, including relocation of the channel entrance through the sand spit (and a connecting landfill to Morro Rock), an expanded northern sand spit and an extensive marina development between the Embarcadero and the spit (Append. J). A great number of residents expressed dissatisfaction with this city plan, which ultimately was rejected.

Pursuing alternatives that would reflect a greater concensus concerning harbor development, the City presented another plan, the Preliminary Harbor Plan, November, 1970 (U. S. Army Corps of Engineers, 1970) based on the following principles: 1) minimum dredging, 2) preservation of biological attractive wildlife habitat and natural configuration of the bay, 3) development only in areas not in conflict with ecological integrity of the bay, 4) control of drainage flows and siltation and stabilization of sand dunes, 5) widening and realignment of natural channels and appropriate dredging of boating and recreational areas, 6) possible realignment of harobr entrance, and 7) provision of 1,500 boat slips and supporting public facilities. The 1970 Plan consisted, then, of two breakwater extensions, relocation and widening of the Navy and Morro Channels plus a large enchorage and turning basin (Append.I)--all within the tidelands under jurisdiction of the City of Morro Bay.

In a review report of Morro Bay Harbor (U. S. Army Corps of Engineers, 1970) the Corps presents and analyzes four alternate plans for future harbor development and the existing maintenance project (Append. I-L):

Plan 1 - embraces the 1970 City Preliminary Harbor Plan outlined above.

Plan 2 - presents the 1967 City plan as an alternate.

Plan 3 - was developed by the Corps of Engineers to provide maximum

boating capacity with minimum dredging; and includes: a single breakwater extension, the Navy Channel widened 500 feet and the Morro Channel widened 100 feet westerly, the entire length of the existing project (Append. K).

Plan 4 - Modifies Plan 3 to provide maximum berthing, but with minimum development and dredging. Plan 4 calls for a shorter breakwater extension, a 400-foot Navy channel width and the Morro Channel widened per alternate Plan 3 (Append. L). It is noted in their Review Report that the Corps also presents a "No Development Alternate" which "recognizes tidal scour within the channels as a limiting factor to marina development in the bay.

The Department of Fish and Game recognizes the need for harbor improvement and dredging, especially that which would improve or insure adequate tidal prism and circulation. The Department also recognizes the pressure that the city and county governments are under for continued development. However, if the natural resources are to be maintained, any harbor development must be carried out with minimal adverse impact on those resources. None of the four Alternate Plans demonstrate fish or wildlife habitat improvement, although preservation of some areas as "sanctuaries" is indicated.

Oysters are cultured on some 400 acres of the bay. Sedimentation from dredging activities and poor circulation can destroy oyster beds. Clam beds, long a popular source of recreation in Morro Bay, would be threatened by plans such as Alternate Plans 1 and 2. And, eel grass, the principal food of the black brant and the vital tidal flats which support the host of shorebirds, as well as wading and diving birds, would be

adversely affected by Alternate Plans 1 and 2. Estimates were made in 1971 of habitat that would be lost with the implementation of the alternate plans:

	Open Bay Water	Tidal Flats
Plan 1	35 acres	40 acres
Plan 2	90 acres	50 acres
Plan 3	25 acres	--
Plan 4	25 acres	--

There are few means to mitigate for the loss of vital habitat. Some plans, by providing improved tidal flushing, could mitigate for the effects of increased boating on water quality and insure a lessened sedimentation rate, etc.

But loss of habitat, decreased tidal circulation, and reduced tidal prism are some of the direct adverse effects of harbor improvement which do not consider the natural resources. Indirect effects of proposed developments must also be considered. As the channels and navigation are improved, and as the number of boating facilities are increased, more people will be attracted to the area and more and more support services will be required, etc. Both direct and indirect effects on the environment and natural resources will have to be weighed against the needs of additional people attracted to the area improved by proposed developments. The choice and decision will be difficult.

Private Tidelands Development

Almost three-fourths of the tidelands in Morro Bay are in public ownership. However, about 23% of the lands under tidal influence consists of three tideland areas in private ownership (Plate 4). Tideland location #220 consists of 28 acres of salt marsh and tidal flats; location #131, 538 acres of tidal flats and channels; and the Los Osos creek and

estuarine area, east of South Bay Road comprise 140 acres of freshwater, saltwater and intermediate brackish water marsh. Together, these privately-held lands represent vital and irreplaceable habitats that support almost every kind of wildlife and invertebrate species found in the Morro Bay area, including rare and endangered species. The 538 acre parcel (tideland location #131) is particularly significant since it contains a large portion of the eel grass beds so important to the black brant. The Los Osos creek and marsh area, with its 29 mammals, 183 birds (89 of which are residents), 14 fish and 25 reptiles and amphibian species, makes it very significant as an educational, scientific and recreational nature study area.

In the past, development of these private tidelands has been considered. The 1959 Moffat and Nichol, Engineers, master plan suggested that the 538 acre parcel in South Bay be developed by private enterprise into a marina and boating basin. A large acreage of mudflats, channels and eel grass beds would have been significantly altered and lost. In 1969 a project for a boat launching facility also in South Bay, was planned, approved and funded by the State (Navigation and Ocean Development). The project called for 6,400 feet of channel dredged to a depth of 5 feet below mean lower low water and having a minimum bottom width of 75 feet. The dredging was to affect only eleven acres, but would have occurred in the middle of the prime eel grass beds (Plate 6). Spoil deposition plans of this proposed project also posed serious problems for both estuarine habitats and wildlife species. Indirect effects, i.e. increased human activity and noise levels and stimulation of further development, perhaps were the greatest threat posed by this project. Based on recommendations by the U. S. Fish and Wildlife Service, the Army Corps of Engineers rejected the request for the dredging permit required to implement the project.

The South Bay boat launching plan typifies the problems and conflicts in attempting to develop the private tidelands. Sponsors of the plan wishing to make the area more attractive for greater numbers of people were bitterly disappointed. On the other hand, local conservation groups and many residents were pleased with the Corps' decision because they preferred shoreline access placed where no damage or distribution of the habitats and wildlife of the bay would be involved.

Increasing ecological awareness on the part of the residents, and the public in general, recently have given rise to other types of plans for the private tidelands, which do not conflict with natural resource preservation, but do conflict with the above type of development plans.

The Department plans to purchase the Sweet Springs Marsh (Plate 4), a combination of tidal marsh and freshwater springs, located partly within Tideland Parcel #131, at the southern edge of the bay near the unincorporated community of Cuesta-by-the-Sea. Funds from the Environmental Protection Program (made available by the sale of personalized car license plates) have been approved by the State for this purchase in the fiscal year 1974-75. The broad spectrum of support for this type of acquisition is reflected by the following list of some of the county and local organizations that have endorsed this transaction:

The South Bay Advisory Committee
The SLO County Planning Commission
The Morro Coast Audubon Society
The Sierra Club
The League of Women Voters
Morro Bay Tomorrow
The California Native Plant Society
The County Archaeological Society
The Environmental Center of San Luis Obispo

Similar efforts have been and are being made to preserve the Los Osos creek and marsh area (Plate 4). A proposal sponsored by the Morro Coast

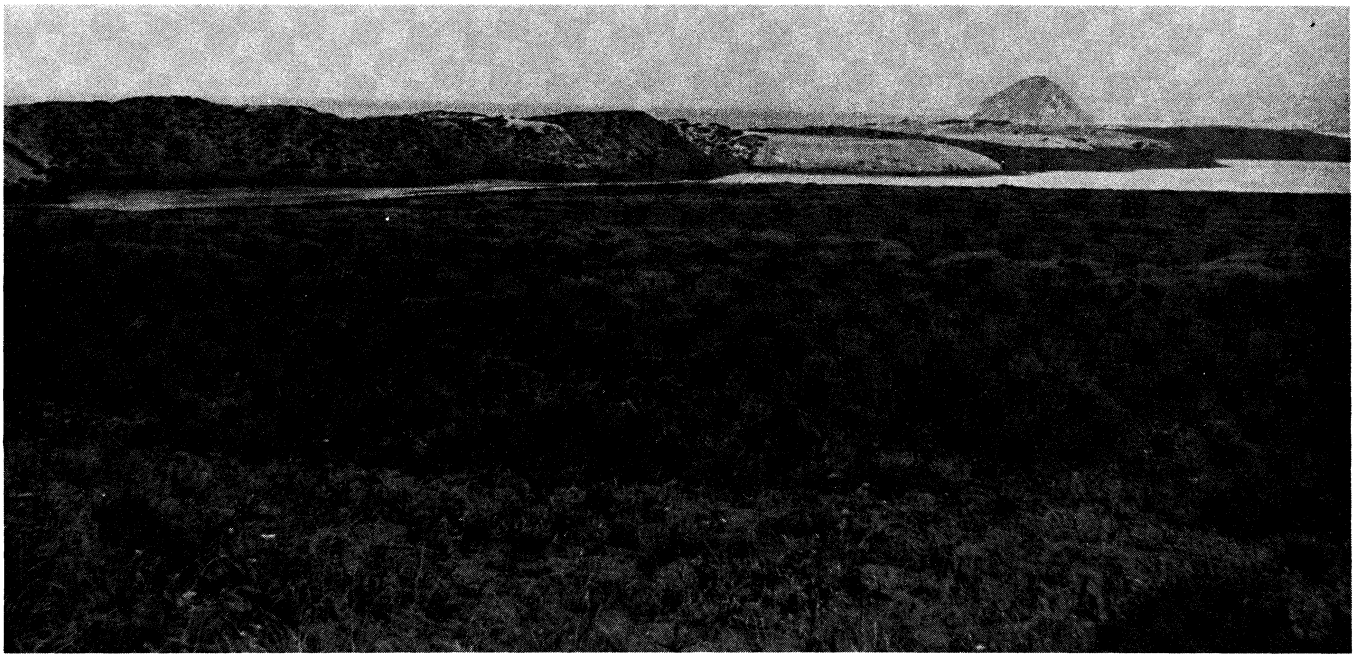
Audubon Society was made in 1972 (Richards, 1972) to purchase the 140 acre Los Osos marsh together with a buffer of upland scrub to protect it. Six parcels of private land are involved. Three of the private parcels contain the marsh and a portion of scrub hillside; the other three consist of the chaparral scrub, which in addition to serving as a buffer to the surrounding development tracts, also embraces key habitat of the Morro Bay kangaroo rat, an endangered species. A local conservation organization, the Small Wilderness Area Preserve (SWAP) group, together with the National Audubon Society, has secured several options to buy the Los Osos Marsh property. Their intent was to hold it until a public agency could secure the necessary funds for acquisition. The Los Osos Marsh is included in the Department of Parks acquisition plans for Morro Bay. The purchase of this riparian and estuarine habitat has been made possible by the passage of the 1974 Park Bond Act.

The Department supports the concept of public acquisition of lands valuable to fish and wildlife when it has been demonstrated that the alteration and development of such lands will not be permitted. However, until acquisition funds are made available, there must be a measure of control on developments incompatible with bay and wetland values.

