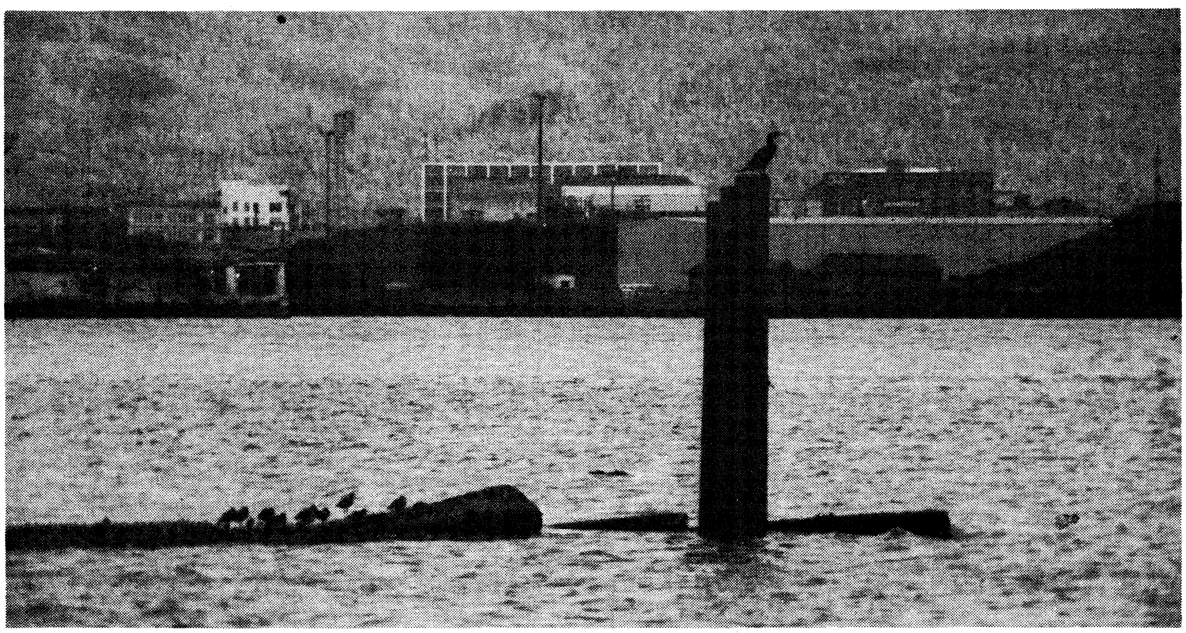
THE NATURAL RESOURCES of HUMBOLDT BAY

December, 1973



STATE OF CALIFORNIA

DEPARTMENT OF FISH AND GAME

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THE NATURAL RESOURCES

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HUMBOLDT BAY

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December, 1973

COASTAL WETLAND SERIES #6

Humboldt Bay David H. Swanlund Eureka December, 1969

ACKNOWLEDGEMENTS

This report was prepared by personnel of the Department's Region I field office in Eureka and staff members of the Wildlife Management Branch in Sacramento. Members of the Marine Resources and Environmental Services Branches, Marine Resources Region and Planning Unit also contributed essential data and editorial assistance. Forest Reynolds and Clark Blunt, Jr., formerly from the Eureka field office, were particularly helpful. Nancy Nelson and Larry Quirollo from the Eureka office; Tom Lambert and Dr. John De Martini from California State University, Humboldt; and Robert Talmadge of Eureka, assisted in the preparation of the marine fish tables and check lists. Plates were drawn by Kenneth Gonzales of the Department's Engineering Section.

Dr. Stanley Harris and Dr. Archie Mossman, both from California State University, Humboldt, supplied information used in the preparation of the bird and mammal check lists. Dr. Robert Thompson provided geological and sediment data; the American Chemical Society is acknowledged for permitting the use of this data.

Preparation of the report was supported in part by Federal Aid to Wildlife Restoration Projects.

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INTRODUCTION

One of the most important aspects of fish and wildlife conservation today is the preservation of habitat necessary for the survival of all living forms. The rapid increase in human population and the rush of many segments of industry to develop this environment have led to a great reduction in terrestrial and aquatic habitats and a corresponding reduction in many fish and wildlife populations. This is not because people and industry in general are not concerned about conservation, but rather because their interests have not included an understanding and appreciation of basic relationships of the animals to their habitat.

It is comparatively easy to stimulate sympathy and emotion when wanton illegal killing of fish and wildlife occurs. Often the public cries for severe penalties to the offender and stronger laws and enforcement for better protection. Yet a temporary loss of this kind will be replaced through annual reproduction. Often the same people who cry for justice in this case are capable of watching a marsh being filled without once wondering what will happen to the fish and wildlife living there. A loss of this latter kind is permanent and can never be replaced.

A common belief is that fish, birds or animals, threatened with loss of habitat, will move elsewhere. Unfortunately, this usually is not the case. For many specialized species, such as estuarine and marsh organisms, habitat is disappearing so rapidly that there is no place left to go and most habitat is already supporting the maximum number of living things that it can naturally support. When a unit of habitat is lost the fish or wildlife which lived there are usually lost forever. This cannot continue indefinitely without the ultimate decline of our fish and wildlife resources.

In spite of its past abuses by man, Humboldt Bay is one of the few coastal estuaries remaining in California that has not been rendered largely unsuitable for wildlife by commercial development, dredging, filling or pollution. Its importance is emphasized considering that about 65 percent of the State's original estuarine tidelands have already been destroyed. The people have demonstrated their concern for our dwindling natural resources. If we are to preserve what remains it will be necessary for the people to exercise the wisest possible use of these resources.

Because of the importance of coastal wetlands to the fish and wildlife of California, the Department of Fish and Game has initiated a high priority statewide inventory of these wetlands. This publication is an integral part of that program. It is intended as a guide for citizens, planners, administrators and all others interested in the use and development of coastal lands and waters.

The Department has been charged with the responsibility of protecting and maintaining the fish and wildlife resources of the State. This publication is directed towards meeting this responsibility by outlining the specific resources and recreational aspects of Humboldt Bay, elucidating problems, and recommending courses of action for future development.

Preservation of the Humboldt Bay resources is much more than a local issue. What is done or not done here can have statewide, national and international implications. It also must be recognized that there is an obligation to future generations. Decisions made today will affect all those who follow in our footsteps.

SUMMARY

Humboldt Bay is one of California's largest coastal estuaries and is the only harbor of commercial importance for major shipping between San Francisco and Coos Bay, Oregon. Excluding its tributary sloughs the bay is about 16,000 acres in size. Historically the bay was much larger, perhaps 27,000 acres, but land reclamation of salt marshes and intertidal flats has reduced it to its present size.

The bay's 288 square mile drainage basin lies in the foothills of the Coast Range. Except for the coastal plain near the bay, much of the area is covered by dense forests of redwood and Douglas fir. The climate is rainy temperate with an average rainfall of about 38 inches.

The land use pattern around the bay is quite diversified. Residential, commercial and industrial zones are located in or near the cities of Arcata and Eureka, along the Samoa Spit and at several other locations along the bay shore. The intervening areas are either devoted to agriculture or are undeveloped. Commercial, urban and industrial expansion is gradually encroaching on these lands.

The major industries are wood products, commercial fishing, agriculture and tourism. The bay provides port facilities for shipping and commercial fishing.

About 5,000 acres of the bay are in private ownership; approximately 4,600 acres are tideland grants to the cities of Arcata and Eureka, and the remainder is ungranted state tidelands. A National Wildlife Refuge has been authorized which is expected to acquire some 8,000 acres in and adjacent to the bay. Less than 3 miles of the bay's 40-mile shoreline is in public ownership.

The wide variety of habitat in and around the bay provides necessary living space and life requirements for many different species of wildlife.

The waters, intertidal flats, marshes and agricultural lands are of particular importance to water-associated wildlife. Over 250 species of birds and at least 50 species of mammals are found here. Some 100 or more species are dependent on the bay and its associated wetlands.

Humboldt Bay is a vital link in the coastal flyway for migratory waterfowl, shorebirds and other water-associated birds. It also supports many resident species throughout the year.

For the Pacific black brant, the bay is the most important estuary in California. The preservation of eel grass beds on which they feed is a critical factor in maintaining the entire flyway population of these unique birds.

A major egret and heron nesting site of statewide significance is located on Indian Island. Nesting colonies of cormorants and Caspian terns are located on the old Arcata wharf and on Sand Island in Arcata Bay. The California clapper rail, on the Department's list of rare and endangered species, is found in the salt marshes of the bay.

Although much reduced in numbers, king salmon, silver salmon, steelhead and coastal cutthroat trout still enter the bay and pass into its tributaries to spawn. Stream channel changes, siltation, water diversions and pollution have contributed to the decline in anadromous fish populations.

Humboldt Bay provides habitat for some 95 species of marine fish. Some spend their entire life in the bay. Others use it as a spawning and nursery area, and some only visit the bay occasionally to feed.

The bay is particularly important as a nursery area for English sole & the marke or dungeness crab. It also provides rearing areas for forage species, such as herring and anchovies which are utilized as food by commercially important fish. The bay plays an important role as a nursery ground for at least three species of recreationally or commercially important crabs:

the market crab, red crab and rock crab. Native oysters, mussels and ten species of edible clams also are found in abundance at various locations throughout the bay.

Humboldt Bay provides a multitude of outdoor recreational opportunities which are associated with its biological resources. Because of cold air and water temperatures water contact recreation such as swimming and water skiing is limited. The area's greatest recreational potential is therefore closely tied to fish, wildlife and esthetic values.

The most significant appropriative use of wildlife in the immediate area of the bay is waterfowl hunting. It is estimated that current hunting effort is in excess of 25,000 hunter days annually. Approximately 75 percent of the total state black brant kill occurs in Humboldt Bay. Hunting effort for species other than waterfowl account for several thousand additional hunter days annually.

Humboldt Bay is one of California's primary sport fishing areas. Anglers catch at least 41 different species of fish. In addition, the bay provides recreational fishing for oysters, mussels, clams and crabs. Marine organisms such as shore crabs, ghost shrimp and other invertebrates are collected for bait and thereby contribute to sport fishing activities.

The total sportfishing within the bay and its tributaries is estimated to be in excess of 35,000 angler days annually. The marine sport fishery which is served by the bay accounts for at least 17,000 angler days annually.

The heaviest recreational uses of the bay's biological resources are non-appropriative. These uses include nature study, wildlife observations, photography and simply enjoying the natural aspects of the bay and its environs. Many thousands of user days are expended annually in pursuit of these recreational opportunities.

The bay also plays an important role in science and education. The proximity of College of the Redwoods and California State University, Humboldt, creates exceptional opportunities for these kinds of use. Over 20,000 user days annually are expended by the colleges, high schools, grammar schools and other similar institutions.

The commercial fishery served by the bay is one of the most important in the State. Fish landings at Eureka exceed those of all other California ports north of Los Angeles. Over 26 million pounds of fish were landed here in 1969.

Within the bay, oyster culture is the largest commercial fishing activity. The 350,757 pounds of oyster meat produced here in 1969 represents 49 percent of the total California production for that year. The potential for increased oyster production is high if water quality can be improved.

The future of Humboldt Bay and its natural resources will depend on man's activities. Abuses of the land and water in the past have impaired the bay's productivity in many ways. Without corrective action, further deterioration can be expected.

Sedimentation, accelerated by logging, road construction, excessive grazing and land subdivision, has changed the bay's character substantially over the past 100 years. Channels formerly navigable by large ships have been filled by sediment deposition to the point where the channels no longer are usable. Expensive dredging operations are required to maintain existing navigable channels. Although an aware and concerned logging industry has improved this situation,there is a definite need for a better understanding of siltation as it relates to all aspects of bay resources and their use.

Contamination and pollution significantly influence both the utilization and well-being of aquatic and wildlife resources. Shellfish production currently is limited by contamination. Periodic, and sometimes dramatic, losses of fish and wildlife occur from pollution. Contaminants and pollutants originate from direct discharge by shore-based industrial and municipal facilities, septic tank overflows and leach field failures, and from direct discharge of wastes from ships. Sources of present or potential major pollution problems include petroleum storage facilities, forest products industries, fish processing plants, municipal discharges, nuclear power facilities, and garbage and refuse dumps. Agricultural wastes could also become a problem if pesticide use increases.

Attempts have been made by State legislation to form a Humboldt Bay Harbor Recreation and Conservation District. Although the necessary legislation was passed, local problems have prevented actual formation of the district. This district, if created, would provide for harbor development, and protection and use, of natural resources.

The need for additional commercial and recreational boat facilities is recognized. The desire for improved port facilities for ocean shipping is also understandable from an economic viewpoint. However, such development would be detrimental to natural resources if not properly planned. Marshlands and mud flats essential for the preservation of fish and wildlife should not be considered as sites of future harbor or marina development.

One of the most serious threats to fish and wildlife preservation is the unplanned and uncontrolled sprawl of urban and industrial development. Many areas of biological importance in and around the bay have been destroyed by land fill or other activities associated with development. Agricultural lands which are not only important for wildlife, but also valuable to the local economy and necessary for food production, are being lost to urban expansion. Each area lost reduces the bay's capacity to support fish and wildlife. If the present trend is not reversed the ultimate result will be a drastic reduction in biological resources. It is of the utmost importance, therefore, that adequate zoning laws be enacted and enforced to insure the highest and best use of the lands and waters according to their biological capabilities.

At the present time the bay and its resources are not being used to their fullest potential largely because of access problems. Although much of the bay is in public ownership or open to public use because of its navigable status, all but three miles of the forty mile shoreline are privately owned. There is a definite need to provide for public access at strategic points around the bay shore. Creation of the approved National Wildlife Refuge will help to fill this need to some extent.

Humboldt Bay, in spite of the many changes brought by man, still serves as one of the most important estuarine ecosystems of the California coast. The problems and threats to its continued biological integrity are many. However, man's changing attitudes and increasing concern for protection and preservation of our natural resources is encouraging. Hopefully, we will have the foresight and the means to insure that the natural resources and attractions of Humboldt Bay are preserved for the benefit of future generations.

RECOMMENDATIONS

The high values of fish, wildlife and recreation in Humboldt Bay make it one of the most important coastal wetlands in California. Some ecologically significant areas of the bay already have been lost. However, Humboldt Bay has been less affected by man's activities than many other bays and estuaries in the State; and, the bay and its environs have great potential for increased productivity and recreational use.

To preserve the natural resources and esthetic quality of Humboldt Bay and to provide means for attaining the full biological and recreational potential of the bay, the Department of Fish and Game recommends that:

1. A master plan be made for the development and use of Humboldt Bay and its environs that will provide for the preservation, maintenance and wise use of its natural resources. A master plan should recognize recreational, educational, and scientific use of these resources as one of the highest and best uses of the area's total assets. Development plans often emphasize industrial and commercial use without devoting serious attention to other values. The master plan should consider only development that is beneficial to, or compatible with, the natural resources of the bay area. These resources can be maintained through full recognition of their total importance to the ecosystem and to man; and, by insuring their protection through long-range planning.
2. The remaining agricultural, as well as undeveloped lands critical or necessary to wildlife, adjacent to the periphery of the Humboldt Bay (Pl. 1), be protected and preserved by means of: a) adequate zoning, b) planning

commission regulations and/or c) land acquisition. A large percentage of bay area waterfowl and other wildlife use the agricultural lowlands between Table Bluff and Mad River for feeding and nesting. These lands also contribute to the highly aesthetic "open" qualities of the bay area.

Maintenance of shoreline lowlands is essential to the preservation of existing natural resources and will insure public use and enjoyment of these resources.

3. No filling or dredging of tidal mud flats or salt marshes be permitted in Arcata or South bays; nor that any part of the bay, adjacent marshes or agricultural lands be used for deposition of dredge spoil. Mud flats and salt marshes comprise one of the most productive ecosystems known, and support a wide variety of birds, mammals, fish and shellfish, including several endangered species. Dest uction by dredging and filling has reduced these vital habitats to a critically low point throughout the State.

Dredging should not be permitted except in existing navigation channels. If dredging operations are restricted, industrial and commercial activities can still be maintained, but without further destruction of natural resources.

Deposition of spoil material should be confined to areas where wildlife habitat and water quality will not be destroyed or degraded.

4. Any development of the Humboldt Bay area for commercial, industrial or recreational purposes, be made with minimal adverse impact upon natural resources. Future development should be restricted to marine-related or bay-dependent industry or commerce,

and should be made in locations only where minimal, or no, degradation or destruction of natural resources takes place.

5. The City of Eureka take prompt action to transfer ownership in Indian Island, by sale or other means, to the U. S. Department of the Interior for inclusion in the proposed Humboldt Bay National Wildlife Refuge. Indian Island is the site of one of the largest egret and heron rookeries in the State and contains the largest tract of salt marsh in the bay; and, it should be preserved.

6. The provisions for the establishment of the Humboldt Bay National Wildlife Refuge be promptly implemented as authorized. In september, 1971, the proposed Humboldt Bay National Wildlife Refuge was approved by the Migratory Bird Conservation Commission, which allowed the Bureau of Sport Fisheries and Wildlife to take the initial steps in buying land within the approved boundary of the refuge. Primarily set up to preserve and enhance natural habitat for migratory birds, the refuge will also be recognized as a biological life support system for fish, shell fish and marine life, and as important open space that will support significant recreational use such as huntint, fishing, clamming, nature study and other non-appropriative uses.

7. Tributary streams capable of supporting anadromous fish be returned to a productive state through stream clearance and habitat improvement insofar as possible. Potential exists for increasing the anadromous fishery in the bay and its tributaries. This can only be accomplished by restoring spawning habitat and maintaining or upgrading water quality.

8. A watershed protection and management plan be developed and implemented to reduce the inflow of sediments into the bay. Emphasis should be placed on reducing erosion from logging, road building and land subdivisions. Erosion and sedimentation accelerated by these activities pose a continued threat to the biological resources and cause problems to navigation which result in environmentally damaging and expensive dredging programs. Appropriate watershed protection measures will help to protect resources and reduce need for channel maintenance.

9. The Elk River spit be maintained in public ownership as a park or recreation area and public access be provided. The location of the spit is ideal for public use activities related to the bay. Hiking, picnicking, surfing, photography, fishing, wildlife observation and an excellent view of fishing boats and ocean-going vessels can be provided at this site.

10. A public fishing pier be established along the main channel near Eureka or on the Samoa Spit. The deepwater channel has great potential for sportfishing activities. Unfortunately the public has little opportunity to enjoy these activities because of limited access.

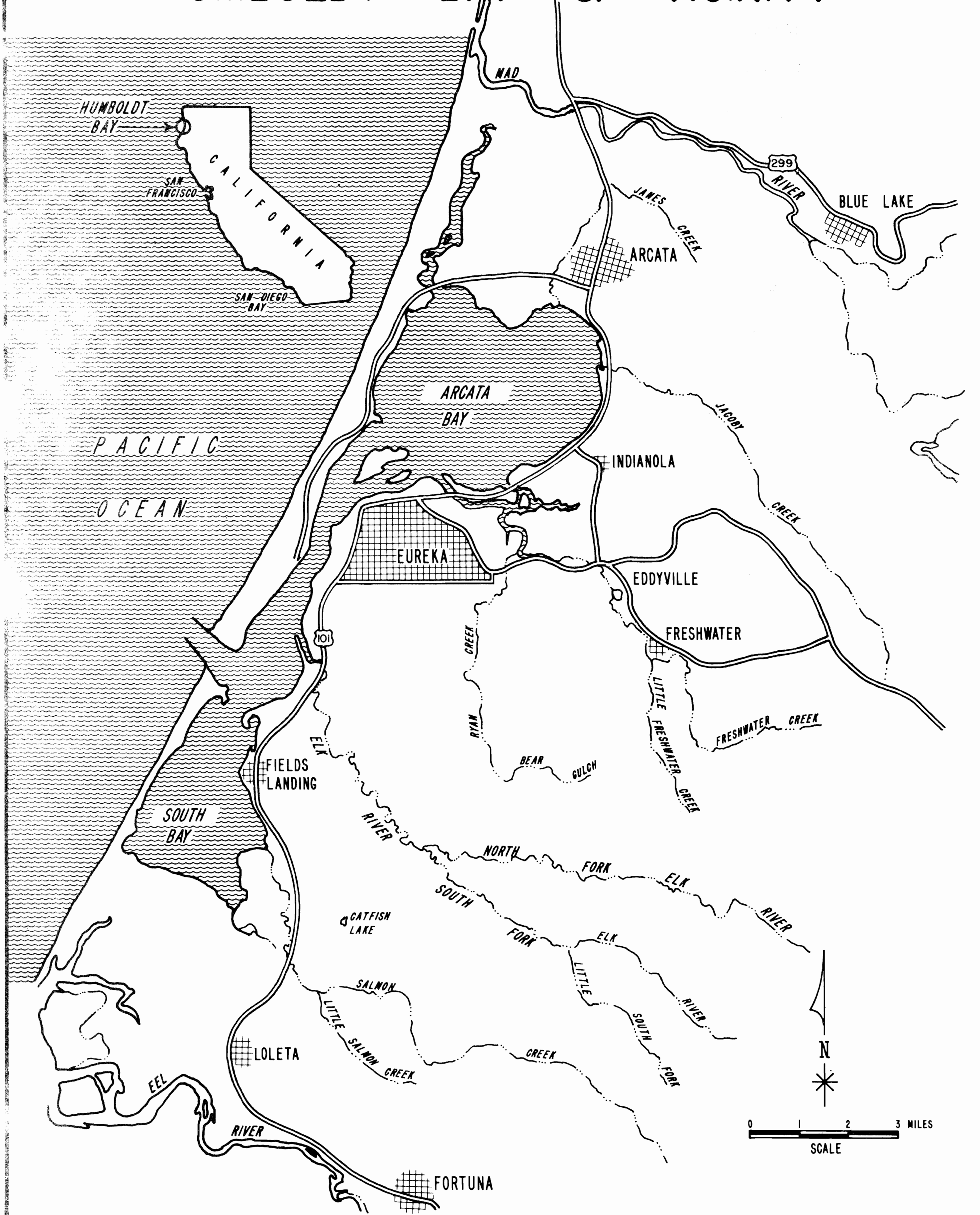
11. Public access along the edge of Arcata Bay via the levee between the Arcata land-fill and Mad River Slough be obtained through easement or acquisition. The opening of this portion of the bayshore would be a major step in providing public access for outdoor recreation. A nature trail for hiking, bicycling and horseback riding, some four miles in length, could be developed at relatively small cost in proportion to the recreational opportunities which could be realized.

12. Legal public access to ocean beaches along the South Spit and Samoa Spit be provided by acquisition or land easement. The demand for beach-oriented recreation is apparent. The availability of approximately 14 miles of highly scenic beach would assure the public suitable access at strategic sites along these spits.

13. Federal, state, county and local authorities continue to work in a cooperative effort to reduce contamination and pollution of Humboldt Bay and raise and maintain the quality of bay waters at optimal levels for growth and beneficial use of fish, wildlife and shellfish. High water quality is essential to the maintenance and utilization of natural resources and aesthetic values. The full potential of the bay for public benefit can only be realized by insuring that waters of the bay are free from contamination.

PLATE 1

HUMBOLDT BAY & VICINITY



THE HUMBOLDT BAY AREA

Description of Area

Humboldt Bay is an estuary located approximately 200 miles north of San Francisco and 90 miles south of the California-Oregon border (Plate 1). It is one of the larger bays on the California Coast and is the only harbor of commercial importance for major shipping between San Francisco and Coos Bay, Oregon. And, it is one of the most valuable coastal wetlands in California in terms of natural resources.

The bay consists of two wide, shallow northern and southern arms connected by a relatively narrow channel. The bay is 14 miles long and 4.5 miles wide at its widest point. The total surface area is approximately 17,000 acres. A deep-water channel located near the north end of South Bay connects the bay to the ocean providing daily interchanges of seawater. The bay contains approximately 130,000 acre feet of water during high tide. About 50% or 65,000 acre feet are exchanged with the sea at each tide change. Mean high tide is 6.30 feet above mean lower low water (MLLW). Mean sea level is 3.39 feet above MLLW. The highest tide recorded is 10.0 feet above MLLW, and the lowest tide reported is 3.0 feet below MLLW (USC76S datum).

Arcata Bay, also called North Bay, is the largest of the two bay segments and covers a surface area of about 8,000 acres. For the most part it is extremely shallow and about 4,500 acres of mud flats are exposed at low tide. The shallow tidelands are interlaced with deeper channels,formed by tributaries and erosion from tidal drainage. South Bay is about 4,600 acres in size and is similar to Arcata Bay in character. Much of it is shallow and about 2,600 acres of mud flats are exposed at low tide.

The connecting channel (Samoa Channel) between the two bays is about 6 miles long and varies from about one-half mile to over one mile in width.

Humboldt Bay is separated from the sea on the west by narrow sand spits. The south spit is very narrow and is typified by low sand dunes with sparse vegetative cover. During extreme high tides and high seas the surf often passes over the low dunes directly into the bay. The north (Samoa) spit also possesses a dune community but is much higher and wider than the south spit. Much of Samoa Spit is developed for industrial and residential purposes.

To the north and east the terrain is composed primarily of lowlands that were formerly marshy extensions of the bay. These lands have been diked and reclaimed and are now devoted to agriculture. The lowlands are intersected by low foothills of the **Coast Range** which extend almost to the bay shore at several locations. To the south the bay is separated from the flood plain of the Eel River by a high bluff which extends from the foothills to the sea.

Two major cities, Eureka and Arcata, and seven smaller communities, are located on or near the bay. The present population is about 70,000, most of which is centered in the Eureka-Arcata areas.

Port facilities for shipping, commmercial fishing vessels, and associated services occupy much of the shoreline on both sides of the channel connecting Arcata and South bays. Several industrial sites also are situated at widely separated locations along the bay shore. The remaining shoreline is primarily devoted to agriculture or is undeveloped.

History

Humboldt Bay was discovered by Captain Jonathan Winship, of the sailing ship "O'Cain," on June 22, 1806. It was first called the Bay of Indians or the Bay of Resanof, but was later renamed Humboldt Bay in honor of Baron Alexander Von Humboldt by members of a party from the ship Laura Virginia in April of 1850. The name is believed to have been chosen by Lieutenant Douglas Ottinger.

Settlement of the area began in the 1850's when the City of Eureka was established. Humboldt Bay became a point of embarkation and supply for the gold mines of Trinity and Siskiyou counties. The lumber industry began in earnest in 1854 when mill owners formed the Humboldt Lumber Manufacturing Company. Shipping facilities were developed to export lumber products and to import the needs of the increasing population. During this period from 1850 until the turn of the century the sea provided the most feasible avenue of transportation and the community revolved about the bay and its shipping. At this time sailing vessels even penetrated Arcata Bay to a point near McDaniel Slough where the City of Arcata maintained a dock. In 1881 the U. S. Army Corps of Engineers began dredging operations to improve and maintain navigational channels and has continued to provide this service since that time.

In 1914 the Northwestern Pacific Railroad reached the Humboldt Bay area and several years later the "Redwood Highway" was completed. These new opportunities for transportation caused a decline in shipping and many of the old facilities including the Arcata docks fell into disuse and eventually disappeared.

During the past 120 years Humboldt Bay has been changed substantially by man, both directly and indirectly. Much of the bay shoreline has been developed for industrial, commercial, agricultural and residential purposes. The bay, including its adjacent salt and brackish water marshes, is believed to have been over 27,000 acres in size before development began. Reclamation projects which began in the 1800's--and are still continuing--have reduced the bay and its estuaries to about 17,000 acres.

Channel dredging for shipping has altered both habitat and water quality. Commercial oyster farming also has altered the existing ecological balance wherever oyster cultures are maintained. Extensive logging and road building in the drainage area of the bay, and subsequent erosion, have resulted in siltation and changes in water quality. The discharge of sewage and industrial wastes has adversely affected water quality and reduced potential recreational uses of the bay and its resources.

Climate

The climate of the area is rainy temperate. The average annual rainfall at Eureka is about 38 inches, most of which comes during the period from November through April. Characteristically, precipitation increases from sea level to higher elevations eastward. In the upper reaches of the Humboldt Bay tributaries the average annual rainfall may exceed 60 inches.

Temperatures range from winter lows of 20°F to summer highs of 85°F. Temperatures below freezing are infrequent. The average annual mean temperature is 52°F. The lack of temperature extremes is indicated by the annual mean high and low of 58°F and 47°F respectively. There is rarely a difference of more than 10 to 20 degrees in the daily temperature range.

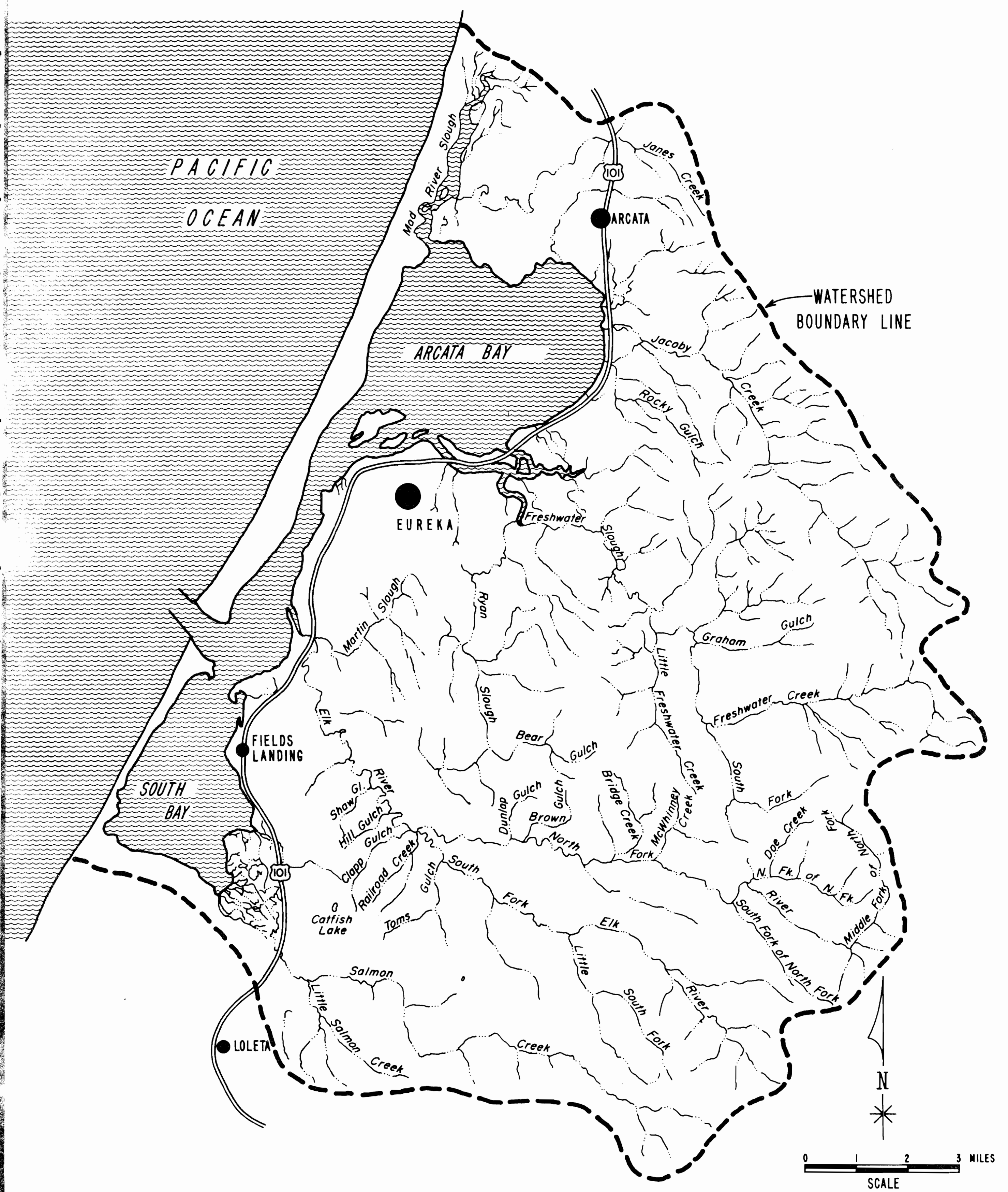
Fog, particularly during the morning and evening hours, is common during the summer months. Prevailing winds are from the north and northwest. During winter months storms from the south may bring winds of gale force (55-75 miles per hour).

Drainage

Humboldt Bay receives runoff waters from a drainage area of approximately 288 square miles (Plate 2). The main tributary streams are: Jacoby Creek, Freshwater Creek, Elk River and Salmon Creek. Many smaller streams also enter the bay directly or by way of one of its tributary sloughs. During flood

PLATE 2

HUMBOLDT BAY WATERSHED



periods overflow water from the Mad River also may enter the bay via the old Mad River Slough. At one time the Mad River flowed into Humboldt Bay but its course changed sometime before 1800. During the 1800's the Mad River was diverted back into Humboldt Bay for use in transporting logs to the mills. Siltation problems occurred and it was later re-diverted to its previous channel where it now passes into the ocean some five miles north of the bay.

Most of the watershed is covered by second growth redwood and Douglas fir. Some of this timber is being re-logged which contributes to the silt load carried by tributary streams. The porous nature of the soils in the region and the natural heavy vegetative cover provide a good medium for absorbing the heavy precipitation which occurs here. Only when natural cover is disturbed through logging, road-building or excessive grazing does siltation become serious.

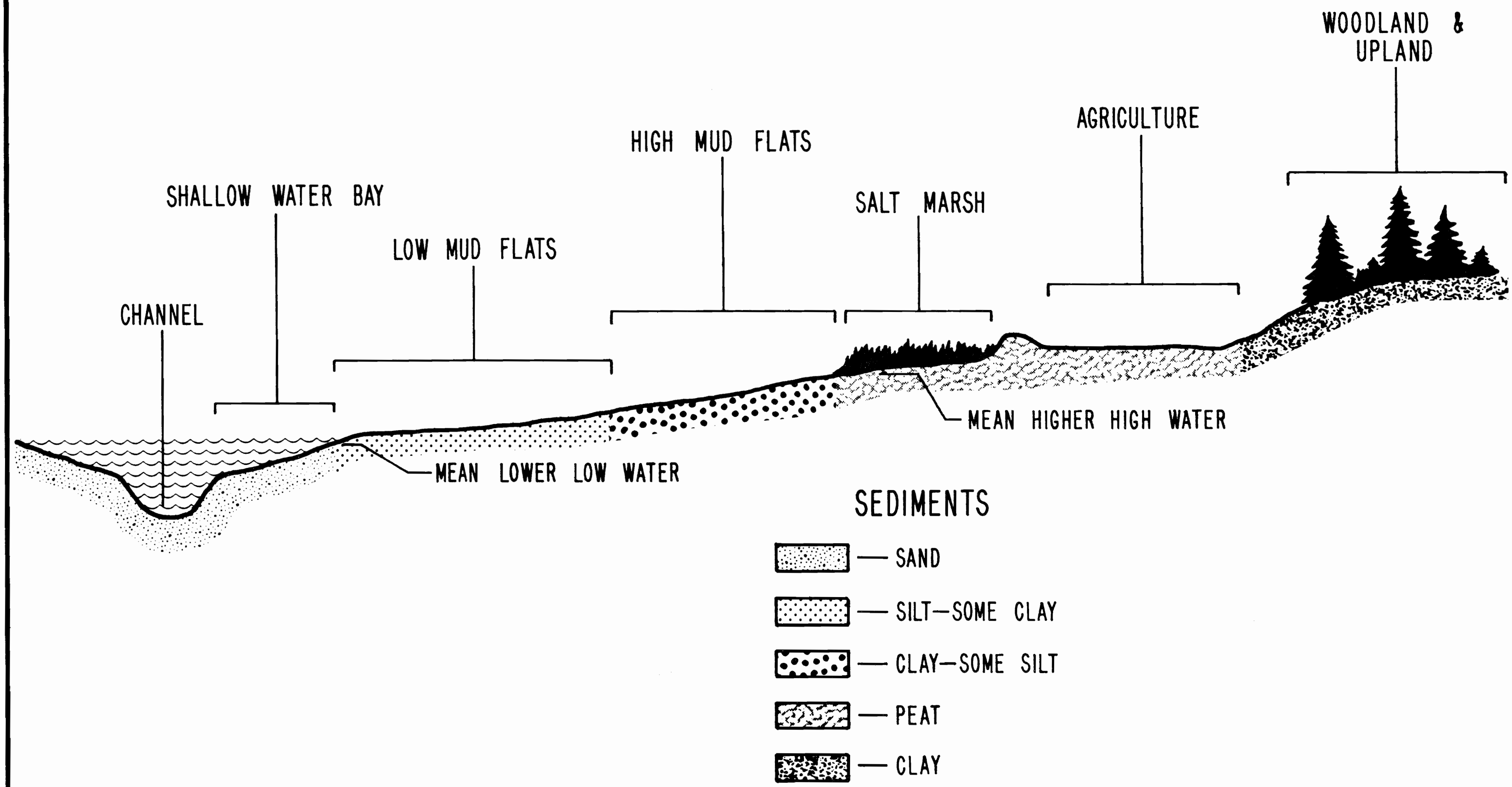
Geology and Soils

The Humboldt Bay drainage lies within the California Coast Ranges and the southwest portion of the Klamath Mountains. Geologically the Coast Ranges are composed of Mesozoic and Cenezoic sediments while the Klamath Ranges are composed of Paleozoic and pre-Paleozoic sedimentary rock. The immediate area of the bay is blanketed with recent alluvium and upper Pleistocene gravels, sands and clays. Older sediments are found to the south, east and north.

Upper Jurassic and Cretaceous Franciscan and Yager formations surround Humboldt Bay. The Jurassic Franciscan consists of graywacke, shale, chert, basalt and shist. The Yager is composed of graywacke, shale and conglomerate. Formations of mudstone and sandstone described as non-marine Pleistocene are also present.

Originally Humboldt Bay was a much larger estuary than it is today. (Ogle, B.A., 1963). During the middle to upper Pleistocene period it is

PLATE 3



HUMBOLDT BAY PROFILE MAP

believed that the Eel, Van Duzen, Elk and Mad Rivers all flowed into a common bay which extended from Centerville to the Mad River Bluffs. Continental and marine sediments were deposited through this area extending further west than the present coastline. A sedimentary deposit more than 400 feet thick described as the Hookton Formation was thus created. Sometime after deposition warpage caused an uplift of this formation which raised Table Bluff and separated the Eel-Van Duzen drainage from Humboldt Bay.

The existing bay was born in more recent geologic time, perhaps 15,000 years ago. The old bay had disappeared and evidence indicates that sea level was about 400 feet below its present level. During this time Mad River, Jacoby Creek, Freshwater Creek, Elk River and Salmon Creek flowed directly into the ocean far seaward of their present position and presumably occupied significant valleys at the present site of the bay.

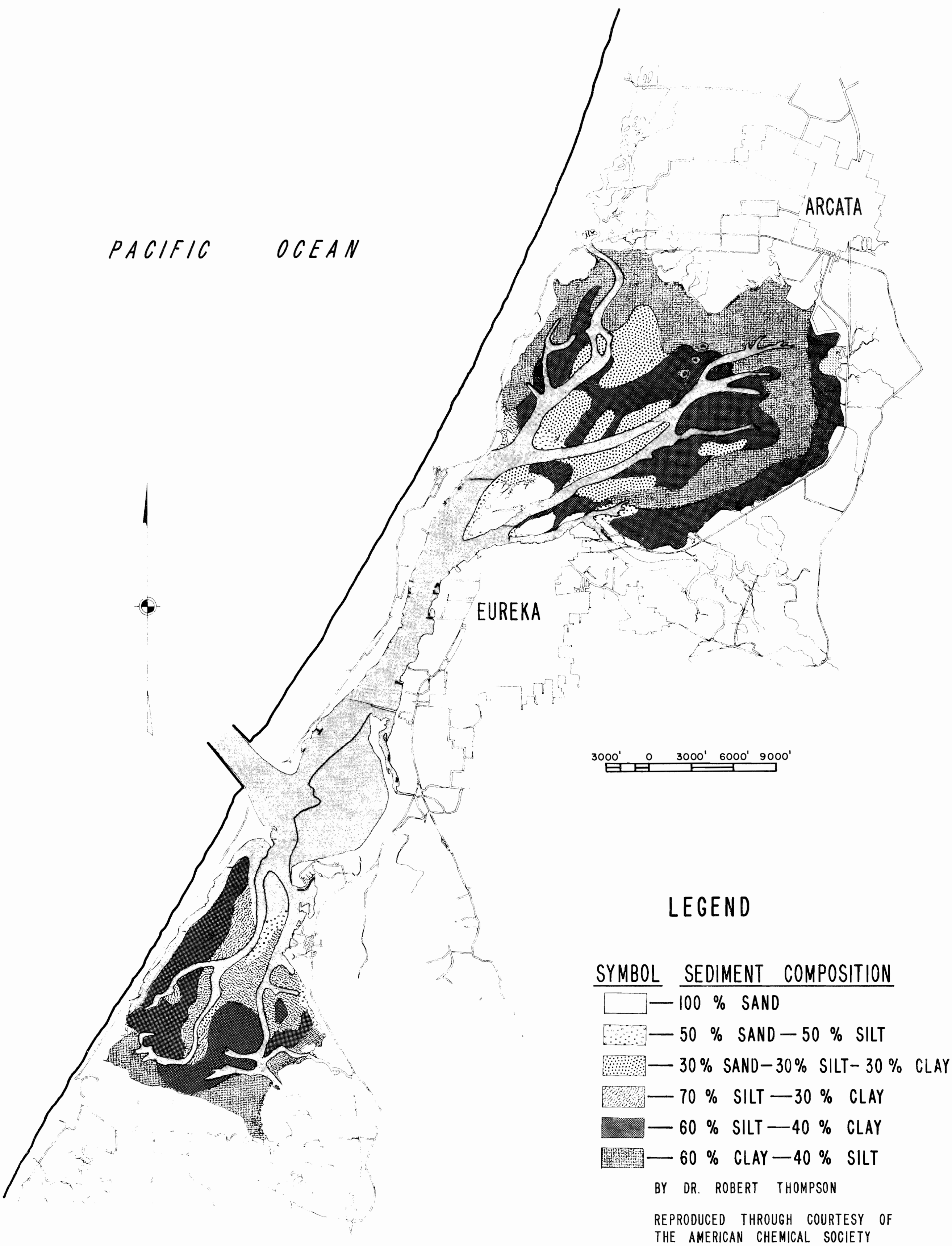
Over the past 15,000 years the sea has steadily risen to reach its present level. As the sea rose it began to flood the former stream valleys to form a series of small individual tidal estuaries extending from the mouth of Mad River to Table Bluff. Once the sea level became somewhat stabilized the coastal streams began to push the shoreline back seaward again by deposition of sediments around their mouths. At the same time sand spits began to form between the headlands at Table Bluff and the mouth of Mad River through the transport and deposition of sand by ocean currents and wave action. The extension of these spits formed a barrier to the sea and the area shoreward was protected from the open ocean waves. The gradual reduction in bay volume by continued deposition of sediment from its tributaries has resulted in the bay's estuarine characteristics.

The bay floor is characterized by three morphologic sub-divisions (Plate 3) described as follows:

1. Tidal channels which are below mean lower low water level (MLLW).

PLATE 4

HUMBOLDT BAY SEDIMENTS



2. Intertidal flats which are from MLLW level to 4-5 feet above MLLW.

3. Salt marshes at mean high water.

The tidal channels average 20-25 feet below MLLW nearer the bay mouth but decrease in depth in the bay's upper reaches to 5-10 feet. Water currents determine the pattern of these channels and also the bottom sediments. Higher water velocities prohibit the settling out and accumulation of mud within the channels so that sand composes most of the sub-strate. Near the inlet and along the main channel, sand is coarse and mixed with shell fragments and gravel. Further up the bay the sand becomes finer and is mixed with some silt and clay.

The intertidal flats are divided into two morphologic units described herein as high and low mud flats, the difference being gradient and sediment composition. The low flats are composed mostly of silt with some sand and clay with a gradient of 0.5/1000 feet or less. In contrast, high flats are primarily clay with some silt and no sand. The gradient is 1/1000 feet. About 70% of the bay is classified as intertidal.

Salt marsh sediments generally are the finest in the bay. The particles are bound together by roots of marsh plants to form peat--basically a deposit containing very high concentrations of plant-derived organic matter.

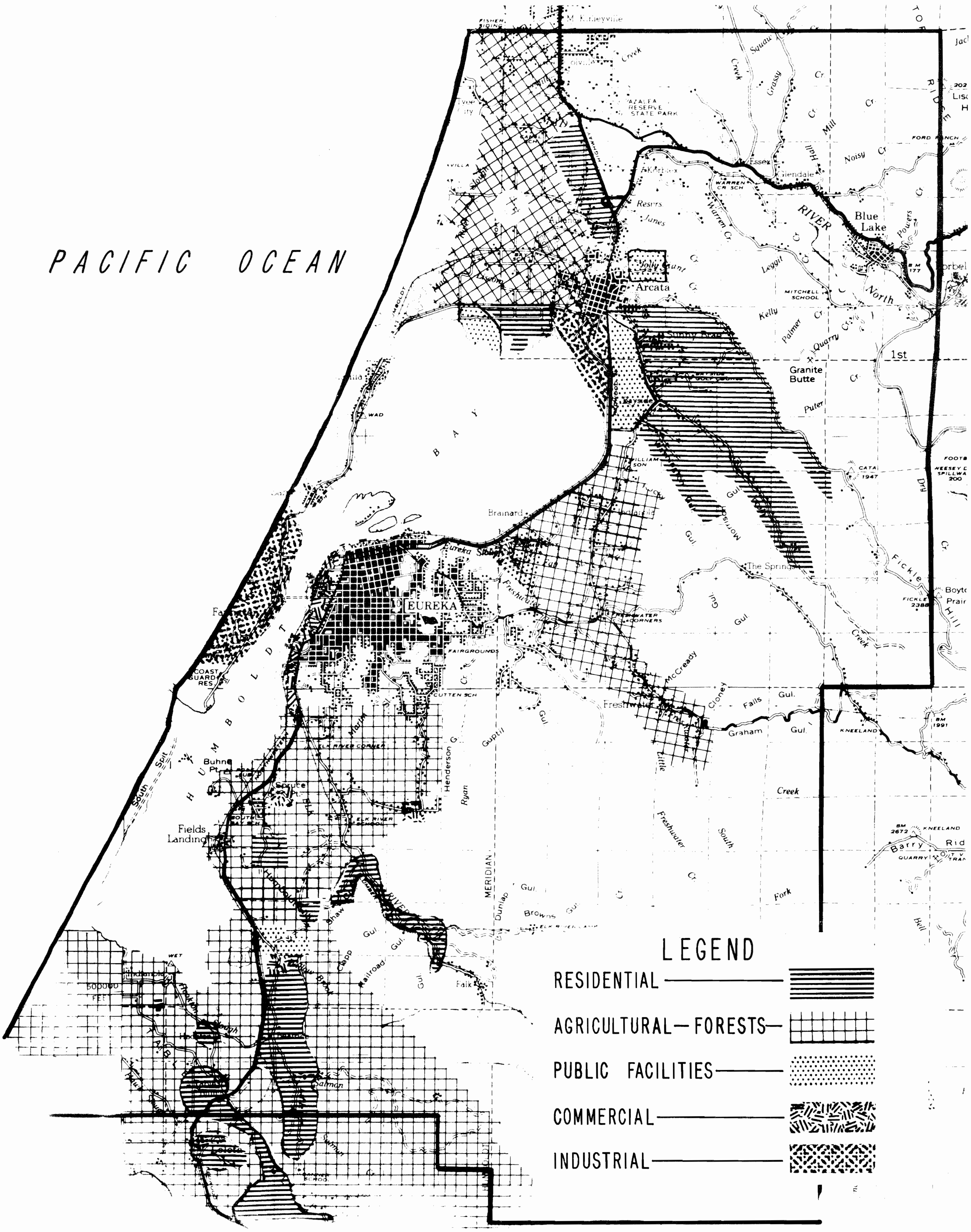
Generally the pattern of sediment distribution is one of decreasing particle size with increasing elevation and distance away from the bay mouth. Sediment types found within the bay have been categorized by percentage of sand, silt and clay (Plate 4).

Land and Water Uses

The land use pattern around Humboldt Bay is quite diversified (Plate 5). At present the area reflects the urban, industrial and commercial sprawl illustrative of unplanned expansion which is typical of many other regions

PLATE 5

GENERAL LAND USE MAP



in California. Even though comprehensive planning has been initiated, plans are often readily altered to accommodate special uses of lands zoned for other purposes.

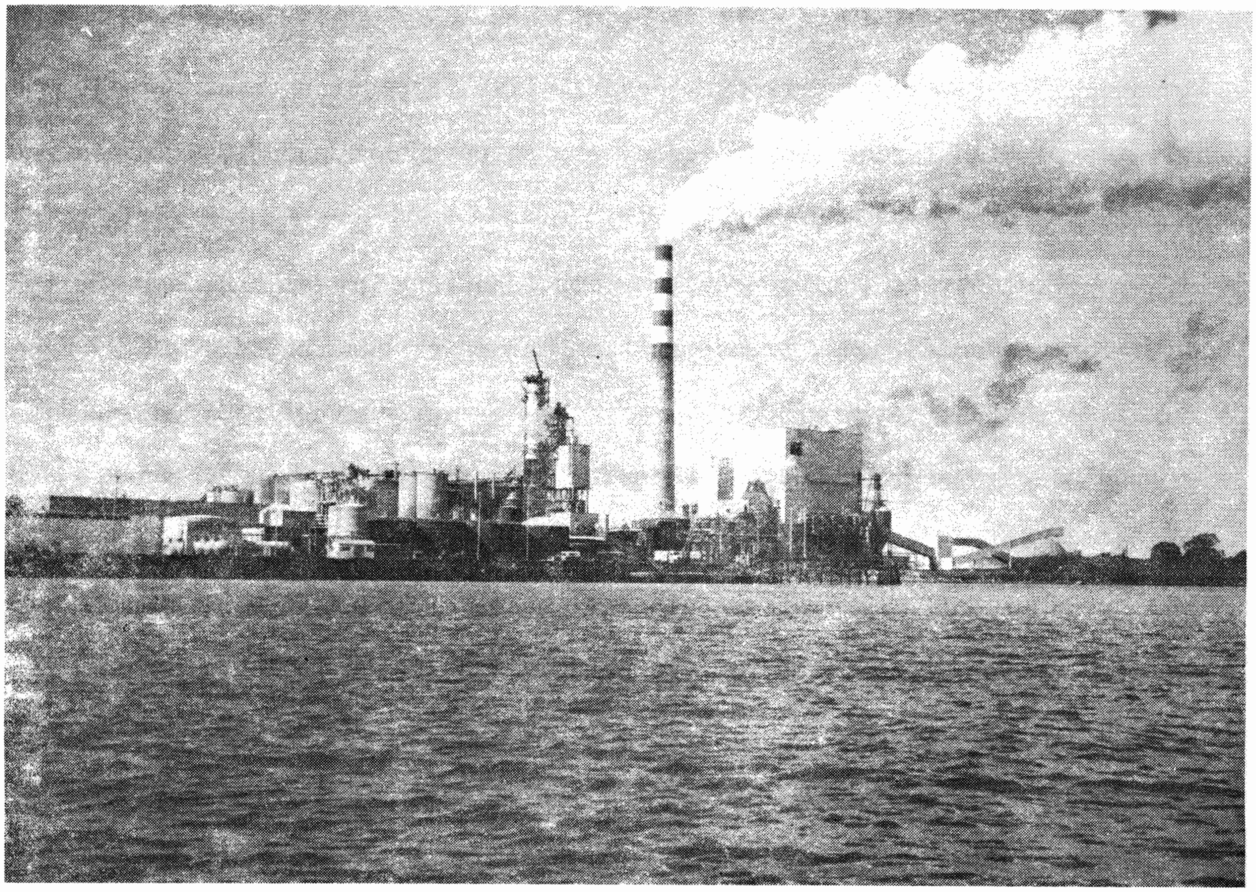
Residential zones generally are located in and around the cities of Eureka and Arcata, and the other communities near the bay. Expansion to outlying areas is occurring at an accelerated pace because of land subdivisions. Although most expansion has been directed towards the foothills east of the bay, housing tracts have encroached on farmlands in the Arcata bottoms and, to a lesser extent, on other agricultural areas.

Lands used for commercial purposes are centered primarily in and around the cities, residential areas and along Highway 101. Many commercial enterprises are associated with the tourist industry. Because of increasing tourism, substantial future development can be expected adjacent to the highway and along the waterfront near Eureka and Arcata.

Humboldt Bay industries are largely oriented towards lumber and other wood products. Lumber mills, pulp mills and related activities are located at widely scattered points. Large industrial complexes are situated on the Samoa Spit and on the west side of the channel between Fields Landing and Eureka. Present local planning is directed towards increasing industrial development.

The shipping industry has expanded to meet increasing coastal and overseas transportation demands for saw logs, lumber and paper pulp. Approximately 1,246,208 tons of cargo were handled in 1968. Docking facilities for ocean-going cargo vessels are located on the Samoa Spit, Fields Landing and the south Eureka waterfront.

Commercial fishing also is an important industry. Harbor and service facilities which serve the local fleet are found at Fields Landing, King



Top Photo: Industrial sites and port facilities occupy much of the shoreline on both sides of the Samoa Channel.

Bottom Photo: Harbor and service facilities serving the local fishing fleet are found at Field Landing, King Salmon and Eureka.

Department of Fish and Game Photos
December, 1969

Salmon and the Eureka waterfront. Several fish processing plants are located on the bay. Fish landed and processed are shipped throughout California and the United States.

Other industries include construction, sand and gravel, and service companies for communications, transportation and power generation.

Livestock and dairy products are the major agricultural commodities. Some row crops are grown but the majority of agricultural land is devoted to grazing for dairy stock, beef cattle and sheep.

An example of the relative value of the major industries of Humboldt County (Greater Eureka Chamber of Commerce, 1964) is as follows:

Table 1

Industry	Value	Percent of Economy
Forest Products	$159,831,130	73.30%
Tourism	30,000,000	13.76%
Agriculture	12,747,115	5.84%
Commercial Fishing	12,000,000	5.50%

Acreages and classification of general land use in the bay area are as follows:

Table 2

Land Use Classification

Classification	Approximate Acreage
Residential	21,000
Commercial	2,000
Industrial	4,400
Public and Recreation	10,400
Agriculture-Forest	146,520
Total area in drainage	184,320

Land Ownership

The ownership pattern in and around Humboldt Bay is very complex (Plate 6). This is particularly true in the tidelands area where ownership boundaries are not well defined and are often contested between claimants. According to the State Lands Division many of the parcels within the bay which are listed and taxed by the county as privately owned are also claimed by the State as unconveyed sovereign lands. Until such time as the State conducts detailed surveys of land ownership in the bay, many of these contested boundaries will remain unresolved.

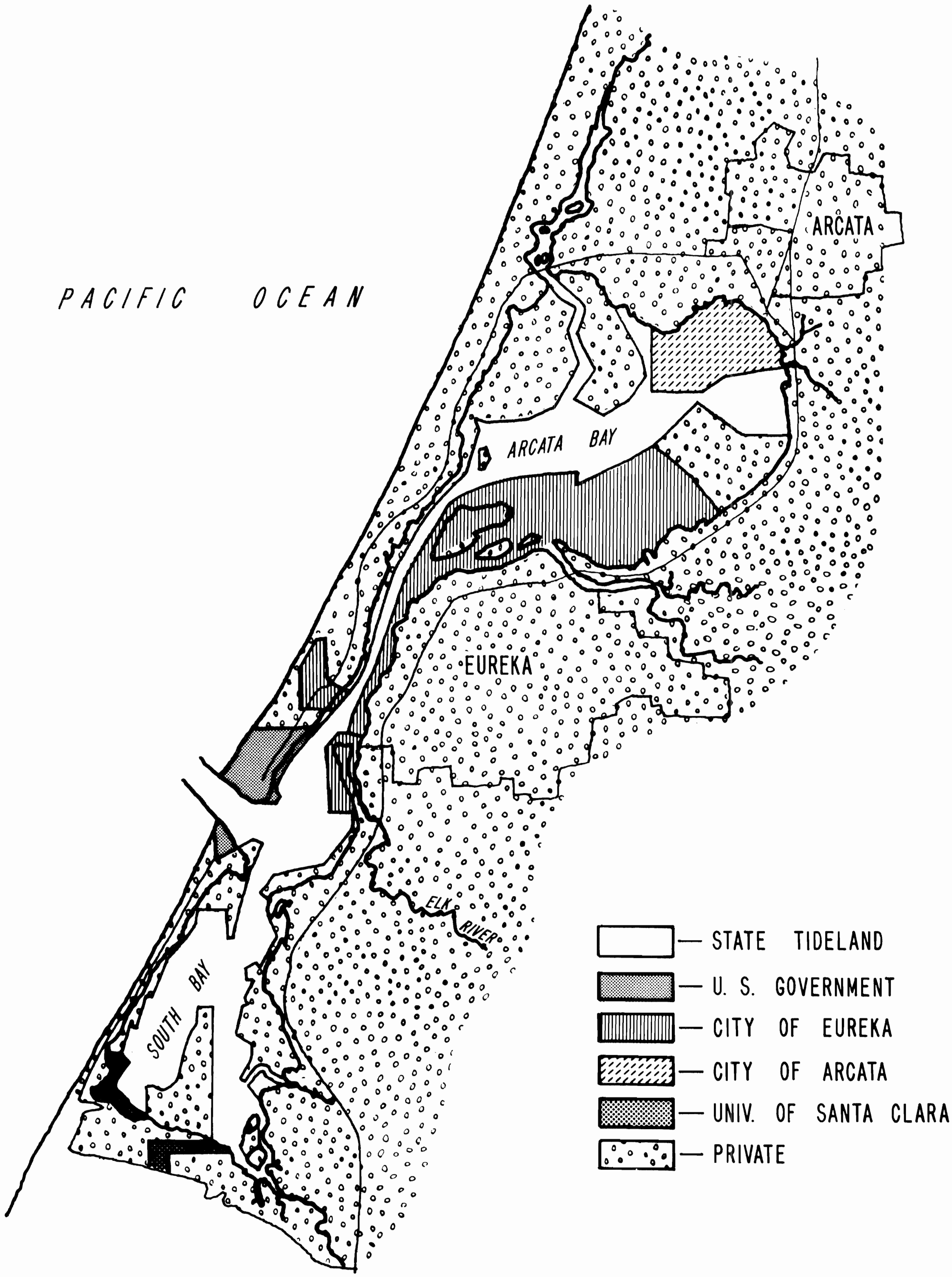
Humboldt Bay has a shoreline of approximately 40 miles, of which less than three miles are in public ownership. Public lands are, for the most part, owned either by the U. S. Coast Guard or the cities of Eureka and Arcata and are closed to general public use. A small parcel located on the north spit is owned by the State and is maintained as a boat launching site for public recreation. Public boat launching facilities also are located at the City of Eureka ramp at the Eureka Boat Basin and at Fields Landing, a county operation. Public use of access along the remaining shoreline of the bay is at the discretion of the landowner.

There are 207 separate parcels of land located on the shore of Humboldt Bay which are in private ownership. These parcels range from lot size to large tracts involving several hundred acres. Most of these lands are closed to public use.

Approximately one-third of the land within Humboldt Bay itself is in private ownership according to county records, although, as previously stated, the validity of some of these ownerships is questionable. This private bay land is composed of 52 parcels totalling over 5,000 acres. Parcels range from a few acres to several hundred acres in size.

PLATE 6

HUMBOLDT BAY LAND OWNERSHIP



The City of Eureka controls approximately 3,260 acres of granted state tidelands extending from Bucksport to a point two miles north of Eureka Slough. The City of Arcata has a state tideland grant of about 1,380 acres located in the northeastern corner of Arcata Bay. The remaining land and water area, totalling 11,400 acres, is in State ownership as ungranted tide and submerged lands administered by the State Lands Division.

Water Quality Characteristics

Chemical and Physical Quality

There have been few studies designed to characterize the chemical and physical properties of Humboldt Bay waters. Information concerning some of the important factors such as dissolved oxygen, temperature and salinity has been gathered incidential to other studies and these data are few, scattered and difficult to relate to an overall characterization. Exceptions include extensive temperature data collected by the Coast Oyster Company at various oyster bed locations and the extensive oceanographic survey of the bay conducted by Humboldt State College Department of Oceanography in 1961-62 (Skeesick, Humboldt State Library). Because of the systematic manner in which the data were collected, the results of the Humboldt State College study represents the best characterization of salinity, temperature and dissolved oxygen of bay waters available at this time.

The survey, conducted between September, 1961 and September, 1962, revealed that natural characteristics of water in the bay are quite variable, undergoing changes in both time and space. The pattern of the qualitative characteristics analysed indicated that they were affected by three independent, variable factors: (1) climatic conditions; (2) distance from the entrance channel, and (3) quality of ocean water entering the bay.

The distribution of salinity in Humboldt Bay varies with the season, with the distance from the entrance channel, and with the quality of the water entering on the incoming tide. In general, relatively high salinities approaching open sea water conditions [aximum of 34.27 parts per thousand (ppt)] occur during the summer and fall months with lower (minimum 28.35 ppt), more variable salinities occurring during the winter and spring, the latter values being influenced by dilution of storm runoff waters.

Bay water temperatures are influenced by the temperature of incoming sea water, the distance from the entrance channel and air temperatures. Water temperatures display the least variability near the bay entrance and are most variable at the point farthest removed from the entrance. In 1961-62, the lowest recorded water temperature was 7.08°C (44.7 F) in January and the highest was 14.51°C (58.1 F) in April.

The distribution of dissolved oxygen values in the bay is related to the oxygen concentration in the incoming water and the mixing process as the water moves away from the entrance channel. The greatest variation and lowest values were usually found nearest the entrance. The lowest dissolved oxygen value at the bay entrance was 5.2 milligrams per liter (mg/l) in September and the highest dissolved oxygen value at this location was 11.0 mg/l in August.

<u>Sanitary Quality</u>

A characterization of the quality of Humboldt Bay waters would not be complete without taking into account its bacteriological content. In sharp contrast with the relative lack of physical and chemical data, the bacteriological aspects of Humboldt Bay waters have been studied extensively. Since 1953 the State Department of Public Health has conducted over 30 water quality investigations (Gannon, 1966). These studies have been carried out in accordance with statutory responsibilities related to sewage and waste disposal and the sanitary control of shellfish. The primary object of these studies is to determine density and distribution of sewage-born bacteria as they relate to recreational uses and shellfish culture of Humboldt Bay. For these purposes, the coliform group of bacteria is used as an indicator since one of the principal habitats of this group of organisms is the intestinal tract of man. It is estimated that each person contributes about one hundred and sixty billion coliforms to municipal sewer systems each day. Therefore, when tests are properly executed and evaluated, the coliforms serve as a sensitive biological indicator of the sanitary quality of water. Unfortunately, the coliform indicator group organisms also include bacteria not related to sewage sources. Such bacteria originate from the intestinal tracts of waterfowl, livestock and from the soil.

In general, the highest coliform densities occur during winter months. These densities are related to heavy rains which cause community sewer systems to become overloaded and surcharged with infiltration and storm water. Consequently, each winter poorly disinfected sewage overflows into tributary streams and into the bay during and following heavy storms. Winter storms also saturate the soil with rain, and runoff causes failure and overflow of septic tank systems. Furthermore, it is during periods of heavy rainfall that the greatest number of animal-borne and soil-nurtured coliforms enter the bay.

NATURAL RESOURCES

Habitat Inventory

The Humboldt bay area, or zone of bay influence, excluding foothills and forest lands of the upper drainage, encompasses approximately 37,240 acres (Plate 7). Of that total, 8,775 acres are intensively developed for industrial, commercial and residential use; hence, their value, insofar as fish and wildlife are concerned, has been seriously impaired. The remaining 28,465 acres are important to fish and wildlife to a greater or lesser degree and contain many different habitat types, which are classified as follows: agricultural lands, uplands, woodlands, sand dunes, freshwater marsh, salt marsh, intertidal flats, shallow water bays, tidal channels, deep water channels and jetties and reefs (Plate 7). The foothill areas and upper portions of the bay drainage not included in these habitat categories are primarily fir and redwood forests. Habitat acreages are summarized as follows:

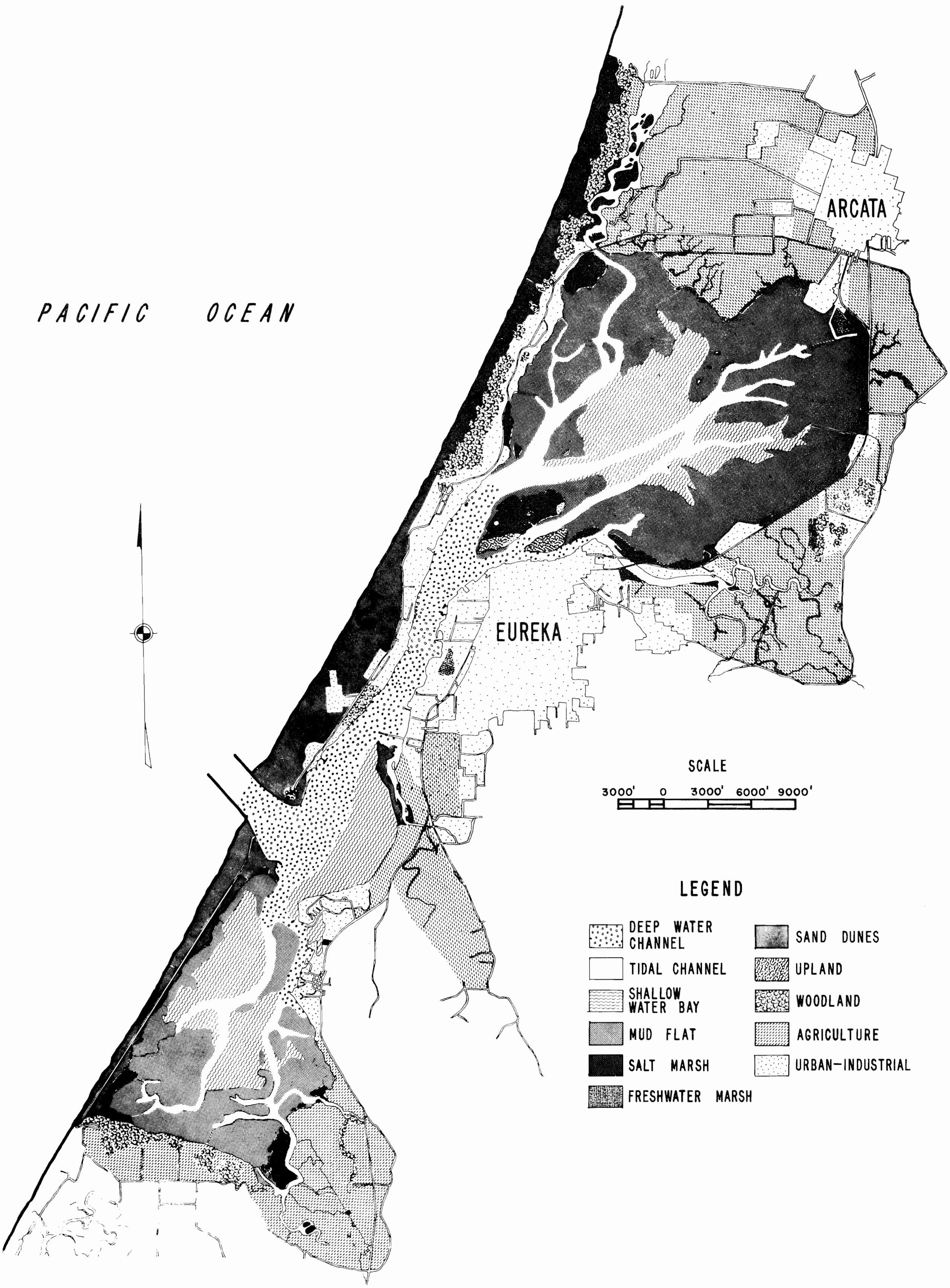
Table 3

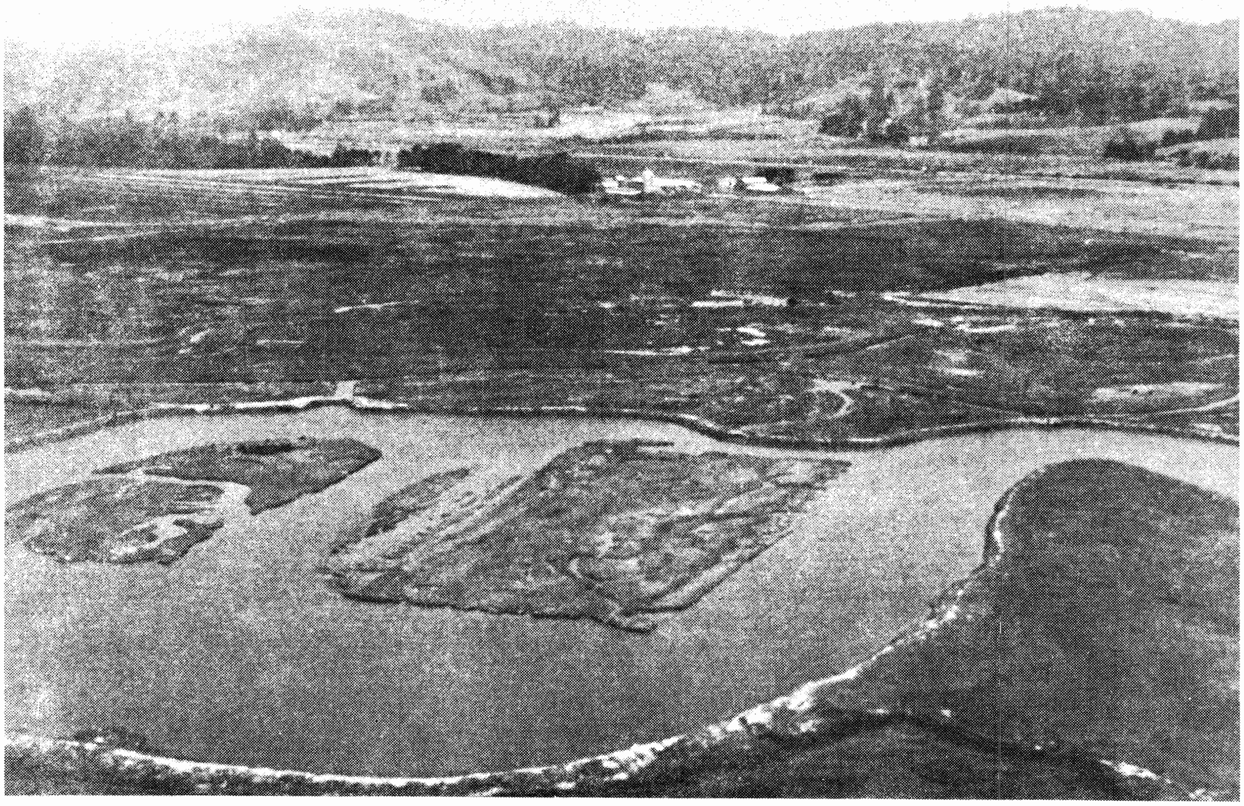
Habitat Acreage - Bay Influence Zone

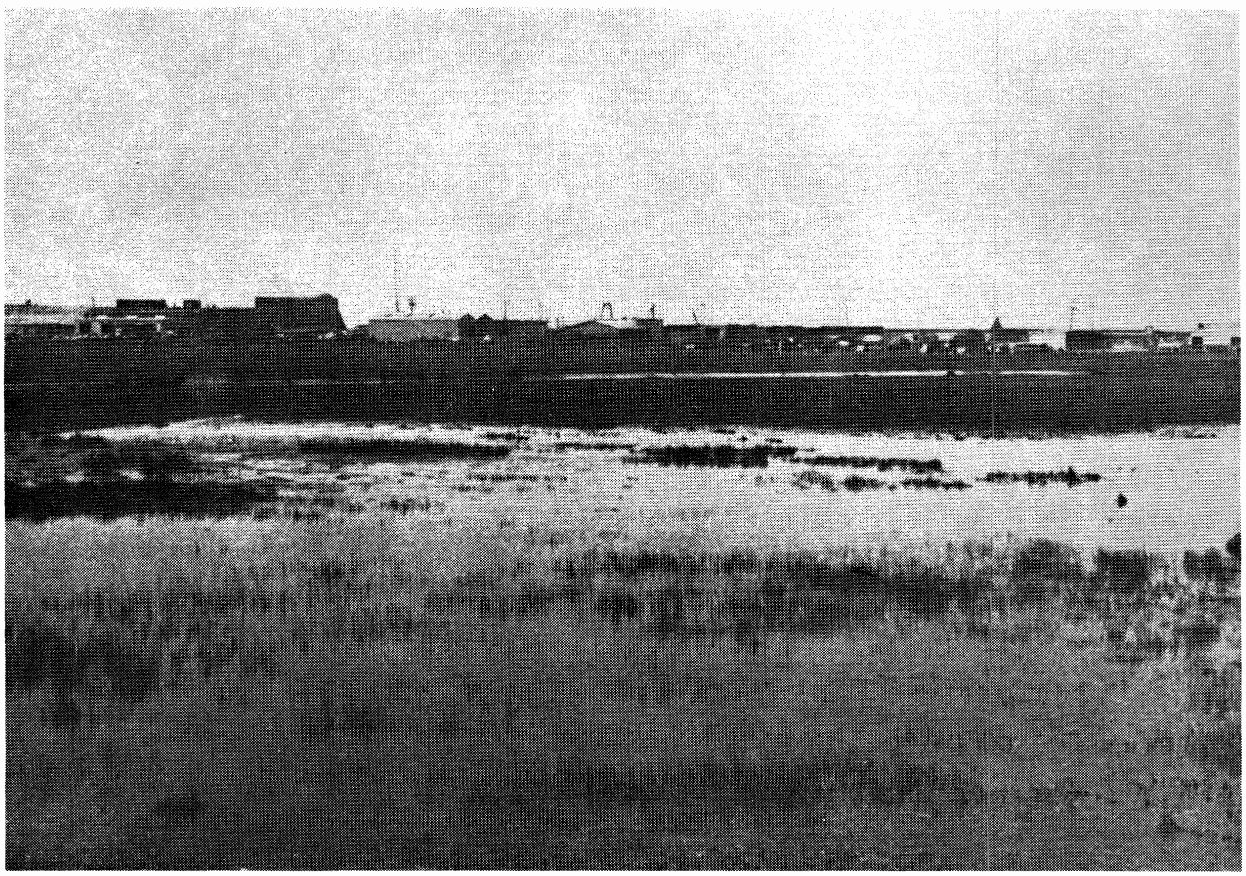
Type	Acres
Agriculture	6,670
Woodland	1,160
Upland	250
Sand Dunes	3,520
Freshwater Marsh	40
Salt Marsh	600
Shallow Water Bays	6,000
Deep Water Channels	2,000
Tidal Channels	1,000
Intertidal Flats	7,200
Jetties and Reefs	25
Urban and Industrial	8,775

PLATE 7

HUMBOLDT BAY HABITAT TYPES







Top Photo: Agricultural and undeveloped lands such as Beatrice Flats and the pasture land below Table Bluff should be protected and preserved for wildlife.

Bottom Photo: Seasonal flooding of agricultural and undeveloped bay area lands creates attractive habitat for thousands of water associated birds.

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Agricultural Lands

The total area of agricultural lands within the zone of bay influence is approximately 6,665 acres. Most of this land occurs where alluvial deposits have been formed by tributaries to the bay. Other habitat types can be found associated with the agricultural lands, occurring as islands within, or as fringe, along the edge of such areas.

The primary agricultural use is livestock grazing. During high use periods as many as 15,000 head of livestock, primarily cattle, are grazed within the area. About 15 percent of Humboldt County milk production is from around the bay. Other uses of livestock are for beef, mutton, wool and hides.