Development of Private Shoreline

About half of the shoreline of Morro Bay is in public ownership. The State Park-owned shoreline on the east side of the bay and the large portion of the Park-owned sand spit on the west side are free from the demands of development. The shoreline of the City of Morro Bay is already developed for the most part. However, the balance of the shoreline--

UNDEVELOPED LANDS ALONG THE PERIMETER OF THE SOUTH BAY ARE VALUABLE WILDLIFE HABITAT AND SERVE AS A BUFFER BETWEEN EXISTING DEVELOPED LANDS AND THE VITAL TIDELAND RESOURCES. (DEPT. FISH & GAME PHOTO BY JOHN SPETH - JUNE, 1974)



UNDEVELOPED LAND TO THE SOUTH OF SHARK INLET IS HABITAT CRITICAL TO THE INDIGENOUS AND ENDANGERED MORRO BAY KANGAROO RAT.
(DEPT. FISH & GAME PHOTO BY JOHN SPETH - JUNE, 1974)

the City-owned portion, the privately-owned 90 acres at the north end of the spit and the privately-owned shoreline between Los Osos Creek and Shark Inlet--is still subject to the pressures of "economic progress" and urbanization. Further development of the shoreline will eliminate much of the maritime and upland habitat which supports many wildlife species, including habitat of the Morro Bay kangaroo rat. But, in addition to causing the loss of valuable types of habitat, the ecological integrity and aesthetic quality of the bay also will be jeopardized. Besides the direct effect of spoiling the open space quality of the South Bay, vital nesting, roosting and escape cover will be lost to the wildlife. And, indirect effects from further development, such as increased noise levels, domestic animal disturbances and access problems etc., will further deteriorate the ecological quality of the bay.

Hence, the Department supports the general concept of leaving the undeveloped portions of the lands surrounding the bay tidelands in a natural state. This would not only protect and preserve the ecologically necessary upland habitat, but also would preserve the undisturbed aesthetic quality of the existing shoreline and prevent the usual "bath tub effect" found at many coastal wetland areas where development occurs in solid masses right to the water's edge. A buffer zone between existing developed uplands and the vital tidelands also would be created. Hence, undeveloped lands along the perimeter of the bay between the mouth of Los Osos Creek and Shark Inlet, and at least 100 feet above the higher high tide line, should be preserved by zoning ordinance or public acquisition, or a combination of both methods.

The Department further supports the concept of preserving the sand spit in its entirety which would entail the purchase of the privately-

owned 90 acres on the north end of the spit and purchasing or zoning the City-owned tip of the spit as open space. The Department of Parks and Recreation also supports this concept. Purchase of the balance of the spit not already in the State Park is part of their proposed acquisition program (Plate 4).

Once again there is a two-fold purpose for this proposal. One need only look across the bay anywhere from the Embarcadero or from the balcony of the White Point Natural History Museum to appreciate the uninterrupted view of the sand-duned spit and the ocean beyond, and to understand the need for preserving this natural attraction that is famous statewide, if not nationally. The sand spit also serves as nesting and loafing habitat for some of the migratory birds.

Morro Bay Task Force

A look at the history of the development of Morro Bay and the documentation of the problems and conflicts concerning use of the bay's natural resources clearly reveals the need for a comprehensive area-wide plan. This obvious need ultimately produced a mandate, in the form of Senate Resolution No. 176 (Introduced by Senator Fred S. Farr) in the 1966 First Extraordinary Session of the State legislature. The California State Resources Agency was asked by the resolution "to conduct a study of Morro Bay--and prepare a plan for the preservation of the natural resources therein." In compliance with Senate Resolution No. 176, the Resources Agency had the Department of Fish and Game prepare a report summarizing the natural resources of the bay, together with a proposal for a comprehensive area plan (Resources Agency, December, 1966). Recommendations of this 1966 report stressed the formation of a representative planning task force to develop an area plan and a decision-making body, headed by the

County of San Luis Obispo, to resolve conflicts between proposed users and assist the planning unit with problem solution. As a result of the legislative resolution and the recommendations of the 1966 Resources Agency Report, the Morro Bay Task Force was created.

The Task Force under the leadership of the San Luis Obispo County and Cities Area Planning Coordinating Council is made up or representatives of federal, state and local agencies (Plate 11) (attached) and has recommended that a Citizens Advisory Committee be created to represent local communities and interest groups such as: conservation-wildlife, conservation-land, agricultural-cattlemen, agricultural-farm bureau, commercial and pleasure boating, sportsman and business organizations and education and public information groups. A Technical Committee will also be selected when needed.

The Morro Bay Task Force, to date, has designed a "Comprehensive Environmental Plan Study" divided into 8 major phases:

I. Program Design and Orientation.

II. Collection and Inventory of Data.

III. Preliminary Formation of Policy Objectives and Values.

IV. Analysis and Evaluation of Data and Policy Issues.

V. Formulation of Policy Statement.

VI. Preparation of Preliminary Plan

VII. Formulation of Implementation Program.

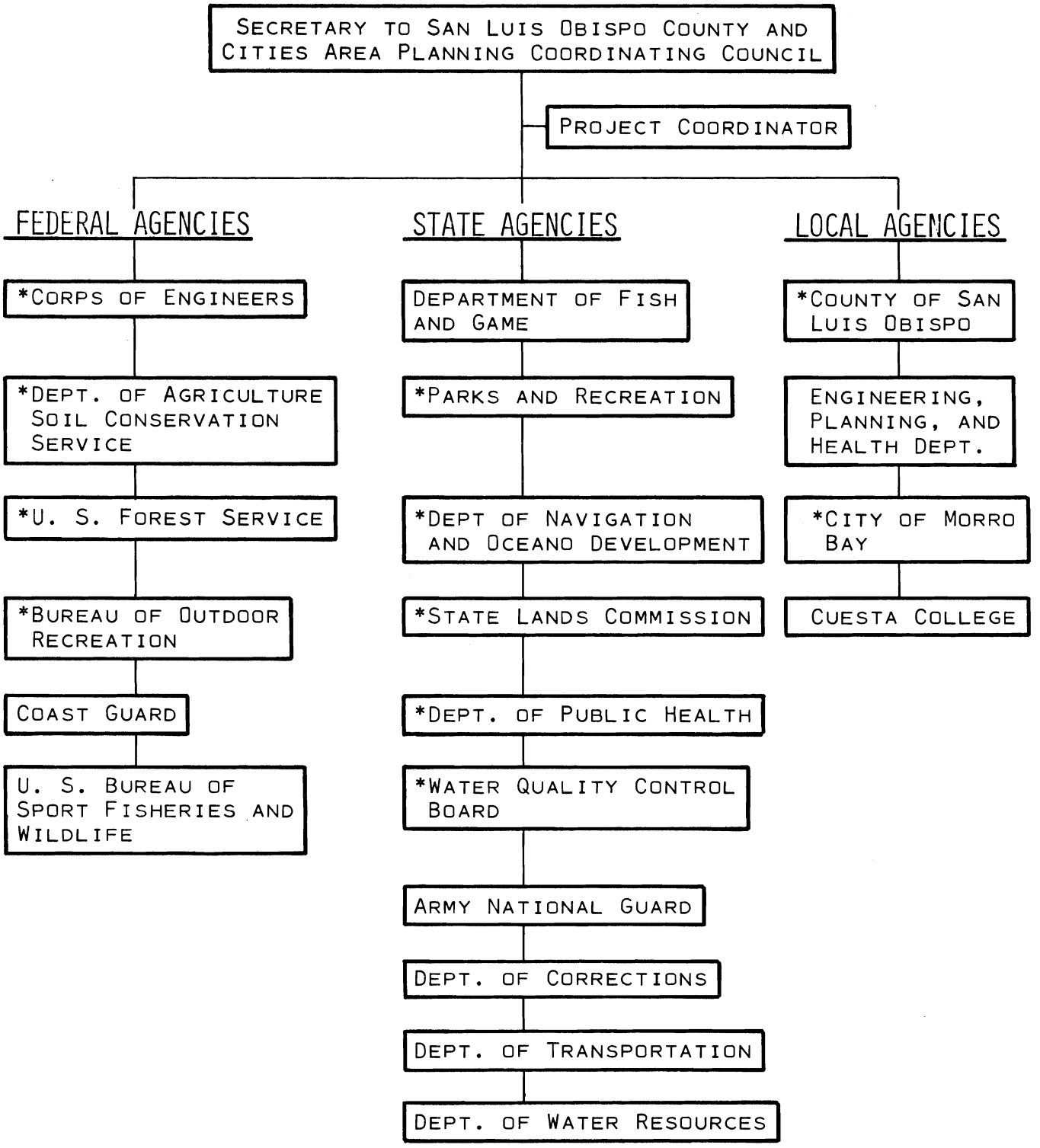
VIII. Preparation of Final Plan.

The Task Force has already procured an overall program design and work program entitled, Intergovernmental Comprehensive Morro Bay Watershed Study (Patri and Ingmire, 1974). The Task Force also has applied and

PLATE II

MORRO BAY PLANNING TASK FORCE

(MORRO BAY TASK FORCE, 1971)



* MEMBER OF ORIGINAL TASK FORCE

received Housing and Urban Development (HUD) "701" funds to implement the study plan. HUD funds of $40,000, with matching funds from the Task Force of $20,000 in cash and $20,000 of "in kind services," are to be used to contract with land use consultant firms to prepare the final comprehensive plan.

The Department of Fish and Game commends all of the city, county, state and federal agencies and local citizens groups for their tremendous cooperative spirit and action in behalf of the natural resources of Morro Bay. And, the Department pledges to continue giving support to those concerned with the preservation, management and wise use of this resource.

Sedimentation

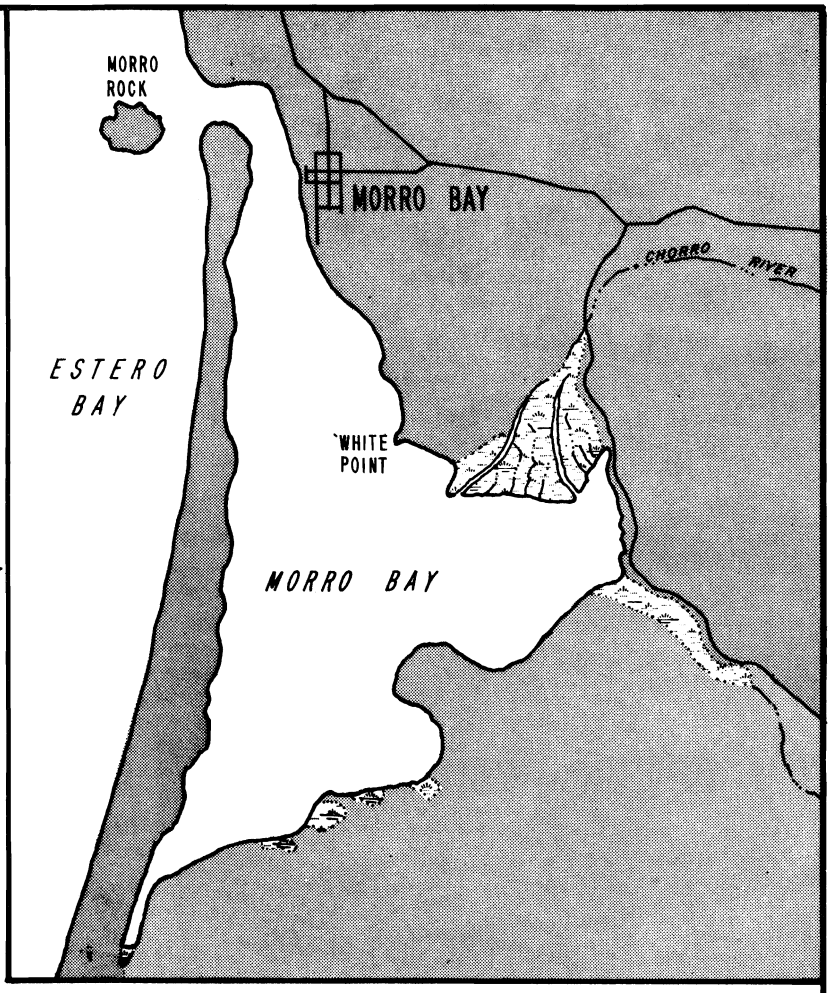
At present sedimentation is not a serious problem in Morro Bay as it is in other coastal wetlands in California. However, any development or other disturbance in the watershed adjacent to or above Morro Bay could make sedimentation a factor in the degradation of water quality and habitat. Hence, any such development should occur only with guarantees against any degradations of bay waters and habitat.