Row crops have been increasing during the past several years. Approximately 400 acres of potatoes, 300 acres of sileage, 100-500 acres of barley or oats and occasionally small plots of carrots, beans, cucumbers, squash, and cabbage are grown annually on the higher ground. Approximately 60 acres of cut flowers and bulbs also are produced; but land use for this purpose appears to be declining.

Most of these agricultural lands were formerly extensions of estuarine areas and were, before reclamation, salt and brackish water marshes. The lands are now protected from salt water infusion by a series of dikes. Because the land surface is near and sometimes below sea level, these lands are periodically subjected to flooding during the rainy season.

The Arcata bottom lands are mostly pastures separated only by narrow sloughs. This is the largest tract of unbroken agricultural land in the bay area and totals approximately 2,000 acres.

The pasture land between Arcata and Eureka is more broken and separated by groves of trees, patches of brush, and by houses and utility buildings. There are numerous small waterways, backwaters and sloughs in this area.

This strip of agricultural land, located between U. S. Highway 101 and the forested hillside, totals 2,600 acres.

The Elk River drainage enters the bay between Eureka and King Salmon. Near the Highway 101 overcrossing the stream becomes a tidal estuary. There are numerous small groves of alder and brush patches with the pastures extending slightly up onto the hillside. Approximately 865 acres of farm land are situated along this tributary.

Historically, most of Beatrice Flats and the pasture below Table Bluff at the south end of Humboldt Bay were salt marsh and now are maintained by dikes which confine bay waters into several narrow sloughs. Where some of these dikes have broken the land is returning to salt marsh. Agricultural land in this area totals 1,200 acres. Stands of eucalyptus have been planted on the low lands. Brushlands occur on the hillsides, and groves of redwood, Douglas fir, Sitka spruce and cypress are found on the high ground.

Since the soils and climate of the pasture land do not differ markedly there is little apparent variety in the vegetation. The vegetation found in the pasture lands within the area generally varies only in the frequency and dominance of individual plant species. The common plants[1/] are Salina clover, ladino clover, red clover, orchardgrass, ryegrass, velvetgrass, bentgrass, water foxtail, water buttercup, water celery, poison hemlock, carex sedge, quackgrass and silverweed. The clovers are generally more common in the Arcata Bay area while the sedges, buttercup and silverweed are more common in the vicinity of South Bay.

Woodlands

Prior to the settlement of Humboldt Bay, woodland habitat covered most of the hillsides and plains down to the edges of the marshland. Woodlands were

1/ A check list of common and scientific names of Humboldt Bay plants is appended (Appendix A).

cleared for building sites and to provide lumber. At present, remnants of the original woodland stands are found only in small isolated groves. A notable exception is found on the north spit where a strip of woodland occurs immediately adjoining the ocean beach and dune areas.

There are two types of woodland found in the Humboldt Bay area, lowland riparian habitats associated with streamside locations and woodlands found on higher ground with better drainage. The riparian habitats are generally more dense and impenetrable in aspect and support a somewhat different fauna than do the upland woodlands.

Riparian woodlands are typified by willow, alder, black cottonwood, blackberry, salmon berry and Himalaya berry. This type of habitat is found along most of the permanent freshwater streams and sloughs and on low ground with poor drainage where grazing is restricted. Riparian woodland is most common in the lowlands east of Arcata Bay, the Elk River drainage at the southern edge of Beatrice Flat and along the bayshore of the north spit, covering a total area of approximately 140 acres.

Other woodlands, which cover approximately 1,020 acres, are located on the Samoa spit, along the east shore of South Bay, and on Table Bluff and are comprised of combinations of beach pine, Sitka spruce, Monterey cypress, lowland fir, Douglas fir, redwood, and the plants of the riparian and upland habitats.

Uplands

The upland habitat type is relatively uncommon in the bay area, occurring in small disassociated acreages. Common upland plants are wild blackberry, willow, red alder, bayberry, black twin-berry, coyote brush, silktassel and Indian-plum. In most cases it is a combination of riparian and upland habitat that provides food and cover for populations of small mammals and many species of bird life.

On the higher ground of Indian Island, Woodley Island, Beatrice Flat, areas of Elk River Valley, near waterways and sloughs, and at the edges of pastures east of Arcata Bay, upland habitat occurs in small plots. These areas are visible as areas of darker vegetation among the pasture lands and adjacent to woodlands. Commonly the vegetation is blackberry and coyote brush with other less common and less noticeable plants among them.

Together with the ungrazed grasslands and dikes, brushlands constitute the upland habitat. In its many forms varying amounts of this habitat are found throughout the bay area, totalling about 250 acres.

Sand Dunes

The sand dunes extend along the entire ocean beach, cover most of the south spit, a large part of the Samoa Spit and areas near King Salmon and the mouth of Elk River. Plant cover is quite variable but consists primarily of European dunegrass, beach strawberry, bush lupine, dune tansey and sand verbena. A number of other small grasses and forbs are found on all but the most unstable parts of these dunes.

On the north jetty the woodland and upland type habitats form an ecotone with the sand dunes. In these areas such plants as beach pine, silk tassel and blackberry are common.

The acreage of sand dune habitat totals 3,520. It is one of the more noticeable habitat types and is one of the most valuable for upland game species.

Freshwater Marsh

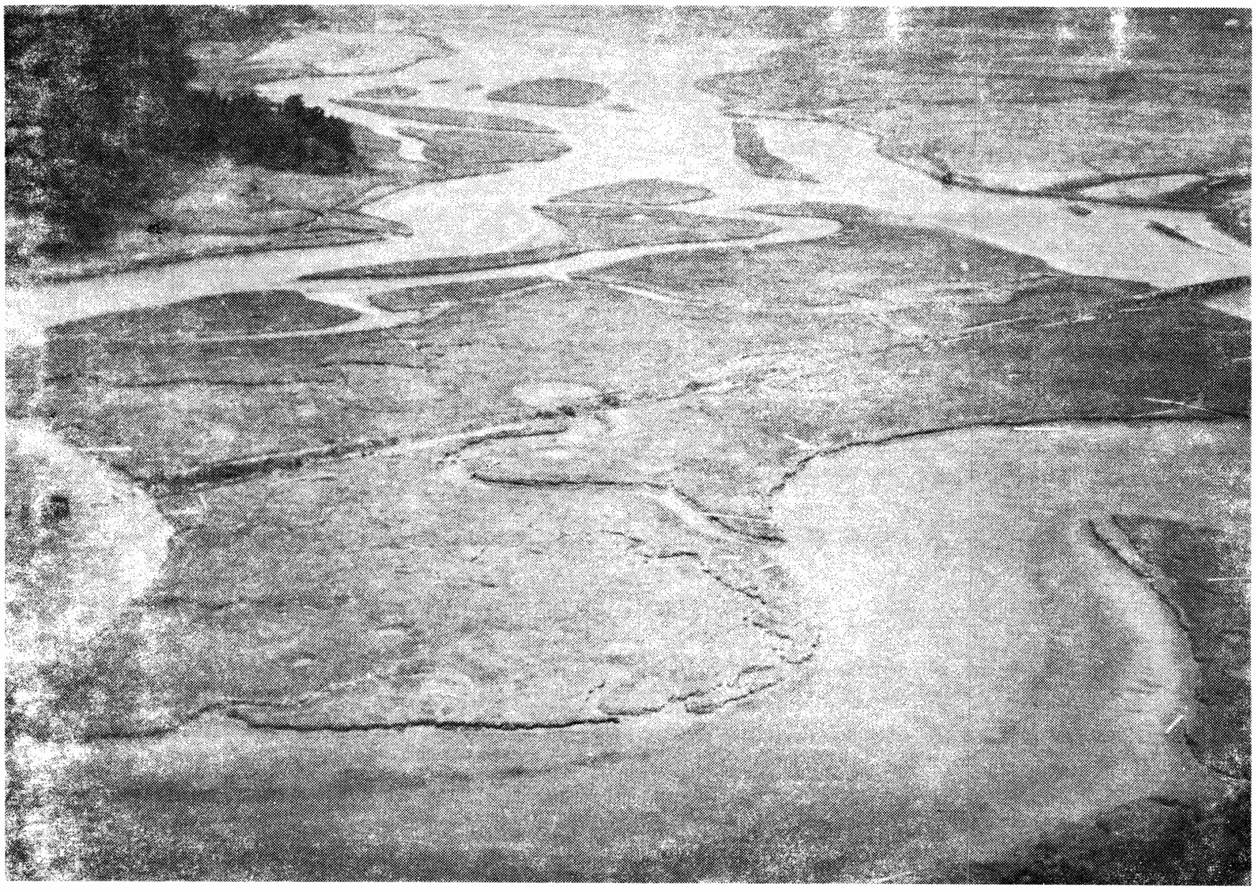
The flat pasture lands surrounding the bay are interlaced with shallow drainage ditches and borrow pits, which together with meandering courses of the various streams flowing into the bay create a myriad of freshwater marsh habitats. During the relatively dry summer months this habitat type is confined to the limits of the stream banks; however, with the arrival of winter rains the waters extend out over the lowlands and create additional areas of freshwater marsh.

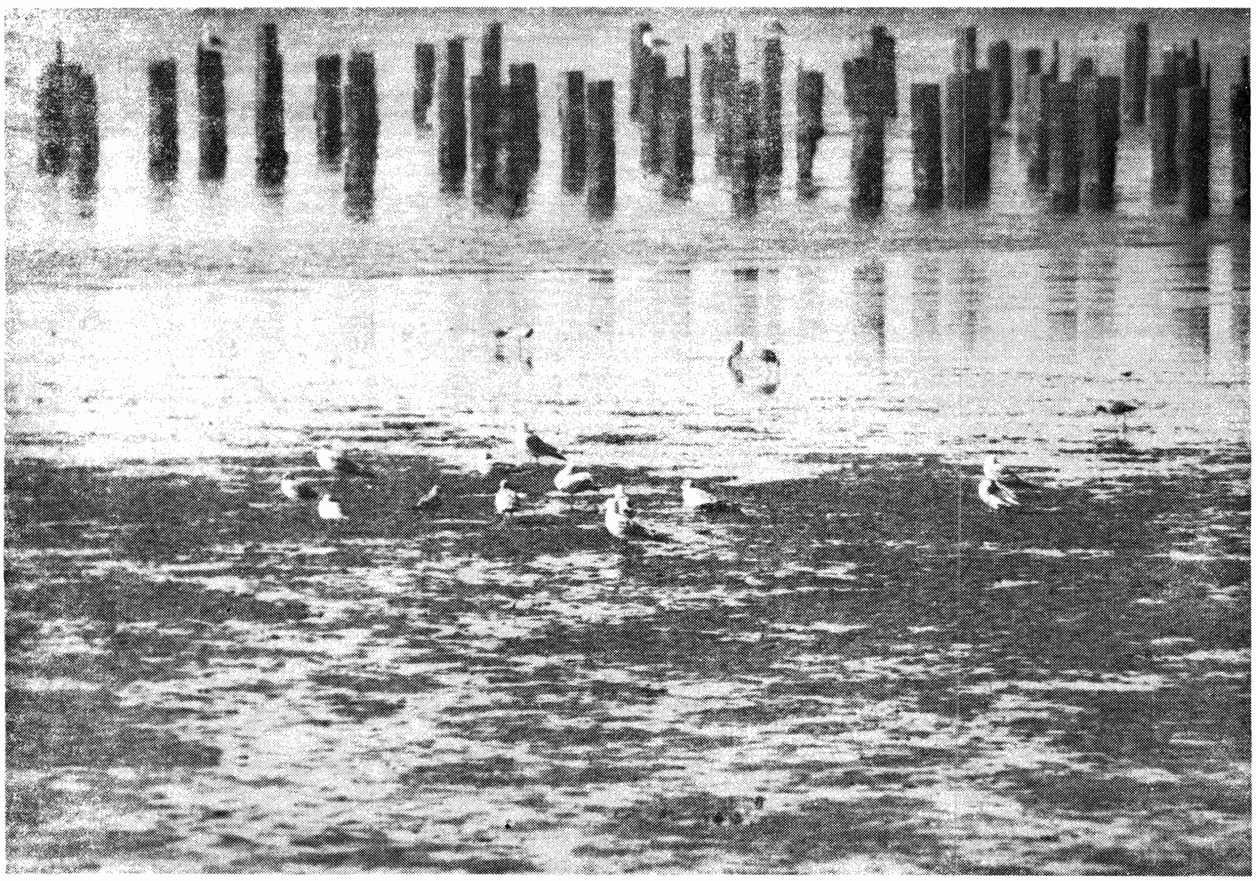
Plants common in the freshwater marshes of Humboldt Bay are creeping spikerush, bulrush, sago pondweed, widgeon grass, water naiad, arrow grass, and saltgrass. Humboldt Bay marshes are generally highly productive of wildlife food and possess a wide variety of plant species. The seasonal freshwater marshlands are primarily flooded pasture lands that support plant species typical of most low lying pastures in Humboldt County.

Permanent freshwater marshes are found at the southeast end of the bay in the Salmon Creek and Elk River drainages extending into the area known as Beatrice Flat; between the cities of Eureka and Arcata in the flats east of the bay; and in the bottomlands to the north of the bay extending northward nearly to the Mad River and along the Mad River Slough. There are small ponds near the north end of the south spit, at the south end of the Samoa Spit, and near Buhne Point on the east edge of the bay. These ponds are each about one acre when full.

There are ponds throughout the agricultural land which are flooded seasonally at the discretion of the landowners. The location of these ponds varies according to the location of check dams constructed by the landowners and the dams are frequently washed out by flood conditions in mid-winter.

The permanent and semi-permanent freshwater marshes total approximately 40 acres. The fact that this habitat is well distributed throughout the area greatly enhances its value and creates the impression of abundance. The seasonal freshwater marsh, dependent on rainfall and stream flows, may increase the freshwater marsh total by approximately 400 acres during the winter months.





Top Photo: Salt marsh such as that along Mad River Slough is critical habitat for many Humboldt Bay area wildlife.

Bottom Photo: Intertidal mudflats are probably the most important habitat type in the bay area.

Department of Fish and Game Photos
December, 1969

Salt Marsh

The salt marsh habitat type occurs only in remnant stands along the perimeter of the bay, in tidal tributaries and on islands within the bay. The dominant plant cover is composed primarily of cordgrass, pickleweed, and saltgrass. Other plants common in this community are marsh rosemary, gum plant arrow grass, salt rush and jaumea.

The original salt marsh, prior to the period of land reclamation, is estimated at 7,000 acres. Most of the present agricultural lands in the Arcata Bottoms, Jacoby Creek, Eureka Slough, Elk River and Beatrice Flats areas were salt marsh before that time. The loss of this habitat type is continuing at an alarming rate. The total salt marsh remaining is estimated at 600 acres.

The largest single tract of salt marsh is on Indian Island, which lies north and west of the city of Eureka and contains 200 acres of habitat. A smaller salt marsh of about 10 acres known as Daby Island lies between Indian Island and Eureka Slough.

The 70 acre Eureka Slough marsh extends from the mouth of Eureka Slough north to the Arcata Redwood Mill along the east side of Arcata Bay.

The Jacoby Creek salt marsh also lies along the east shore of Arcata Bay. It extends from Brainards Cut north to the Arcata oxidation pond and covers about 25 acres.

Mad River Slough contains a number of small salt marsh islands ranging from less than 1 to 50 acres. In combination, these islands and the marsh areas along the edge of the slough are approximately 100 acres.

Adjacent to the mouth of Mad River Slough there is a salt marsh of about 35 acres. This area was diked at one time but erosion and tidal action have broken down the old levees allowing salt water intrusion. The marsh, although recovering, still shows the scars of past activities by man. Small, isolated patches of salt marsh, generally less than an acre, are found in other areas along the perimeter of Arcata Bay. The combined size of these isolated patches is less than 100 acres.

In South Bay, salt marsh habitat types are confined to small islets or narrow edge cover along the shoreline and tributary sloughs. They total approximately 100 acres.

Shallow Water Bays

Approximately 6,000 acres are classified as shallow water bay. This habitat type is most common in Arcata and South bays. Although these areas are shallow the bottom is rarely, if ever, completely exposed at low tide, thus separating them from the adjacent mud flats as a distinct habitat type.

It is the shallow water bays that produce the vast majority of eel grass, which is so important to black brant and other waterfowl species (Plate 8). Eel grass growth in these areas, except where oyster culture has disturbed it, is so dense that boat passage through the beds is extremely difficult.

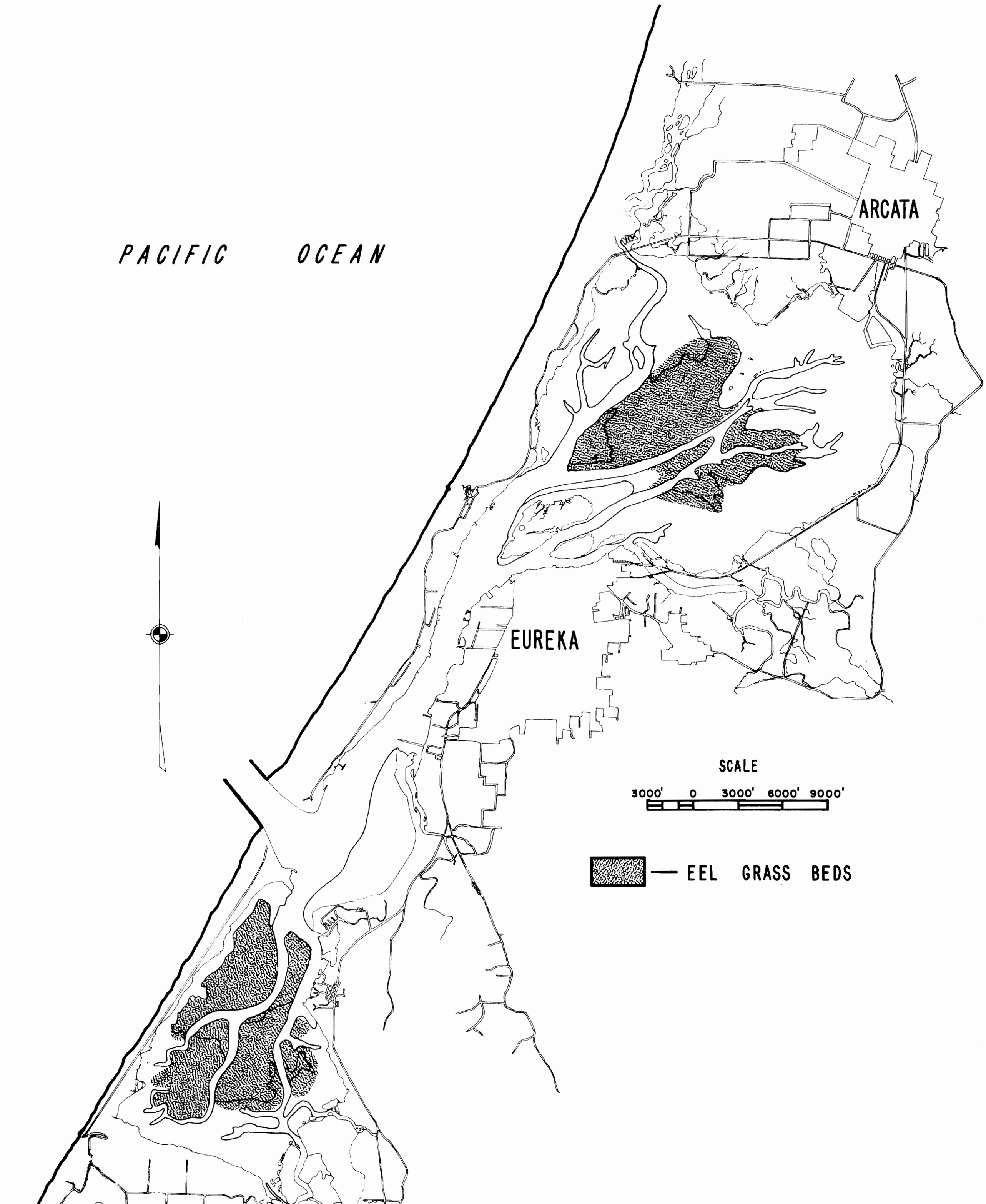
Deep Water Channels

Deep water channels are defined as those areas of the bay that are maintained for shipping and other commercial uses. The depths may vary from 5 to 30 feet below mean lower low water levels. The channels are periodically dredged and the shoreline is usually extensively developed with port facilities, marinas, mills, terminals, fish processing plants and storage areas.

Deep water channels extend from Fields Landing in South Bay to the north end of Indian Island in North Bay. At present there are approximately 2,000 acres of this habitat type.

PLATE 8

EEL GRASS BEDS



Filamentous green algae, brown algae, sea lettuce and occasionally eel grass are about the only vegetation found in these deeper waters. Since dredging disturbs the bottom flora, most of the above named species, with the exception of the filamentous algae, occur only along the edges or other undisturbed portions of the channels.

Tidal Channels

The tidal channels differ from deep water channels in that they are generally more shallow and occur naturally. Location and depth is determined by tidewater action, tributary flows, water velocity and siltation. Tidal channels are not dredged or otherwise substantially altered directly by man except for tributary sloughs which are confined by dikes.

Within the bay itself these channels occur as a network within the mudflats and relatively shallow waters of Arcata and South bays. Eel grass grows in dense stands in and along the edges of many of the tidal channels, particularly in South Bay.

The tributary sloughs are tidal channels quite different in character from those found within the bay. They meander through agricultural lands adjacent to the bay and are confined by dikes to prevent flooding. During low tides a portion of the mud bottom of these sloughs is exposed. Because the tributary slough water is mixed with incoming fresh water it is less saline than bay water. As a result, associated vegetation along the tributary channel edges is more varied than that found in the bay itself.

Common plants in the less saline portions of these sloughs include creeping spikerush, widgeon grass, sago pondweed, and bullrush. Where the water is more saline the common edge cover is composed of chordgrass, arrow grass, saltgrass, and pickle weed.

In the upper reaches of the tributaries, where salt water seldom penetrates, the vegetation is composed of typical freshwater plant species. The major tributary slough systems are Mad River Slough, Jacoby Creek, Fay Slough and Eureka Slough in Arcata Bay, Elk River on the deep water channel, and Beatrice and Hookton Sloughs in South Bay.

Intertidal Mud Flats

Much of the bay is composed of intertidal mud flats which are fully exposed at low tide. At high tide the flats are entirely covered by water. The total varies, according to the extent of tidal fluctuation; however, the average is about 7,200 acres. The largest areas of intertidal flats are located in Arcata and South bays (Arcata Bay - 4,600 acres, South Bay - 2,600 acres).

Intertidal flats are of two distinct types described as high and low mud flats (see Geology and Soils). Low mud flats are characterized by an irregular surface configuration superimposed on a gradual contour. The irregularities are formed by small hummocks separated by shallow water depressions and small channels. In the water filled depressions and along the transition zone between the mud flats and shallow water bays, eel grass and widgeon grass grows in small clumps and larger beds. Widgeon grass grows in association with eel grass in the depressions. Other plant life is limited to several species of algae including *Smithora naidum*, *Enteromorpha* sp. and *Polysiphonia* sp. During the summer algae blooms of *Enteromorpha* may cover the mud and eel grass in dense layers.

The high mud flat is extremely smooth and gently contoured, transected at wide intervals with tidal drainage channels. The only plant life normally found here is algae of species listed for the low mud flat type.

The mud flats are rich in the invertebrate life upon which most of the avian wildlife of the bay is dependent. Most invertebrates occur in the top 6 inches of the strata with approximately 97 percent being found in the upper 2 inches (Holmberg and Carrin, 1970). The species and numbers of invertebrates present are determined by the sediment composition and location in relation to tidal submergence time. As a wildlife habitat the intertidal mud flat is probably the most important area in the bay. The total bird days use recorded here surpasses that on all other habitat types.

Jetties and Reefs

These artificial habitats result from man's activities in improving navigation at the bay entrance or in attempting to experiment with and develop artificial reefs that will attract and hold desirable sportfish. The north and south jetty, which guard the entrance channel, are approximately 1.2 and 1.5 miles long respectively. Until recently these jetties were composed of quarry rock. Today both jetties are covered by specially designed concrete forms designed to resist wave action and current. Approximately 20 acres of habitat for such fish as kelp greenling, striped seaperch and redtail surfperch have been established by these jetties.

Artificial reefs have been popular in California for many years and in 1968 a reef was constructed in south port channel of South Bay. Discarded truck tires were banded together in groups of three and four and depositied in water of 22 ft. depth at mean low water. The reef is approximately 90 ft. by 24 ft. Studies by Humboldt State College students have shown that the reef attracts a variety of marine plants, invertebrates and fish, such as rockfish and kelp greenling which prefer rocky habitat.

Wildlife

Humboldt Bay is one of the most important estuarine areas of the California coast in terms of wildlife resources. It is second only to San Francisco Bay in the variety and numbers of wildlife species which use it annually. The bay forms a vital link in the chain of coastal wetlands which extend from the Arctic Circle to South America and provide habitat essential to the survival of migrating and wintering water associated birds. In addition, it supports large numbers of resident birds and mammals throughout the year.

Many species are dependent on such bays and their environs. Other species not dependent on the bay specifically, find conditions suitable in surrounding open space areas with diverse habitat types. Over 250 species of birds have been recorded in the general area of Humboldt Bay (Harris and Yocum, 1973). Many are common residents or migrants while others occur only rarely. Lists of birds that may be seen in and around Humboldt Bay are appended. These lists include only the more common species and those of special interest, and are not intended as complete check lists (Appendix B).

The value of Humboldt Bay to wildlife is substantially increased by the proximity of the Eel River Delta with its agricultural and marsh lands, and other nearby coastal lagoons. Wildlife utilization patterns indicate a general interchange of birds between the bay, the Eel River Delta and the lagoons. This interchange occurs as the birds move to adapt to changing climatic and tidal conditions, and to make use of available food sources.

Local wildlife populations, particularly bird species, undergo dramatic seasonal fluctuations. The highest numbers and greatest variety occur during the fall and winter months when migrant birds appear. Their numbers are constantly changing as new birds arrive and others depart. Populations are generally more stable and at much lower levels during summer months. In order to determine the numbers and varieties of wildlife which use Humboldt Bay, the Department conducted monthly aerial census flights over a three-year period beginning in October of 1967 and extending through September of 1970 (Appendix C). Aerial census is only effective for determining water-associated wildlife use and cannot be used for land species which are found in heavier cover and are more widely scattered. For this reason, no population figures are available for the latter species.

Mammals

At least 50 species of mammals are found in the Humboldt Bay area (Appendix D). The mammals can be broadly classified as marine and terrestrial species. The marine species, including the sea lions, seals, dolphins and porpoises, inhabit the sea and salt water areas of the bay and its tributary sloughs. All are migratory and local populations fluctuate.

The Pacific harbor porpoise is a regular visitor but is not normally found in large numbers and is the only porpoise which commonly uses the Humboldt Bay. It is usually seen in the deep water channels and spends its entire life in the water. Dolphins, similar to the porpoise in appearance and habits, are seldom seen in the bay but are present offshore. The common dolphin and the Pacific bottlenose dolphin occur along the Humboldt coast.

Unlike dolphins and porpoises, the seals and sea lions leave the water for short periods of time. They "haul out" on land to rest and to give birth to young. They are usually seen close to the coast at times may move some distance offshore. The Steller sea lion and occasionally the California sea lion are seen in the Humboldt Bay area. They are more commonly seen in the ocean but do use the bay, and sometimes venture some distance inland through tributary streams and sloughs.

The harbor seal is by far the most common marine mammal of Humboldt Bay. Large numbers of these animals can be seen at low tide on hauling areas in North and South Bay. Peak populations occur from February to August. Over 500 seals have been counted in a single day. Humboldt Bay is a favored pupping area for these animals.

Most terrestrial mammals are not associated directly with the bay but utilize the adjacent upland areas. One exception is the river otter. Although the otter is generally more at home in the fresh water of tributary streams, it is sometimes seen in the bay and sloughs. The beaver, another mammal of aquatic habits, occurs in the Mad River drainage and as a transient in some freshwater streams flowing into the bay.

Other furbearers found within the study area include the gray fox, coyote, bobcat,ringtail cat, raccoon, striped skunk, spotted skunk, mink, weasel and badger. The pine marten and possibly the fisher may inhabit higher elevation forests in the upper reaches of the drainage; but, if so, they are quite rare.

The most common big game animal is the blacktail deer. They are most numerous in the foothills adjacent to the bay but also occur in the lowland agricultural areas, within the city limits of Arcata and Eureka, and on Gunther and Woodley Islands. Deer somtimes can be seen swimming between the two islands and the mainland. Another big game animal, the black bear, ranges throughout the forested areas of the Humboldt Bay drainage, but generally does not appear in the more developed areas immediately surrounding the bay. The mountain lion inhabits similar habitat in the upper portions of the drainage but is much less common and rarely seen.

The blacktail jack rabbit, brush rabbit, gray squirrel, flying squirrel, chickaree and many other rodents and small mammals occupy various habitat types of the bay area. Some are small game and provide hunting opportunity, others are seen and enjoyed by recreationists and all are part of the complex food chain which supports the higher forms of flesh-eating birds and mammals of the eco-system.

Birds

The most spectacular wildlife forms of Humboldt Bay are its birds. Each fall and winter millions of migrating birds pass along the California coast on their way southward to warmer climates. Most pause to rest and feed on, or adjacent to, the bay for varying periods of time. Others may spend the entire winter locally without moving further south. It is during this season that the area becomes a popular attraction for both hunter and nature enthusiast. In addition to the seasonal migrants, the Humboldt Bay region supports a variety of resident birds.

For the purposes of this report the avian species may be broadly classified into three divisions: the land birds, raptors and water-associated birds.

Land Birds

The land birds are generally found in agricultural areas and uplands and are not dependent on the bay to any great extent. Although they display a wide variation in appearance, all have developed certain similar characteristics which make them well suited for living in this particular environment. The predominant forms in terms of numbers and varieties are the songbirds. Over 80 species are known to occur within the bay's drainage area. Sparrows, thrushes, flycatchers, wrens, larks, warblers, finches and juncos are examples of this group. Some are residents while others are migratory. A wide variety of other land birds including crows, ravens, jays, woodpeckers, flickers, swallows and hummingbirds are common residents or migrant visitors.

Upland game birds which inhabit the area include the valley quail, mountain quail, blue grouse, ring-necked pheasant, mourning dove and band-tailed pigeon. The band-tailed pigeon and mourning dove are summer residents and usually move south in the winter. The others are permanent residents. All of these birds are hunted during the legal season and provide many days of hunting recreation.

Raptors

The raptor group is composed of eagles, hawks, falcons, ospreys, kites, vultures and owls. Within the avian class these birds of prey represent the top of the food chain.

The largest of the local raptors are the eagles. Two species, the bald eagle and golden eagle, occur here, although sightings of either are becoming increasingly rare. The golden eagle is usually seen inland while the bald eagle is more closely associated with aquatic or marine habitat.

The buteos, or broad-winged hawks, are the raptors most often seen. They are easily identified by their large size and their habit of soaring lazily overhead or perching on power poles along roadsides. The red-tailed hawk is by far the most common species but the rough-legged, ferruginous, red-shouldered and Swainson's hawk also are found here. These hawks feed almost entirely on rodents and other small mammals.

The accipiters, more secretive birds and seldom seen even though some species are fairly common, are smaller than the broad-winged hawks and have short, rounded wings and long slender tails. These birds do not soar and are not often seen in open country. They frequent wooded areas where they prey on small mammals and birds. The goshawk, Cooper's hawk and sharp-shinned hawk are members of this group.

The falcons are typified by long pointed wings and rapid flight. Four species occur in Humboldt County. The most common is the sparrow hawk, a small bird at home in many habitat types but most often seen in agricultural areas. The pigeon hawk is similar but slightly larger and much less common. The prairie falcon is rare but local sightings are occasionally reported. One of the rarest of California's birds is the peregrine falcon, or duck hawk. Once common over most of North America, its numbers have been reduced to the point where its future is uncertain. In the past this bird nested along the North Coast but it is now seen only rarely. Only two peregrines were recorded during the three years of census counts on Humboldt Bay. Falcons feed on insects, and small birds and mammals.

The harriers are slender hawks with long, rounded wings and long tails. They search for food, primarily rodents, by gliding swiftly a few feet above the ground. This group is represented locally by the marsh hawk, which is most often seen in open agricultural areas, marshlands and along the sand dunes.

Of all the members of the hawk family, the osprey is the most dependent upon the bay. A fish diet ties it closely to large streams or bodies of water. Several pairs nest within the bay area.

Until a short time ago the white-tailed kite was considered to be comparatively rare, but now is increasing in numbers. Although it is still not considered common along the North Coast, the kite is regularly seen here. The white-tailed kite is the only member of the kite family represented in California.

The turkey vulture is common in all habitat types. Like the broad-winged hawks, it spends most of its time soaring slowly through the air looking for food. It does not kill its own prey but feeds exclusively on carrion. In winter many vultures move south to warmer climates.

The owls are very similar in many ways to the hawks and perform the same function within the ecosystem. Like other raptors they have hooked beaks and sharp talons for capturing and feeding upon prey species and occupy the same level of the food chain as the hawks. However, hawks are diurnal or daytime feeders and owls are primarily nocturnal, becoming active only from evening to early morning hours.

There are 9 species of owls relatively common to the Humboldt Bay area. The largest is the great horned owl with a wing span of up to 60 inches. The smallest is the robin-sized pygmy owl. One of the most frequently seen owls is the barn owl, a common resident of agricultural areas. Others include the screech owl, long-eared owl, short-eared owl, spotted owl, burrowing owl and saw-whet owl. A very rare visitor, the snowy owl has been recorded at Humboldt Bay on several occasions. This bird is normally a resident of arctic regions.

Water Associated Birds

Humboldt Bay, as an ecological unit, is most important to the water associated birds. Without the bay and other similar areas of habitat along the coast, many species could not survive. For this reason, emphasis is placed on these birds and their life requirements.

The water associated birds have developed very specialized morphological characteristics which enable them to utilize an aquatic, freshwater or marine environment. Hence, these birds are very efficient at utilizing various segments or micro-habitats within this type of environment. Unfortunately specialization leads not only to biological efficiency, but also to greater species vulnerability to habitat change. Thus, man's activities in altering the land to suit his own desires have seriously affected many populations of water associated wildlife. Some are near extinction, others are threatened and many are greatly reduced in numbers.

Although many water birds have certain structural similarities, as a group they exhibit a great deal of diversity in size, form and habits. They include nine orders of birds and are represented by over 100 species in the Humboldt Bay area. The various species may be grouped logically according to their relationship with each other and/or the habitat which they occupy.

Waterfowl

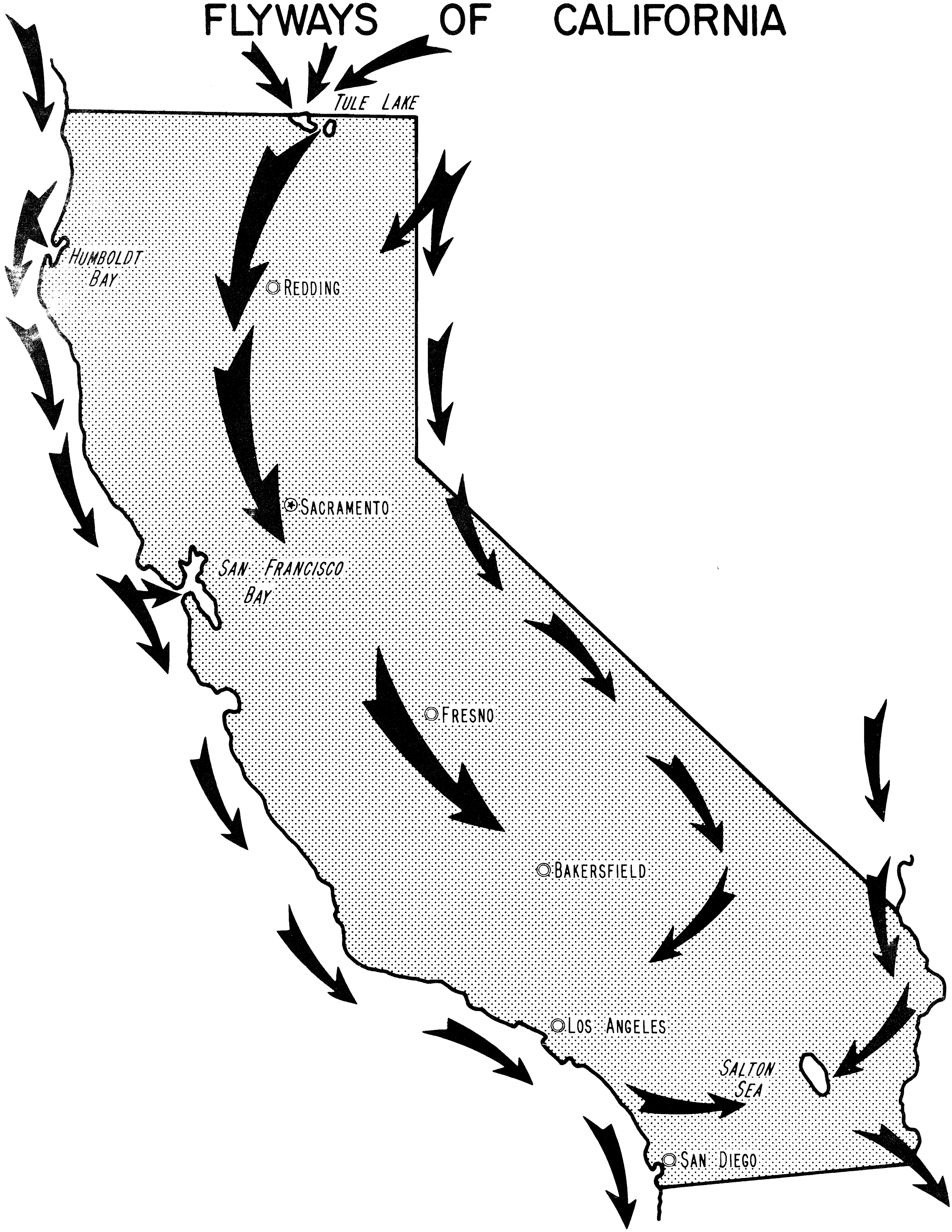
All species of waterfowl, which include the ducks, geese and swans, belong to the order Anseriformes. They are all migratory birds and, although many nest locally, the vast majority are fall and winter visitors which nest as far north as the Arctic Circle. From many years of leg-banding returns, the patterns of waterfowl migrations in North America have been well defined. Basically there are four major paths or flyways, which these birds follow in their seasonal movements. These paths are known as the Atlantic, Mississippi, Central and Pacific flyways.

The Pacific flyway extends from Alaska to South America and includes that portion of the United States which lies west of the Rocky Mountains. Most of the birds using this flyway are produced in Alaska or western Canada. They winter in the United States, Central America and South America. The importance of California's wetlands to waterfowl in this flyway is demonstrated by the fact that approximately 68 percent of the entire Pacific flyway population of ducks and 83 percent of its geese winter in California.

Within California most waterfowl follow one of three primary migration paths (Plate 9). The route which extends from the Tule Lake area south through the Central Valley is the most important in terms of the total numbers of birds using it. Second in importance is the coastal route used mostly by pintails, widgeon, brant and the diving ducks. The third route passes along the east side of the Sierra Nevada Mountains.

PLATE 9

MAJOR WATERFOWL FLYWAYS OF CALIFORNIA



The breeding grounds of the Pacific flyway waterfowl in Alaska and Canada have suffered less from man's interference than those of other major flyways. And, efforts of the Canadian government and conservation organizations have resulted in a breeding territory far greater than the area available as wintering grounds. In California these wintering grounds are estimated to have been originally about 5 million acres in size. Today less than 500 thousand acres remain. The future of waterfowl populations within this flyway obviously depends on how man affects the remaining habitat, particularly in this state and in the Alaskan and Canadian breeding grounds.

There are 22 species of ducks which commonly use Humboldt Bay. Although all are closely related and bear many similar characteristics, they are often quite dissimilar in their feeding habits and habitat preference. In general they can be classified as puddle ducks, diving ducks and fish ducks. The more common puddle ducks include the pintail, widgeon, mallard, gadwall, green-winged teal, cinnamon teal and shoveller. Widgeon, or baldpates, are the most abundant species visiting the bay area and generally comprise about 50 percent of the total waterfowl numbers during winter months. Pintails also are abundant and are second only to the widgeon in total numbers. Pintails are early migrants and begin to appear as early as August. Relatively high populations of shovellers and green-winged teal occur at certain times but their numbers may fluctuate a great deal from month to month. Mallard & gadwall populations are not usually large but are present the year around and nest locally. The cinnamon teal also nests here and is seen most commonly during spring and summer months.

The puddle ducks feed predominantly on aquatic vegetation or agricultural crops. While feeding on submergent vegetation they do so in areas of shallow water and do not dive below the surface as do the diving ducks and mergansers.

Although the puddle ducks can be seen in large numbers on the open water of the bay, food habits studies indicate that they do most of their feeding in the freshwater marshes and agricultural lands adjacent to the bay (Appendix E). The one major exception is the widgeon which feeds extensively on eel grass. Other important puddle duck food plants are barley, prairie bulrush, creeping spikerush, widgeon grass, pondweed, buttercup, saltgrass and clover. Animal matter is taken to a lesser or greater extent according to species. Green-winged teal and pintails tend to consume more animal foods than do the others. Small clams, mollusks, arthropods, gastropods and insects are the principal animal organisms taken.

The common diving ducks of Humboldt Bay scoters, scaup, canvasbacks, redheads, buffleheads, ring-necked ducks, golden-eyes and ruddy ducks. Scoters (3 species) occur in the greatest numbers. Scaup are next in order of abundance and are probably the most important local diving duck in terms of hunting use. Two species, the greater scaup and lesser scaup, are found here. They are so much alike in appearance no effort has been made to separate them for census purposes, however, the greater scaup is probably the most abundant (Yocum and Keller, 1961). Canvasbacks, redheads, buffleheads and ruddy ducks also occur in fairly high numbers. The American goldeneye, Barrows goldeneye and ring-necked duck are less common. Like the puddle ducks, most divers are winter migrants that spend the summer in more northern latitudes. None is known to nest locally.

Ducks of this group obtain food by diving beneath the water surface. Some are capable of diving to depths of 20 to 30 feet or more, although most feeding is done in more shallow water. Food habits between species vary considerably.[1/] The ruddy duck, for instance, locally consumes aquatic vegetation, while the scoters take animal organisms almost exclusively. Dietary preferences of individual species may vary from location to location as

1/ Appendix E

Top Photo: During the winter black brant occur in large numbers on Humboldt Bay and offer fine hunting opportunities.

Bottom Photo: The common egret is one of the bay's more spectacular and beautiful resident wildlife species.

Department of Fish and Game Photos
December, 1969

determined by food availability. In general, however, divers tend to consume more animal matter than do puddle ducks.

Shallow water areas and mud flats of the bay are main feeding grounds of diving ducks. The many small marine organisms located in the substrate provide over 70 percent by volume of the food items consumed (Appendix F). Another important source of food, for the diving species that also utilize aquatic vegetation, are the many small freshwater marshes adjacent to the bay. Very few of the divers use agricultural crops as food.

All three species of mergansers or fish ducks, the American, red-breasted and hooded, are represented in Humboldt Bay. Both the red-breasted and American are common; the latter nests locally. The hooded merganser is not often seen. Mergansers feed almost entirely on animal matter. Small fish comprise the bulk of their diet along with various mollusks, crustaceans and insects. Mergansers pursue and capture their prey underwater and they are at home in the bay, on the ocean or in tributary streams, wherever sufficient food of the proper kind is available.

The Pacific black brant is a unique species among waterfowl. It is smaller than most geese and is strictly maritime in its habits. The brant nests in arctic regions of the coasts of western Canada, Alaska, and Siberia. A portion of this population moves down the Asian coast to winter and the remainder flies south along the west coast of North America. Coastal bays and estuaries of California and Mexico constitute the principal wintering grounds for these birds. A major share of the entire Pacific flyway population utilizes Humboldt Bay at some time during winter migration.

In the fall most brant pass through the local area, pausing only for short periods of time to rest and feed, and then moving on south. In late December they begin to return in large numbers. Many stay in the bay until late April or early May and then continue their northern journey to ancestral breeding grounds. At their peak local brant populations may exceed 100,000 birds.

Brant food habits are much more restricted than those of most other waterfowl (Appendix E). They feed almost exclusively on eel grass, a maritime plant which grows in shallow water areas of coastal bays from Mexico to Alaska. The destruction of eel grass beds by dredging, siltation and pollution, in other bays along the California coastline, has drastically reduced the winter habitat available to brant, and caused their disappearance from many areas where they were formerly common. For short periods, when eel grass is not available, brant will subsist on grasses from agricultural lands adjacent to the bay.

The appearance of geese other than brant is rare. However, Canada geese (including sub-species), snow geese, Ross's geese, white-fronted geese and emperor geese have all been recorded. Apparently geese were more common in years past when more cereal grains were grown locally. Their preference for grain usually attracts them to areas where such crops are cultivated. It is conceivable that geese would become more common if grain acreages were increased.

The swan is the largest and one of the most beautiful members of the waterfowl family. It is the whistling swan that nests in the remote arctic regions of western Canada and Alaska, that visits the bay area each winter. They migrate south to spend the fall and winter months along the west coast, principally in California. Their arrival is usually in late November or December. They remain until March and then return to the breeding grounds. From 500 to 1,500 swans winter in the Humboldt Bay-Eel River area. They feed on vegetation from pasture lands and freshwater marshes, primarily in the Beatrice Flats adjacent to South Bay and, very rarely, in the bay itself.

Although the Humboldt Bay area is not generally considered as a major waterfowl breeding ground, a substantial number of birds are produced. Species which have nested locally include wood ducks, American mergansers, pintails, shovelers, mallards, and cinnamon teal. However, local breeding activity by other than mallards, cinnamon teal and American mergansers is described as rare. The latter bird usually nests along tributary streams and broods are not seen commonly in the bay proper. The number of mergansers produced within the bay's drainage basin probably is not high.

The most important local breeders are mallards and cinnamon teal. Nesting activity is confined primarily to the agricultural lands and associated freshwater marshes and sloughs adjacent to the bay. Most nests are located along these water courses within a few feet of the water. Approximately 8,000 acres of suitable nesting habitat are available within the bay area (Plate 10). Humboldt Bay waterfowl nesting studies conducted by Wheeler and Harris (1970) in 1964 and 1965 indicate a significant annual production (Table 4).

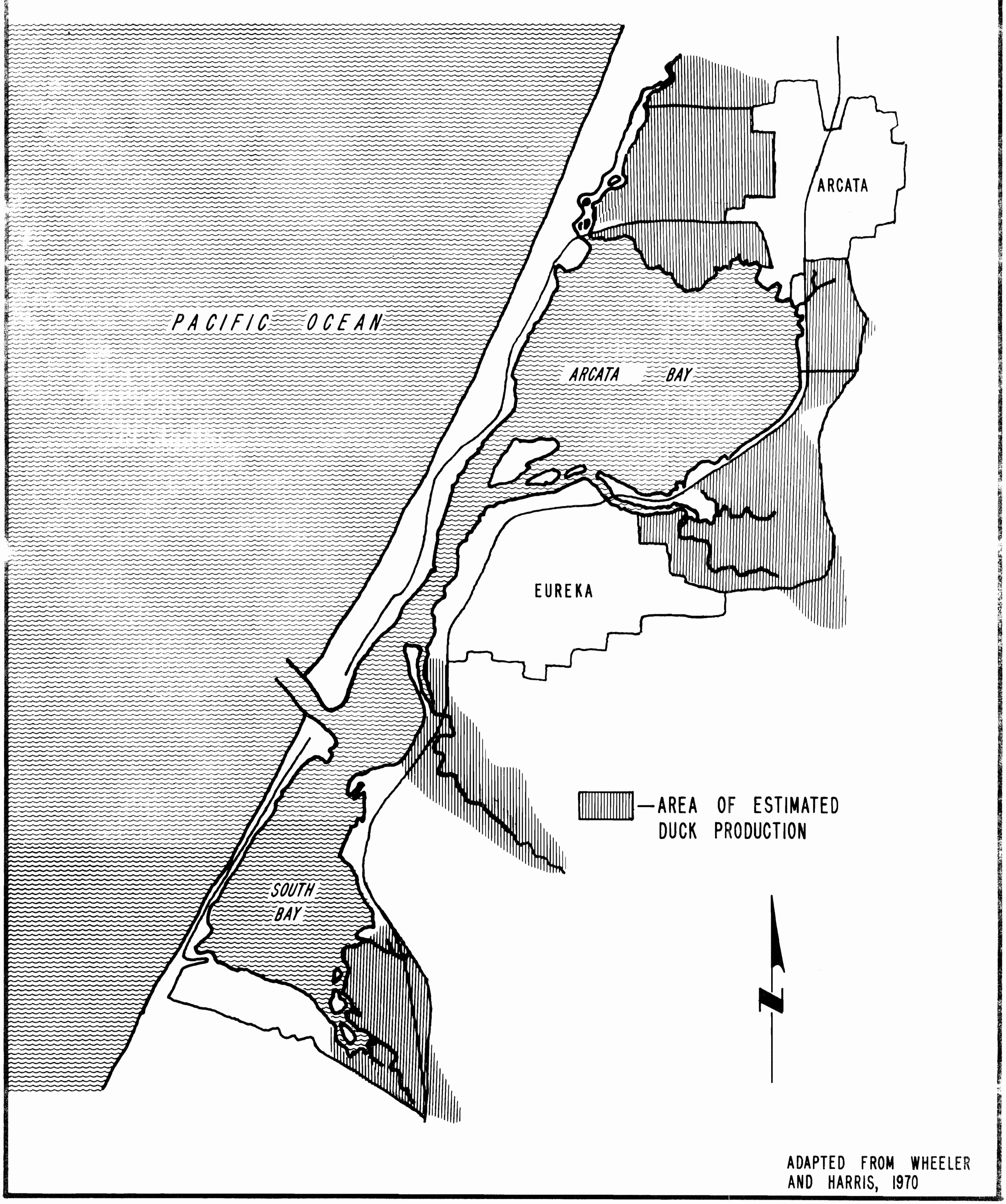
Table 4

Estimated Duck Production, Humboldt County, California, 1964-1965

	Estimated number of broods produced		Estimated number of ducklings produced	
	1964	1965	1964	1965
Mallard	205	183	902	880
Cinnamon teal	86	38	491	221
Total	291	221	1,393	1,101

PLATE 10

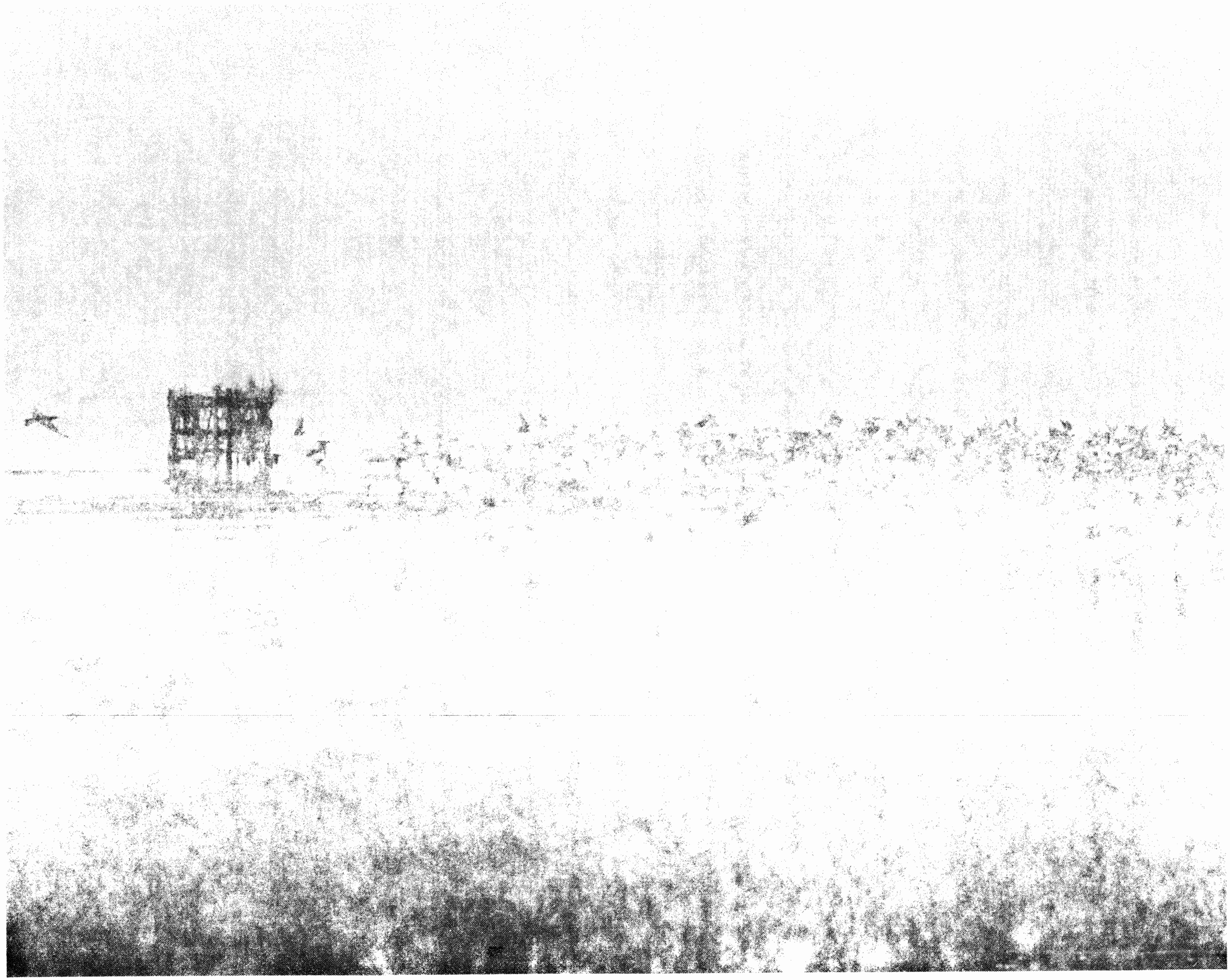
HUMBOLDT BAY WATERFOWL NESTING



Waterfowl populations locally are very dynamic and fluctuate almost daily as birds trade back and forth between Humboldt Bay and other nearby areas. During the day many waterfowl rest on open water. At night they may move to freshwater marshes or pasture lands to feed. Storms may bring new arrivals from the north or cause local birds to leave the area and move further to the south. During any given time period these changing conditions may affect the total numbers present or alter their species composition. Hence, it is difficult to say exactly how many individual birds use Humboldt Bay any given year; however, the total undoubtedly is quite high.

Even though the number of individual waterfowl which visit the bay cannot be accurately determined, the total waterfowl use annually can be defined in terms of bird days use. A bird day use represents 1 bird present for 1 day. Ten birds present for a 5-day period could therefore be expressed as 50 bird days of use. The average monthly population from 1967 to 1970, as determined by aerial census, was 15,875 birds. The total annual average for the three year period therefore is computed as about 5,794,375 waterfowl days use (Appendix F). Only 5 percent, or 289,719 days use, occurred during the months of May, June, July and August. The remaining 95 percent, or 5,504,657 days use, occurs between the months of September and April when winter migrants are present.

Arcata Bay supports over 70 percent of the duck use with South Bay receiving less than 30 percent. Only about two percent of the duck use occurs in the channel between the two bays. South Bay is by far the most important brant area. Over 90 percent of the brant use is recorded there, the balance in Arcata Bay.



During lowtide the exposed mudflats attract thousands of shorebirds and furnish most of their food. Department of Fish and Game Photo December, 1969

Shorebirds

Shorebirds belong to the order Charadriiformes. There are five families and at least 31 species represented locally. Some twenty species are considered common. Many others are less abundant but are seen on the bay regularly. A few are occasional or rare visitors. All share certain similar characteristics, but individual species vary considerably in size, color and external features. Some are no larger than sparrows, others much larger. Most shorebirds tend to be drab in color but a few, such as the avocet, exhibit striking color contrasts. The most common Humboldt Bay shorebirds include the dunlin, western sandpiper, least sandpiper, black-bellied plover, short-billed dowitcher, sanderling, willet, marbled godwit, black turnstone, killdeer, northern phalarope and the common snipe, which is a popular gamebird.

Like the waterfowl, shorebirds follow well established flyways between breeding and wintering grounds. Although a few nest in the northwestern United States, the majority is produced in Canada and Alaska. Some migrate through inland areas but the greatest numbers travel along the coastal zone. The primary wintering grounds are the coastal bays and estuaries from California to Central America. Humboldt Bay historically has been known as one of the most important shorebird concentration areas in California. Continuing encroachment by man and his developments on other winter habitat throughout the state has increased the importance of Humboldt Bay to shorebirds.

There are five general habitat types which shorebirds frequent. The most important type in terms of food production and total use is the intertidal mud flat. Shorebirds move to these areas as soon as the tide begins to recede, following the waterline out. At low tide, when the flats are completely exposed, thousands of birds can be seen moving about probing the soft mud for food organisms. On the rising tide they move shoreward again, staying just ahead of the incoming water.

When forced to leave the bay by high water, shorebirds move to adjacent agricultural lands and their associated freshwater marshes. The greatest utilization of this habitat type for feeding purposes occurs when pastures are wet from rains and flooding. Ocean beaches also provide feeding opportunities for some species. For resting and roosting habitat large numbers of birds use the salt marshes along the bay's perimeter. These salt marshes also are used for feeding to some extent.

Shorebirds feed almost exclusively on animal organisms. The bulk of their diet is composed of small clams, gastropods and other mollusks, arthropods, insects and worms. The intertidal flats provide a wealth of such food items which explains the extremely heavy bird use on these areas. On an acre for acre basis no other habitat type approaches the mud flat in shorebird food production.

Most shorebirds have developed characteristically long legs and bills in proportion to body size. The long legs and toes enable them to move freely about in shallow water and soft mud. They probe with their bills into the substrate searching for food items. A few species, including phalaropes, avocets and stilts, swim readily and often skim the water surface for small insects or other floating animal life.

During the summer months small numbers of non-breeding shorebirds are present in Humboldt Bay. Migrant birds from northern breeding grounds begin to arrive as early as late July. Local populations reach their highest numbers from September through April when the daily average is in excess of 26,000 birds.[1/] The total annual shorebird days use averaged 7,092,315 for the period October 1967 through September 1970.[2/] Because of the small size of many species and their habit of using salt marsh and agricultural areas where cover makes them difficult to see, many birds are not counted during census flights. Therefore, it is assumed that actual populations are much higher than recorded.

1/ Appendix C, Table 2; 2/ Appendix C, Table 1

Arcata Bay consistently harbors the greater numbers of shorebirds. The large expanses of mud flats and the particular substrate composition found there are highly productive in food organisms shorebirds require. South Bay is also important but does not approach Arcata Bay in total bird days use.

Wading Birds

Some of North America's most beautiful birds are included in this category. They are members of the order Ciconiiformes which includes herons, ibises and related species. In Humboldt Bay they are represented only by the heron family; common species are the blue heron, black-crowned night heron, green heron, common egret and American bittern. Two other species, the snowy egret and cattle egret, also occur here but are not common. Although some wading birds migrate to some extent, most of those that use the bay area are year-round residents of the North Coast.

Several of the wading birds were almost exterminated during the early part of this century, because their plumage was in great demand for women's hats. One of the nation's earliest conservation movements was initiated to save these birds. National legislation provided protection that eventually brought their numbers back. Today they are still protected by law but are faced with new threats posed by pollution, pesticides and loss of habitat.

The wading birds have extremely long legs and wide toes adapted for moving in shallow water and mud. Most have long necks and their bills are long and sharp for grasping prey species. The primary visible differences between species are in size, color and habits.

The food habits of the waders are similar for all species. They feed primarily on small fish, crustaceans, amphibians and other water associated organisms. The blue heron and common egret also may feed on small mammals and reptiles.

The most important feeding areas for the blue heron, common egret and night heron are the large shallow water areas of Arcata and South Bay, the salt marshes, freshwater marshes and agricultural lands. The green heron prefers the salt and freshwater marshes, and tributary streams. The bittern is found only in the dense cover of salt marshes, freshwater marshes and along the edges of streams and sloughs.

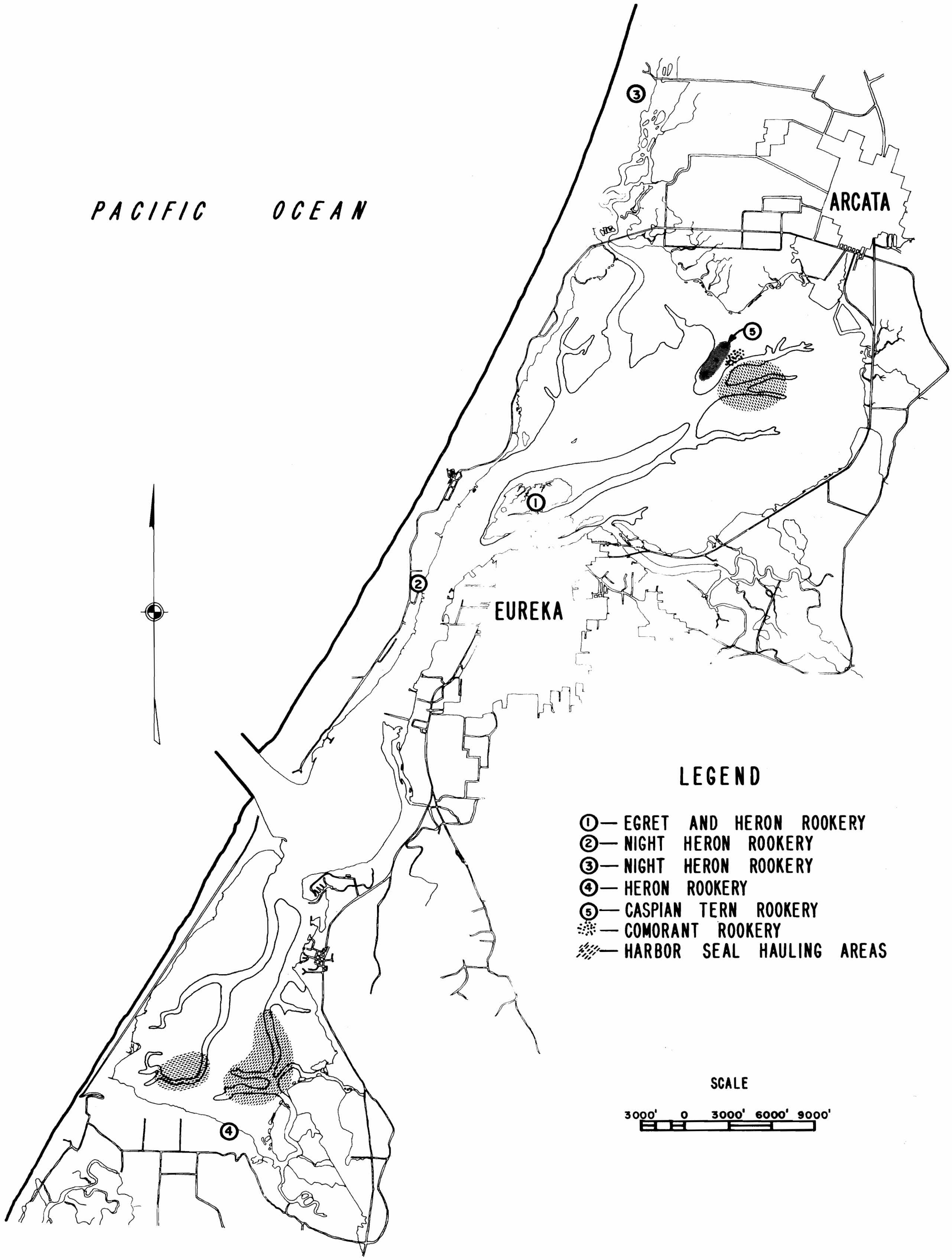
Humboldt Bay is the most important area of northwestern California insofar as maintaining wading bird populations is concerned. It is doubtful if any other estuary in California, with the exception of San Francisco Bay, supports populations which surpass those found in Humboldt Bay. The average annual bird days use over the three year census period totaled 163,155. The highest daily numbers of blue herons and common egrets recorded was 465 and 1,004 respectively. Because the night heron is not usually active during the day, and the green heron and bittern are almost impossible to see from the air, the total wading bird days use is undoubtedly higher than the counts indicate.

Egrets and herons are colonial nesters and usually concentrate on the same sites year after year unless disturbed by man. Studies of the nesting activities of these birds on the Indian Island rookery (nesting site) indicate that at least 184 pairs of common egrets, 55 pairs of blue herons and 62 pairs of night herons nest there (Jonathan H. Ives, 1971). A second rookery used only by night herons is located on the Samoa Spit. Two other rookeries, one on the Mad River Slough and one on Table Bluff, apparently have been abandoned and no nesting has been recorded at either site for at least three years. The total production from existing rookeries is estimated to be in excess of 450 birds annually (Plate 11).

Many wading birds from outlying areas move to the bay to utilize these rookeries.

PLATE 11

SPECIAL WILDLIFE USE AREAS



The nesting period usually begins in March and extends through June. The number of adult birds present in the bay increases sharply during this period. The monthly population from October to February has averaged 133. During March and April the average increased to 386 birds.

The nesting period is a critical time in the life cycle of these magnificent birds. While feeding they are able to tolerate a certain amount of human disturbance. They can even be seen feeding within a few feet of major highways, seemingly oblivious to passing traffic. During nesting, however, a complete change in this behavior is observed. Nesting birds become sensitive to even very minor disturbances and, if sufficiently disturbed over extended periods, may abandon all nesting activity. Nest abandonment is well documented; therefore, it is essential that major breeding colonies be protected from unnecessary human activity. This protection along with preservation of habitat and protection from pollution and pesticides will be determining factors in maintaining the various wading bird species.

Miscellaneous Water Associated Birds

Coots, rails, grebes and loons are the unique, water associated birds included in the miscellaneous group. There is a great deal of diversification between them in size, form, coloration and habits, but all have in common, dependency on marsh and aquatic environment. Each has developed special characteristics that are designed to make it more efficient in utilizing some particular niche within that environment.

The American coot, or mud hen, is a member of the rail family and is quite common throughout North America. It is at home in almost any aquatic habitat type. Although it usually prefers to graze on grass, the coot will feed on aquatic vegetation, alfalfa and other agricultural crops. In the Humboldt Bay area the coot is seen most often in freshwater marshes and sloughs within the agricultural lands, which average 240,170 bird days use annually in those areas. Coots are migratory and populations are highest during winter months.

Three other members of the rail family occur in Humboldt Bay. The Virginia rail and sora rail are the most common but are seldom seen. They inhabit marshy areas with dense vegetation. Although both species may be found in the salt marshes of the bay, they prefer freshwater areas. The third, the California clapper rail, is extremely rare and is on the State's list of rare and endangered species (Leach and Fisk, 1972). This secretive bird depends on salt marsh almost exclusively. The loss of extensive areas of salt marsh over most of its range probably is the cause for its decline. If this rare rail is to be saved, the remaining salt marshes must be preserved.

The grebes occupy all open water habitats in and around the bay. They are swimming birds that are almost helpless on land. Their feet are lobed, rather than webbed, as are most other swimming and diving birds. Five species are found in the Humboldt Bay area. The western grebe is the largest and also the most common member of this family locally. It is usually seen in the deeper water areas of the bay and on the ocean offshore. The red-necked grebe is similar in size and appearance and is seen in the same habitat types as the western grebe. The horned grebe, eared grebe and pied-billed grebe are much smaller. These smaller grebes use the bay, but are rarely seen in the ocean and most often are observed in sloughs, ditches and freshwater marshes adjacent to the bay. The average annual total bird days use for all five species over a three year period was 168,265. The highest total count for a single day was 1,452. As with other migratory species grebe populations are highest during winter months. Some nesting, particularly by the pied-billed grebe, probably occurs locally.

Three species of loons, the Arctic, common and red-throated, are found in the bay and offshore areas during winter months. Although they are often seen they cannot be considered as numerous. Total bird days use averages 8,030 annually. They prefer the deeper water areas of North and South bay and the connecting channel.

Pelagic and Coastal Birds

At least 34 species representing three orders of birds which frequent the open seas and coastal areas have been recorded locally. The petrels, fulmers, shearwaters, albatrosses and jaegers are predominantly pelagic and tend to remain well offshore. Murres, guillemots, puffins and auklets are found closer inshore along the ocean beaches and rocky headlands. A few, particularly the murres, are seen inside the bay. Gulls and terns are common residents or migrants. Several species of gulls are especially abundant. The Caspian tern nests on Sand Island in Arcata Bay. Both the gulls and terns are more closely associated with the bay and, to some extent the inland areas, than are the other pelagic birds.

The brown pelican is a common coastal visitor that uses the bay extensively during late summer and fall months but is absent or rare during the remainder of the year.

Three species of cormorants, the Brandts, pelagic and double-crested, are common residents. They use the channels and shallow water bays primarily. A large nesting colony is located on the remains of the old Arcata wharf in Arcata Bay. An average of 92,710 bird days use has been recorded annually from 1967 to 1970. Daily numbers of up to 700 cormorants have been recorded.

Marine Resources

Fish

Humboldt Bay provides habitat for many species of marine fish. In all, 95 species representing 41 families of fish are listed from the bay (Appendix G). Some species spend their whole lives within the bay, while others migrate out of the bay after they develop into adult-forms. Still others only visit the bay and feed.

Many fish such as gunnels, pipefish, poachers, and sand lances are seldom seen; but all fish are important to the ecosystem of the bay. They serve as predators, scavengers or as forage for other fish.

Sharks and Rays

The largest fish in Humboldt Bay is the sevengill shark, attaining a length at least nine feet. One of the more palatable sharks, the sevengill lives in the deeper channels of the bay. The leopard and the brown smoothhound are two other sharks common to Humboldt Bay. Both are caught by anglers fishing the bay channels and tidal flats.

The bat ray is another cartilaginous fish found in the bay channels and on the tidal flats. The teeth of this ray are particularly suited to crushing oysters, clams and crabs, hence it can be very destructive to oysters and is a major reason for fencing often seen around commercial oyster beds. The stings of this fish produce painful wounds (Roedel, 1953).

Herring and Anchovies

Pacific herring enter Humboldt Bay in the winter and spring to spawn, depositing their eggs in clusters on eel grass, algae and rocks in shallow water. Northern anchovies also enter the bay. Both of these fish provide forage for game fish; in some years attracting many salmon into the bay.

Smelts

Surf smelt, night smelt and longfin smelt are found within the channels of the bay where they are fed upon by larger fish.

Silversides

Top smelt and jacksmelt, often occurring in schools throughout the bay, make up a large portion of the angling catch from piers.

Surfperches

Surfperches are not true perches, nor are they confined to the surf. Eight species are found in Humboldt Bay where they contribute very significantly to the sportfishing catch.

Rockfishes

Rockfishes are members of the scorpion fish family, and,like the surf-perches, give live birth after the young develop to survival size inside the female. Six species have been reported within Humboldt Bay. Rockfish, often called rock cod, include important commercial and game fish. Most live near rocky areas or reefs.

Greenlings

Kelp greenling and lingcod are two of the greenlings found in the bay. Both are desirable game fish. These colorful fish are usually taken from the jetties and other rocky areas, but do occur in the mud flat water courses and in channels.

Sculpins

At least a dozen species of sculpin have been found in Humboldt Bay. The cabezon and the Pacific staghorn sculpin are best known. The cabezon is recognized as a desirable game fish with flesh of excellent quality. The roe of the cabezon is poisonous, however, and can cause severe illness if eaten.

The Pacific staghorn sculpin, like many sculpins, is often called a "bullhead." Although easy to catch, they are seldom eaten because of their small size and unattractive form. Often they are a nuisance to adult fishermen, but provide great enjoyment to children who lack the skill or patience to catch more desired fishes. The staghorn tendency to "gobble-up" any animal matter on the bay bottom makes it an important scavenger.

Flounders

Eight members of the flounder group live at least part of their lives inside Humboldt Bay in the channels and on the sandy and mud flat bottoms. Some are valuable food fish (fillet of sole); most are prized by sportsmen; and all have developed a most unusual body form adapted to life on the bottom. As the fish grow from larvae, the eyes migrate to one side of the head. The bottom (blind) side of the flatfish is white or pale, the eyed top side varies in color and often in pattern to match the bottom on which the fish happens to be. English sole, California halibut, and starry flounder are examples of flounders found in Humboldt Bay.

Shellfish

Crabs

Humboldt Bay plays an important role as a nursery ground for at least three species of recreationally or commercially important crabs, the Dungeness or market crab, the red crab and the rock crab. Intertidal mudflats, particularly those areas with heavy eelgrass growth, provide cover and feeding grounds for large numbers of juvenile crabs. As they grow larger, young market crabs move to the deeper water of the channels and eventually most move out of the bay to the ocean. Many red and rock crabs remain on the tidal flats to adultood and can become serious predators of oysters.

In addition to market, red and rock crabs which are sought by sportsmen, smaller shore crabs, kelp crabs and others serve both as scavengers or as forage in Humboldt Bay.

Clams

Extensive clam beds exist throughout most of the intertidal area of Humboldt Bay with several species of clams occurring subtidally as well. Although well over 25 species of clams are found here, only 10 are harvested by man. These include two species of gaper clams, two species of Washington clams, the littleneck clam, basket cockle, softshell clam, bentnose clam, geoduck and the rough piddock. Mussels and native oysters also are taken.

Miscellaneous Invertebrates

In addition to the more commonly seen and recognized animals, inconspicuous but highly interesting invertebrate forms also occur in Humboldt Bay. Among these are microscopic protozoans, polychaete worms, burrowing shrimp, and a worm-like echiurid, named the fat innkeeper. Within the innkeeper's burrow are found three guests: a scale worm; a small pea crab; and the arrow goby, which is a small fish. All are important to the ecosystem of the bay, eating and being eaten--converting vast materials to higher and higher forms of food.

A current listing or marine invertebrates found in Humboldt Bay is appended (Appendix F). This list represents the combined efforts of many people, but probably is incomplete. Positive identification of all animals cannot be guaranteed, but it is believed that the list is a good representation of the invertebrate fauna of Humboldt Bay.

Anadromous Fish

The anadromous fish of Humboldt Bay include the king salmon, silver salmon, steelhead and coastal cutthroat trout. All have generally similar life cycles in which the adults spend varying periods at sea before returning to freshwater streams to spawn. The eggs are laid in stream gravel where they are incubated. After hatching, the young move downstream and enter the sea to renew the cycle. Humboldt Bay provides nursery area for young silver salmon, king salmon, steelhead, rainbow trout and possibly cutthroat trout. Adult salmon and steelhead enter the bay to feed and to spawn in tributary streams.

In past years the tributaries of Humboldt Bay supported large populations of these fish which contributed significantly to the bay fishery. Over the years, however, stream habitat has been severely damaged and fish populations have been much reduced and even eliminated in some streams. Damage to stream habitat has taken many forms. Many, if not all, of the tributaries have been adversely affected by channel changes. When natural channels are altered much necessary habitat is lost. The deposition of mud, gravel, sand and silt from logging, road building and other activities causes rapid deterioration of stream quality. Water diversions reduce stream flows and block fish passage, and pollution destroys aquatic life. All of these factors have contributed to the decline in the bay's anadromous species.

Following is a list of Humboldt Bay tributaries with an evaluation of the present status of the anadromous fisheries in each:

Mad River Slough

At the present time Mad River Slough does not produce any anadromous fish although it may provide some nursery area for juvenile salmonids.

Liscom Slough

Liscom Slough has no known value to anadromous fishes. The habitat is not suitable for spawning.

McDaniel Slough and Jones Creek

This drainage presently does not support any anadromous fish. It is heavily silted and is subjected to industrial and domestic pollution.

Beis Creek

Silver salmon were known to spawn in this creek until a diversion dam was constructed to provide water for a duck club. Anadromous fish can no longer ascend the stream. Resident cutthroat are present.