Sedimentation is a normal and usually continuing process throughout the life span of most estuarine systems. Normal drainage and storm run-off deposit silt from the eroding watershed. Silt can smother some estuarine organisms, affect food plants such as eel grass and destroy or alter other habitats and the life which they support.

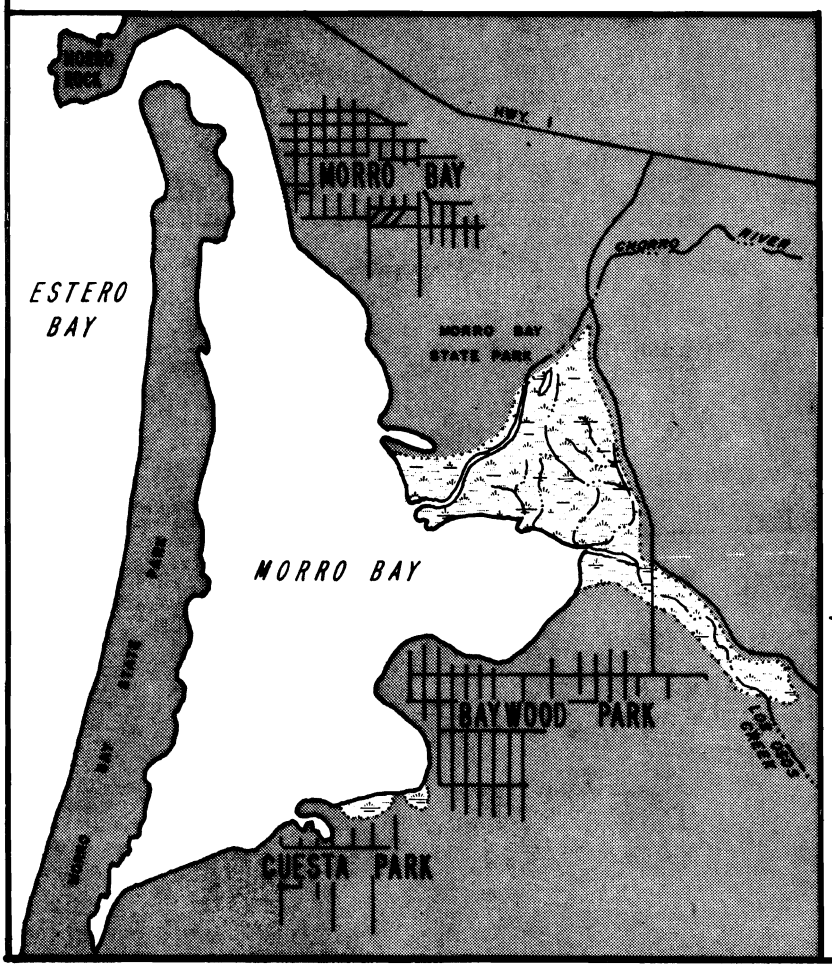
Over a period of about 50 years sedimentation increased the size of the salt marsh delta of Chorro and Los Osos creeks over 50%. In 1895 the salt marsh area extended over an area of about 280 acres (Plate 12). In 1951 the area covered by salt marsh was 421 acres (U. S. Geological

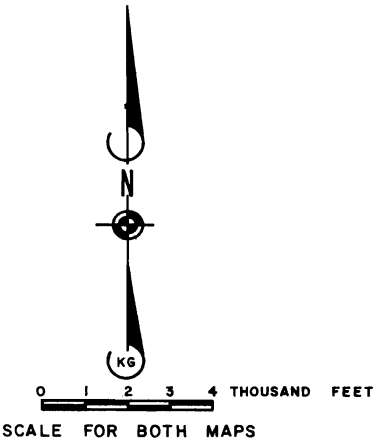
PLATE 12

MARSH EXPANSION



MORRO BAY
1897





MORRO BAY
1965

Survey, 1951). Between 1951 and 1965 the same salt marsh extended only two more acres (U. S. Geological Survey, 1965), indicating that the rate of salt marsh encroachment into the bay due sedimentation has decreased to almost a stable situation. Comparison of Department aerial photographs in 1967 with others taken in 1970 supports this declining trend in sedimentation in spite of a record rainfall (28.7 inches) in 1968 - 69. A Report entitled, "Our Changing Coastlines" indicates that Chorro Creek, at least, "does not appear to constitute much of a menace to the harbor" (Shepard and Wanless, 1971).

However, local problems do arise when debris from storm run-off clogs the streams in the upper watershed. Blockage undercuts stream banks causing erosion and increased siltation in the lower drainage. Such a condition recently caused problems for the land owners in the watershed above the bay and actually prevented tillage of some cropland. The sedimentation also destroyed a significant section of the oyster beds. Hence some problems from sedimentation do exist and development and disturbance in the watershed and drainage to the bay will have to be closely monitored.

The U. S. Army Corps of Engineers biennially must dredge the existing project channels to keep them clear. Some of the problems of channels filling in come from erosion and run-off sedimentation and much of it comes by sand deposition due to sand movement across the dunes and from the ocean which causes shoaling, the building up of shallows. Active tongues of sand along the spit, not protected by vegetation, especially at the mouth end, contribute to shoaling. Wind transport of sand across the spit can build shallows to the detriment of oyster culture in the tidal flats adjacent to the spit. Growth rate of the oysters is decreased due to poorer circulation and increased water temperatures in the shallows caused

by sedimentation. Although no precise measurements are presently available to document the total effect of this latter type of shoaling in the bay, it does appear that stabilization of the dunes by a planting program should be undertaken. The problem of shoaling due to sedimentation, as it affects oyster culture, would make a good study for the local scientific and educational community.

Pollution

In the usual, orderly documentation of the natural resources of most of the coastal wetlands of California, pollution and/or contamination of the waters, if not the most critical problem affecting the resources and their use, generally is listed as one of the major problems. The Department is pleased to document in this report that Morro Bay has some of the "cleanest" waters on the coast. And, the local residents, county and city representatives, and water quality agencies, such as the County Public Health Department and Central Coast Regional Water Quality Control Board, are commended for the concern, cooperation and effort that it took to create the clean environment of Morro Bay waters.

It has not always been so. During and immediately after the war years, pollution from untreated sewage disposal from Camp San Luis Obispo forced a State Board of Public Health closure of oyster beds in Morro Bay. Most of the oyster beds were closed from 1943 to 1953 and all of them from 1953 to 1954 (Calif. Dept. Public Health, 1954).

Sewage from that camp and the State Men's prison facility is now treated prior to release into Chorro Creek. The City of Morro Bay discharges its treated sewage directly into the ocean, and the smaller bay communities apparently create very few problems to date. There is

very little "living on-board" use of boats in Morro Bay, hence boats are not a significant source of pollution or contamination at present.

P.G.&E. also discharges through an ocean outfall, therefore thermal discharges have no effect on the resources in Morro Bay. Some oceanographic pollution has occurred in the past (for example, oil from spills drifting into the harbor from the sea), but has never been a serious adverse factor in Morro Bay.

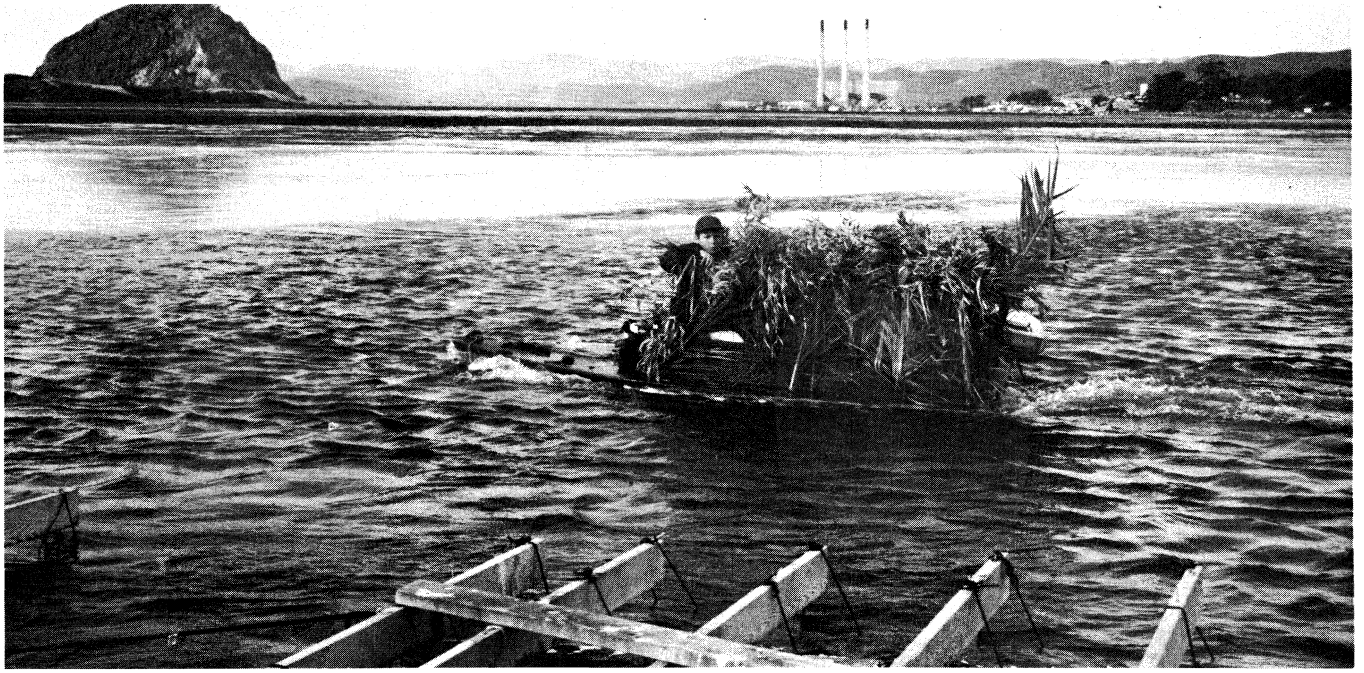
At present pollution and contamination are not a problem in Morro Bay. But, as demands increase for additional development of the harbor, shoreline and particularly of the watershed, the potential threat of pollution and contamination will also increase. Therefore, it will take the continued effort of all concerned to insure that Morro Bay waters stay as clear and clean as they are now.

Appropriative and Non-appropriative Use

"Morro Bay is a Bird Sanctuary." This is the message proclaimed on street signs at every entrance to the city of Morro Bay. And, this is as it should be; since Morro Bay provides the living requirements for a large variety of wildlife species, only a few of which are legal game species. Non-appropriative use (bird watching, photography, sight-seeing, picnicking, etc.) far outweighs the appropriative (hunting, clamming, etc.), in man-days of use of the natural resources of the area. Increasing local concern and awareness of these resources and the impact of their use upon the economy of the Morro Bay area has ultimately led to the concept of Morro Bay as a "sanctuary."

A conflict arises with the sanctuary concept, however, due to the availability of limited opportunities to hunt wild waterfowl in the bay,

THE SIGNIFICANCE OF THE NONAPPROPRIATIVE USE OF THE BAY'S NATURAL RESOURCES AND THE IMPACT OF SUCH USE UPON THE LOCAL ECONOMY HAS LED TO THE CONCEPT OF MORRO BAY AS A "BIRD SANCTUARY." (DEPT. FISH & GAME PHOTO BY JOHN SPETH - JUNE, 1974)



APPROPRIATIVE USE OF THE BAY'S NATURAL RESOURCES DOES NOT CONFLICT WITH OTHER USES. BRANT HUNTERS HAVE TAKEN THE BLACK BRANT FOR GENERATIONS WITHOUT ENDANGERING THE SPECIES. (DEPT. FISH & GAME PHOTO BY FRANK HUBBARD)

or for that matter, anywhere else in San Luis Obispo County. A few ducks are taken, but the principle game bird in Morro Bay is the black brant. The brant is a sea goose highly prized by a small coterie of hunters, which "man and boy" has been hunting for generations. The brant is generally hunted in the broad expenses of South Morro Bay with specialized techniques such as "sculling," which is a method of stalking the birds with a flat, low silhouette, and/or camouflaged boat.

In the long history of brant hunting, the hunters have not endangered the resource; but this bird has been largely exterminated from its historical wintering grounds along the California coast because of habitat destruction. Hunters in Morro Bay take, in good years, about 300 brant a season. The total number of brant taken in the whole Pacific Flyway estimated from Department hunter surveys, is approximately 3,000 during a year when the population is at a peak. The average number of black brant in the Pacific Flyway population estimated from annual aerial censuses the last ten years has been approximately 150,000. Hence the California harvest is about 2% of the population and the Morro Bay hunters about 0.2%. From these facts it is concluded that the brant resource is not threatened by hunting in Morro Bay.

Hunting does cause some "noise pollution," but most of the brant are taken in the relatively isolated expanses of South Morro Bay. Unfortunately, there are always isolated cases of inconsiderate and irresponsible persons who shoot protected species. Although some special measures in the form of additional patrol or area restrictions may become necessary in the future to reduce conflicts between hunters and other users, at present there is adequate and ongoing monitoring of hunting efforts. And, because the resource is not threatened, the Department feels that

hunting is, and should remain, a compatible use of the area's resources and that the heritage of the black brant hunters in Morro Bay should be preserved.

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APPENDIX A

Algae Collected at Morro Bay

(Bellin, 1970)

CHLOROPHYTA (Green Algae)

Blidingia minima

Bryopsis corticulans

Enteromorpha clathrata

Enteromorpha crinita

* *Enteromorpha prolifera*

Enteromorpha tubulosa

Ulva expansa

Ulva linza

Ulva rigida

RHODOPHYTA (Red algae)

* *Antithamnion glanduliferum*

Antithamnion kylinii

Ceramium eatonianum

Gigartina agardhii

Gigartina leptorhynchos

Gigartina tepida

Gracilariopsis sjoestedtii

Iridaea splendens

RHODOPHYTA (Red algae) continued

Platythamnion villosum

Polysiphonia acuminata

Polysiphonia brodiaei

Polysiphonia paniculata

Porphyra perforata

Pterosiphonia dendroidea

Smithora naiadum

Spermothamnion snyderae

PHAEOPHYTA (Brown algae)

Fucus distichus

Giffordia oviger

Macrocystis pyrifera

Pelvetia fastigiata

Scytosiphon lomentaria

CHRYSOPHYTA (Diatoms)

Navicula grevillei

Navicula ramosissima

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* Species identification tentative

APPENDIX B

Water-associated Birds of Morro Bay

(Adapted from Gerdes, 1970)

WV - Winter visitor
SV - Summer visitor
AY - A few present all year
M - Migrant
R - Resident
Occ. - Occasional
Rare - Only a few records

Common Name	Scientific Name	Number	Population Peak Season (1966-67)
Common Loon	*Gavia immer*	136	WV
Arctic Loon	*Gavia arctica*	3	WV
Red-throated Loon	*Gavia stellata*	13	WV
Red-necked Grebe	*Podiceps grisegena*	20	WV
Horned Grebe	*Podiceps auritus*	31	WV
Eared Grebe	*Podiceps caspicus*	17	WV
Western Grebe	*Aechmophorus occidentalis*	240	WV
Pied-billed Grebe	*Podilymbus podiceps*	261	R
White Pelican	*Pelecanus erythrorhynchos*	180	WV
Brown Pelican	*Pelecanus occidentalis*	523	AY
Double-crested Cormorant	*Phalacrocorax auritus*	113	R
Brandt's Cormorant	*Phalacrocorax penicillitus*	26	R
Pelagic Cormorant	*Phalacrocorax pelagicus*	2	R
Great Blue Heron	*Ardea herodias*	293	R
Green Heron	*Butorides virescens*	1	R
Common Egret	*Casmerodius albus*	15	AY
Snowy Egret	*Leucophoyx thula*	40	AY
Black-crowned Night Heron	*Nycticorax nycticorax*	95	R

Common Name	Scientific Name	Number	Population Peak Season (1966-67)
Wood Ibis	*Mycteria americana*	2	Occ. WV
Canada Goose	*Branta canadensis*	1	Occ. WV
Black Brant	*Branta nigricans*	8028	WV; AY
Emperor Goose	*Philacte canagica*	1	Occ. WV
White-fronted Goose	*Anser albifrons*	1	Occ. WV
Mallard	*Anas platyrhynchos*	6	R
Pintail	*Anas acuta*	449	WV; AY
Green-winged Teal	*Anas carolinensis*	474	WV
Cinnamon Teal	*Anas cyanoptera*	178	R
American Widgeon	*Mareca americana*	230	WV
Shoveler	*Spatula clypeata*	14	WV
Greater Scaup	*Aythya marila*	23	Rare WV
Lesser Scaup	*Aythya affinis*	240	WV
Common Goldeneye	*Bucephala clangula*	4	Rare WV
Bufflehead	*Bucephala albeola*	134	WV
White-winged Scoter	*Melanitta deglandi*	28	WV
Surf Scoter	*Melanitta perspicillata*	85	WV; AY
Ruddy Duck	*Oxyura jamaicensis*	530	R
Common Merganser	*Mergus merganser*	15	Occ. WV
Red-breasted Merganser	*Mergus serrator*	40	WV
Virginia Rail	*Rallus limicola*	1	R
American Coot	*Fulica americana*	1145	R
Semipalmated Plover	*Charadrius semipalmatus*	50	WV
Snowy Plover	*Charadrius alexandrinus*	4	R
Killdeer	*Charadrius vociferus*	23	R
Black-bellied Plover	*Squatarola squatarola*	32	WV

Common Name	Scientific Name	Number	Population Peak Season (1966-67)
Black Turnstone	*Arenaria melanocephala*	8	WV
Long-billed Curlew	*Numenius americanus*	144	WV
Whimbrel	*Numenius phaeopus*	30	WV; AY
Spotted Sandpiper	*Actitis macularia*	9	WV
Wandering Tattler	*Heteroscelus incanum*	1	WV
Willet	*Catoptrophorus semipalmatus*	3070	AY
Greater Yellowlegs	*Totanus melanoleucus*	80	WV
Least Sandpiper	*Erolia minutilla*	1575	WV
Dunlin	*Erolia alpina*	450	WV
Short-billed Dowitcher	*Limnodromus griseus*	177	WV
Western Sandpiper	*Ereunetes mauri*	1248	WV
Marbled Godwit	*Limosa fedoa*	4169	WV; AY
Sanderling	*Crocethia alba*	363	WV
American Avocet	*Recurvirostra americana*	30	WV
Wilson's Phalarope	*Steganopus tricolor*	1	Rare M
Northern Phalarope	*Lobipes lobatus*	21	M
Parasitic Jaeger	*Sterocrarius parasiticus*	1	Occ. WV
Glaucous-winged Gull	*Larus glaucescens*	6	WV
Western Gull	*Larus occidentalis*	321	R
Herring Gull	*Larus argentatus*	61	WV
California Gull	*Larus californicus*	480	AY
Ring-billed Gull	*Larus delawarensis*	282	AY
Mew Gull	*Larus canus*	45	WV
Heermann's Gull	*Larus heermanni*	2072	SV; AY
Forster's Tern	*Sterna forsteri*	26	AY
Least Tern	*Sterna albifrons*	1	Rare

Common Name	Scientific Name	Number	Population Peak Season (1966-67)
Royal Tern	*Thalasseus maximus*	19	WV
Elegant Tern	*Thalasseus elegans*	145	WV
Caspian Tern	*Hydroprogne caspia*	48	M
Pigeon Guillemot	*Cepphus columba*	3	WV

APPENDIX C

Total Bird Numbers by Date

Morro Bay, Calif., (1966-67) (Gerdes, 1970)

Count Dates	Bird Numbers	Number of Stations Counted
9- 1-66	7649	15
9-15-66	8185	16
10- 1-66	6325	17
10-15-66	11619	19
11- 1-66	11900	20
11-15-66	8830	17
12- 1-66	13531	19
12-15-66	12590	19
1- 1-67	14931	20
1-15-67	14535	20
2- 1-67	16733	20
2-15-67	25106	20
3- 1-67	9916	16
3-15-67	11259	17
4- 1-67	14536	18
4-15-67	8712	17
5- 1-67	8154	18
5-15-67	1809	18
6- 1-67	941	18
6-15-67	1108	20
7- 1-67	1961	16
7-15-67	3491	18
8- 1-67	4254	19
8-15-67	4820	19

APPENDIX D

Fishes Collected at Morro Bay

(From Fierstine, Kline and Garman, 1973)