Jacoby Creek

Jacoby Creek is an important salmon and steelhead stream in addition to providing a summer trout fishery. Both rainbow and cutthroat trout are present. In the past the stream has been stocked with steelhead and cutthroat trout.

Washington and Rocky Gulches

Washington Gulch supports a population of cutthroat trout. Rocky Gulch once had populations of silver salmon and trout. Heavy siltation from logging operations has eliminated these populations in the lower part of the gulch although salmonids may still be present in the headwater portions of the stream.

Fay Slough

The upper portions of Cochran and Redmond Creeks have populations of trout. The lower portions of the streams are heavily silted with little or no fish habitat.

Eureka Slough

Eureka Slough serves primarily as a passageway for salmonids migrating into and out of upstream areas. It may provide some nursery area for young salmonids, however, the extent of this use is unknown. Pollution of the waters of Eureka Slough has raised questions concerning the survival of fish.

Ryan Slough

Ryan Slough has populations of silver salmon and cutthroat trout. The stream has been damaged by siltation.

Freshwater Slough

Freshwater Creek is an important spawning tributary for steelhead and salmon. It has been planted in the past by the Department of Fish and Game and is currently being planted with king salmon by the Fish Action Council, a local group which was formed to restore salmon runs in Humboldt Bay. Fish entering Freshwater Creek must pass through the slough which has been channelized, silted, and may have low oxygen problems.

Cooper Canyon

Cooper Canyon and the two unnamed streams entering Eureka Slough just east of Cooper Canyon do not now support anadromous fish populations.

Elk River

Elk River is the major salmon and steelhead spawning tributary of Humboldt Bay. It is used by both salmon and steelhead. The Elk River system is currently being planted with 40,000 yearling silver salmon each year. Log jams have been removed in recent years to allow full utilization by anadromous fish.

Salmon Creek

This drainage may support a few steelhead but the current status of salmon populations is not known. The stream remains muddy through the winter while other streams in the area clear up. A tidegate at the mouth impedes the movement of fish into the stream.

Outlook for the Future

Further deterioration of the remaining anadromous fish habitat in Humboldt Bay tributaries can be anticipated. Activities which have affected the streams in the past will continue. Logging pollution may diminish somewhat, depending on future logging practices. Erosion from other sources, such as road building, homesite clearing, and livestock grazing probably will increase. The sources of domestic pollution will undoubtedly increase as more homes are built around the bay, unless adequate treatment facilities are provided. The diversion of water from the streams for domestic and irrigation purposes will increase. Some water may be returned to the streams as drainage water, however, this water will be of low quality. Additional channel changes and levee construction probably will occur.

The planting of salmon by the Department and by private groups in some of the tributaries of Humboldt will continue. These efforts will supplement the remaining natural production. It is extremely doubtful that the natural salmon runs can be restored to their former magnitude by planting. At the same time, the remaining habitat is not capable of sustaining large runs of fish without supplemental planting.

ECOLOGY OF THE BAY

By definition, Humboldt Bay actually is a coastal estuary. It is a large shallow body of water with associated mud flats, salt marshes and brackish freshwater marshes, and during the rainy season its water is influenced by freshwater flowing in from its tributaries. As with all true estuaries, the bay is slowly yielding to the sedimentation that will ultimately lead to its death. In an estuary as large as Humboldt Bay the dying is slow and almost imperceptible. Under natural conditions the process occurs over thousands of years. When man interferes through misuse of watersheds, land reclamation and pollution, the process is much accelerated. Such has been the case with Humboldt Bay.

The key to the survival of any living organism, from the smallest single-celled bacteria to the largest mammal, is the environment in which it lives. All life is adapted to certain environmental conditions which must be met if life is to continue. For some kinds of living things the range of environmental conditions in which survival is possible is quite large. For others, the requirements are so specific that they can exist in only a few places. For example the robin is at home in many different habitat types, but the clapper rail would perish without the salt marshes in which it lives.

Not only are living organisms influenced by their physical surroundings but also by all the other living things around them. The relationships between the organisms themselves and their physical and biological habitat form a very complicated ecological system in which all things are interdependent. Humboldt Bay may be viewed as such a ecosystem. In a larger sense, however, the bay also must be viewed as a composite of many smaller individual ecosystems which comprise the total and give the area its particular character.

Ultimately all life subsists on the energy produced by plants in the presence of sunlight and this energy is passed from organism to organism through a complex food chain, or web, in the form of fats, carbohydrates and proteins. Living things may be classed as either producers, consumers or decomposers, depending on their particular role within the system. Plants, the producers, are the only organisms which can manufacture organic nutrients from raw materials and sunlight. By the process of photosynthesis the tiny one-celled diatoms and algae that float in the bay waters, and the plants which are rooted in the bottom sediments manufacture carbohydrates and release oxygen necessary to support animal life. The plants provide nourishment to the grazing animals from single cell size to the higher invertebrates and vertebrates, the consumers. These organisms are in turn fed upon by other consumers up through the food chain until the now concentrated fats, carbohydrates and proteins are ultimately utilized by the largest predators, including man himself.

The energy is returned to the system by the decomposers. As plants and animals die and sink to the bottom they form a rich layer of organic material over the soft mud. Plant and animal tissues washed in from surrounding areas add more nutrients. As this material accumulates bacteria thrive, multiply and break down the organic matter, and in the process of cell respiration, form by-products of gasses and liquids. The organic residue is filtered from the waters by clams and other mollusks to be used as food. Other invertebrates ingest mud and extract nutrients made available by the bacteria. That which remains is assimilated by plants and the process begins again. The endless cycle continues from producer to consumer, to decomposer and back to producer again. Death is the end result of life and from death comes new life. This process has existed unbroken from the beginning of life, millions of years ago.

The ocean continually pours new life into the bay. The waters of the incoming tides are filled with free-swimming or floating larvae of jellyfish, worms, mollusks, crabs, shrimps and scores of other marine invertebrates. As the sea gives life to the bay, so the bay gives life to the sea. Countless living organisms, eggs, sperm and decomposing organic matter are dislodged by tidal erosion and wave action, and are carried out with the receding tide to enrich the sea.

Fish of many sizes and descriptions enter and leave the bay freely. At high tide they range across the wide reach of shallow waters in search of food. With the outgoing tide they retreat to deeper channels or rest in tidal pools. Some use the bay for spawning or as a nursery area. Many fish and shellfish caught in the sea by fishermen are produced or spend a part of their life within the bay. Commercial and sport fisheries depend upon many fish which need the bay during part of their life cycles.

The small bait fish attract salmon and other large fish into the harbor entrance where the latter provide recreation and become food for man. The bay also serves to transport salmon and steelhead in their movement to the fresh-water tributaries in which they spawn.

Dolphins, porpoises, seals and sea lions follow the fish into the bay. Most are temporary visitors in search of food or shelter from heavy seas. Some, like the harbor seal, are semi-permanent residents that give birth to their young, nurse them in the quiet waters and rest on the exposed sand and mud bars at low tide.

Much of the food material which supports the higher forms of life comes from the rich bottom sediments of the bay. Countless numbers of clams and other bivalves lie buried in the substrate. Worms and worm-like creatures burrow through the soft mud and other small worms, amphipods, isopods and crustaceans are found along the surface. Numbers, varieties and distribution of these organisms are determined by the composition of sediments and site location in relation to tides and currents. Consequently different kinds of organisms are found in different areas of the bay in varying densities, each life form utilizing the particular ecological niche to which it is best suited.

Likewise, vertebrate animals are distributed according to their habitat preference and the quantity and availability of food material. Vertebrate use of habitat also is influenced by seasons, tides, weather and other factors including human disturbance. The food habits of different species are as different as the variety of food items available for consumption. Some species have similar food habits but feed in different areas or during different tide or time periods. Others compete directly in time and space for the same food source.

During low tide the exposed mud flats are feeding grounds for thousands of shorebirds. They disperse across the mud probing with their long narrow bills in search of small invertebrates.

Egrets and herons wade through tidal pools or shallow water areas looking for small fish or crustaceans. As the tide returns they move shoreward staying just ahead of the rising water. When the tide is high, the shorebirds roost or feed in salt marshes and pasturelands, and the egrets and herons move to the marshes or fields where they feed on amphibians, reptiles, fish and small mammals. Common egrets and blue herons are active daytime feeders; at night they are replaced in feeding areas by black-crowned night herons.

Waterfowl usually concentrate in the shallow water bays and along the tidal channels at low tide. At high tide, they scatter across the water-covered mud flats to feed on aquatic plant life and small invertebrates. The puddle ducks feed only in shallow water areas. The diving ducks and mergansers prefer deeper water. Brant stay close to the eel grass beds, although they sometimes can be seen in salt marshes or resting on exposed sand bars. At night many of the puddle ducks leave the bay to feed in agricultural lands or fresh-water marshes.

Grebes, loons and cormorants usually remain in relatively deep water and often trade back and forth between the bay and the ocean. They dive and swim beneath the water surface to gather food or escape their enemies. Pelicans are also associated with deeper water areas of the bay and the ocean as are murres, guillemots, fulmars, terns, petrels, albatrosses and other pelagic birds. Gulls are opportunists that scavenge for food in many habitat types, although they are most numerous around the bay and ocean shore.

In the areas surrounding the bay there are many other forms of wildlife. Small birds and mammals of many kinds live in the fields and forests. The birds can usually be seen or heard but the mammals are secretive and most active at night. Their presence is generally made known only by tracks and other signs they leave in passing. These smaller creatures provide food for the hawks, owls, skunks, weasels and other predators that inhabit the ecosystem. Each habitat type has its own particular inhabitants which live and die within its confines.

The importance of the intertidal mud flats cannot be over-emphasized. The bulk of the food organisms consumed by the bay's fish and wildlife is produced in the mud flats. And, it is there that many of the vital life processes, upon which the productivity of the bay depends, are carried out. Each time a portion of mud flat is lost to dredging or filling, the productivity and ability of the bay to assimilate and biologically degrade wastes is reduced.

The salt marshes perform similar functions. In basic nutrients the salt marsh is more productive than the richest agricultural land. The peat soils are rich in organic material including plants and the remains of small animal life that are washed away with rains and tides to fertilize the bay and the sea. The marsh also acts as a filter for incoming sediments and some forms of pollutants and also provides habitat for many kinds of wildlife including one of California's rarest birds--the clapper rail.

As the clapper rail is dependent on the salt marsh, the black brant is dependent on the eel grass. Without it the brant could not survive. Eel grass also produces nutrients and oxygen required for the bay's animal life. Fish lay their eggs in the dense foliage which also provides small crustaceans and other organisms with protection from their enemies.

Nesting habitat is of critical importance in maintaining many wildlife species. The Indian Island egret and heron rookery is probably the best known of its kind in northwestern California. Located in a grove of cypress and eucalyptus trees near the center of the island, this rookery is one of the largest in the State in terms of numbers of nesting birds. It also is one of the most productive. Smaller rookeries used by the black-crowned night heron are found near Mad River Slough and on the Samoa Spit.

Sand Island in Arcata Bay is a nesting site used by terns. A large cormorant rookery is located on the remains of the old Arcata Wharf near Sand Island. These are the only rookeries of their kind in the immediate area of Humboldt Bay. Every effort should be made to protect them.

Humboldt Bay is an important "pupping" area for the harbor seal. Several hundred seals use the bay. There are several areas in North and South Bay that are of particular importance as hauling sites for the adult and young animals (Plate 11).

There is no area that is not used by some living thing, large or small. Although some areas take on added significance, due to their rich biological productivity, specialized habitat, or scarcity, all areas of the bay are of ecological importance. Each plant and animal has its place--a niche where it can thrive and grow. Each is adapted through evolutionary processes to fit some part of the environmental picture. This picture, like a giant jig-saw puzzle, is complete only when all the parts are formed together. Removing one segment affects all the others, and the picture is never the same again.

RESOURCE USE

Recreational Use

Humboldt Bay provides a multitude of outdoor recreational opportunities, most of which are associated with the natural resources. People who live near the bay have come to accept these opportunities as a normal way of life without realizing that such opportunities can be lost easily. It often is the people who reside in metropolitan areas, who already have lost such resources, that remind us of the resource values by traveling hundreds of miles to enjoy them. These resources can be preserved by proper planning and recognition of ecological factors by local entities of government and the public.

Coastal areas always have been attractive to recreational users. The unique combination of redwood forests, rocky headlands, sandy beaches and estuaries make the Humboldt County coastline particularly attractive. The use demand is demonstrated by ever-increasing numbers of visitors to the North Coast. The importance of recreation to the local economy is high. In 1964 the Greater Eureka Chamber of Commerce reported that tourism was second only to the forest products industry and represented 13.76 percent of the total economy.

Patterns of recreational use in and around Humboldt Bay, as elsewhere on the North Coast, are governed largely by weather. Because of the fog, rain and cool temperatures, certain types of recreation found in other coastal areas are not in great demand here. Beach use for swimming or other water contact sports is extremely limited because of cold air and water temperatures. Boating activities are largely oriented towards sport fishing or hunting. It therefore follows that the current and potential recreational use depends upon natural and esthetic resources. Because of the importance of tourism to the local economy, it also follows that these resources should be protected and, wherever possible, enhanced.

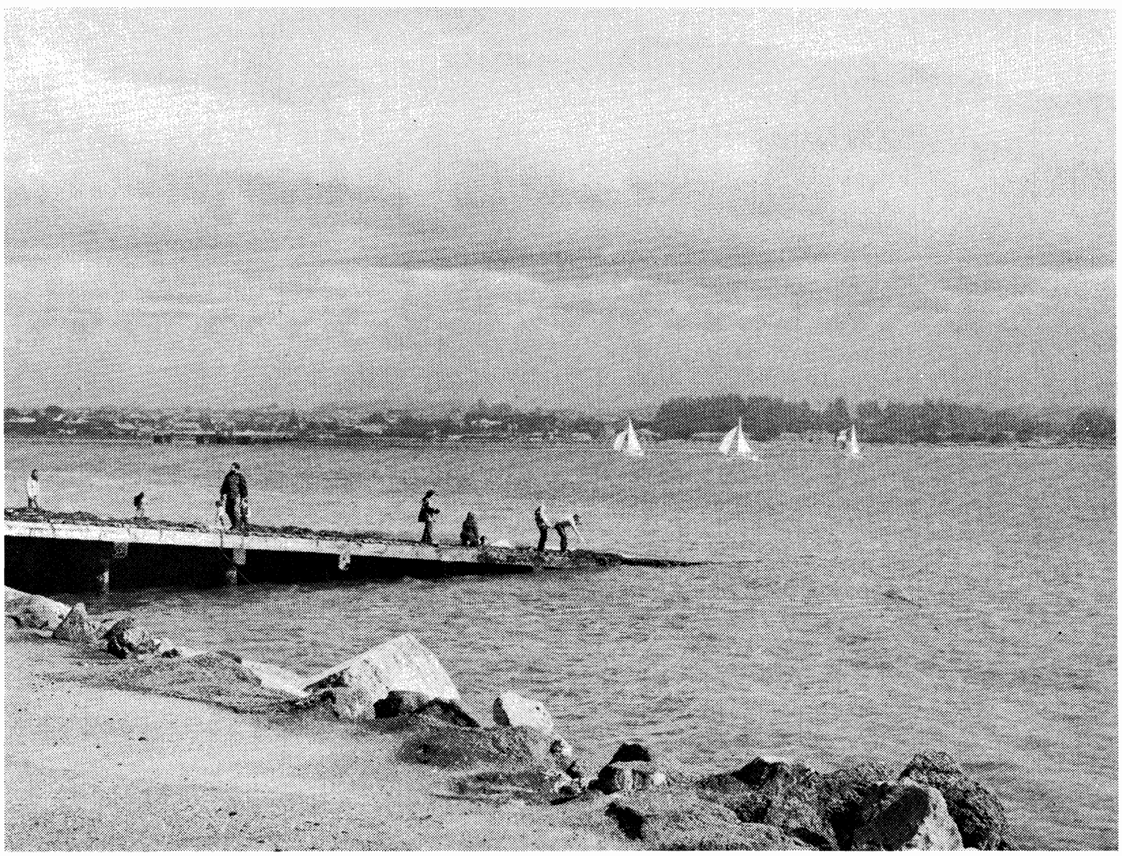
Recreational use of natural resources falls into two distinct types--appropriative and non-appropriative use. Appropriative uses involve the actual removal of individual units, such as fish or game, by fishermen, hunters or other users. The same resources may be used by the non-appropriative user through nature study, wildlife observations, photography, or scenic enjoyment without removing any portion of the resource. Both kinds of use are important and each has its place in the overall recreational picture. Through proper planning both kinds of use can be made entirely compatible and maximum benefits can be derived from each.

Hunting

The most significant appropriative wildlife use in the immediate area of the bay is waterfowl hunting. Such hunting is conducted on the bay, marshes, sloughs and agricultural lands. Most hunting is done from temporary or permanent blinds along the shoreline. Another popular hunting style that is rarely seen in other parts of the state, but is still common locally, is sculling. Sculling is accomplished by approaching rafted birds on open water by the use of a uniquely designed low profile boat. These boats are highly efficient in the hands of an experienced sculler.

The regular waterfowl season usually opens in October and extends into January. For the past two years it has averaged 93 days. The black brant season opens in November, ends in late February; also averages about 93 days. The combined waterfowl season provides about 128 consecutive days of hunting opportunity annually.

Hunter car counts conducted during the 1968-69 and 1969-70 seasons to estimate hunting use on the bay indicated that at least 18,621 hunter days were expended annually. This represents bay use and does not include use on adjacent freshwater marshes, sloughs or agricultural lands. No actual



Top Photo: The most significant appropriative wildlife resource use in the bay area is waterfowl hunting.

Department of Fish and Game Photo – December, 1969

Bottom Photo: Shore fishing, skiff fishing and pleasure boating are popular recreational uses of the bay's resources and there are three public boat launching ramps in the bay area.

Photo by John Hansen – October, 1973

figures are available for total waterfowl hunting use on lands and waters adjacent to the bay. However, it is known that a number of private clubs are in operation and that many private landowners allow hunting on their farmlands by permission. It is estimated that this additional hunting opportunity amounts to at least 6,000 hunter days per year for a total of over 24,000 hunter days annually.

This estimate may be conservative. The Department of Fish and Game 1965 hunter survey indicated that in 1965 Humboldt County ranked fifth in the State in waterfowl kill. The State kill totaled 2,475,000 birds, of which 4.5 percent (111,374 birds) was taken in Humboldt County. Based on the kill and hunter success ratios it was estimated that 7,380 individuals hunted in Humboldt County that year. Each hunter averaged 6.6 days of hunting for a total of 48,708 user days. Since Humboldt Bay provides a major share of the waterfowl hunting opportunity in the county, it is reasonable to assume that hunter use in the bay area may be considerably higher than 24,000 days.

Aside from the enjoyment derived from waterfowl hunting, the sport also contributed to the area's economy. The 1965 economic survey conducted by the U. S. Fish and Wildlife Service (National Survey of Fish and Hunting, Resource Publication #27) concluded that waterfowl hunters spend an average of $6.74 per day. The total county waterfowl hunting effort of 48,708 user days would therefore represent an annual income to Humboldt County of about $328,000.00.

Humboldt Bay is the most important brant hunting area in California, contributing up to 75 percent of the total state kill. It is apparent that the bay offers a unique attraction for hunters who wish to engage in this particular sport.

Wilson's snipe are now hunted over a season which coincides with the waterfowl season. These birds are found in salt marshes, freshwater marshes and wet pasture lands adjacent to the bay. Few people are aware of this hunting opportunity and it is estimated that only about 1,000 user days are expended in pursuit of the snipe each year. Here again, use potential is not being fully realized. Through hunter education and incentives to encourage more use of private lands this type of recreation could be increased.

The day use factor for upland game hunting for pheasant, quail, doves, band-tailed pigeon, grouse, squirrels and rabbits is presently unknown. This use is probably high, but the fact that such hunting is spread throughout the entire drainage basin, and in many habitat types, makes specific use counts impractical. In all probability, however, the total runs to several thousand hunter days annually.

Deer hunting is the major appropriative use of big game. Deer tag returns indicate that about 50 bucks are reported taken each year within the bay area. The total annual hunting use is estimated at 2,600 user days. Occasionally bear and lion are taken in the vicinity of Humboldt Bay, however user days directed towards these species is not high. Hunting effort also is expended for mammalian and other non-protected wildlife. No figures are available for estimating user days on these species. It is estimated that the Humboldt Bay area currently sustains over 35,000 hunter days use annually for all forms of hunting.

Outlook for the Future

The use demand for all waterfowl hunting is increasing. With proper planning for preserving and enhancing waterfowl habitat and use opportunities, there is a high potential for increasing this form of recreation. Under the proper management, and without additional loss of habitat, waterfowl hunting use can probably be safely increased by a substantial degree.

Sport Fishing

Humboldt Bay is one of California's primary sport fishing areas. Anglers fishing in Humboldt Bay catch at least 41 species. In addition, the bay provides recreational fishing for oysters, 10 species of clams, and 3 species of crabs. Animals such as shore crabs and ghost shrimp are collected by fisherman for bait and thereby contribute to sport fishing activities.

During the period of 1957 through 1960, the Department made surveys of the sport fishery catch and fishing effort from the Oregon border to Point Arguello (Miller and Gotshall, 1965). These surveys, limited to fin fish fisheries, determined that an average of 27,144 angler days was expended annually in Humboldt Bay during the survey period. The fishing effort was separated into skiff, shore, pier, and skindiving categories (Appendix H). During the survey period, skiff fishermen averaged 5,997 angler days annually. Shore fishing, predominantly from the South Jetty and Buhne Point Jetty, attracted the largest number of anglers who expended an average of 12,495 angler days. Shore fishermen also caught the widest variety of species; their catches included 27 different species. Pier fishermen caught the most fish, 41,134 annually, with an average catch of 6.08 fish per angler day. Pier fishing effort averaged 8,402 angler days and there was an average of 250 skindiver days.

In 1965, a census of the sport crab fishery was conducted by the Department. An estimated 800 angler days were devoted to this sport from December, 1964 through March, 1965 (Appendix I). The catch consisted of 2,623 crabs; 400 of these were market crabs, the remainder were red and rock crabs (Gotshall, 1966). Approximately 3,500 angler days are expended annually by sport clam diggers in Humboldt Bay. The species most commonly sought and taken are, in order of importance, gapers, Washingtons, littlenecks, basket cockles, and soft shell clams. Most of the effort takes place in South Bay, probably because the clam beds there are more accessible and because standing crops of the more desirable clams are higher than in Arcata Bay. The most popular areas in South Bay for clam digging are the northern end of Clam Island and

Buhne Point. In Arcata Bay, clamming effort is greatest on Indian Island, Bird Island, Sand Island, and along Mad River Channel. Native oysters also are taken in Arcata Bay. They are most abundant north of Woodley Island and in the Arcata Channel.

Seven of California's 12 shellfish reserves are in Humboldt Bay (Plate 12). The most recently-designated reserve was established in 1959. These areas of state land within the bay have been set aside by the State for clam digging and native oyster taking by the public as authorized by Section 6497 of the State Fish and Game Code (Stats. 1969) and Section 6482 of the State Fish and Game Code (amended by Stats. 1965, Chapt. 1114). Titles to these reserves may not all be valid, however. Most of the reserve areas contain land which may have been transferred from the State to the cities of Arcata and Eureka. Until ownership is resolved, the status and value of the reserves is questionable.

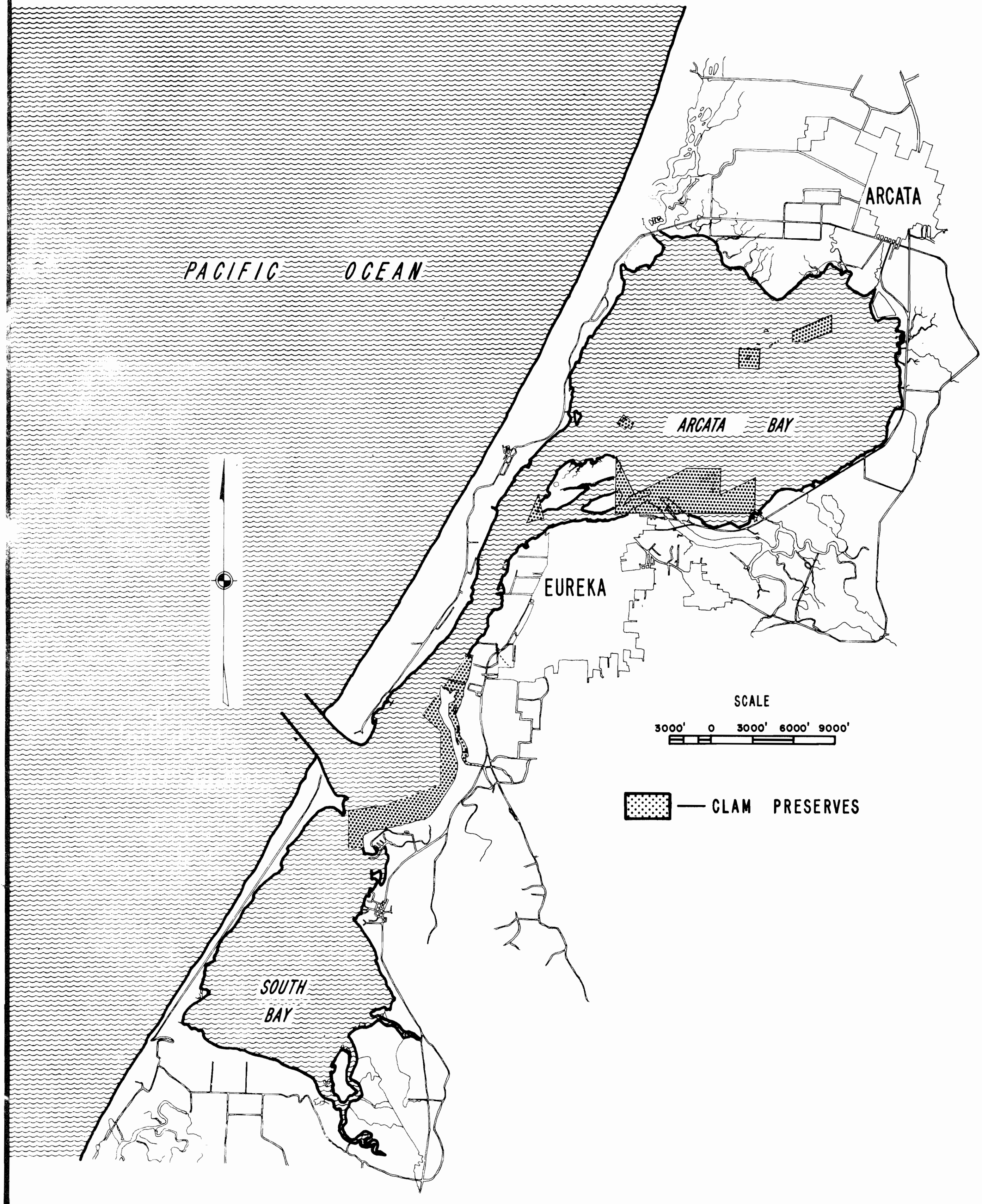
Skiff Fishery

Humboldt Bay supports a very active marine skiff fishing center. As used here, the term "skiff" includes all boats which are used for sport fishing, other than party boats. Miller and Gotshall (1965) reported more skiff fishermen fishing out of Humboldt Bay than at any other skiff fishing location from the California-Oregon line to Point Arguello. A total of 16,799 angler days, including 6,488 skiff days was recorded for Humboldt Bay in 1959. Most skiff fishing effort in and about Humboldt Bay occurs during the summer and fall; days of favorable weather are less frequent during the winter.

In the warm water of 1957 and 1958 (Radovich, 1961), several white seabass were caught from skiffs at Humboldt Bay and Trinidad. Pacific albacore, during those same years, ranged to within 10 to 15 miles of Humboldt Bay. A few of the more adventuresome skiff fishermen, who made the trip offshore, reported fair success (Miller and Gotshall, 1965, p. 68).

PLATE 12

CLAM PRESERVES



Bottom fishing from skiffs for rockfish and lingcod is not as popular around Humboldt Bay as it is in areas to the north and south. The only rocky habitats within reach of Humboldt Bay skiff fishermen are the two jetties at the bay's entrance. Except on the calmest days, it is unsafe to fish this area from a boat because of swift tidal currents and unpredictable swells. The species composition of the Humboldt Bay skiff fishery catch reflects this lack of rocky habitat.

The skiff fishery in northern California has grown considerably during past years. Three factors contributing to the growth are: population increase, improved outboard motors and small boat design. Small craft harbor construction and new electronic safety equipment for skiffs will encourage continued expansion of the skiff fishery throughout the State, according to Miller and Gotshall, 1965. This projection should apply to the skiff fishery in Humboldt Bay as well.

Party Boat Fishery

There were 26 licensed partyboats in the northern California area (Crescent City-Marshall) in 1963, approximately 5 percent of the state-wide fleet (Appendix J). Of the 18 active boats, 5 operated from Humboldt Bay. These 5 Eureka boats fished for salmon (Appendix K), and averaged 5-3/4 hours per trip (Miller and Gotshall, 1965). Usually they spent some time trolling within Humboldt Bay before reaching the fishing grounds outside of the harbor. About 90 percent of the trips were made June through September. Three of the boats also fished commercially during part of the year. Salmon and crabs generally make up the catch.

Shore Fishing

Surf-casting, surf-netting, and rocky shore fishing are three general types of shore fishing. Surf-casting and surf-netting take place along the ocean side of Humboldt Bay's sand spits. Rocky shore fishing occurs both within and outside the bay. Surf casters are usually in quest of surf-perches. The gear is a long pole with heavy line essential in the surf-breaking area where the fish are located.

Surf-netting is a specialized means of netting one species at a time in a specific habitat on open beaches. Both night smelt and surf smelt are taken from the ocean side of the sand spits.

Rocky shore fishing is quite varied, in that quiet inlets and rock jetties are frequented. "Poke-polers" use bamboo poles or broomhandles to probe with baited hooks for blennies and greenlings among the rocks of the breakwaters and jetties. Jetty and rock fishermen use anything from long surf-casting rods and reels to small spinning outfits, or occasionally a handline.

At Humboldt south jetty, rock-frequenting species dominate the catch, with kelp greenling, striped seaperch, and black rockfish accounting for over 64 percent of the annual total. Redtail surfperch are also taken from December through August. During those years when large numbers of salmon enter the bay to feed, this prized fish adds to the jetty fishermen's catch. In 1969, an estimated 1600 salmon were taken by anglers fishing from the south jetty.

Shore fishing inside Humboldt Bay is typified by Buhne Point jetty fishing. This jetty is actually a long rock-reinforced bank on the east side of the bay. When casting from this jetty, catches are made on fine sand bottom. Consequently the catch consists mostly of redtail surfperch, walleye surfperch, silver surfperch, and flatfish representing sandy bottom forms. Jacksmelt, shiner perch and pile perch represent the more or less wandering bay forms, and an occasional rock-frequenting form, such as the striped seaperch, kelp greenling or rockfish, is landed. Generally, the best catches are made from October through May when redtail surfperch and jacksmelt are most available (Miller and Gotshall, 1965).

Most shore fishing requires casting ability which limits this sport to those persistent enough to learn. New types of spinning gear and casting reels have enabled more people to enjoy this sport each year, but loss of hooks and sinkers in rocky areas is still a problem. Shore fishing most often entails a family outing with usually one or two members of the family fishing, while the others remain on the beach at a nearby picnic area. Most shore fishing areas are too rugged and dangerous for small children (Miller and Gotshall, 1965).

Pier Fishing

One of the most striking differences Miller and Gotshall (1965) found in the sport fisheries from Oregon to Pt. Arguello, was the low amount of pier-fishing effort north of San Francisco. None of the coastal piers from Oregon to Fort Bragg were built expressly for sport fishermen, as are many piers farther south. In contrast to this general situation, several small piers inside and adjacent to Humboldt Bay are fully utilized by sports fishermen during summer and better-than-average catches are taken from them. Miller and Gotshall (1965) estimated that in 1958 Lazio, TPL, and Paladini piers in Humboldt Bay received a total of 8,090 angler-days of effort. Surveys determined that success varied from slightly less than one fish per day at Trinidad pier to almost eight fish per day at Lazio pier, Humboldt Bay. At most other piers from Oregon to Pt. Arguello, the yearly average catch per day ranged from one to three fish.

Most piers in California as well as those in Humboldt Bay are constructed over sand or mud bottoms, so the dominant species are either surf-frequenting forms (such as surfperches), bottom-dwelling forms (such as white croaker, Pacific staghorn sculpin, flat fish and sharks), or surface-feeding forms (such as jacksmelt, true smelts, anchovy and herring). Debris and rocks under or near piers attract rock-frequenting species which occasionally are taken (Miller and Gotshall, 1965).

Occasionally a large concentration of anchovies or herring will enter the inshore area, and contribute added sport to pier fishermen. These concentrations add interest and importance to pier fishing but are secondary to the generally resident species caught throughout each year (Miller and Gotshall, 1965).

Pier fishing owes much of its popularity to the fact that this is the only fishing method that children of all ages, and for the most part unattended, can use safely and cheaply in ocean water. Older children can participate in other fishing methods, but not often in the company of the entire family, which is possible on piers. And, piers are enjoyed by older, retired people who find the comfort of sitting on chairs or benches, or leaning on a rail and chatting, splendid pastime and social activity. Pier fishing also is popular with tourists, since little special equipment or skill is needed. The comforts of a clean, usually dry, place to fish near restrooms, coffee shops, and bait and tackle supply, appeal to tourists and local residents alike (Miller and Gotshall, 1965).

<u>Skindiving</u>

Skindiving is California's newest method of sportfishing. Gotshall (1966) reported 250 man-days of effort annually for Humboldt Bay. New and more efficient diving equipment is being developed constantly, and new adherents are rapidly joining the sport. Skindiving was more or less a rarity 15 years ago in central and northern California. The neoprene diving suit is the primary factor responsible for bringing this sport to waters that rarely rise above $62^{\circ}F$, and can be as low as 45° (Miller and Gotshall, 1965).

The fish most commonly speared by skin divers are lingcod, seaperch, rockfish, kelp greenling and cabezon. Other skindiving activities include abalone picking, urchin collecting, shell collecting, coral collecting, diving for hire, and clamming (Miller and Gotshall, 1965).

Tributary Fishing

A few salmon and steelhead still use bay tributaries for spawning. Elk River is probably the most significant but runs are not large. The present fishing use on bay tributaries is estimated at 3,000 angler days annually. Stream rehabilitation work conducted on Elk River in 1969-70 may improve spawning conditions and increase annual salmon and steelhead runs.

Outlook for the Future

Of all the ocean coast of California, the section from Oregon to Fort Bragg, Mendocino County is the least exploited by sportfishermen; yet, it is relatively rich in fish resources. Shortage of shore access, poor roads, especially during winter, and distance from large population centers, have precluded a rapid increase in fishing effort in this area; in spite of the evidence that it probably has the highest potential within the State for increased recreational ocean fishing (Miller and Gotshall, 1965).

Nature Study

By far the heaviest recreation use of the bay's natural resources are non-appropriative. Such uses come in a variety of forms including nature study, wildlife observation and photography. They are enjoyed by residents and visitors alike, and provide many user days of recreation each year.

The interest in wildlife and ecology has been increasing dramatically over the past decade. The numbers of people who engage in wildlife oriented activities is high as evidenced by the growing membership of such organizations as the Audubon Society, Wildlife Federation and other similar groups.

A local chapter of the Audubon Society was established in Eureka in 1969. Since its inception the membership has grown to over 300.

However, membership in formal organizations is not necessarily typical of those who participate in non-appropriative wildlife uses. Large numbers of people with no organizational ties are enthusiastic students of natural history. The one thing all of these people have in common is the pleasure they derive from observing wildlife.

An even larger segment of the American public enjoys wildlife as a part of their overall outdoor recreation experience. The thousands of tourists who pass through the North Coast country do so primarily to enjoy its natural aspects. The sighting of deer, seals, or a flight of waterfowl can become a very meaningful part of the trip that will be long remembered.

Although we have no way of accurately determining the total non-appropriative use of the bay and its environs at the present time, there are many indications of its magnitude. Studies conducted in San Francisco Bay indicated that non-appropriative uses were at least twice that of the appropriative uses. By applying this same measure to the Humboldt Bay area we could expect the use would be in excess of 135,000 user days annually.

One of Humboldt Bay's unique assets is the egret and heron rookery on Indian Island. The potential this site has to offer for visitors is shown by a similar rookery on land owned by the Audubon Society at Bolinas Lagoon. Audubon officials report up to 30,000 people per year visit the area to view the nesting birds.

The current non-appropriative use of the bay's wildlife is far below potential. The future opportunity for use can be numbered in many thousands of visitor days annually if the resource is properly protected. And, non-appropriative use can provide substantial economic benefits to the county.

Boating

Most boating activity in the bay is associated with commercial or sport fishing, however, pleasure craft use the area to some extent and this use is increasing. One yacht club is active locally. There are three small craft harbors in the bay located at Fields Landing, King Salmon and Eureka. An additional harbor is planned at Arcata and expansion of the facilities at King Salmon is being considered. In addition there are three public boat launching ramps, situated at King Salmon, Eureka and on the Samoa spit near the Coast Guard Station.

The primary reasons that pleasure boat use here has not kept pace with many other areas of the state are weather conditions and low water temperatures. Cold water and cool weather inhibit water skiing and other water contact sports. Rough seas and often rough water in the bay also discourage much boating activity. Although increases in use may be expected, it is not probable that pleasure boating will become as popular as it has in locations where the climate is more favorable.

Scientific and Educational Use

The coastal tidelands are the most used, productive and valuable part of California's ocean shore. The State is now faced with the urgent need to create and implement a management program so that coastal areas can be preserved, developed and used for our continuing benefit.

In a report published by the Coordinating Council for Higher Education (Rechnitzer, 1970), the importance of the tideland resources for scientific and educational purposes is described as follows:

"In depth knowledge is essential to any sound management program. Planning must be based on scientific knowledge. California's institutions of higher education have the responsibility of developing such knowledge. Unfortunately, attempts by higher education to accelerate man's understanding of this regime have been thwarted by the degradation of the tidelands--an educational resource that is considered and used as a vital extension of campus facilities. We still lack much of the knowledge we need to fully assess and predict the effects of man and his modifications of the marine environment.