Common Name	Scientific Name	Number of Months Collected	Evidence of Reproduction
Horn shark	*Heterodontus francisi*	2	X
Gray smoothhound	*Mustelus californicus*	3	
Leopard shark	*Triaksis semifasciata*	2	X
Pacific angel shark	*Squatina californica*	1	
Thormback	*Platyrhinoides triseriata*	1	
Shovelnose guitar-fish	*Rhinobatus productus*	2	
Big Skate	*Raja binoculata*	1	
Round stingray	*Urolophus halleri*	6	X
Bat ray	*Myliobatis californica*	7	X
Pacific herring	*Clupea harengus*	1	
Pacific sardine	*Sardinops sagax*	1	
Northern anchovy	*Engraulis mordax*	5	X
Steelhead rainbow trout	*Salmo gairdneri*	1	
California killifish	*Fundulus parvipinnis*	2	
Mosquitofish	*Gambusia affinis*	1	
Three spine stickleback	*Gasterosteus aculeatus*	3	
Kelp pipefish	*Syngnathus californiensis*	2	
Bay pipefish	*Syngnathus griseolineatus*	1	
Green sunfish	*Lepomis cyanellus*	2	
Jack mackerel	*Trachurus symmetricus*	2	

Common Name	Scientific Name	Number of Months Collected	Evidence of Reproduction
Black perch	*Embiotoca jacksoni*	9	X
Striped seaperch	*Embiotoca lateralis*	3	
Walleye surfperch	*Hyperprosopon argenteum*	6	
Shiner perch	*Cymatogaster aggregata*	6	X
Rainbow seaperch	*Hypsurus caryi*	1	
Dwarf perch	*Micrometrus minimus*	2	
Sharpnose seaperch	*Rhanerodon atripes*	3	X
White seaperch	*Phanerodon furcatus*	4	
Rubberlip seaperch	*Rhacochilus toxotes*	4	
Pile perch	*Rhacochilus vacca*	5	
Arrow goby	*Clevlandia ios*	3	
Longjaw mudsucker	*Gillichthys mirabilis*	1	
Bay goby	*Lepidogobius lepidus*	1	
Brown rockfish	*Sebastes auriculatus*	1	
Calico rockfish	*Sebastes dalli*	1	
Blue rockfish	*Sebastes mystinus*	1	
Bocaccio	*Sebastes paucispinis*	4	
One-spot fringehead	*Neoclinus uninotatus*	1	
Grass rockfish	*Sebastes rastrelliger*	2	
Olive rockfish	*Sebastes serranoides*	1	
Lingcod	*Ophiodon elongatus*	6	X
Painted greenling	*Oxylebius pictus*	3	
Smoothhead sculpin	*Arteduis lateralis*	1	
Prickly sculpin	*Cottus asper*	1	
Riffle sculpin	*Cottus gulosus*	1	
Pacific staghorn sculpin	*Leptocottus armatus*	7	

Common Name	Scientific Name	Number of Months Collected	Evidence of Reproduction
Cabezon	*Scorpaenichthys marmoratus*	1	
Crevice kelpfish	*Gibbonsia montereyensis*	1	
Giant kelpfish	*Heterostichus rostratus*	1	
Penpoint gunnel	*Apodichthys flavidus*	1	
Rockweed gunnel	*Xererpes fucorum*	2	
Monkeyface prickleback	*Cebidichthys violaceus*	1	
Pacific pompano	*Peprilus simillimus*	1	
Topsmelt	*Atherinopsis affinis*	6	X
Jacksmelt	*Atherinopsis californiensis*	3	
Speckled sanddab	*Citharichthys stigmaeus*	5	X
California halibut	*Paralichthys californicus*	8	X
Diamond turbot	*Hypsopsetta guttulata*	6	
English sole	*Parophrys vetulus*	5	X
Starry flounder	*Platichthys stellatus*	9	X
Sole	*Pleuronichthys conenosus*	1	
Spotted turbot	*Pleuronichthys ritteri*	1	
Sand sole	*Psettichthys melanostictus*	3	
California tonguefish	*Symphurus atricauda*	1	
Kelp clingfish	*Rimicola muscarum*	1	
Plainfin midshipman	*Porichthys notatus*	2	X

APPENDIX E

Marine Invertebrates of Morro Bay [1]

Common Name	Scientific Name
SPONGES:	*PORIFERA:*
Boring sponge	*Cliona celata*
Crumb-of-bread sponge	*Halichondria panicea*
Sponge	*Haliclona permollis*
Sponge	*Leucosolenia eleanor*
Sponge	*Lissodendoryx noxiosa*
Red sponge	*Ophlitaspongia pennata*
Red sponge	*Plocamia karykina*
Sponge	*Rhabdodermella nuttingi*
Sulphur sponge	*Verongia thiona*
HYDRAS AND ANEMONES:	*COELENTERATA:*
Hydroid	*Abietinaria anguina*
Hydroid	*Aglaophenia inconspicna*
Hydroid	*Aglaophenia struthionides*
Hydroid	*Plumularia lagenifera*
Hydroid	*Sertularella turgida*
Hydroid	*Sertularia furcata*
Hydrocoral	*Allopora porphyra*
Aggregated anemone	*Anthopleura elegantissima*
Giant green anemone	*Anthopleura xanthogrammica*
Small red anemone	*Corynactis californica*
Anemone	*Epiactus prolifera*

1/ From Barnes, 1963-64; Curtis, 1965; Fosdick, 1957: Reish and Barnard, 1967; Menzies and Molin, 1952; Light, 1967; Hedgpeth, 1964; Rickets and Calvin, 1965, and others.

Common Name	Scientific Name
Polychaete	*Boccardia polybranchia*
Polychaete	*Capitella capitata*
Polychaete	*Cassura longocirrata*
Polychaete	*Chone infundibuloformis*
Polychaete	*Ctenodrilus serratus*
Polychaete	*Eteone californica*
Polychaete	*Eteone dilatae*
Polychaete	*Eudistylia vancouveri*
Polychaete	*Exogone loueri*
Polychaete	*Glycera robusta*
Polychaete	*Haploscoloplos pugettensis*
Polychaete	*Hesperonoe adventor*
Polychaete	*Heteromastrus filiformis*
Polychaete	*Hypoeulalia bilineata*
Polychaete	*Lumbrineris zonata*
Polychaete	*Magelona papillicornus*
Polychaete	*Neanthes limnicola*
Polychaete	*Nephtys caecoides*
Polychaete	*Nephtys californiensis*
Polychaete	*Nereis brandti*
Polychaete	*Nereis latescens*
Polychaete	*Nereis procera*
Polychaete	*Nerinides acuta*
Polychaete	*Pectinaria californiensis*
Polychaete	*Pilargis maculata*
Polychaete	*Pista alata*

Common Name	Scientific Name
Polychaete	*Platynereis bicanaliculata*
Polychaete	*Polydora ligni*
Polychaete	*Prionospio cirrifera*
Polychaete	*Prionospio pygmaeus*
Polychaete	*Pseudopolydora kempi*
Polychaete	*Rhynochospio arenincola*
Polychaete	*Scoloplos acmeceps*
Polychaete	*Sphaerosyllis hystrix*
Polychaete	*Spiophanes missionensis*
Polychaete	*Spirorbinae* (unidentified
Polychaete	*Stauronereis articulata*
Polychaete	*Streblospio benedicti*
Polychaete	*Stylarioides infandibularis*
Polychaete	*Typosyllis fasciata*
INNKEEPER WORMS;	*ECHIURIDA:*
Fat innkeeper	*Urechis caupo*
SIPUNCULID:	*SIPUNCULIDA:*
Sipunculid worm	*Golfingia hespera*
Sipunculid worm	*Phascolosoma agassizii*
Sipunculid	*Siphonosoma ingens*
ARTHROPODS:	*ARTHROPODA:*
Copepod	*Porcellidium viridis*
Copepod	(Assorted Harpacticords)
Barnacle	*Balanus cariosus*
Barnacle	*Balanus glandula*
Barnacle	*Balanus improvisus*

Common Name	Scientific Name
Acorn barnacle	*Balanus nubilus*
Acorn barnacle	*Balanus tintinnabulum*
Barnacle	*Chthamalus fissus*
Gooseneck barnacle	*Mitella polymerus*
Barnacle	*Tetraclita squamosa*
Leptostracan	*Epinebalia pugettensis*
Pill bug	*Idothea resecata*
Pill bug	*Idothea stenops*
Sea spider	*Pycnogonum stearnsi*
Gribble	*Limnoria quadripunctata*
Gribble	*Limnoria tripunctata*
Amphipod	*Allorochestes angustus*
Amphipod	*Ampelisca cristata*
Amphipod	*Ampithoe lacertosa*
Amphipod	*Ampithoe (longimana)*
Amphipod	*Ampithoe valida*
Amphipod	*Aoroides columbiae*
Amphipod	*Batea transversa*
Amphipod	*Caprella californica*
Amphipod	*Corophium acherusicum*
Amphipod	*Corophium baconi*
Amphipod	*Corophium spinicorne*
Amphipod	*Corophium venoi*
Amphipod	*Elasmopus rapax*
Amphipod	*Erichthonius brasiliensis*
Amphipod	*Heteroploxus oculatus*

Common Name	Scientific Name
Amphipod	*Microdeutopus schmitti*
Amphipod	*Paraphoxus epistomus*
Amphipod	*Paraphoxus spinosus*
Amphipod	*Paraphoxus (stenodes)*
Amphipod	*Photis brevipes*
Amphipod	*Pontogeneia minuta*
Amphipod	*Pontogeneia rostrata*
Amphipod	*Synchelidium rectipalmum*
Amphipod	*Symchelidium shoemakeri*
Blacktailed shrimp	*Crago nigricauda*
Shrimp	*Crago nigromaculata*
Sand crab	*Emerita analoga*
Broke-back shrimp	*Spirontocaris cristata*
Blue mud shrimp	*Upogebia pugettensis*
Red ghost shrimp	*Callianassa californiensis*
Crab	*Cancer productus*
Rock crab	*Cancer antennarius*
Market crab	*Cancer magister*
Purple shore crab	*Hemigrapsus nudus*
Hairy mud crab	*Hemigrapsus oregonensis*
Hermit crab	*Pagurus hemphillii*
Lined shore crab	*Pachygrapsus crassipes*
Masking crab	*Scyra acutifrons*
Pea crab	*Pinnixa littoralis*
MOLLUSKS:	*MOLLUSCA:*
Gum boot	*Cryptochiton stelleri*

Common Name	Scientific Name
Chiton	*Ischnochiton regularis*
Black chiton	*Katharina tunicata*
Mossy chiton	*Mopalia muscosa*
Chiton	*Mopalia lignosa*
Chiton	*Mopalia hindsi*
Chiton	*Nuttallina californica*
Chiton	*Tonicella lineata*
Black limpet	*Acmaea asmi*
Rough limpet	*Acmaea digitalis*
Limpet	*Acmaea insessa*
File limpet	*Acmaea limatula*
Dunce cap limpet	*Acmaea mitra*
Shield limpet	*Acmaea pelta*
Flat limpet	*Acmaea scabra*
Owl limpet	*Lottia gigantea*
Top shell	*Astraea gibberosa*
Blue top shell	*Calliostoma ligatum*
Brown turban	*Tegula brunnea*
Black turban	*Tegula funebralis*
Keyhole limpet	*Diodora aspera*
Volcano shell limpet	*Fissurella volcano*
Giant keyhole limpet	*Megathura crenulata*
Black abalone	*Haliotis cracherodii*
Red abalone	*Haliotis rufescens*
Horn shell	*Cerithidea californica*
Boat shell	*Crepidula adunca*