"Information about the coastal zone is fundamental to the political decisions needed to manage the environment. To apply laws and regulations wisely to the natural environment requires an understanding of what natural conditions govern the environment. Understanding the fundamentals of ecology and the potential impact of man on the environment provides a basis for applying better engineering and technology. Given adequate tidelands resources, higher education can develop the needed scientific and technical information and educate sufficient manpower in marine sciences to satisfy governmental, business, and industrial needs of the State."

Humboldt Bay is endowed with a wealth of natural resources and physical features which make the area highly attractive for educational and scientific purposes. It offers almost unlimited possibilities for the study of natural history, ecology and marine sciences. The close proximity of California State University, Humboldt and College of the Redwoods provides students and teachers alike with opportunities not available to many other institutions.

College of the Redwoods is located within 1/2 mile of South Humboldt Bay. This junior college offers lower division courses in life sciences for many of the natural resource majors who will later attend California State University, Humboldt. The bay is used extensively by the college staff for field trips and as a source for plant and animal specimens. In addition to formal field trips, students use the bay for individual study and for fulfilling class assignments. The combined total for life science classes including Botany, Zoology, General Biology, Field Biology and Wildlife Ecology is estimated by instructors to be in excess of 7,000 student trips annually (Richard L. Ridenhour, pers. comm.).

California State University, Humboldt, is one of the foremost natural resource schools in California. Courses in forestry, range management, oceanography, fisheries management and wildlife management are available to students who seek a bachelor's or master's degree. This university is located in Arcata and is within three miles of North Bay. There are at least 28 classes in the natural resources field, with an annual enrollment total of 1,587 students, which use the bay and its resources for study. The University estimates that approximately 4,822 student trips are within the bay and its environs each year (Richard L. Ridenhour, pers. comm.). Classes not included in the natural resources division, such as zoology, botany, general biology and geology also utilize the area. In addition, there are approximately 15 graduate students in the various disciplines who are doing research on projects involving the bay and approximately 25 undergraduate students doing field study projects annually. There also is a great deal of use of the bay as a source of specimens and materials for use in laboratory work on campus.

High school and grammar school instructors use the bay and its resources for field trips and classroom work. The recent addition of environmental subjects in State schools has stimulated educational interest and a demand for outdoor classroom sessions. The combination of plants, animals, birds and marine organisms within a relatively small area is ideally suited for this type of study. Requests from schools for Department assistance in conducting field trips around the bay for various school classes has increased many fold over the past five years. These field trips have become a regular part of many school conservation programs.

Scientific use of the bay also is made by many governmental agencies, independent foundations and private industry. Studies involving fish, wildlife, plants, geology, pollution, bacteriology, archeology and other fields have been conducted. An indication of Humboldt Bay's contributions to man's scientific knowledge can be seen in the bibliography of technical publications concerning the bay and its resources that has been prepared by the Humboldt Bay Ecological Society. Over 500 publications are recorded.

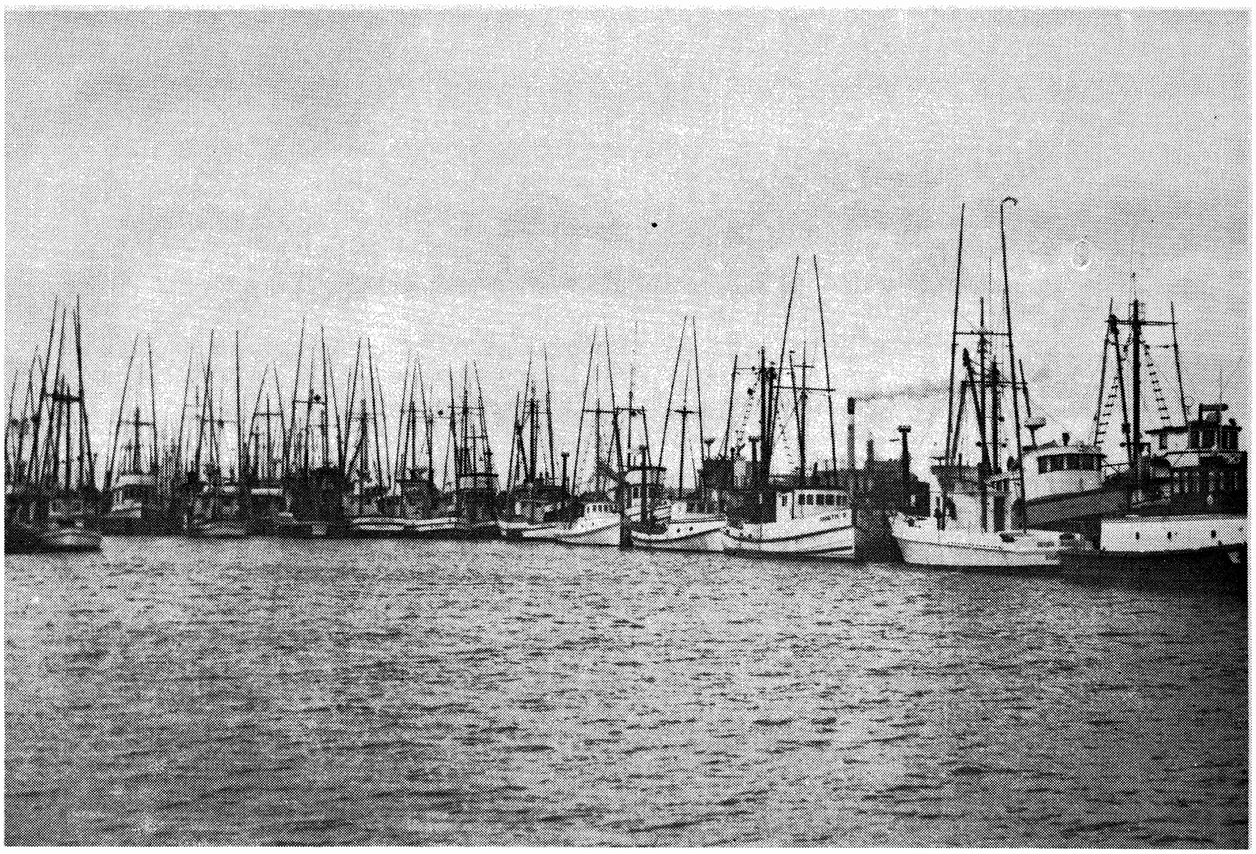
The combined total of all scientific and educational use is estimated to be over 20,000 user days annually. This use will undoubtedly increase as student enrollment and the demand for knowledge increases. The demand for such use can only be met by protecting the remaining resources.

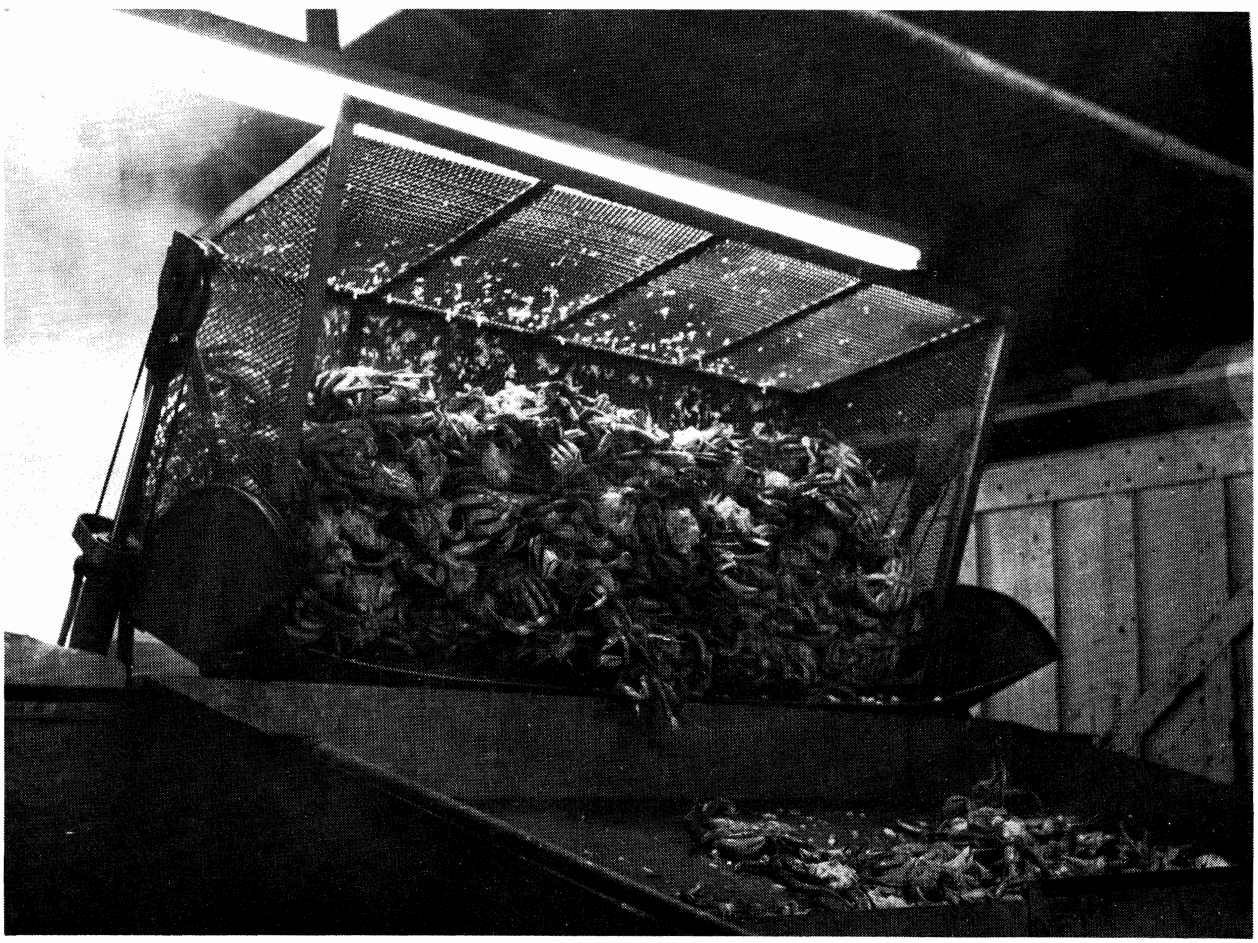
Commercial Fishing

Oyster culture is the largest commercial fishing activity within Humboldt Bay itself. A limited amount of other commercial fishing occurs. Small landings of sea perches are made for local fresh fish markets. Some clams within Humboldt Bay are taken for commercial use, which requires a valid, daily, written order from a dealer or restaurant.

Stocks of fish within Humboldt Bay can sustain additional sport fishing pressure, but cannot support an intensive commercial fishery. The bay serves as a nursery area for commercially significant juvenile fish and shellfish. Humboldt Bay is particularly important as a nursery area for English sole and market crabs. The bay also provides rearing areas for forage species, such as herring and anchovies, which are utilized by commercially important fish.

Commercial fish laws have been enacted to protect brood stock entering the bay, and to protect juveniles of important fish and shellfish and their





Top Photo: Approximately 450 commercial fishing vessels operate from Humboldt Bay.

Department of Fish and Game Photo – December, 1969

Bottom Photo: Crab is a commercially important species and commercial fish landings in Humboldt Bay exceed those of all other California ports north of Los Angeles harbor.

Department of Fish and Game Photo – September, 1972 food supplies. These laws prohibit the commercial taking of salmon and market crabs within the bay or near its mouth. Trawl nets are excluded from Humboldt Bay by a prohibition against use within the coastal three mile limit.

In addition to being a nursery area for commercially important species, such as salmon, crab and English sole, Humboldt Bay provides the harbor for the most important commercial fishing center in northern and central California. Approximately 450 commercial fishing vessels operate from Humboldt Bay, with many more finding refuge there during inclement weather. Eight receiving stations, five processing plants, an animal food plant and a cannery provide employment for 200 to 800 people annually (Smith, 1966). Fishery support facilities supply ice, groceries, fuel, marine hardware, fishing supplies, and vessel services and repairs.

The commercial fish landings of Eureka, including those of nearby Fields Landing, exceed those of all other California ports north of Los Angeles. Although total annual landings at Los Angeles and San Diego are several times greater than Eureka landings, southern California landings are largely composed of fish of the tuna, anchovy and mackerel families; and, some come from distant waters. Eureka is the primary port of landing for fish taken from California's near shore and offshore waters. In 1969, over 26 million pounds of fish and shellfish were landed at commercial fish facilities in Humboldt Bay, including 1 million pounds of salmon, 3 million pounds of market crabs and 17 million pounds of trawl-caught fish (Appendix L).

As population increases, demand for ocean products increases. Smith (1966) estimated that if the north coast area is to maintain its production of 53 percent of California's fresh and frozen seafood commodities, local dealers and fishermen in 1980 must land and process an additional 20 to 22 million pounds. This additional production will require a substantial increase over the current bottomfish harvest of 12-1/2 million pounds, and the creation of new fisheries.

Oysters

Included in Eureka's commercial marine fish catch for 1971 were 692,515 pounds of giant Pacific oyster meat. This represented 70 percent of California oyster production in 1971. The remainder came from Drakes Estero, Tomales Bay and Morro Bay.

The giant Pacific oyster is not native to North America. It requires warmer water than Humboldt Bay offers to successfully reproduce. Although some spawning takes place, the larvae do not survive. Because giant Pacific oysters can be cultured for a profit within the bay, seed oysters are imported from Japan, British Columbia or Washington. In Humboldt Bay they grow to marketable size in 24 to 36 months.

Attempts have been made to raise eastern oysters within Humboldt Bay without success. Eastern oysters were introduced from the Atlantic coast in 1890's, again in 1910, and from 1935 to the early 1940's.

Native oysters grow within Humboldt Bay; however, they are small and, therefore, less desirable as a commercial species than the larger cultured oysters.

Oyster culture began in California in San Francisco Bay in the last century and reached an annual production of 2.7 million pounds before its gradual decline and abandonment in the late 1930's. Failure of the industry was blamed chiefly on industrial and domestic pollution (Barrett, 1963).

When conditions in San Francisco Bay became unfavorable for growing oysters, attempts were made to develop other areas. In the 1930's the Department (then Division) of Fish and Game attempted unsuccessfully to develop a commercial oyster industry in Humboldt Bay based upon the native oyster.

The prohibition of the introduction of giant Pacific oysters, and World War II, delayed the establishment of the current industry. Large scale oystering developed in Humboldt Bay in the mid-1950's, after the ban on using giant Pacific oysters was removed.

With the introduction of giant Pacific oysters, Humboldt Bay's landings fluctuated around 1.4 million pounds of oyster meat annually between 1957 and 1963. After 1963, landings began a gradual decrease, reaching a low of 351,000 pounds in 1969. Landings of 663,000 pounds in 1971 give an optimistic indication that the downward trend is being reversed (Appendix M).

Oyster landings in Humboldt Bay have been limited by a combination of factors. In some years there has been a shortage of seed oysters. Experiments using warmed water baths to "set" larvae from oysters spawned artificially have shown encouraging results. If successful procedures are developed, Humboldt Bay growers will become independent of out-of-state seed sources.

Heavy mortality, particularly in the oyster's second year, has been very damaging to oyster production in Humboldt Bay and in some other California areas as well. Federally financed oyster disease studies have been conducted by the California Department of Fish and Game. The Department is currently experimenting with oysters which appear to possess a resistance to summer mortality.

In some years, following storms, high bacterial counts from sewage and other sources have occurred in the area of the oyster beds. As a result, oyster harvest was suspended until bacterial counts returned to safe levels. Delays during seasons of high oyster demand (particularly during holidays) result in lost sales. Efforts are being made to safeguard water quality within the bay; however, the risk of delayed harvest will remain as long as sewage continues to be discharged into the bay.

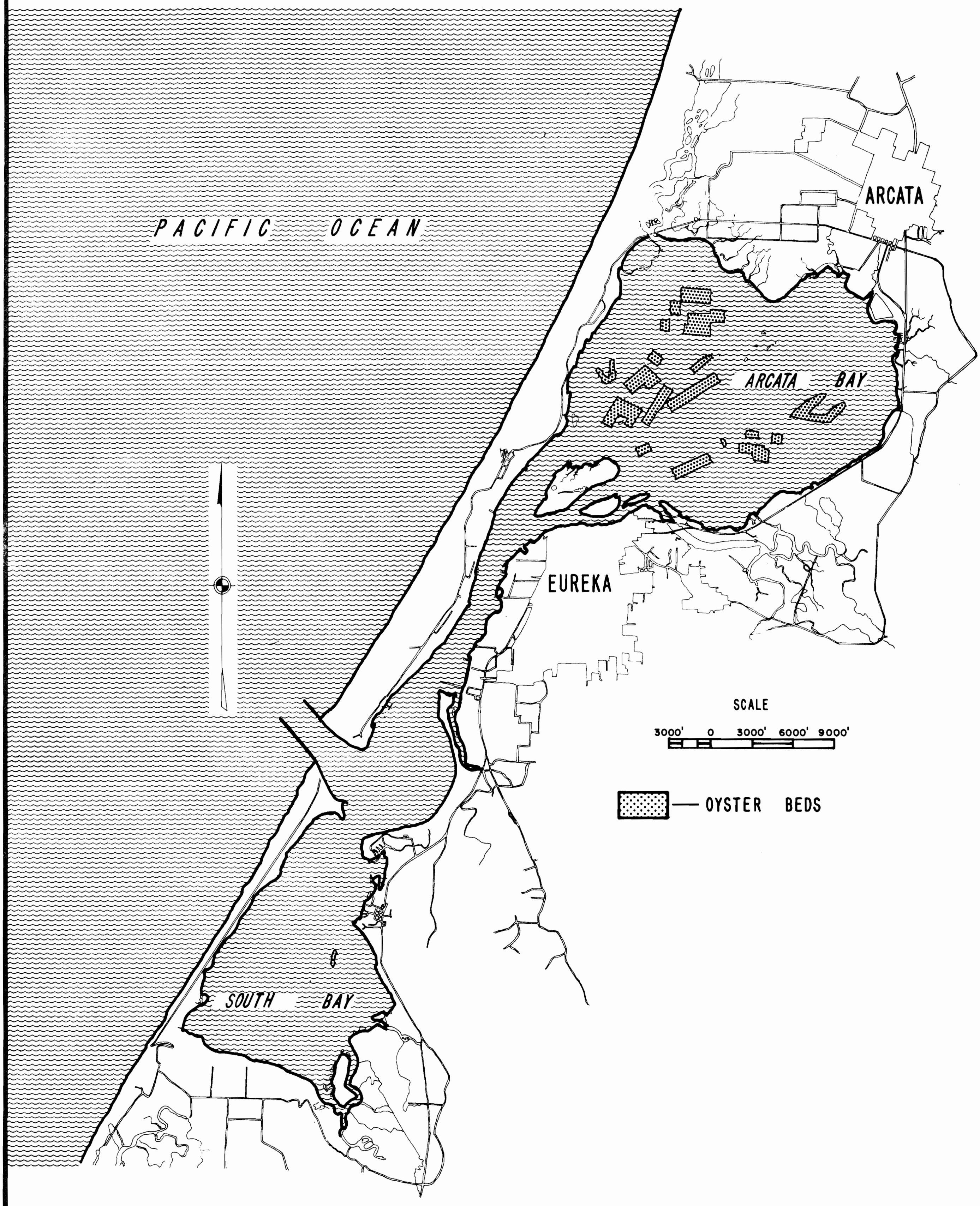
It is assumed that oyster seed supply and oyster mortality problems will be solved, and that water quality will be protected; then, the availability of oyster culture space will ultimately determine the size of the oyster industry in Humboldt Bay. Not all areas under oyster cultivation (Plate 13) are equally good or even suited for oyster culture. When oysters are grown on the bottom of the bay they are planted in shallow, protected waters where defense against destructive bat rays is feasible and where generally calmer waters make working the beds easier. The best areas are near natural channels where conditions are best for feeding; i.e. where strong currents bring fresh food supplies and firm bottoms allow free water circulation. Oysters grown on soft mud tend to sink into it, which inhibits feeding activities and results in reduced growth. During storms, oysters in soft mud are easily buried and lost (Barrett, 1963).

The firmest bay bottoms are composed of sand and mud and are found in areas with strong currents which prevent thick silt deposits. Oyster beds in the vicinity of Bird Island and one farther up the Mad River Channel are among the best examples.

Hanging culture methods are relatively new in California but are mpw used in Humboldt Bay. In this method, seed oysters are "set" on oyster or scallop shells, which are then threaded onto wires and suspended above the bay bottom from wooden racks. The chief advantage of this method is the use of subtidal areas with more water column. There are other advantages, including protection from pests, access at varying tidal stages, improved growth rates and reduced mortality (Water Dahlstrom, 1972, pers. comm.).

PLATE 13

OYSTER BEDS



The use of rack or hanging culture methods allows some areas not suitable for bottom culture to be utilized; but all areas are not equally suitable for these methods either. The continued success of this industry is dependent upon the availability of suitable oyster culture area within the bay.

PROBLEMS AND CONFLICTS

Sedimentation

Sedimentation is a normal and continuing process throughout the life span of any estuary. This process created the estuarine characteristics of Humboldt Bay and will continue to mold its character in the future. Current and potential problems from accelerated sedimentation are largely the result of man's activity.

When settlement of the area began, both Arcata and South bays were deeper, particularly in the natural channels and tributary sloughs. A major harbor serving ocean-going vessels was located at Arcata until sometime after the turn of the century. Today large ships cannot navigate Arcata Bay because of siltation (sedimentation of fine silt) which occurred over a period of about 50 years.

The causes behind the acceleration in sedimentation in Humboldt Bay can be traced to several factors, the most important of which is logging. The period of most extensive logging activity within the bay's drainage basin coincided with the period of greatest siltation. As timber was removed, erosion increased the silt load carried by tributaries and the silt was eventually deposited in the bay. But, it has been many years since the area experienced logging operations as intensive as those of the 1800's and early 1900's. New forestry practices and re-vegetation programs by a concerned logging industry have reduced the stream silt load. As a result sediment deposition in the bay has probably been slowed.

Another factor in sediment problems has been the loss through reclamation and land fill of extensive salt marshes which occupied much of the lowland areas. These marshes probably acted as an effective filtering system for removing particulate matter from run-off waters. Today the silt laden waters are carried directly to the bay through well defined channels. Because of the relatively high water velocities the particles are held in suspension until they reach the bay and settle out.

Other activities which disturb vegetation and soils and thereby contribute to erosion and siltation include road construction, subdivision projects and intensive livestock grazing.

Another form of siltation which may be deleterious to animal life comes from dredging operations within the bay. Dredging is conducted regularly in the main navigation channels by the U. S. Army Corps of Engineers to maintain water depths. Unless dredging and spoil disposal operations are conducted with great care, resuspended sediments may cause excessive turbidity in the water column and possibly smother the bottom invertebrate organisms. Land deposition of spoil from dredging operation can produce similar effects if it is placed in areas where it can erode or flow back into the bay. In addition, spoils placed on marsh lands can seriously reduce valuable wildlife habitat. Careful controls over bay dredging and spoil deposition should continue to be exercised through Federal and State public notice and permit procedures.

Unfortunately little is known about current siltation rates and their effects on the bay's ecology. The problem is recognized, but generally only as it affects commercial uses of the main navigational channels. There is a definite need to gain a better understanding of siltation as it relates to all aspects of the bay's resources and use. However, recognition and understanding of the problems will be of little value without adequate solutions. While some positive methods for controlling sedimentation have been recognized, such as green belt buffer strips and keeping roads away from stream beds, it is obvious that additional studies will be necessary to achieve a better understanding of the problems and their solutions.

Until viable long-term plans can be developed, interim measures should be initiated to help reduce the silt inflow through a better program of watershed management. To be effective, broad controls over land use practices are needed. The major thrust should be toward reducing erosion from logging operations, road building, land subdivisions or other causes. The amendments to the Water Quality Control Plan adopted by the State Water Resources Control Board in September 1972 are one such interim measure. These amendments relating to logging and construction activities are as follows:

a. The discharge of soil, silt, bark, slash, sawdust, or other organic and earthen materials from any logging, construction or associated activity of whatever nature into any stream or watercourse in the basin in quantities deleterious to fish, wildlife and other beneficial uses is prohibited.

b. The placing or disposal of soil, silt, bark, slash, sawdust or other organic and earthen materials from any logging, construction, or associated activity of whatever nature at locations where they may be washed into streams or watercourses of the basin by rainfall or runoff in quantities deleterious to fish, wildlife and other beneficial uses is prohibited.

Implementation and enforcement of such prohibitions will assure better protection of fish and wildlife.

Contamination and Pollution

Definition

The terms "contamination and "pollution" are often used incorrectly by the general public. The two terms must be defined to provide a better understanding of the water quality problems existing in Humboldt Bay, since the problems involve both "contamination" and "pollution."

The State Water Code (Section 13005) defines water contamination "an impairment of the quality of the waters of the State by waste to a degree which creates a hazard to the public health through poisoning or through the spread of disease." The same code section defines water pollution as "an "an alteration of the quality of the waters of the State by waste to a degree which unreasonably affects: (1) such waters for beneficial uses or (2) facilities which serve such beneficial uses."

As an example, when a public health agency prohibits taking shellfish from a body of water "to protect the public health," it is a matter of contamination. On the other hand, disposal of waste materials which adversely affect domestic or industrial water supplies, navigation recreation, aesthetic enjoyment, the well-being of fish and wildlife resources or their habitat, or any other beneficial use of the water, constitutes pollution.

The effects of contamination and pollution can significantly influence the utilization of, and/or the well-being of, aquatic and wildlife resources. For example, contamination of Humboldt Bay waters from inadequately treated domestic wastes and other sources currently limits commercial shellfish operations and at times has placed serious doubts on whether the public should consume shellfish collected from several sport shellfish areas. It should be emphasized that contaminating organisms may have little, if any, effect upon the actual well-being of the shellfish. The problem arises from the tendency of filter-feeding shellfish such as clams and oysters to accumulate organisms, some of which may be pathogenic, in their bodies. The shellfish is apparently unharmed by this accumulation. Conversely, other pollutants such as heavy metals, are also concentrated by shellfish in their tissue. Their concentrated pollutants may exert harmful effects on the shellfish themselves and on food chain organisms, including man, that feed on the shellfish. In either case, the well-being and/or use of shellfish resources can be adversely affected by inadequately treated or improper waste discharges to Humboldt Bay.

Sources

Contaminants and pollutants in Humboldt Bay originate from four major sources: direct discharge of substances to bay waters from shore-based industrial and municipal facilities, septic tank overflows and leach field failures, direct discharge of wastes and other materials to bay waters from ships, and storm runoff which carries loads of dairy wastes, silt and other materials.

In 1968 the Department of Fish and Game conducted a survey to catalog all known outfalls discharging materials from adjacent lands to the bay (Klein, 1968). The study was carried out by walking the entire shoreline at low tides. A total of 63 outfalls was reported, including storm drains as well as outfalls from municipal and industrial operations. Most of these drains were found along the Eureka and the Samoa Peninsula waterfronts. Some of the pollution problems originating from these outfalls are attributed to accidental spills. In other cases the problems arise from deliberate pollution. A discussion of discharges contributing to pollution is combined in a subsequent section of this report.

During the past several years the State Department of Public Health has pinpointed several areas in which septic tank overflows and leach field failures have occurred (California Department of Public Health, 1966, 1967, 1968). These failures have been noted in the Eureka area, Fields Landing, Arcata Bay area and along the Samoa Peninsula. In addition, the Health Department has recorded that raw or inadequately treated sewage has entered the bay from the Arcata treatment plant and from the three lagoon systems in the South Bay area. As pointed out earlier, most of the septic tank overflows, leach field failures and discharges from overloaded treatment plants occur in the winter months during and following heavy rainstorms. As a consequence, a significant load of sewage-born bacteria is placed in bay waters at the time when shellfish are being harvested. Although some progress has been made toward elimination of inadequately treated sewage discharges to the bay through construction of additional facilities, the threat of bacterial contamination currently is the most serious water quality problem in Humboldt Bay.

The discharge of wastes and other materials from ships often contributes to the pollution of Humboldt Bay waters. A particular problem is the deliberate discharge of waste oil during bilge cleaning operations. Although this practice is illegal, it is difficult to trace offenders. For example, since 1957, an unknown total, but large number of oil spills has occured in the bay, but the Department of Fish and Game has been able to apprehend only four offenders.

Periodically, accidental ship spills occur and considerable amounts of oil are spread throughout the bay. Under certain circumstances these spills could lead to disastrous effects on aquatic and wildlife resources. Such was the case of a large accidental oil spill in 1968. The spill was responsible for loss of a large number of waterfowl and shorebirds, tainting of oysters to the extent that they were unmarketable and, perhaps, contributing to an abnormally high mortality of shellfish. Shellfish losses could not be positively proved but high mortalities of oysters did occur in the weeks following the spill.

Waste Disposal Practices

Sanitary Wastes

Presently there are eight community sewage treatment and disposal systems which discharge to the bay (Calif. RWQCB - North Coastal Region, 1970). Most of the heavily populated areas around the bay are provided with community sewers and sewage treatment and disposal works.

City Of Eureka Systems

The City of Eureka maintains three sewage treatment plants which all discharge treated effluent into Humboldt Bay (Table 5). An Interim Basin Plan for the North Coastal basin, amended and adopted December 13, 1972, states that the consolidation of waste treatment facilities of the City of Eureka will efficiently achieve water quality objectives for Humboldt Bay. This program should include the following steps:

a. Phase out the overloaded McCullen Street Sewage Treatment Plant and the Hill Street Sewage Treatment Plant with diversion of these flows to the Murray Street Sewage Treatment Plant.

b. Construct facilities at Murray Street Sewage Treatment Plant needed to meet the current water quality objectives in the Board's Interim Basin Plan.

c. Upgrade Murray Street Sewage Treatment Plant to provide for "secondary" treatment pursuant to Federal and State requirements with consideration for reclamation-reuse, continued bay discharge, and/or ocean discharge.

City of Arcata System

The City of Arcata's sewage treatment facility is a primary treatment plant which discharges to a 55-acre oxidation pond on the edge of Humboldt Bay. Information on this plant (North Coastal RWQCB, 1967) is as follows:

Waste Flow (Average Daily):
Dry Weather - 0.9-1.0 million gallons per day (mgd)

Storm Periods - 3-6 mgd

Design - 2.6 mgd

Flow Sequence:

Comminution, grit removal, aeration, clarification, oxidation pond, chlorination

Flows greater than 1.4 mgd are by-passed to the oxidation pond. The addition of chlorination facilities to the Arcata plant in 1966 was a significant step toward improving the bacterial quality of the bay. Bacteriological

TABLE 5

CITY OF EUREKA WASTE TREATMENT FACILITIES *
Flow data in terms of million gallons per day (mgd)

	Treatment Plants		
	Murray Street	McCullen Street	Hill Street
Waste Flow			
Dry Weather (mgd)	2.0	0.40	0.6
Storm periods (mgd)	8.0 - 10.0	0.75 - 1.50	1.7 - 2.7
Design flow (mgd)	10.0	0.40	1.09
Flow Sequence			
Grit removal	1		
Comminution	2	1	1
Prechlorination	3		
Clarification	4	2	2, 5
Trickling filtration			3
Chlorination	5	3	4, 6

* Modified from data provided by North Coastal Regional Water Quality Control Board (1967).

TABLE 6

HUMBOLDT BAY LAGOON TREATMENT SYSTEMS*

District	Lagoon Size (Acres)	Population Served	Estimated Flow (gpd)1/
South Bay County Sanitation District	1.4	424	38,000
King Salmon County Sanitation District	2.0	460	42,000
Seaview Manor County Sanitation District	2.0	518	47,000

* Modified from data provided by California Regional Water Quality Control Board - North Coastal Region (1970).

1/ Gallons per day.

testing has shown that Arcata's effluent meets standards except at times of heavy runoff when leaky collection lines overload the treatment plant. Arcata is currently involved in an extensive construction project which will increase treatment capacity and reduce winter infiltration. The project also will provide sewage facilities to areas which formerly had inadequate septic tank facilities and thus should improve the bacterial quality of several streams which empty into the bay.

College of the Redwoods System

Wastes are treated with an activated sludge facility, chlorinated and discharged to Whites Slough, and thence to South Humboldt Bay. The facilities are designed to accommodate 3,000 persons. The results of effluent monitoring indicate that the treatment facility is performing satisfactorily (Calif. RWQCB - North Coastal Region, 1970).

Lagoon Discharge Systems

Presently there are four sewage lagoon systems in the area immediately adjacent to Humboldt Bay. One of them is quite small and operates with an infrequent overflow. The three major lagoon systems (Table 6) are located adjacent to the bay in the area south of Elk River and they are owned and operated by three separate county sanitation districts. All are under the jurisdiction of the Humboldt County Board of Supervisors.

Of particular interest regarding the above-mentioned lagoon discharges is a study conducted by the Department of Public Health (1969). The study was conducted to determine the influence of the lagoon discharges on the bacterial quality of shellfish being taken for human consumption. The conclusions were: (1) clams and overlying growing waters were of unsuitable quality for the safe harvesting of edible shellfish in areas adjacent to the effluent discharge, and (2) the public should be warned about taking clams in these areas until improvements are made. The Health Department recommended chlorination and the lagoon systems have performed satisfactorily since chlorination was initiated.

It is proposed that the King Salmon, Sea View Manor and South Bay Sanitation Districts (Table 6) be consolidated along with some adjacent areas to form Humboldt County Service Area #3, which will operate the King Salmon facilities. The Sea View Manor plant will be eliminated by the construction of an interceptor to the King Salmon plant. The new facilities also will serve some areas which are unserved at present. The King Salmon oxidation ponds will be deepened and surface aeration installed to provide a design capacity of 0.4 mgd (RWQCB - Order No. 72 - 52, August, 1972). Bay disposal of the waters is proposed either through the P. G. & E. outfall or through an outfall to Hookten Channel.

Chlorine Toxicity

Disinfection of sewage effluent is necessary in Humboldt Bay to assure that public health standards are maintained to protect the beneficial use of shellfish harvesting. However, disinfection with chlorine, an extremely toxic compound, has resulted in an increase in toxicity of municipal wastes and a release of toxic residual chlorine and chloroamines into the environment. As a result strict standards are necessary to assure that chlorine-induced toxicity is not a serious environmental hazard. The North Coast Regional Water Quality Control Board has recognized this problem and has adopted waste discharge requirements for maximum chlorine residuals in municipal waste discharges to Humboldt Bay. These requirements will necessitate more efficient and reliable chlorination practices and encourage dechlorination of effluents prior to discharge.

Industrial Wastes

There are a number of intermittent and continuous industrial discharges around Humboldt Bay, most of which are located along the Eureka waterfront and the Samoa Peninsula. These discharges are from a variety of sources, including fishing boats, cargo vessels, wash water from fish receiving and processing areas, lumber processing plants, rendering operations, a power generating plant, and garbage and refuse dumps.

The report of the waste outfall inventory conducted by the Department of Fish and Game was forwarded to the North Coastal Regional Water Quality Control Board for action (letter report dated February 1, 1969). Subsequently, the Board investigated each of the outfalls and has directed corrective actions, which are now complete or underway. As a follow-up, staff members of the Regional Board conducted a second low-tide walk-around in February, 1970 to define areas requiring additional correction (Calif. RWQCB - North Coastal Region, 1970). Discharges and potential problem areas, which were noted by the RWQCB at that time, are grouped by categories below.

Petroleum Storage Facilities

There are at least six petroleum terminals situated near the shoreline of Humboldt Bay. Each poses a potential for accidental discharge to the bay. Such an incident occurred in November, 1968, when 85,000 gallons of diesel fuel escaped into the bay. Results of this spill included extensive waterfowl losses and tainting of shellfish and commercial oyster beds.

Forest Products

Over six miles of bay frontage is occupied by forest products manufacturing, storage or transportation operations. The following process discharges were observed during the February, 1970 field work:

Samoa

1. Overflow of highly-colored glue waste from inadequate treatment-reuse facility at plywood plant.
2. Water-borne sawdust from pipe draining study mill area.
3. Hydraulic log de-barker effluent from plywood plant. The effluent is highly colored.
4. Condenser cooling water from powerhouse serving operations at Samoa.

Mad River Slough

1. Log ponding operation in slough contributing large quantities of bark and debris to the bay.

Other log ponds and holding areas are located in Eureka Slough, and at Eureka.

Characteristic of log stoarage areas along the bay frontage is the deep layer of bark and other debris that has accumulated over the many years of wood processing operations. Continuous wave action and lack of effective bulkheads allow erosion, permitting such materials to be carried by tide and wind to other areas of the bay. In addition to being unattractive, waste wood materials may blanket shellfish habitat, reduce dissolved oxygen, stimulate aquatic plant growths or release toxic components. The effect of this practice in Humboldt Bay has never been evaluated.

Fish Processing Facilities

Numerous seafood processing plants along the bay shore operate at various intensities depending on season and market conditions. Most of the plants discharge floor and table wash water which includes particulate organic material and shell. The major operations are:

1. Humboldt Bay Fisheries, Eureka
2. Coast Oyster Co., Eureka
3. Lazio Fish Co., Eureka

4. Eureka Fisheries, Eureka

5. Paladini Fish Co., Eureka

6. Nor-Cal Fisheries, Eureka

Some fish scrap material may be discharged to the bay, however, most of these wastes are converted into mink food or disposed of at a rendering plant. Periodically, the discharge at the Fields Landing plant causes local discoloration of bay waters.

Rendering Plants

Rendering plant liquid-wastes are discharged from the Eureka Tallow Works into Elk River Slough. A field check in 1970 confirmed that the plant was in violation of current waste discharge standards. Subsequently, waste discharge requirements have been modified and new treatment facilities are being designed to meet newly-adopted requirements.

Ship and Boat Wastes

Sewage and other ship and boat waste are discharged to the bay at all docking and moorage areas. Nation-wide action to alleviate this type of pollution threat is aimed at requiring dockside sewerage facilities, ship-to-shore hook-ups, and use of holding tanks. State-supported marina construction now requires facilities to transfer wastes from boats equipped with holding tanks. Such facilities have not yet been provided at Humboldt Bay.