Common Name	Scientific Name
Northern slipper shell	*Crepidula nummaria*
Onyx slipper shell	*Crepidula onyx*
Periwinkle	*Littorina planaxis*
Periwinkle	*Littorina scutulata*
Oyster drill	*Urosalpinx cinereus*
Moon snail	*Polinices draconis*
Southern moon snail	*Polinices recluzianus*
Giant moon snail	*Polinices lewisi*
Nuttall's hornmouth snail	*Ceratostoma nuttalli*
Basket whelk	*Nassarius fossatus*
Dire whelk	*Searlesia dira*
Channeled purple	*Thais canaliculata*
Snail	*Lacuna porrecta*
Purple olive snail	*Olivella biplicata*
Cove shell	*Conus californicus*
Barrel shell	*Rictaxis punctocaelatus*
Sea hare	*Aplysia californica*
Tectibranch	*Aglaja diomedea*
Tectibranch	*Cheladonura inermis*
Tectibranch	*Phyllaplysia taylori*
Tectibranch	*Haminoea vesicula*
Bubble snail	*Bulla gouldiana*
Sea lemon	*Anisodoris nobilis*
Nudibranch	*Acanthodoris (rhoduceras)*
Nudibranch	*Acteocina inculta*
Nudibranch	*Aegires albopunctatus*

Common Name	Scientific Name
Nudibranch	*Aeolidia papillosa*
Nudibranch	*Aglaija (ocelligera)*
Nudibranch	*Antiopella barbarensis*
Nudibranch	*Archidoris montereyensis*
Nudibranch	*Armina californica*
Nudibranch	*Cadlina luteo*
Nudibranch	*Corambe pacifica*
Nudibranch	*Coryphella trilineata*
Nudibranch	*Cumanotus beaumonti*
Nudibranch	*Dendrodoris fulva*
Nudibranch	*Dendronotus frondosus*
Nudibranch	*Dendronotus subramosus*
Nudibranch	*Dialulula sandiegensis*
Nudibranch	*Doridella steinbergae*
Nudibranch	*Doriopsilla albopunctata*
Nudibranch	*Eubranchus rusytus*
Nudibranch	*Hancockia californica*
Nudibranch	*Hermissenda crassicornis*
Nudibranch	*Hopkinsia rosacea*
Nudibranch	*Melibe leonina*
Nudibranch	*Okenia angelensis*
Nudibranch	*Onchidoris bilamellata*
Nudibranch	*Onchidoris hystricina*
Nudibranch	*Polycera atra*
Nudibranch	*Polycera hedgpethi*
Nudibranch	*Precuthona divae*

Common Name	Scientific Name
Nudibranch	*Triopha carpenteri*
Nudibranch	*Triopha grandis*
Nudibranch	*Triopha maculata*
Rock oyster	*Hinnites giganteus*
California mussel	*Mytilus californianus*
Horse mussel	*Volsella demissa*
Edible mussel	*Mytilus edulis*
Pacific oyster	*Crassostrea gigas*
Cockle	*Chione undatella*
Basket cockle	*Clinocardium muttalli*
Clam	*Cooperella subdiaphann*
Urechis clam	*Cryptomya californica*
Clam	*Lyonsia californica*
Bent-nose clam	*Macoma nasuta*
Eastern soft shell clam	*Mya arenaria*
Geoduck clam	*Panope generosa*
Boring clam	*Platyodon cancellatus*
Littleneck clam	*Protothaca staminea*
Boring clam	*Saxicava pholadis*
Washington clam	*Saxidomus nuttalli*
Razor clam	*Siliqua patula*
Jackknife clam	*Tagelus californianus*
Tellen clam	*Tellina bodegensis*
Tellen clam	*Tennina modesta*
Pismo clam	*Tivela stultorum*
Gaper clam	*Tresus nuttalli*

Common Name	Scientific Name
Rough piddock	*Zirfaea pilsbryi*
Jingle shell	*Pododesmus macroschisma*
Shipworm	*Bankia setacea*
ECHINODERMS:	*ECHINODERMA:*
Starfish	*Astropecten armatus*
Leather star	*Dermasterias imbricata*
Starfish	*Henricia leviuscula*
Starfish	*Leptasterias hexactis*
Starfish	*Leptasterias pusilla*
Sea bat	*Patiria miniata*
Ochre star	*Pisaster ochraceus*
Sunflower star	*Pycnopodia helianthoides*
Brittle star	*Amphipholis occidentalis*
Brittle star	*Amphipholis pugetana*
Sand dollar	*Dendraster excentricus*
Giant red urchin	*Strongylocentrotus franciscanus*
Purple urchin	*Strongylocentrotus purpuratus*
Dirty white sea cucumber	*Leptosynapta albicans*
TUNICATES:	*CHORDATA:*
Sea squirt	*Ascidia ceratodes*
Tunicate	*Ciona intestinalis*
Sea squirt	*Styela montereyensis*
Mushroom tunicate	*Distaplia occidentalis*
Acorn-tongue worm	*Saccoglossus pusillus*
Lancelet	*Branchiostoma californiense*
Lancelets	*Branchiostoma* spp.

APPENDIX F

Birds of Western San Luis Obispo County
--Other than included in Appendix B--
[From Roest (1970) and Peterson (1961)]

WV - Winter visitor
SV - Summer visitor
AY - a few present all year
M - Migrant
R - Resident
Occ. - Occasional
Rare - Only a few records

Common Name	Scientific Name	Population Peak
Black-footed Albatross	*Diomedea nigripes*	AY
Fulmar	*Fulmaris glacialis*	WV
Pink-footed Shearwater	*Puffinus creatopus*	Occ. SV
Sooty Shearwater	*Puffinus griseus*	M; SV
Manx Shearwater	*Puffinus puffinus*	Occ. M
Fork-tailed Petrel	*Oceanodroma furcata*	M
Ashy Petrel	*Oceanodroma homochroa*	M; SV
Black Petrel	*Loomelania melania*	SV
Least Bittern	*Ixobrychus exilis*	Rare R
American Bittern	*Botaurus lentiginosus*	R
Whistling Swan	*Olor columbianus*	Occ. WV
Snow Goose	*Chen hyperborea*	Occ. WV
Fulvous Tree Duck	*Dendrocygna bicolor*	Rare M
Gadwall	*Anas strepera*	Occ. R
Blue-winged Teal	*Anas discors*	Occ. M
European Widgeon	*Mareca penelope*	Rare M
Wood Duck	*Aix sponsa*	Occ. WV

Common Name	Scientific Name	Population Peak
Redhead	*Aythya americana*	Occ. WV
Ring-necked Duck	*Aythya collaris*	WV
Canvasback	*Aythya valisineria*	WV
Oldsquaw	*Clangula hyemalis*	Rare WV
Harlequin Duck	*Histrionicus histrionicus*	Rare WV
Turkey Vulture	*Cathartes aura*	R
* California Condor	*Gymnogyps californianus*	Rare R
White-tailed Kite	*Elanus leucurus*	Occ. R
Sharp-shinned Hawk	*Accipiter striatus*	WV; Rare R
Cooper's Hawk	*Accipiter cooperii*	R
Red-tailed Hawk	*Buteo jamaicensis*	R
Red-shouldered Hawk	*Buteo lineatus*	R
Rough-legged Hawk	*Buteo lagopus*	Occ. WV
Ferruginous Hawk	*Buteo regalis*	Occ. WV
Golden Eagle	*Aquila chrysaetos*	R
Bald Eagle	*Haliaeetus leucocephalus*	Rare M
Marsh Hawk	*Circus cyaneus*	Ay; Occ. R
Osprey	*Pandion haliaetus*	Occ. M
Prairie Falcon	*Falco mexicanus*	Rare WV
* Peregrine Falcon	*Falco peregrinus*	Rare R
Pigeon Hawk	*Falco columbarius*	Rare WV
Sparrow Hawk	*Falco sparverius*	R
California Quail	*Lophortyx californicus*	R
Mountain Quail	*Oreortyx pictus*	R

* Endangered species

	Common Name	Scientific Name	Population Peak	
	Ring-necked Pheasant	*Phasianus colchicus*		R
	Turkey	*Meleagris gallopavo*		R
	Sora	*Porzana carolina*		R
*	Black Rail	*Laterallus jamaicensis*	Rare	R
	Common Gallinule	*Gallinula chloropus*	Occ.	R
	Black Oystercatcher	*Haematopus bachmani*		R
	Golden Plover	*Pluvialis dominica*	Rare	M
	Surfbird	*Aphriza virgata*		WV
	Ruddy Turnstone	*Arenaria interpres*		WV
	Common Snipe	*Capella gallinago*		WV
	Solitary Sandpiper	*Tringa solitaria*	Rare	WV
	Lesser Yellowlegs	*Totanus flavipes*	Rare	M
	Baird's Sandpiper	*Erolia bairdii*	Rare	M
	Long-billed Dowitcher	*Limnodromus scolopaceus*		WV
	Black-necked Stilt	*Himantopus mexicanus*	Occ.	M
	Red Phalarope	*Phalaropus fulicarius*		M
	Bonaparte's Gull	*Larus philadelphia*		WV
	Black-legged Kittiwake	*Rissa tridactyla*	Occ.	WV
	Sabine's Gull	*Xema sabini*	Occ.	M
	Common Tern	*Sterna hirundo*		M
	Common Murre	*Uria aalge*		WV
	Marbled Murrelet	*Brachyramphus marmoratum*	Occ.	WV
	Xantus's Murrelet	*Endomychura hypoleuca*	Occ.	WV
	Ancient Murrelet	*Synthliboramphus antiquum*		WV
	Cassin's Auklet	*Ptychoramphus aleutica*		WV
	Rhinoceros Auklet	*Cerorhinca monocerata*		WV

* Rare specie

Common Name	Scientific Name	Population Peak
Band-tailed Pigeon	*Columba fasciata*	R
Rock Dove	*Columba livia*	R
White-winged Dove	*Zenaida asiatica*	Occ. WV
Mourning Dove	*Zenaidura macroura*	R
Roadrunner	*Geococcyx californianus*	R
Barn Owl	*Tyto alba*	R
Screech Owl	*Otus asio*	R
Great Horned Owl	*Bubo virginianus*	R
Pygmy Owl	*Glaucidium gnoma*	R
Burrowing Owl	*Speotyto cunicularia*	R
Spotted Owl	*Strix occidentalis*	Rare R
Long-eared Owl	*Asio otus*	Occ. R
Short-eared Owl	*Asio flammeus*	Occ. WV
Poor-will	*Phalaenoptilus nuttallii*	R
Common Nighthawk	*Chordeiles minor*	SV
Lesser Nighthawk	*Chordeiles acutipennis*	SV
Black Swift	*Cypseloides niger*	Rare M
Vaux's Swift	*Chaetura vauxi*	M
White-throated Swift	*Aeronautes saxatalis*	R
Black-chinned Hummingbird	*Archilochus alexandri*	Occ. SV
Costa's Hummingbird	*Calypte costae*	SV
Anna's Hummingbird	*Calypte anna*	R
Rufous Hummingbird	*Selasphorus rufus*	SV
Belted Kingfisher	*Megaceryle alcyon*	R
Red-shafted Flicker	*Colaptes cafer*	R
Acorn Woodpecker	*Melanerpes formicivorus*	R