Pacific Gas and Electric Plant

The Humboldt Bay Power Plant is located at Buhne Point. Cooling water (150 mgd) for this facility is drawn from the bay north of Buhne Point and discharged to the south into the King Salmon Channel. The thermal effect of this cooling water effluent is limited to a temperature increase of less than 2°F in the receiving waters. Part of the generating capacity of this power plant is provided by a nuclear reactor. The plant operates under very strict waste discharge requirements and radiation standards. Analysis of the monitoring reports and detailed checking by the State Department of Public Health, Bureau of Radiological Health confirms that standards are met at all times.

Periodically the reactor cooling system is cleaned with potassium chromate. Following this treatment, the waste solution is discharged to Humboldt Bay at a concentration of 0.067 mg/l or less. Since this practice was initiated there has been no overt evidence of toxicity in bay waters, however, the effects from such discharges have not been subjected to a comprehensive examination.

Garbage and Refuse Dumps

Several dumps are receiving use at sites near the bay shoreline:

1. Near Arcata an 80-acre site receives about 55 tons per day of most classes of materials. The dump site is within an area separated from Arcata Bay by a levee. Tide gates allow drainage and runoff from the dump to enter the bay. The risk of disposing toxic or hazardous compounds at this site is quite high.
2. Humboldt County operates a dump near Table Bluff at a site about one-half mile from the bay. The dump covers about one acre and receives about ten tons of solid wastes per day. Drainage and runoff from the site flows into South Humboldt Bay without control.
3. At the old Simonson Mill, between Eureka and Arcata, mixed refuse is dumped into a slough tributary to Arcata Bay. Although not used routinely, the dump is subject to future increased use, which may cause problems.
4. At the foot of Hilfiker Avenue in Eureka, a solid waste dump consisting of discarded concrete products was noted in a survey conducted by

the staff of the Regional Water Quality Control Board in February, 1970. Since then a significant amount of the disposed material has been removed.

Agricultural Wastes

At the request of the County Sanitarian, the Department of Public Health conducted a survey to determine contribution of dairy wastes to contamination of Humboldt Bay (pers. comm., Humboldt Co. Sanitarian, 1970). It was concluded that contamination of bay waters from cattle wastes was rather insignificant. As a rule, ranchers do not permit barn wastes to accumulate in areas where they would pass into bay tributary drainages. It is their usual practice to collect and mix with sawdust and redistribute the wastes on their lands. Of course, it is inevitable that some wastes reach bay waters. Perhaps the greatest contribution of these wastes to the quality of bay waters is in the form of nutrients which leach from the land and pass into the drainage systems. The value of this contribution is unknown. Agricultural waste is a source of coliform bacteria which may confuse bacterial analysis of shellfish and water.

The lands adjacent to Humboldt Bay not being utilized for agricultural purposes other than livestock grazing are not subject to great pesticides use (pers. comm., Humboldt Co. Sanitarian, 1970). Pesticide use is limited primarily to control of noxious weeds with herbicides. The most commonly used herbicides are Simazine, 2,4-D and amino triazole. Approximately 90 percent of the herbicide spray programs are conducted by the Humboldt County Agriculture Commissioner's office.

Study results show that the relative level of pesticide contamination in Humboldt Bay reflects low agricultural use in the area. During 1966 and 1967 oysters from commercial beds were analyzed for chlorinated hydrocarbon content. The study was part of a federal program designed to determine the seasonal and geographic variation of organo-chlorine residues in estuaries (Modin, 1969). Two stations were established in Arcata Bay from which samples were collected from January, 1966 through December of 1967. The samples were analyzed for DDE, DDD and DDT. Results of the study showed that pesticide content in Humboldt Bay oysters is very low, remaining mostly below ten parts per billion (ppb). The highest value observed was 30 ppb. In contrast, oysters collected adjacent to extensive agriculture areas from other locations in the State contained chlorinated hydrocarbon levels as high as 3,600 ppb. The very low levels in Humboldt Bay may originate from general home and garden use of pesticides.

Logging Wastes

The water drainage area tributary to Humboldt Bay consists of approximately 288 square miles. The principal streams are Freshwater Creek, Elk River, Salmon Creek, Jacoby Creek and Mad River Slough. The forests in these drainages are composed primarily of redwood and Douglas fir, prime timber of past and present logging operations. Historically, logging probably had a tremendous influence on the quality of bay waters. It is known, for example, that some of the operations created severe siltation problems which undoubtedly extended into the bay. Once in the bay the lighter soil particles tend to remain in suspension and thereby affect productivity of the bay's living resources through curtailment of light penetration. Sunlight is essential for the growth of aquatic plants which form the base of the food chain. In contrast, the heavier particles tend to settle, thus covering and reducing bottom habitats necessary for the development of bottom-dwelling organisms. Basic nutrients attendant with the silts and sediments also entered bay waters, although the effect of such substances probably was more beneficial than detrimental to the overall ecology.

In recent years the intensity of logging in the watersheds has been rather low. The remaining forests stripped of old growth trees decades ago do not offer opportunities for large scale operations. Furthermore, increasing concern for the environment by the logging industry has led to improved method of operations.

The pesticide endrin is used to some extent in the drainages during reforestation. Endrin is applied to the seeds of conifers prior to application, at a concentration of about one percent by weight. Pesticide use is subject to strict controls administered by the Humboldt County Agriculture Commissioner's Office. The total amount of endrin used has been rather small and has never been detected in fish and wildlife from the bay by Department of Fish and Game monitoring efforts.

Water Quality Control Planning

In 1967, the North Coast Regional Water Quality Control Board adopted a Humboldt Bay Water Quality Control Policy (Calif. NCRWCB, 1967). The policy, developed in response to 1965 State and Federal Legislative action, outlined the beneficial uses (Table 7) for the bay waters. This 1967 policy has served as the framework for Water Quality Control Planning for Humboldt Bay.

The creation of the State Water Resources Control Board and the adoption of the Porter-Cologne Water Quality Control Act in 1970, issued from the need for a long-range, balanced plan for water quality management throughout California.

To comply with the Porter-Cologne Water Quality Control Act and to satisfy federal and state requirements for construction grant programs the Regional Board prepared an Interim Water Quality Control Plan. The overall objective of the interim plan was to set forth a definitive program of action designed

HUMBOLDT BAY

BENEFICIAL WATER USES TO BE PROTECTED

Table 7

Classifications of Beneficial Water Uses	Extent of Use Present	Extent of Use Foreseeable Future
SCENIC ENJOYMENT	Moderate	Increasing
WATER-ORIENTED RECREATION		
Sport Fishing	Significant	Increasing
Hunting	Moderate	Increasing
Water-Contact Sports	Moderate	Increasing
Shellfish Gathering	Significant	Increasing
NATURAL RESOURCES		
Fish and Aquatic Life	Significant	Increasing
Wildlife	Significant	Increasing
Shellfish	Significant	Increasing
COMMERCIAL FISHING	Significant	Increasing
COMMERCIAL SHELLFISH CULTURE	Significant	Increasing
NAVIGATION	Significant	Increasing
INDUSTRIAL WATER SUPPLY		
Cooling Water	Significant	Increasing
Process Water	Moderate	Increasing
EDUCATIONAL STUDY	Moderate	Increasing

to preserve and enhance water quality and protect beneficial water use in a manner which would result in maximum social and economic benefits to the people of the state (NCRWQCB, Interim Plan, 1971). The interim plan was adopted in 1971 and has subsequently been revised as needs and policies have dictated. The fully developed plan, scheduled for adoption in 1973, should provide the conceptual plans for wastewater management in Humboldt Bay and insure the protection of all beneficial uses, including the fish and wildlife resources, their use and users.

Another program of importance to Humboldt Bay water quality problems is the mid-Humboldt County Water, Sewage and Drainage Plan. This plan was developed by an independent planning and engineering firm under the direction of the Humboldt County Association of Governments. Financial support of the project is through the Housing and Urban Development (HUD) and the Federal Water Quality Administration (FWQA) grant programs. The goal of the plan is to consolidate all waste flows and treat these wastes in a single large facility and finally discharge the effluent from a single point on the Samoa Peninsula. Much of the information and recommendations generated in this Water, Sewage and Drainage Plan was used in preparing the final water quality control plan which was scheduled for adoption in July 1973.

Harbor Development

Historically, the bay has seen many changes, many of them ecologically undesirable. Channels have been dredged, tidelands filled and piers, docks and service buildings constructed with little or no regard for the bay as a natural resource. There has never been a single administrative entity charged with overall responsibility for development of Humboldt Bay.

The first attempt at orderly planning for bay development began in 1967, when the cities of Eureka and Arcata, in cooperation with Humboldt County, formed the Humboldt Bay Development Commission. This body was given responsibility to study the bay and its resources and to determine what course of action would be most acceptable. As a result recommendations were made for enacting special legislation to form the Humboldt Bay Harbor Recreation and Conservation District. Legislation was passed by both houses of the State Legislature in 1970. Under this proposal a board composed of both appointed and elected commissioners would be responsible for harbor development, recreation and conservation, with complete authority over all bay projects. The enabling legislation includes a "burden of proof clause" requiring potential developers to show proof that any project proposed will not significantly affect the bay's ecology. In 1972 the district was officially adopted by the people of Humboldt County by public vote. Hopefully the new Harbor Commission will be a key factor in preserving the natural resources of the bay through wise land and water use planning.

Current harbor maintenance is performed by the U. S. Army Corps of Engineers, including the dredging of the entrance channel, the shipping channel to Fields Landing and the Samoa Channel north to Eureka. Dredging does not in itself pose significant threats to the fish and wildlife resources of the bay as long as it is confined to these channels and precautions are taken to control siltation. The deposition of dredge spoil, however, is a problem. Some would like to see this material used for filling marsh and mud flat areas and it has been used for this purpose in the past. In 1966 proposals were made to use spoil dredged from the Samoa Channel to fill Indian Island. Fortunately these plans were dropped and an alternate site was selected after opposition was voices by the Department of Fish and Game, U. S. Fish and Wildlife Service and conservation organizations.

Cargo shipping in Humboldt Bay is expected to require three hundred or more vessel trips in the next decade, according to the Humboldt Bay Development

Commission Report. If additional facilities are necessary to accommodate shipping they should be developed along the Samoa Channel between Fields Landing and Eureka where adverse ecological effects will be minimal. Where dredging is involved, careful consideration should be made concerning spoil deposition site selection. Existing marshlands and mud flats should not be used for this purpose.

Small boat harbor facilities are presently available at Fields Landing, King Salmon and Eureka. At Fields Landing the emphasis is on ship reconditioning rather than berthing, although a few boats are berthed there. Approximately 110 berths are located at King Salmon. The Eureka Boat Basin has 138 berthing spaces and is the only public marina. Public boat launching ramps are located at Fields Landing, Eureka and the Samoa Peninsula. Private boat launching service is available at King Salmon. Only 141 of the total berths (2,481) are for pleasure boats; the remainder is used by commercial fishing vessels.

There are now more than 4,000 registered boat owners in Humboldt County; 3,600 of them live within 25 miles of the bay. There are another 200 plus fishing boats registered with the U. S. Customs in Eureka. Ninety percent of all boats are under 18 feet in length, and are powered by outboard motors.

At present existing facilities are not capable of meeting the demand for berths. This lack of facilities probably discourages ownership of larger pleasure boats that require storage and special servicing. Use projections indicate that both pleasure and fishing boat numbers will increase. In order to meet future demand, additional berthing spaces will be needed.

The City of Arcata has begun development of a small craft harbor in Arcata Bay near McDaniel Slough. A navigation channel approximately 5,500 feet long, to connect the harbor to the Arcata Channel, has been dredged. A land fill of about 45 acres superimposed on the mud flats is under construction. A deep water harbor of 12.5 acres will be dredged and confined by mud dikes. Initial plans call for berthing of 265 boats with provisions for future expansion.

The City of Eureka also plans to construct another marina. Originally this marina was to be situated on Indian Island which would have posed serious threats to wildlife and caused significant salt marsh habitat loss. However, a special committee created to study possible uses of the city-owned island recommended that Indian Island be preserved as a natural area and ownership transferred to the U. S. Fish and Wildlife Service. A resolution to this effect was passed by the Eureka City Council in 1969. No new proposals as to location or design have been decided upon at this time.

The Department of Fish and Game recognizes the need for providing adequate small craft harbor facilities to accommodate commercial fishing and pleasure boating and to provide access to the bay's natural resources. However, such developments, if not carefully planned and controlled, can destroy the very resources upon which most of the boating use depends. When other suitable sites are available, the filling or dredging of mud flats and marshlands which are essential to fish and wildlife, is not in the best long range public interest and should not be considered. Many of the problems can be avoided if the project developers involve the Department and other conservation agencies in the earliest planning stages. If resource problems are not resolved beforehand, the developer may be faced with state and federal opposition to his project.

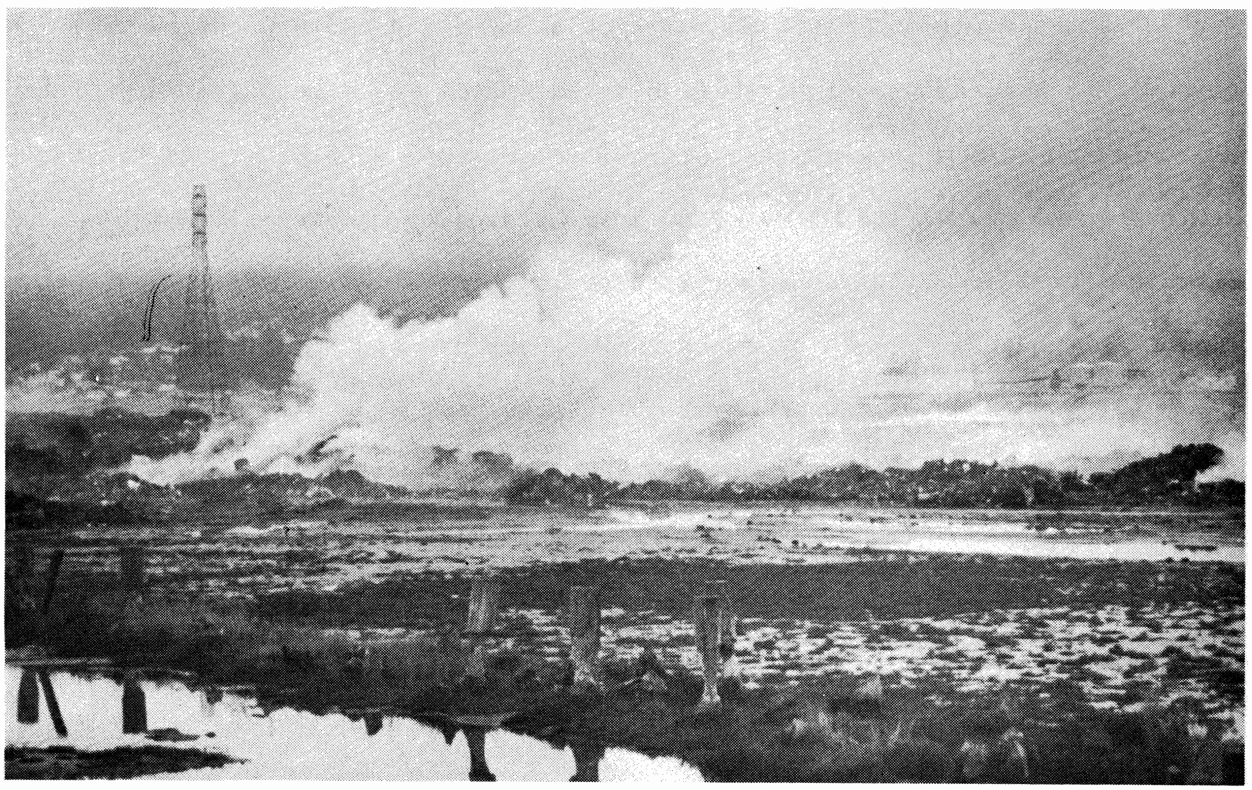
Through the cooperation of all parties, both public and private, marinas can be developed to meet the public need without undue ecological damage. The Department will cooperate with all entities to insure the best possible solutions; and, at the same time, will exercise its responsibility for fish and wildlife protection in any and all cases which may be detrimental to the resource.

Urban and Industrial Expansion

One of the greatest hazards to fish and wildlife preservation is the unplanned and uncontrolled sprawl or urban and industrial development that has been experienced on Humboldt Bay as well as in other areas of the State. The problems are evidenced by the rapid expansion of housing tracts and commercial enterprises into the most important agricultural lands adjacent to the bay. Not only are these areas a valuable part of the county's agricultural economy, and an important food source for the human population, they are also an integral part of the bay environment. These lands, and their associated freshwater marshes, provide a major share of the food consumed by waterfowl. They also provide habitat for shorebirds, wading birds and many other forms of wildlife. Loss of the agricultural lowlands would result in immeasurable damage to the biological resources of the area.

In the bay many areas of valuable fish and wildlife habitat have been destroyed by land fill to create commercial or industrial sites. Two such areas were developed along the east side of Arcata Bay and are now occupied by lumber mills. They are isolated industrial sites situated well apart from any other industries and are prime examples of unwise land use. Not only have they resulted in wildlife loss, they also impair vision of the bay from Highway 101 which carries most of the tourist traffic. These industries would be more properly situated in well-planned complexes designed specifically for industrial use. Many such sites are available where natural resources and esthetics would be less effected.

Currently the City of Arcata is creating a 45-acre fill in Arcata Bay by using it as a refuse dump. Another refuse dump fill is located adjacent to Highway 101 near Brainards Cut. At Fields Landing in South Bay several acres of salt marsh have been filled to create space for decking logs. In at least



Top Photo: Many areas of valuable fish and wildlife habitat in Humboldt Bay have been destroyed by land fills to create commercial or industrial sites.

Bottom Photo: Refuse dumps are another example of the steady encroachment into the bay's wetland habitat and open spaces.

Department of Fish and Game Photos – December, 1969 one case, filling has been done illegally without required Corps of Engineers' permits (U. S. Army Corps of Engineers, pers. comm.).

The Humboldt Bay Bridge was another project which involved filling of both mud flats and salt marsh, and a small freshwater pond which received heavy waterfowl use also was lost. Although modifications were made to keep the bridge 800 feet from the egret and heron rookery on Indian Island, there is no guarantee that the distance will be sufficient to prevent disturbance to the rookery or that the birds will continue to nest there.

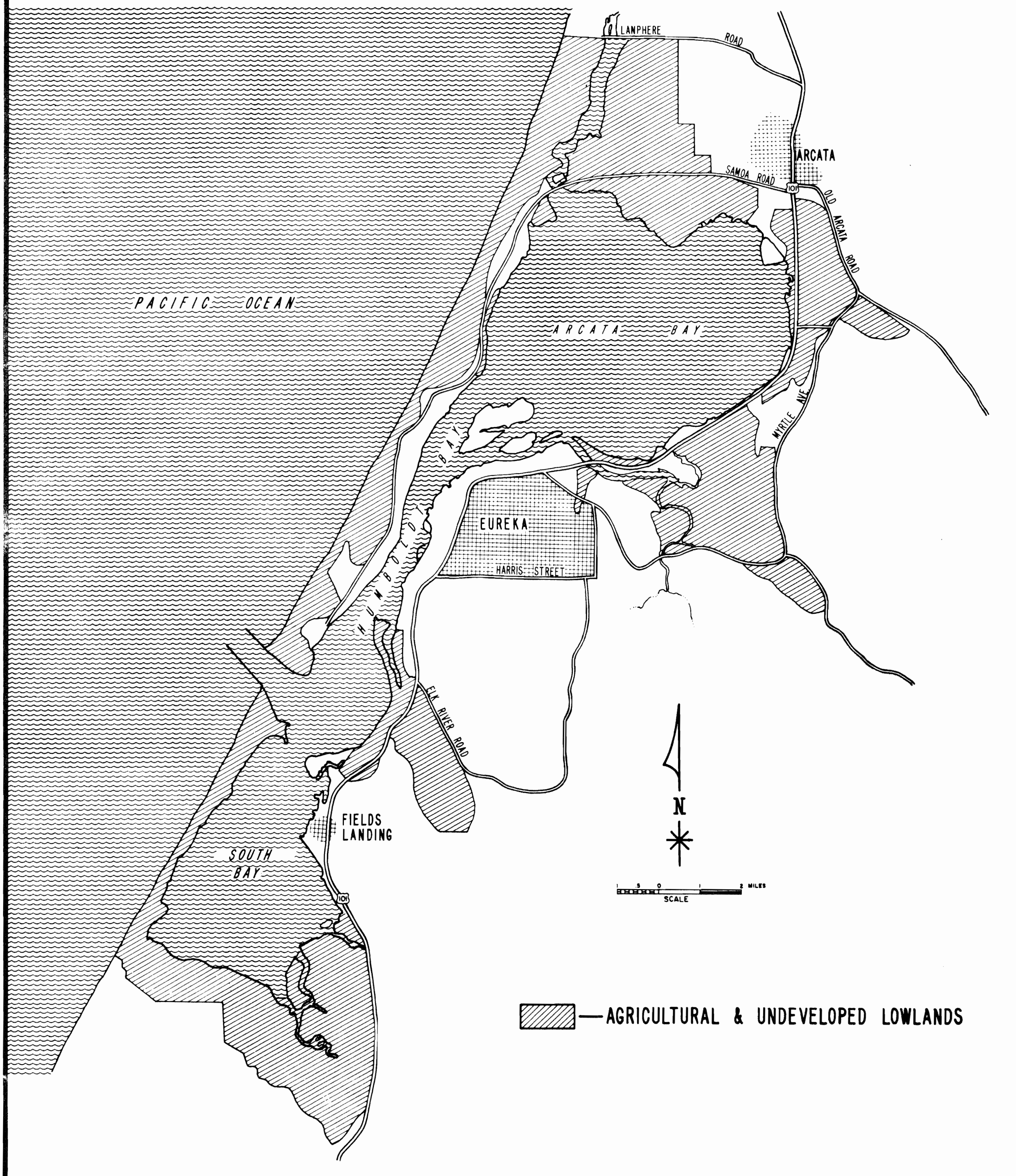
Each area lost, regardless of size, reduces the bay's capacity to support fish and wildlife and leads further down the path that could eventually destroy much of the area's resources. Experience has shown that this has already happened in other areas. San Francisco Bay, for example, was approximately 678 square miles in size in 1850. Today it is only 435 square miles. Its size has been reduced over 35% by filling. Fishing, hunting, other recreational uses and commercial fishing have suffered substantially as a result.

If is difficult to understand how the destruction of our most productive open space lands can continue for short term profits, in the face of human population increases and dwindling natural resources. People are becoming increasingly aware of the problem and the need for controls are well recognized at state and federal levels. Unless local governments accept this responsibility and take positive action more land use controls will be necessary through state or federal legislation. The alternative is irreversible loss of the resources.

In whatever form, adequate zoning laws with strict adherence are necessary to protect the agricultural, scenic and biological values of the Humboldt Bay area. Zoning could be accomplished by means of an area commission such as the proposed Humboldt Bay Harbor and Conservation District and/or the

PLATE 14

AGRICULTURAL AND UNDEVELOPED LOWLANDS OF HUMBOLDT BAY



cities and county. The Department urges that the necessary steps be taken by local government to develop comprehensive general plans which include open space (now required by law) and agricultural land protection as soon as possible (Plate 14).

Access

Resource use within the bay is largely dependent on the availability of public access. Only with the provision of such access can the highest recreational potential be achieved. Not only is the amount of access important but also the type and location. Provisions for use should be directed towards all compatible recreation forms, but should be planned so that the access in itself does not present a threat to any of the resources. The vast majority of recreation is dependent on the bay's biological and scenic aspects.

At the present time the bay and its resources, in most cases, are not being used to their fullest extent; primarily because of access problems. The bay has a total shoreline of approximately 40 miles but only about 3 miles are in public ownership. Most of the publicly owned shoreline is controlled by the U. S. Coast Guard or the cities of Eureka and Arcata and only a small portion is open to general public use. The vast majority of private shoreline lands are closed to the public.

In South Bay a portion of the spit is open to the public although it is in private ownership. This area receives heavy use by hunters and moderate use by clammers and other recreationists. The South Jetty is publicly owned and is open to fishing. For those who do not have boats the South Jetty is one of the most popular fishing areas in the bay. Boat access to South Bay for fishing, hunting, clamming and other activities is provided by a public ramp at Fields Landing. Some of the better clamming areas in the South Bay mud flats are privately owned and are posted against trespassing. Recreational use days for hunting and clamming could be increased substantially in South Bay if public use was permitted around the rest of the shoreline. Such access would also ease the pressure now exerted on the south spit and would improve the quality of both hunting and clamming. Because of its tremendous importance for recreation, the south spit should be in public ownership to insure its continued availability.

Another popular shore fishing area is located along the rock sea wall behind the Pacific Gas and Electric power plant at King Salmon. P. G. & E. has provided a parking area for fishermen there and that company is commended for its interest in encouraging recreation. A sandy extension of Buhne Point protrudes beyond the sea wall adjacent to the P. G. & E. recreation site, making an excellent spot for picnicking, birdwatching and for viewing scenery. The combination of possible uses make the Buhne Point area ideal for family outings; and, it should be acquired by a public agency and maintained in its natural state.

The Elk River Spit also is an ideal spot for family recreation and already is in public ownership as part of the City of Eureka's tideland grant. However, it is not available to the people (except by boat) because of the private lands which separate the spit from the nearest public road. In order for the area to be used, a public easement to guarantee access should be considered by the city.

Two boat launching ramps, one at Eureka and one on the Samoa Peninsula, provide adequate boat access to the channel. Since most of the channel shoreline is already extensively developed there is little opportunity for shoreline activities. Some fishing is done from private docks along the Eureka waterfront and the boat launching ramp on the Samoa Peninsula. Fishing could be improved in both quantity and quality by constructing a public fishing pier either on the peninsula or near Eureka.

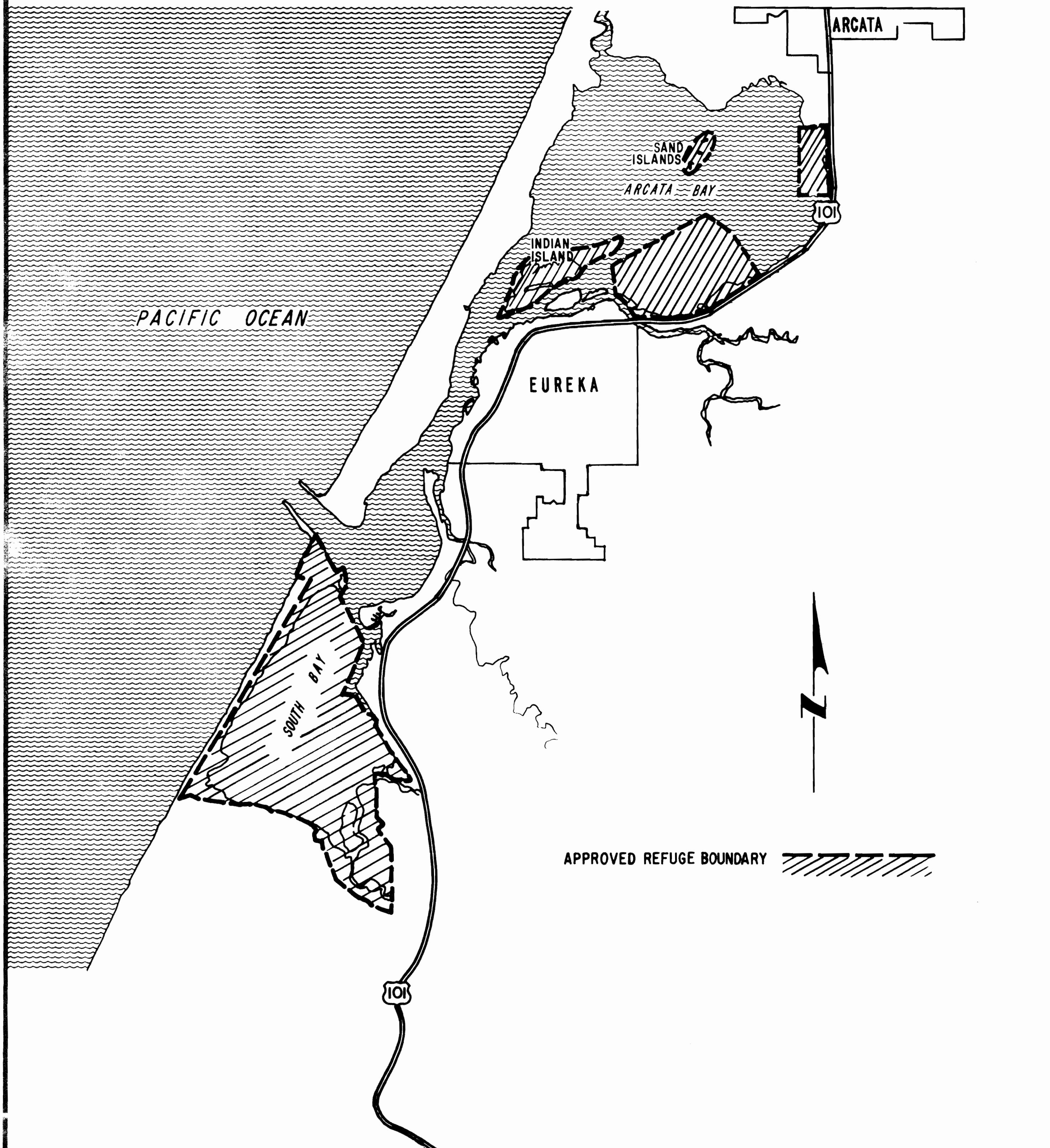
In Arcata Bay access is even further restricted. At present only one boat launching facility is available. The entire shoreline, except for city land fill projects and the oxidation pond, is privately owned. Arcata does not permit public use on the oxidation pond but does permit use along the western edge of the land fill. The marshes of Eureka Slough, west of Highway 101 and south of the Arcata Redwood Mill, have not been posted and the public currently uses the area for hunting. This land could be closed at any time at the discretion of the landowner. No other shoreline areas are open to the general public. A major share of the bay's tidelands are private and could also be closed to public use. In areas where commercial oysters are raised public use has already been restricted.

In spite of the fact that Arcata Bay is the larger segment and contains the most resources, it does not receive the heavy use that South Bay does. This undoubtedly reflects the access problems which are more severe in Arcata Bay. Some possible methods of improvement are suggested. Acquisition of the Eureka Slough and Jacoby Creek salt marshes by a public agency would guarantee hunting and nature study opportunities on two of the best areas for such activities in the entire bay. Public ownership would prevent destruction of the scenic values along Highway 101. The possibility of using the levee between Mad River Slough and the Arcata land-fill for public foot travel should be explored. The levee would make an excellent "nature trail" and would offer access to the bay for hunting and clamming. A second boat launching ramp located near the bridge on Mad River Slough would help to spread use over a larger area of Arcata Bay.

A major step in achieving some of the proposed opportunities for access will be accomplished by the creation of a Humboldt Bay National Wildlife Refuge (Plate 14). In September, 1971, the proposed Humboldt Bay

PLATE 15

HUMBOLDT BAY NATIONAL WILDLIFE REFUGE



National Wildlife Refuge was approved by the Migratory Bird Conservation Commission. This allowed the Bureau of Sport Fisheries and Wildlife to take initial steps in buying land within the approved boundary of the refuge. The money for purchasing land will come from the Migratory Bird Hunting Stamp Fund, created with the revenue from the sale of "duck stamps."

The refuge, which will be managed by the U. S. Fish and Wildlife Service, was established primarily to preserve and enhance those values associated with migratory birds. However, it also recognizes the value of the bay as a nursery ground for fish, shellfish and other marine life, and as a biological system producing human benefits associated with estuarine and salt bay environments. These benefits include maintaining natural beauty, open space, and the general esthetic cultural qualities so important for a full life.

The refuge as authorized will protect key wildlife habitat along the east side of Arcata Bay, Sand Island, Indian Island and most of South Bay. Hence the provisions of the authorized national refuge should be implemented as soon as possible. And, since one of the largest egret and heron rookeries in the state is located on Indian Island, that which lies within the proposed boundaries of the refuge, ownership of the island should be transferred to the U. S. Department of the Interior as soon as possible. This can be accomplished by jurisdictional transfer of ownership of state and/or city lands and by speedy acquisition of private lands involved.

Indian Island, which is included in the boundary of the proposed Humboldt Bay National Wildlife Refuge, contains one of the largest heron and egret rookeries in California and should be preserved.

California Department of Fish and Game Photos
December, 1969

DISCUSSION AND REVIEW

Through this report the Department has attempted: (1) to describe the natural resources of Humboldt Bay, (2) to demonstrate the intricate relationships between the living organisms and the lands and waters in which they live, and (3) to convey an understanding of the importance of these resources to both our present and future generations. Fortunately there is an increasing awareness and concern for ecology and our environment which indicates the value that people place on natural resources; and, hence, an increasing awareness of the Department's role and responsibility in maintaining and protecting those resources.

There are many problems and conflicts in maintaining the biological and esthetic values with which the Humboldt Bay area is richly endowed. Many of these conflicts can be resolved if they are recognized, and the vital requirements of living creatures understood, by people who are in positions to plan and to act. All too often land use decisions are made without the understanding and full realization of what the consequences will be to the natural resources. The loss of one acre can be just as serious as a loss of one hundred acres, depending on the habitat affected and the species and numbers of fish and wildlife dependent on that acreage. Consequently, the various types of habitat which are found in and around the bay have been outlined in this report together with their importance to the various fish and wildlife forms which use them. Some habitat types already have been drastically reduced and wildlife dependent on them have suffered.

Special areas of ecological importance have been listed, such as rookeries, habitat used by rare and endangered species, and hauling sites of seals. With the careful delineation of these locations it is hoped that provisions for their protection can be made in land use planning.

In today's world of material and economic values it is sometimes difficult to compare fish, wildlife and esthetic aspects to other possible land uses on a dollar basis. Some of these intangible benefits are priceless and cannot be measured on a strictly monetary basis. Realistically, however, our system often relies on economic measurements in making its decisions. Therefore use-estimates of these resources by the people for both recreational and commercial purposes have been included. Although accurate measurement is not possible in all cases, the best use estimates are presented together with economic returns, when available.

Local governments also have demonstrated increasing concern for the natural resources of the bay area and are working for their protection. The Department commends the Humboldt County Board of Supervisors for its foresight in ratifying the proposed National Wildlife Refuge. The Humboldt Bay Development Commission deserves much credit for recognizing the importance of conservation in harbor district legislation. And, planning commission and city government action in cases involving endangered wildlife species has been especially encouraging.

The Department of Fish and Game stresses that development of Humboldt Bay for a wide range of interests and uses can be accomplished without destroying its natural resources. This can be accomplished through judicious planning and by giving full consideration to fish and wildlife needs. The Department is prepared to assist, in any way possible, other agencies, local governments and private industries in any program to protect, maintain and enhance the natural resources of the unique and valuable Humboldt Bay.

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APPENDIX A

Common Plants of the Humboldt Bay Area

Green Algae

Cladophora spp.
Enteromorpha spp.
Sea lettuce, *Ulva* spp.