Common Name	Scientific Name	Population Peak
Yellow-bellied Sapsucker	*Sphyrapicus varius*	WV
Hairy Woodpecker	*Dendrocopos villosus*	R
Downy Woodpecker	*Dendrocopos pubescens*	R
Nuttall's Woodpecker	*Dendrocopos nuttallii*	R
Western Kingbird	*Tyrannus verticalis*	SV
Cassin's Kingbird	*Tyrannus vociferns*	SV
Ash-throated Flycatcher	*Myiarchus cinerascens*	SV
Black Phoebe	*Sayornis nigricans*	R
Say's Phoebe	*Sayornis saya*	WV
Traill's Flycatcher	*Empidonax traillii*	SV
Western Flycatcher	*Empidonax difficilis*	SV
Western Wood Peewee	*Contopus sordidulus*	SV
Olive-sided Flycatcher	*Nuttallornis borealis*	SV
Horned Lark	*Eremophila alpestris*	R
Violet-green Swallow	*Tachycineta thalassina*	SV; AY
Tree Swallow	*Iridoprocne bicolor*	M
Bank Swallow	*Riparia riparia*	Rare SV
Rough-winged Swallow	*Stelgidopteryx ruficollis*	SV
Barn Swallow	*Hirundo rustica*	SV
Cliff Swallow	*Petrochelidon pyrrhonota*	SV
Purple Martin	*Progne subis*	Rare SV
Steller's Jay	*Cyanocitta stelleri*	R
Scrub Jay	*Aphelocoma coerulescens*	R
Yellow-billed Magpie	*Pica nuttalli*	R
Common Raven	*Corvus corax*	Rare WV
Common Crow	*Corvus brachyrhynchos*	R

Common Name	Scientific Name	Population Peak
Clark's Nutcracker	*Nucifraga columbiana*	Rare WV
Chestnut-backed Chickadee	*Parus rufescens*	R
Plain Titmouse	*Parus inornatus*	R
Common Bushtit	*Psaltriparus minimus*	R
White-breasted Nuthatch	*Sitta carolinensis*	Occ. WV
Red-breasted Nuthatch	*Sitta canadensis*	WV
Pygmy Nuthatch	*Sitta pygmaea*	R
Brown Creeper	*Certhia familiaris*	R
Wrentit	*Chamaea fasciata*	R
House Wren	*Troglodytes aedon*	R
Winter Wren	*Troglodytes troglodytes*	WV
Bewick's Wren	*Thryomanes bewickii*	R
Long-billed Marsh Wren	*Telmatodytes palustris*	R
Canon Wren	*Catherpes mexicanus*	R
Rock Wren	*Salpinctes obsoletus*	R
Mockingbird	*Mimus polyglottos*	R
California Thrasher	*Toxostoma redivivum*	R
Robin	*Turdus migratorius*	R
Varied Thrush	*Ixoreus naevius*	Occ. WV
Hermit Thrush	*Hylocichla guttata*	WV
Swainson's Thrush	*Hylocichla ustulata*	SV
Western Bluebird	*Sialia mexicana*	R
Mountain Bluebird	*Sialia currucoides*	Occ. WV
Blue-gray Gnatcatcher	*Polioptila caerulea*	R
Golden-crowned Kinglet	*Regulus satrapa*	Occ. WV
Ruby-crowned Kinglet	*Regulus calendula*	WV

Common Name	Scientific Name	Population Peak
Water Pipit	*Anthus spinoletta*	WV
Cedar Waxwing	*Bombycilla cedrorum*	WV
Loggerhead Shrike	*Lanius ludovicianus*	R
Starling	*Sturnus vulgaris*	R
Hutton's Vireo	*Vireo huttoni*	R
Bell's Vireo	*Vireo bellii*	SV
Solitary Vireo	*Vireo solitarius*	SV
Warbling Vireo	*Vireo gilvus*	SV
Orange-crowned Warbler	*Vermivora celata*	R
Nashville Warbler	*Vermivora ruficapilla*	M
Yellow Warbler	*Dendroica petechia*	SV
Myrtle Warbler	*Dendroica coronata*	WV
Audubon's Warbler	*Dendroica auduboni*	WV
Black-throated Gray Warbler	*Dendroica nigrescens*	Occ. SV
Townsend's Warbler	*Dencroica townsendi*	WV
Hermit Warbler	*Dendroica occidentalis*	M
MacGillivray's Warbler	*Oporornis tolmiei*	M
Yellowthroat	*Geothlypis trichas*	R
Yellow-breasted Chat	*Icteria virens*	SV
Wilson's Warbler	*Wilsonia pusilla*	SV
House Sparrow	*Passer domesticus*	R
Western Meadowlark	*Sturnella neglecta*	R
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	M
Red-winged Blackbird	*Agelaius phoeniceus*	R
Tri-colored Blackbird	*Agelaius tricolor*	Occ. R
Hooded Oriole	*Icterus cucullatus*	SV

Common Name	Scientific Name	Population Peak
Bullock's Oriole	*Icterus bullockii*	SV
Brewer's Blackbird	*Euphagus cyanocephalus*	R
Brown-headed Cowbird	*Molothrus ater*	R
Western Tanager	*Piranga ludoviciana*	M
Black-headed Grosbeak	*Pheucticus melanocephalus*	SV
Blue Grosbeak	*Guiraca caerulea*	Occ. SV
Lazuli Bunting	*Passerina ameona*	SV
Purple Finch	*Carpodacus purpureus*	Occ. M
Cassin's Finch	*Carpodacus cassini*	Occ. M
House Finch	*Carpodacus mexicanus*	R
Pine Siskin	*Spinus pinus*	WV
American Goldfinch	*Spinus tristis*	R
Lesser Goldfinch	*Spinus psaltria*	R
Lawrence's Goldfinch	*Spinus lawrencei*	R
Red Crossbill	*Loxia curvirostra*	Occ. WV
Rufous-sided Towhee	*Pipilo erythrophthalmus*	R
Brown Towhee	*Pipilo fuscus*	R
Savannah Sparrow	*Passerculus sandwichensis*	R
Grasshopper Sparrow	*Ammodramus savannarum*	Occ. R
Vesper Sparrow	*Pooecetes gramineus*	Occ. M
Lark Sparrow	*Chondestes grammacus*	R
Rufous-crowned Sparrow	*Aimophila ruficeps*	R
Sage Sparrow	*Amphispiza belli*	R
Slate-colored Junco	*Junco hyemalis*	Rare WV
Oregon Junco	*Junco oreganus*	R
Chipping Sparrow	*Spizella passerina*	R

Common Name	Scientific Name	Population Peak
Harris's Sparrow	*Zonotrichia querula*	Rare WV
White-crowned Sparrow	*Zonotrichia leucophrys*	WV
Golden-crowned Sparrow	*Zonotrichia atricapilla*	WV
White-throated Sparrow	*Zonotrichia albicollis*	Occ. WV
Fox Sparrow	*Passerella iliaca*	WV
Lincoln's Sparrow	*Melospiza lincolnii*	WV
Swamp Sparrow	*Melospiza georgiana*	Rare WV
Song Sparrow	*Melospiza melodia*	R

APPENDIX G

Mammals of Morro Bay Area

(A. I. Roest and others, pers. comm.)

Common Name	Scientific Name
Opossum	*Didelphis marsupialis*
Ornate Shrew	*Sorex ornatus*
Broad-handed Mole	*Scapanus latimanus*
Bats (several species)	(Order Chiroptera)
Black-tailed Jack Rabbit	*Lepus californicus*
Audubon Cottontail	*Sylvilagus audubonii*
Brush Rabbit	*Sylvilagus bachmani*
Beechey Ground Squirrel	*Otospermophilus beecheyi*
Botta Pocket Gopher	*Thomomys battae*
California Pocket Mouse	*Perognathus californicus*
Morro Bay Kangaroo Rat	*Dipodomys heermanni morroensis*
Western Harvest Mouse	*Reithrodontomys megalotis*
California Mouse	*Peromyscus californicus*
Deer Mouse	*Peromyscus maniculatus*
Brush Mouse	*Peromyscus boylii*
Dusky-footed Wood Rat	*Neotoma fuscipes*
California Meadow Mouse	*Microtus californicus*
Muskrat	*Ondatra zibethica*
House Mouse	*Mus musculus*
Gray Fox	*Urocyon cinereoargenteus*
Raccoon	*Procyon lotor*
Long-tailed Weasel	*Mustela frenata*

Common Name	Scientific Name
Badger	*Taxidea taxus*
Striped Skunk	*Mephitis mephitis*
Bobcat	*Lynx rufus*
Mule Deer	*Odocoileus hemionus*
California Sea Lion	*Zalophus californicus*
Harbor Seal	*Phoca vitulina*
Sea Otter	*Enhydra lutris*
Stellar's sea lion	*Eumetopius jubata*

APPENDIX H

Check List of Plants Cited in Text

(see Appendix A for Algae)

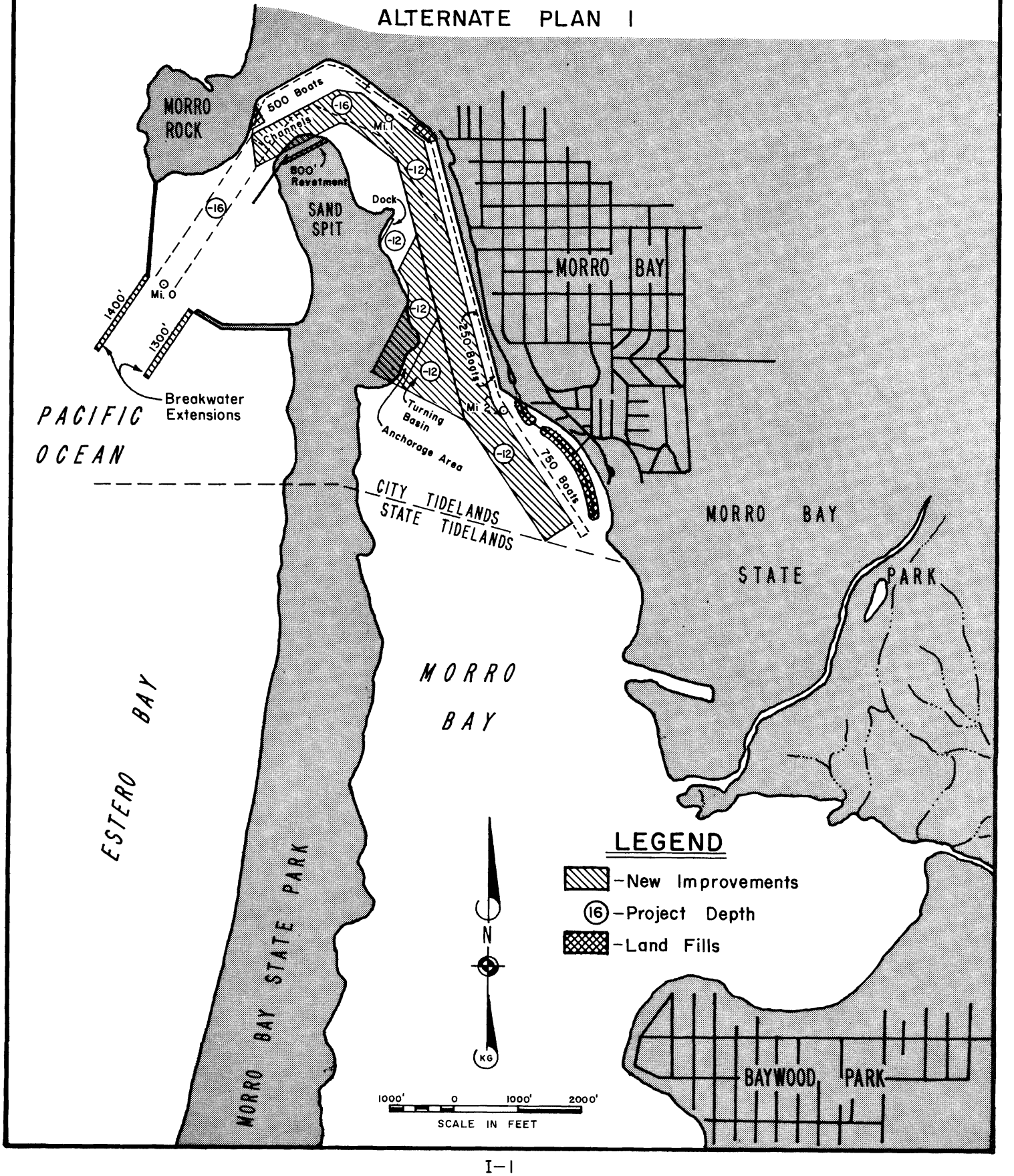
Alkali heath	*Frankenia grandifolia*
Beach primrose	*Oenothera cheiranthifolia*
Black sage	*Salvia melifera*
Brass buttons	*Cotula coronopifolia*
Buckwheat	*Eriogonum parvifolium*
Bush lupine	*Lupinus arboreus*
California sage	*Artemesia californica*
Cattail	*Typha* sp.
Coyote brush	*Baccharis pilularis*
Deer weed	*Lotus scoparius*
Ditch grass	*Ruppia maritima*
Eel grass	*Zostera marina*
Jaumea	*Jaumea carnosa*
Live-forever	*Dudleya* sp.
Lizard tail	*Eriophyllum staechadifolium*
Mock heather	*Haplopappus (Ericameria) ericoides*
Pickleweed	*Salicornia* sp.
Saltbush	*Atriplex patula*
Salt-wort	*Batis maritima*
Sand verbena	*Abronia* spp.
Sea blite	*Suaeda* sp.
Sea rocket	*Cakile maritima*
Silvery lupine	*Lupinus chamissonis*
Spiny rush	*Juncus acutus*
Statice	*Limonium commune*
Tule	*Scirpus* sp.
Willow	*Salix* sp.

APPENDIX I

NAVIGATIONAL IMPROVEMENTS

MORRO BAY HARBOR

ALTERNATE PLAN I

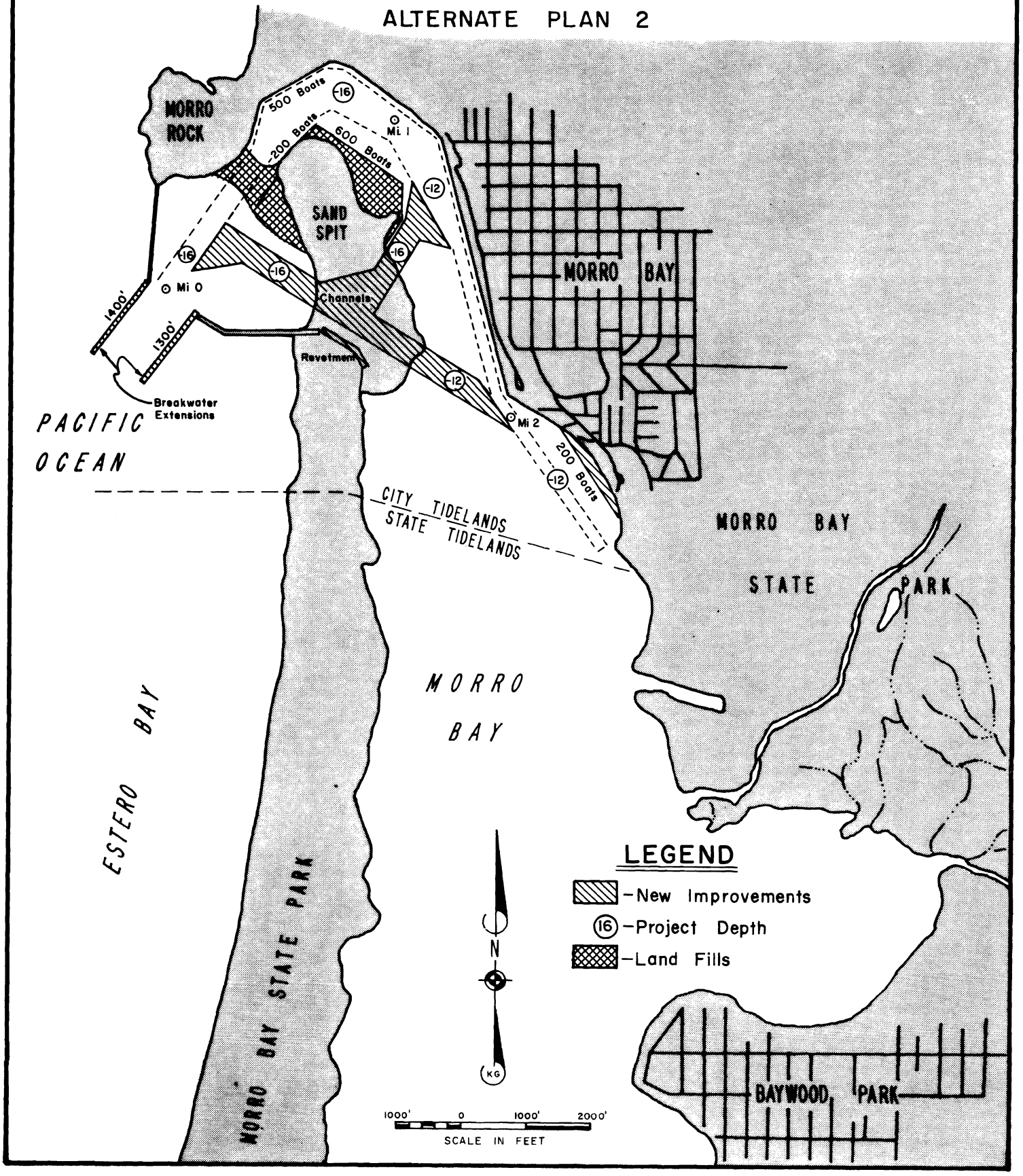


APPENDIX J

NAVIGATIONAL IMPROVEMENTS

MORRO BAY HARBOR

ALTERNATE PLAN 2

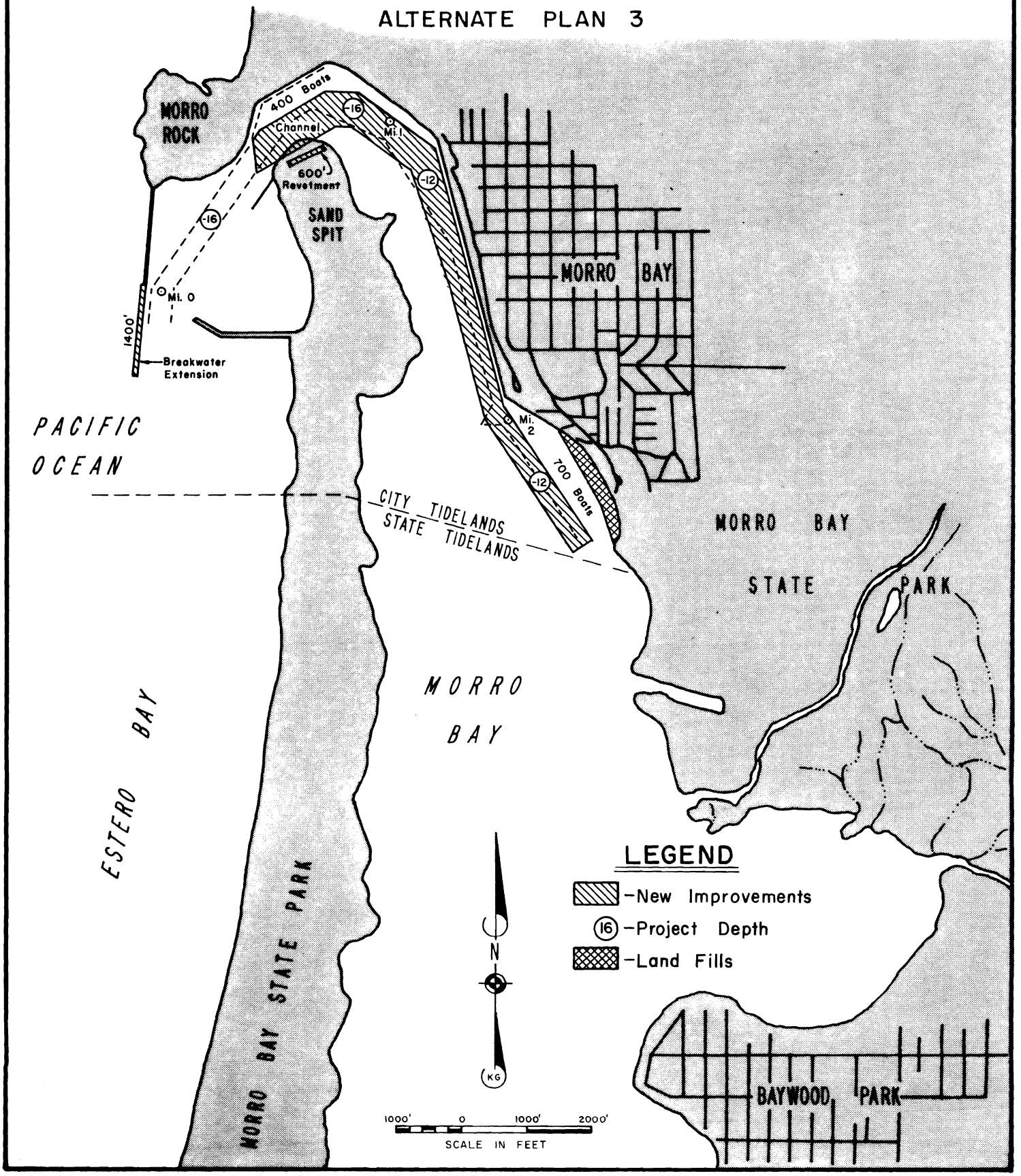


APPENDIX K

NAVIGATIONAL IMPROVEMENTS

MORRO BAY HARBOR

ALTERNATE PLAN 3



APPENDIX L

NAVIGATIONAL IMPROVEMENTS

MORRO BAY HARBOR

ALTERNATE PLAN 4