Brown Algae

Bull kelp, *Nereocystis leutkeana*
Egregia menziesii
Rock weed, *Fucus fureatus*
Pelvitiopsis limitata
Cystoseria osmundacea
Laminaria setchellii

Red Algae

Corallina spp.
Bossea spp.
Endocladia muricata
Gigartina spp.
Prophyra perforata

Flowering Plants

Alder, *Alnus rubra*
Alkali bulrush, *Scirpus robustus*
Arrow grass, *Triglochin maritima*
Bayberry, *Myrica californica*
Beach pine, *Pinus contorta*
Bearberry, *Arctostaphylos uva-ursi*
Bent grass, *Agrostis exarata*
Birds beak, *Cordylanthus maritimas*
Blackberry, *Rubus vitifolius*
Black cottonwood, *Populus trichocarpa*
Black twin-berry, *Lonicera involucrata*
Blue Blossom, *Ceanothus thyrsiflorus*
Bluegrass, *Poa douglasii*
Bracken fern, *Pteris aquilina*
Brass button, *Cotula coronopifolia*
Bulrush, *Scirpus criniger*
Cascara, *Rhamnus purshiana*
Castilleia, *Castilleia latifolia*

Cattail, *Typha* sp.
Chain fern, *Woodwardia radicans*
Chinquapin, *Castanopsis chrysophylla*
Common dandelion, *Taraxacum officinale*
Cordgrass, *Spartina foliosa*
Cotton-batting, *Gnaphalium chilense*
Coyote brush, *Baccharis pilularis*
Deer brush, *Ceanothus integerrimus*
Dock, *Rumex* sp.
Douglas fir, *Pseudotsuga menziesii*
Duck weed, *Lemna minor*
Dune tansey, *Tanacetum camphoratum*
Eel grass, *Zostera marina*
Elderberry, *Sambucus racemosa*
European dunegrass, *Ammophila arenaria*
Evening primrose, *Oenothera cheiranthifolia*
Fat hen, *Atriplex patula*
Fireweed, *Epilobium angustifolium*
Flowering current, *Ribes sanguineum*
Franseria, *Franseria chamissonis*
Gum plant, *Grindelia stricta*
Himalaya-berry, *Rubus thrysanthus*
Horsetail, *Equisetum hymenale*
Huckleberry, *Vaccinium ovatum*
Ice plant, *Mesembryanthemum crystallinum*
Indian plumb, *Osmaronia cerasiformis*
Jaumea, *Jaumea carnosa*
Juncus, *Juncus lesueurii*
Ladino clover, *Trifolium repens*
Lady fern, *Athyrium filix-foemina*
Laurel, *Umbellularia californica*
Leather fern, *Polypodium scouleri*
Licorice fern, *Polypodium vulgare*
Lupine, *Lupinus* spp.
Madrone, *Arbutus menziesii*
Maiden-hair, *Adiantum emarginatum*
Mare's tail, *Hippuris vulgaris*
Marsh rosemary, *Limonium californicum*
Monterey cypress, *Cupressus macrocarpa*
Morning glory, *Convolvulus soldanella*
Nut grass, *Cyperus* sp.
Orchard grass, *Dactylis glomerata*
Parsnip, *Pastinaca sativa*
Persian fireweed, *Polygonum argyrocoleon*
Pickleweed, *Salicornia ambigua*
Pineapple weed, *Matricaria matricaroides*
Poison hemlock, *Conium maculatum*
Poison oak, *Rhus diversiloba*
Quackgrass, *Agropyron repens*
Quail brush, *Atriplex lentiformis*
Rabbits foot,*Polypogon monspeliensis*
Red clover, *Trifolium pratense*

Red goosefoot, *Chenopodium rubrum*
Redwood, *Sequoia sempervirens*
Redwood sorrel, *Oxalis oregana*
Ryegrass, *Lolium multiflorum*
Sago pondweed, *Potamogeton pectinatus*
Salal, *Gaultheria shallon*
Salina clover, *Trifolium fragiferum*
Salmon-berry, *Rubus spectabilis*
Saltgrass, *Distichlis spicata*
Salt rush, *Juncus lesuerii*
Sand verbena, *Abronia latifolia*
Sedge, *Carex* spp.
Silktassel, *Garrya elliptica*
Silverweed, *Potentilla*
Sitka spruce, *Picea sitchensis*
Sour clover, *Trifolium fucatum*
Spanish broom, *Spartium junceum*
Spikerush, *Eleocharis macrostachya*
Strawberry, *Fragaria chilensis*
Tan oak, *Lithocarpus densiflora*
Thimble-berry, *Rubus parvifloris*
Three square bulrush, *Scirpus americanus*
Trefoil, *Lotus corniculatus*
Velvetgrass, *Notholcus lanatus*
Water buttercup, *Ranunculus aquatilis*
Water foxtail, *Alopecurus geniculatus*
Water hemlock, *Conium maculatum*
Water naiad, *Najas* sp.
Water parsley, *Oenanthe sarmentosa*
Wax myrtle, *Myrica californica*
Widgeon grass, *Rupia maritima*
Wild celery, *Apium graveolens*
Wild radish, *Raphanus sativus*
Willow, *Salix scouleriana*
Wood fern, *Aspidium spinulosum*

APPENDIX B

Birds of the Humboldt Bay Area 1/

Gaviidae

Common loon, *Gavia immer* (M 2/)
Arctic loon, *Gavia arctica* (M)
Red-throated loon, *Gavia stellata* (M)

Podicipedidae

Red-necked grebe, *Podiceps grisegena* (M)
Western grebe, *Aechmophorus occidentalis* (M)
Horned grebe, *Podiceps auritus* (M)
Eared grebe, *Podiceps caspicus* (M)
Pied-billed grebe, *Podilymbus podiceps* (M-R)

Procellariidae

Sooty shearwater, *Puffinus griseus* (M)
Fulmar, *Fulmarus glacialis* (M)

Hydrobatidae

Leaches petrel, *Oceanodroma leucorhoa* (M)

Pelecanidae

Brown pelican, *Pelecanus occidentalis* (M)

Phalacrocoracidae

Double-crested cormorant, *Phalacrocorax auritus* (M-R)
Brandt's cormorant, *Phalacrocorax penicillatus* (M)
Pelagic cormorant, *Phalacrocorax pelagicus* (M)

Anatidae

Whistling swan, *Olor columbianus* (M)
Canada goose, *Branta canadensis* (M)
Black brant, *Branta nigricans* (M)
White-fronted goose, *Anser albifrons* (M)
Snow goose, *Chen hyperborea* (M)

1/ Scientific names from Peterson's "A Field Guide to Western Birds."

2/ R = resident; M = migrant

Ross' goose, *Chen rossii* (M)
Emperor goose, *Philacte canagica* (M)
Mallard, *Anas platyrhynchos* (M-R)
Gadwall, *Anas strepera* (M)
Pintail, *Anas acuta* (M)
Blue-winged teal, *Anas discors* (M)
Cinnamon teal, *Anas cyanoptera* (R)
Green-winged teal, *Anas carolinensis* (M)
Common teal, *Anas crecca* (M)
American widgeon, *Mareca americana* (M)
European widgeon, *Mareca penelope* (M)
Shoveler, *Spatula clypeata* (M)
Wood duck, *Aix sponsa* (R)
Redhead, *Aythya americana* (M)
Canvasback, *Aythya valisineria* (M)
Ring-necked duck, *Aythya collaris* (M)
Greater scaup, *Aythya marila* (M)
Lesser scaup, *Aythya affinis* (M)
Common goldeneye, *Bucephala clangula* (M)
Bufflehead, *Bucephala albeola* (M)
Ruddy duck, *Oxyura jamaicensis* (M-R)
Harlequin duck, *Histrionicus histrionicus* (M)
Oldsquaw, *Clangula hyemalis* (M)
Common scoter, *Oidemia nigra* (M)
White-winged scoter, *Melanitta deglandi* (M)
Surf scoter, *Melanitta perspicillata* (M)
Common merganser, *Mergus merganser* (M-R)
Red-breasted merganser, *Mergus serrator* (M-R)
Hooded merganser, *Lophodytes cucullatus* (M-R)
Barrows goldeneye, *Bucephala islandica* (M)

Cathartidae

Turkey vulture, *Cathartes aura* (M)

Accipitridae

White-tailed kite, *Elanus leucurus* (R)
Goshawk, *Accipiter gentilis* (R)
Cooper's hawk, *Accipiter cooperii* (R)
Sharp-shinned hawk, *Accipiter striatus* (R)
Marsh hawk, *Circus cyaneus* (M)
Rough-legged hawk, *Buteo lagopus* (R)
Red-tailed hawk, *Buteo jamaicensis* (R)
Red-shouldered hawk, *Buteo lineatus* (R)
Golden eagle, *Aquila chrysaetos* (M)
Bald eagle, *Haliaeetus leucocephalus* (M)

Pandionidae

Osprey, *Pandion haliaetus* (M-R)

Falconidae

Peregrine falcon, *Falco peregrinos* 1/ (M-R)
Pigeon hawk, *Falco columbarius* (M)
Sparrow hawk, *Falco sparverius* (R)

Tetraonidae

Blue grouse, *Dendragapus obscurus* (R)

Phasianidae

California quail, *Lophortyx californicus* (R)
Mountain quail, *Oreortyx pictus* (R)
Ring-necked pheasant, *Phasianus colchicus* (R)

Ardeidae

Common egret, *Casmerodius albus* (R)
Snowy egret, *Leucophoyx thula* (M)
Cattle egret, *Bubulcus ibis* (M)
Great blue heron, *Ardea herodias* (R)
Green heron, *Butorides virescens* (R)
Black-crowned night heron, *Nycticorax nycticorax* (R)
American bittern, *Botaurus lentiginosus* (R)

Rallidae

Clapper rail, *Rallus longirostris* (R)
Virginia rail, *Rallus limicola* (M-R)
Sora rail, *Porzana carolina* (M-R)
American coot, *Fulica americana* (M-R)

Haematopodidae

Black oystercatcher, *Haematopus bachmani* (M)

Charadriidae

Golden plover, *Pluvialis dominica* (M)
Semipalmated plover, *Charadrius semipalmatus* (M)
Snowy plover, *Charadrius alexandrinus* (M)
Killdeer, *Charadrius vociferus* (M-R)
Black-bellied plover, *Squatarola squatarola* (M)
Surf bird, *Aphriza virgata* (M)
Ruddy turnstone, *Arenaria interpres* (M)
Black turnstone, *Arenaria melanocephala* (M)

1/ May no longer nest locally.

Scolopacidae

Long-billed curlew, *Numenius americanus* (M)
Whimbrel, *Numenius phaeopus* (M)
Marbled godwit, *Limosa fedoa* (M)
Willet, *Catoptrophorus semipalmatus* (M)
Greater yellowlegs, *Totanus melanoleucus* (M)
Lesser yellowlegs, *Totanus flavipes* (M)
Wandering tattler, *Heteroscelus incanum* (M)
Solitary sandpiper, *Tringa solitaria* (R)
Spotted sandpiper, *Actitis macularia* (R)
Rock sandpiper, *Erolia ptilocnemis* (M)
Pectoral sandpiper, *Erolia melanotos* (M)
Bairds sandpiper, *Erolia bairdii* (M)
Least sandpiper, *Erolia minutilla* (M)
Dunlin, *Erolia alpina* (M)
Western sandpiper, *Ereunetes mauri* (M)
Long-billed dowitcher, *Limnodromus scolopaceus* (M)
Short-billed dowitcher, *Limnodromus griseus* (M)
Knot, *Calidris canutus* (M)
Sanderling, *Crocethia alba* (M)
Common snipe, *Capella gallinago* (M)

Phalacropodidae

Wilson's phalarope, *Steganopus tricolor* (M)
Red phalarope, *Phalaropus fulicarius* (M)
Northern phalarope, *Lobipes lobatus* (M)

Recurvirostridae

Black-necked stilt, *Himantopus mexicanus* (M)
American avocet, *Recurvirostra americana* (M)

Stercorariidae

Parasitic jaeger, *Stercorarius parasiticus* (M)
Pomarine jaeger, *Stercorarius pomarinus* (M)

Laridae

Glaucous gull, *Larus hyperboreus* (M)
Glaucous-winged gull, *Larus glaucescens* (M)
Western gull, *Larus occidentalis* (M)
Herring gull, *Larus argentatus* (M)
California gull, *Larus californicus* (M)
Ring-billed gull, *Larus delewarensis* (M)
Mew gull, *Larus canus* (M)
Heermann's gull, *Larus heermanni* (M)

Bonaparte's gull, *Larus philadelphia* (M)
Sabine's gull, *Xema sabini* (M)
Common tern, *Sterna hirundo* (M-R)
Forster's tern, *Sterna forsteri* (M)
Arctic tern, *Sterna paradisaea* (M)
Caspian tern, *Hydroprogne caspia* (M)
Black tern, *Chlidonias niger* (M)
Elegant tern, *Thalasseus elegans* (M)

Alcidae

Tufted puffin, *Lunda cirrhata* (M)
Common murre, *Uria aalge* (M)
Pigeon guillemot, *Capphus columba* (M)
Marbled murrelet, *Brachyramphus marmoratum* (M)
Ancient murrelet, *Synthliboramphus antiquum* (M)

Columbidae

Band-tailed pigeon, *Columba fasciata* (M)
Rock dove, *Columba livia* (R)
Mourning dove, *Zenaidura macroura* (M)

Tytonidae

Barn owl, *Tyto alba* (R)

Strigidae

Snowy owl, *Nyctea scandiaca* (M)
Screech owl, *Otus asio* (R)
Great horned owl, *Bubo virginianus* (R)
Long-eared owl, *Asio ofus* (R)
Short-eared owl, *Asio flammeus* (M)
Saw-whet owl, *Aegolius acadicus* (R)
Pygmy owl, *Glaucidium gnoma* (R)

Caprimulgidae

Common nighthawk, *Chordeiles minor* (M)

Alcedinidae

Belted kingfisher, *Megaceryle alcyon* (R)

Apodidae

Black swift, *Cypseloides niger* (M-R)
Vaux's swift, *Chaetura vauxi* (M-R)

Trochilidae

Anna's hummingbird, *Calypte anna* (M-R)
Rufous hummingbird, *Selasphorus rufus* (M-R)
Allen's hummingbird, *Selasphorus sasin* (M-R)

Picidae

Red-shafted flicker, *Colaptes cafer* (R)
Pileated woodpecker, *Dryocopus pileatus* (R)
Acorn woodpecker, *Melanerpes formicivorus* (R)
Lewis woodpecker, *Asyndesmus lewis* (R)
Yellow-bellied sapsucker, *Sphyrapicus varius* (R)
Hairy woodpecker, *Dendrocopos villosus* (R)
Downy woodpecker, *Dendrocopos pubescens* (R)

Tyrannidae

Tropical kingbird, *Typannus melancholicus* (M)
Western kingbird, *Typannus verticalis* (M-R)
Ash-throated flycatcher, *Myiarchus cinerascens* (M-R)
Black phoebe, *Sayornis nigricans* (R)
Traill's flycatcher, *Empidonax traillii* (M-R)
Hammond's flycatcher, *Empidonax hammondii* (M-R)
Dusky flycatcher, *Empidonax oberholseri* (M-R)
Western flycatcher, *Empidonax difficilis* (M-R)
Western wood pewee, *Contopus sordidulus* (M-R)
Olive-sided flycatcher, *Nuttallornis borealis* (R)

Alaudidae

Horned lark, *Eremophila alpestris* (M)

Hirundinidae

Barn swallow, *Hirundo rustica* (M-R)
Cliff swallow, *Petrochelidon pyrrhonota* (M-R)
Violet-green swallow, *Tachycineta thalassina* (M-R)
Tree swallow, *Iridoprocne bicolor* (M-R)
Rough-winged swallow, *Stelgidopteryx ruficollis* (M-R)
Purple martin, *Progne subis* (M-R)

Corvidae

Steller's jay, *Cyanocitta stelleri* (R)
Scrub jay, *Aphelocoma coerulescens* (R)
Common raven, *Corvus corax* (R)
Common crow, *Corvus brachyrhynchos* (R)

Paridae

Black-capped chickadee, *Parus atricapillus* (R)
Chestnut-backed chickadee, *Parus rufescens* (R)
Common bushtit, *Psaltriparus minumus* (R)

Cinclidae

Dipper, *Cinclus mexicanus* (R)

Sittidae

Red-breasted nuthatch, *Sitta canadensis* (R)

Certhiidae

Brown creeper, *Certhia familiaris* (R)

Chamaeidae

Wrentit, *Chamaea fasciata* (R)

Troglodytidae

House wren, *Troglodytes aedon* (R)
Winter wren, *Troglodytes troglodytes* (R)
Bewick's wren, *Thryomanes bewickii* (R)
Long-billed marsh wren, *Telmatodytes palustris* (R)

Turdidae

Robin, *Turdus migratorius* (M-R)
Varied thrush, *Ixoreus naevius* (M)
Townsend's solitaire, *Myadestes townsendi* (M-R)
Hermit thrush, *Hylocichla guttata* (M-R)
Swainson's thrush, *Hylocichla ustulata* (M-R)
Western bluebird, *Sialia mexicana* (M-R)

Sylviidae

Golden-crowned kinglet, *Regulus satrapa* (M-R)
Ruby-crowned kinglet, *Regulus calendula* (M-R)

Motacillidae

Water pipit, *Anthus spinoletta* (M-R)

Bombycillidae

Bohemian waxwing, *Bombycilla garrulus* (M)
Cedar waxwing, *Bombycilla cedrorum* (M-R)

Laniidae

Northern shrike, *Lanius excubitor* (M)
Loggerhead shrike, *Lanius ludovicianus* (M-R)

Sturnidae

Starling, *Sturnus vulgaris* (R)

Vireonidae

Solitary vireo, *Vireo solitarius* (M-R)
Hutton's vireo, *Vireo huttoni* (M-R)
Warbling vireo, *Vireo gilvus* (M-R)

Parulidae

Orange-crowned warbler, *Vermivora celata* (R)
Nashville warbler, *Vermivora ruficapilla* (M-R)
Black-throated gray warbler, *Dendroica nigrescens* (M-R)
Palm warbler, *Dendroica palmarum* (M)
Yellow warbler, *Dendroica petechia* (R)
Myrtle warbler, *Dendroica coronata* (R)
Audubon's warbler, *Dendroica auduboni* (R)
Townsend's warbler, *Dendroica townsendi* (R)
Hermit warbler, *Dendroica occidentalis* (R)
MacGillivray's warbler, *Oporornis tolmiei* (M-R)
Yellowthroat, *Geothlypis trichas* (R)
Yellow-breasted chat, *Icteria virens* (R)
Wilson's warbler, *Wilsonia pusilla* (R)

Ploceidae

House sparrow, *Passer domesticus* (R)

Icteridae

Western meadowlark, *Sturnella neglecta* (R)
Yellow-headed blackbird, *Xanthocephalus xanthocephalus* (M)
Red-winged blackbird, *Agelaius phoeniceus* (R)
Brewer's blackbird, *Euphagus cyanocephalus* (R)
Brown-headed cowbird, *Molothrus ater* (R)
Bullock's oriole, *Icterus bullockii* (M)

Thraupidae

Western tanager, *Piranga ludoviciana* (M-R)

Fringillidae

Black-headed grosbeak, *Pheucticus melanocephalus* (R)
Evening grosbeak, *Hesperiphona vespertina* (R)
Lazuli bunting, *Passerina amoena* (M-R)
Purple finch, *Carpodacus purpureus* (M-R)
Cassin's finch, *Carpodacus cassinii* (M-R)
House finch, *Carpodacus mexicanus* (R)
Pine siskin, *Spinus pinus* (R)
American goldfinch, *Spinus tristis* (R)
Lesser goldfinch, *Spinus psaltria* (R)
Red crossbill, *Loxia curvirostra* (M-R)
Rufous-sided towhee, *Pipilo erythrophthalmus* (M-R)
Brown towhee, *Pipilo fuscus* (R)
Savannah sparrow, *Passerculus sandwichensis* (R)
Vesper sparrow, *Pooecetes gramineus* (R)
Slat-colored junco, *Junco hyemalis* (M-R)
Oregon junco, *Junco oreganus* (R)
Chipping sparrow, *Spizella passerina* (R)
White-crowned sparrow, *Zonotrichia leucophrys* (R)
Golden-crowned sparrow, *Zonotrichia atricapilla* (R)
White-throated sparrow, *Zonotrichia albicollis* (R)
Fox sparrow, *Passerella iliaca* (R)
Lincoln's sparrow, *Melospiza lincolnii* (R)
Song sparrow, *Melospiza melodia* (R)

Appendix C - Water Associated Bird Census
Table 1 Average Monthly Populations 1967-68-69-70

Species	July	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	Average May-Aug	Average Sep-Apr	Monthly Average All Yr.	Total Annual Bird Days Use
Black brant	0	1	130	4	1,093	19	6	795	12,039	21,208	4,071	4	1,019	4,412	3,198	1,167,270
SUBTOTAL	0	1	130	4	1,093	19	6	795	12,039	21,208	4,071	4	1,019	4,412	3,198	1,167,270
Mallard	53	154	387	785	172	477	293	484	628	219	387	33	157	431	339	
Pintail	9	2,019	4,976	3,491	1,641	1,643	2,940	2,356	1,157	383	0	3	508	2,323	1,718	
Widgeon	2	17	20	4,027	8,903	11,581	11,770	10,338	3,257	1,571	17	2	10	6,438	4,295	
Gadwall	0	0	19	0	32	63	1	1	13	8	0	0	0	17	11	
Green-winged teal	3	83	33	204	295	705	135	1,065	554	1,522	0	0	22	564	383	
Cinnamon teal	2	8	128	6	0	0	0	0	2	0	7	22	10	17	15	
Shoveller	3	0	28	488	120	493	560	887	1,379	842	2	0	1	600	400	
SUBTOTAL	72	2,281	5,591	9,001	11,163	14,962	15,699	15,131	6,990	4,545	413	60	708	10,390	7,161	2,613,765
Scaup	7	119	9	1,019	2,510	3,217	1,805	5,629	5,842	1,377	199	16	85	2,676	1,812	
Redhead	0	0	0	2	34	256	195	952	80	40	10	0	3	195	131	
Canvasback	0	0	0	6	133	208	567	795	236	141	3	0	1	261	174	
Ringneck	0	0	0	0	0	0	20	0	0	0	0	0	0	3	2	
Goldeneye	0	0	0	0	0	0	72	0	0	2	0	0	0	9	6	
Bufflehead	0	3	0	2	155	607	543	2,093	254	354	5	0	2	501	335	
Ruddy	3	8	38	9	154	222	1,230	1,893	110	533	2	2	4	524	350	
Scoter	300	870	635	1,792	6,093	2,535	5,302	4,505	2,699	2,709	1,649	447	817	3,284	2,461	
SUBTOTAL	310	1,000	682	2,830	9,079	7,045	9,734	15,867	9,221	5,156	1,868	465	912	7,453	5,271	1,923,915
Merganser	0	0	0	1	164	8	80	146	71	83	1	0	0	69	46	
Unidentified	7	0	3	23	371	616	10	430	223	497	134	1	36	272	193	
Swans	0	0	0	0	0	0	0	67	0	0	0	0	0	8	6	
SUBTOTAL	7	0	3	24	535	624	90	643	294	580	135	1	36	349	245	89,425
Godwit	3,625	2,577	5,250	3,898	8,842	1,710	1,680	1,558	2,226	3,605	332	341	1,719	2,972	2,554	
Curlew	224	427	322	22	14	0	0	0	2	212	38	17	177	72	107	
Willet	804	1,065	2,773	2,057	1,884	2,207	1,440	2,069	1,494	2,547	164	169	551	2,053	1,552	
Avocet	0	0	34	80	53	96	0	222	3	4	0	0	0	62	41	
Killdeer	0	0	0	6	0	90	400	250	29	0	1	2	1	97	65	
Other shorebirds	3,857	8,332	20,545	16,665	37,291	17,430	14,095	20,613	11,816	29,728	715	259	3,291	21,023	15,112	
SUBTOTAL	8,510	12,401	28,924	22,728	43,084	21,533	17,615	24,712	15,570	36,096	1,250	788	5,739	26,279	19,431	7,092,315
Coots	17	9	39	507	594	1,300	1,480	1,752	585	1,570	30	8	16	978	658	
SUBTOTAL	17	9	39	507	594	1,300	1,480	1,752	585	1,570	30	8	16	978	658	240,170
Blue heron	301	122	108	63	47	27	89	180	104	168	283	245	238	98	145	
Night heron	72	17	1	25	0	0	3	50	0	7	35	69	48	11	23	
Egret	789	507	217	99	70	29	70	88	160	333	452	539	572	133	279	
SUBTOTAL	1,162	646	326	187	117	56	162	318	264	508	770	853	858	242	447	163,155
Grebes	15	2	46	541	1,133	618	1,151	1,107	463	380	58	20	24	680	461	
Loon	12	0	10	6	41	10	50	39	37	28	27	6	11	27	22	
Cormorant	297	354	457	370	122	83	136	230	230	200	301	268	305	229	254	
Pelican	5	14	136	38	23	0	0	0	0	0	1	0	5	25	18	
SUBTOTAL	329	370	649	955	1,319	711	1,337	1,376	730	608	387	294	345	961	755	275,575
TOTAL	10,407	16,708	36,344	36,236	66,984	46,250	46,123	60,594	45,693	70,271	8,924	2,473	9,633	51,064	37,166	13,565,590

APPENDIX C

TABLE 2
COMPARATIVE MONTHLY COUNTS OF SHOREBIRDS CENSUSED
FROM COASTAL WETLANDS

		Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Mth. Avg.
Bolinas Lagoon-Tomales Bay 1/	1968	-	-	-	-	-	-	-	4,505	5,575	12,850	10,899	-	8,457
	1969	9,298	-	8,488	-	2,484	-	-	-	2,467	4,859	12,220	-	6,636
	1970	6,911	5,736	14,051	24,165	-	-	-	-	-	-	-	-	12,715
South San Diego Bay 2/	1970	5,766	8,618	7,614	13,678	466	889	3,699	8,653	8,608	9,750	-	-	6,774
Elkhorn Slough 2/	1967	6,244	4,228	7,718	17,067	341	300	3,915	6,127	3,753	17,457	16,826	8,821	7,733
	1968	10,869	11,191	9,010	9,018	504	836	-	-	-	-	-	-	6,905
Humboldt Bay 1/	1967	-	-	-	-	-	-	-	-	-	22,986	39,908	14,969	25,954
	1968	-	23,681	18,139	38,844	1,494	956	4,212	20,574	50,917	10,255	41,306	-	21,038
	1969	17,615	-	25,528	34,393	670	656	6,995	10,629	18,683	33,940	47,939	30,097	20,650
	1970	-	25,962	7,045	35,051	1,584	754	5,325	5,998	17,172	-	-	-	12,362

1/ Aerial census

2/ On foot

Highest monthly counts are underlined.

APPENDIX D

Mammals of the Humboldt Bay Area 1/

Didelphidae

Oppossum, *Didelphis marsupialis*

Soricidae

Pacific shrew, *Sorex pacificus*
Vagrant shrew, *Sorex vagrans*
Marsh shrew, *Sorex bandirii*
Trowbridge shrew, *Sorex trowbridgii*

Talpidae

Shrew mole, *Neurotrichus gibsii*
Townsend mole, *Scapanus townsendii*
Coast mole, *Scapanus orarius*

Vespertilionidae

Little brown myotis, *Myotis lucifugus*
Fringed myotis, *Myotis thysanoides*
California myotis, *Myotis californicus*
Hairy-winged myotis, *Myotis volans*
Long-eared myotis, *Myotis evotis*
Yuma myotis, *Myotis yumanensis*
Hoary bat, *Lasiurus cinereus*
Silvery-haired bat, *Lasionycteris noctivagans*
Lump-nosed bat, *Plecotus townsendii*
Big brown bat, *Eptesicus fuscus*

Leporidae

Black-tailed hare, *Lepus californicus*
Brush rabbit, *Sylvilagus bachmani*

Aplodontiidae

Mountain beaver, *Aplodontia rufa*

Sciuridae

Beechey ground squirrel, *Otospermophilus beecheyi*
Townsend chipmunk, *Eutamia townsendii*
Gray squirrel, *Sciurus griseus*

1/ Scientific names from Ingles "Mammals of the Pacific States."

Douglas squirrel, *Tamiasciurus douglasii*
Flying squirrel, *Glaucomys sabrinus*

Geomytidae

Pocket gopher, *Thomomys bottae*

Castoridae

Beaver, *Castor canadensis*

Cricetidae

Western harvest mouse, *Reithrodontomys megatotis*
Pinyon mouse, *Peromyscus truei*
Deer mouse, *Peromyscus maniculatus*
Ducky-footed wood rat, *Neotoma fuscipes*
White-footed vole, *Phenacomys albipes*
Red tree mouse, *Phenacomys longicaudus*
Red-backed mouse, *Cleithrionomys occidentalis*
Long-tailed meadow mouse, *Microtus longicaudus*
Oregon meadow mouse, *Microtus oregoni*
California meadow mouse, *Microtus californicus*
Townsend meadow mouse, *Microtus townsendii*

Muridae

Norway rat, *Rattus norvegicus*
Black rat, *Rattus rattus*
Mouse mouse, *Mus musculus*

Zapodidae

Pacific jumping mouse, *Zapus trinotatus*

Erethizontidae

Porcupine, *Erethizon dorsatum*

Delphinidae

Common dolphin, *Delphinus delphis*
Bottle-nosed dolphin, *Tursiops gillii*
Harbor porpoise, *Phocaena phocoena*

Otariidae

Steller sea lion, *Eumetopias jubata*
California sea lion, *Zalophus californianus*
Harbor seal, *Phoca vitulina*

Canidae

Gray fox, *Urocyon cinereoargenteus*
Coyote, *Canis latrans*

Ursidae

Black bear, *Euarctos americanus*

Procyonidae

Raccoon, *Procyon lotor*
Ringtail cat, *Bassariscus astutus*

Mustelidae

Marten, *Martes americana* 1/
Fisher, *Martes pennanti* 1/
Mink, *Mustela vison*
Long-tailed weasel, *Mustela frenata*
Ermine, *Mustela erminea*
Striped skunk, *Mephitis mephitis*
Spotted skunk, *Spilogale putorius*
River otter, *Lutra canadensis*

Felidae

Mountain lion, *Felis concolor*
Bobcat, *Lynx rufus*

Cervidae

Black-tailed deer, *Odocoileus hemionus columbianus*
Roosevelt elk, *Cervus canadensis roosevelti* 1/

1/ Although known to occur here in the past, these species may now be absent within the study area.

APPENDIX E

Table 1

Food of Four Species of Puddle Ducks, Humboldt Bay
(Adapted from Yocom and Keller, 1961)
(Food Items Consumed Shown by Percent of Volume)

Plant Food	(49) Pintail	(24) Mallard	(140) Widgeon	(50) Green-winged Teal
Barley, *Hordeum vulgare*	25.1	49.6	-	-
Pondweed, *Potamogeton* sp.	.1	13.9	.3	2.4
Alkali bulrush, *Scirpus robustus*	14.8	3.9	Trace	7.6
Spikerush, *Eleocharis macrostachya*	4.8	5.8	3.5	15.0
Widgeon grass, *Ruppia maritima*	4.7	-	-	.3
Eel grass, *Zostera marina*	.4	Trace	81.0	-
Buttercup, *Ranunculus* sp.	Trace	1.8	1.4	8.5
Saltgrass, *Distichlis spicata*	.8	-	Trace	.3
Wheat, *Triticum aestivum*	-	-	-	5.2
Clover leafage, *Trifolium* sp.	-	-	6.0	-
Other plants	36.0	21.4	8.9	26.3
Total	86.7	96.4	99.7	65.6

Animal Food				
Clams, *Pelecypoda*	11.2	.9	-	-
Gastropods, *Gastropoda*	1.3	.9	Trace	33.6
Mollusks, *Mollusca*	.8	-	-	.3
Arthropod, *Arthropoda*	Trace	-	-	-
Insects, *Insecta*	-	1.8	.3	-
Other animal matter	-	-	Trace	.5
Total	13.3	3.6	.3	34.4

APPENDIX E

Table 2

Food of Six Species of Diving Ducks, Humboldt Bay
(Adapted from Yocom and Keller, 1961)
(Food Items Consumed Shown by Percent of Volume)

Plant Food	(17) Canvas-back	(13) Lesser Scaup	(20) Greater Scaup	(22) Buffle-head	(17) Scoter	(21) Ruddy
Pondweed, *Potamogeton* sp.	15.7	.7	-	3.6	-	23.1
Widgeon grass, *Ruppia maritima*	2.6	Trace	-	1.9	-	68.1
Eel grass, *Zostera marina*	Trace	-	4.4	-	-	1.1
Alkali bulrush, *Scirpus robustus*	-	.1	Trace	5.1	-	1.1
Wheat, *Triticum aestivum*	-	4.6	-	-	-	-
Saltgrass, *Distichlis spicata*	-	.1	-	-	-	-
Spikerush, *Eleocharis macrostachya*	-	.1	-	Trace	-	1.1
Other plants	-	35.2	.1	0.7	Trace	Trace
Total	18.3	40.8	4.5	11.3	Trace	94.5

Animal Food						
Clams, *Pelecypoda*	81.7	45.5	42.8	17.5	48.8	-
Mollusks, *Mollusca* (unidentified)	-	9.1	2.9	-	-	-
Crustaceans, *Crustacea*	-	4.6	-	29.8	6.6	5.5
Gastropods, *Gastropoda*	-	Trace	49.7	15.5	30.3	-
Insects, *Insecta*	-	-	-	25.7	-	-
Oyster, *Ostra* sp.	-	-	-	-	14.1	-
Other animal food	-	-	.1	.2	.2	-
Total	81.7	59.2	95.5	88.7	100.0	5.5

APPENDIX E

Table 3

Food Habits of Black Brant, Humboldt Bay
(Adapted from Yocom and Keller, 1961)
(Food Items Consumed Shown by Percent of Volume)

	(20)
Plant Food	
Eel grass, *Zostera marina*	81.3
Pickleweed, *Salicornia ambigua*	Trace
Diatoms	Trace
Other plants	18.7
Total	100.0
Animal Food	
Crustaceans, *Crustacea*	Trace
Gastropods, *Gastropoda*	Trace
Total	Trace

APPENDIX F

Invertebrates Found in Humboldt Bay

Sponge

Sponge, *Halicona*

Hydroids

Hydroid, *Aequorea* sp.
Hydroid, *Campanularia integra*
Hydroid, *Obelia surcalaris*
Hydroid, *Plumularia lagenifera*
Hydroid, *Tubularia crocea*
Hydroid, *Tubularia marina*
Hydroid, *Velella lata*

Jellyfishes

Jellyfish, *Aurellia* sp.
Jellyfish, *Chrysaora* sp.
Jellyfish, *Pelagia* sp.

Sea Anemones

Aggregated anemone, *Anthopleura elegantissima*
Great green anemone, *Anthopleura xanthogrammica*
Burrowing anemone, *Cerianthus* sp.
White anemone, *Metridium senile fiombriatum*

Ctenophores (Comb jellies)

Common comb jelly, *Pleurobrachia bachei*

Ribbon Worms

Ribbon worm, *Amphiporus imparispinosis*
Ribbon worm, *Cerebratulus californiensis*
Ribbon worm, *Tubulanus polymorphus*

Polychaetes (Bristle Worms)

Lug worm, *Abarenicola antebranchia*
Lug worm, *Abarenicola humboldtensis*
Lug worm, *Abarenicola pacifica*

Bristle worm, *Glycera americana*
Bristle worm, *Mesochaetopterus taylori*
Bristle worm, *Neanthes* sp.
Mussel worm, *Nereis* spp.
Bristle worm, *Pista pacifica*
Bristle worm, *Platynereis bicanaliculata*
Bristle worm, *Scoloplos* sp.
Bristle worm, *Telepsavus costarum*

Echiurids (Spoon worms)

Spoon worm, *Listriolobus pelodes*
Fat innkeeper, *Urechis caupo*

Copepods

Copepod, *Acartia clausi*
Copepod, *Acartia tunsa*
Copepod, *Eurytemora affinis*
Copepod, *Oithona similis*
Copepod, *Pseudocalanus minutus*

Barnacles

Thatched barnacle, *Balanus cariosus*
White barnacle, *Balanus crenatus curriscutum*
Barnacle, *Balanus eburneus*
Chalky white barnacle, *Balanus glandula*
Warf and piling barnacle, *Balanus nubilis*
Gray barnacle, *Chthamalus dalli*
Leaf barnacles, *Lepas* spp.
Goose barnacle, *Pollicipes polymerus*

Cumaceans

Cumacean, *Cumacea* sp.

Isopods

Marine sowbug, *Alloniscus* sp.
Isopod, *Idothea stenops*
Isopod, *Idothea wosnesenskii*
Isopod, *Ligia occidentalis*
Isopod, *Ligia pallasi*

Decapods (Shrimp, crabs, etc.)

Ghost shrimp, *Callianassa californiensis*
Rock crab, *Cancer antennarius*
Yellow crab, *Cancer anthonyi*

Slender crab, *Cancer gracilis*
Dungeness or market crab, *Cancer magister*
Red crab, *Cancer productus*
Black-tailed shrimp, *Crago nigricauda*
Bay shrimp, *Crago* spp.
Pistol shrimp, *Crangon californiensis*
Common sand crab, *Emerita analoga*
Purple shore crab, *Hemigrapsus nudus*
Yellow shore crab, *Hemigrapsus oregonensis*
Lined shore crab, *Pachygrapsus crassipes*
Hermit crabs, *Paguras* spp.
Coon stripe shrimp, *Pandalus danae*
Porcelain crab, *Petrolisthes* sp.
Commensal pea crabs, *Pinnixa* spp.
Kelp crab, *Pugettia producta*
Broken-back shrimps, *Spirontocaris* spp.
Blue mud shrimp, *Upogebia pugettensis*

Arachnoids (Spiders, Scorpions and Ticks)

Pseudoscorpion, *Halobisium occidentale*

Pycnogonids (Sea Spiders)

Sea spider, *Achelia chelata*
Sea spider, *Achelia echinata*
Green pycnogonid, *Halusoma viridintestinale*

Gastropods (Snails, whelks, limpets, and slugs)

Finger limpet, *Acmaea digitalis*
Common limpet, *Acmaea paradigitalis*
Shield limpet, *Acmaea pelta*
Mask limpet, *Acmaea persona*
Rough limpet, *Acmaea scabra*
Plate limpet, *Acmaea scutum*
Barrel shell, *Actaeon punctocaelatus*
Sea lemon nudibranch, *Anisodoris nobilis*
Translucent assiminea, *Assiminea translucens*
Sea lemon nudibranch, *Archidoris montereyensis*
Top shell, *Calliostoma* sp.
Giant nudibranch, *Dendronotus giganteus*
Rough keyhole limpet, *Diodora aspera*
Nudibranch, *Diaululu sandiegensis*
Nudibranch, *Dirona albolineata*
Nudibranch, *Hermissenda crassicornis*
Newcomb's littorine, *Littorina (Algamorda) newcombiana*
Flat periwinkle, *Littorina planaxis*
Checkered periwinkle, *Littorina scutulata*
Channeled dog welk, *Nassarius fossatus*
Lean dog welk, *Nassarius mendicus*
Japanese oyster drill, *Ocenebra japonica*

Baetic olive, *Olivella baetica*
Purple olive, *Olivella biplicata*
San Pedro olive, *Olivella pedroana*
Tactibranch, *Phyllaplysia taylori*
Bristle-bearing ear-shell, *Phytia setifer*
Moon snail, *Polinices lewisii*
Brown top, *Tegula brunnea*
Black top, *Tegula funebralis*
Pulligo top, *Tegula pulligo*
Emarginate dogwinkle, *Thais emarginata*
Frilled dogwinkle, *Thais lamellosa*

Pelecypods (Clams, mussles, oysters, scallops)

Pacific shipworm, *Bankia setacea*
Basket cockle, *Clinocardium nuttallii*
Giant Pacific oyster, *Crassostrea gigas*
Eastern oyster, *Crassostrea virginica*
Crenella, *Crenella* sp.
Rock scallop, *Hinnites multirugosus*
California lyonsia, *Lyonsia californica*
Inconspicuous macoma, *Macoma inconspicua*
Irus macoma, *Macoma irus*
Bent-nose clam, *Macoma nasuta*
Straight horse mussel, *Volsella recta*
Soft-shell clam, *Mya arenaria*
California sea-mussel, *Mytilus californianus*
Bay mussel, *Mytilus edulis*
Native or California oyster, *Ostrea lurida*
Geoduck, *Panope generosa*
Common or flat-tipped piddock, *Penitella penita*
Abalone jingle, *Pododesmus macroschismus*
Restoration littleneck, *Protothaca restorationesis*
Common or Pacific littleneck, *Protothaca staminea*
Thin-shelled littleneck, *Protothaca tenerrima*
Smooth Washington clam, *Saxidomus giganteus*
Common Washington clam, *Saxidomus nuttalli*
Northern razor clam, *Siliqua patula*
Sickle razor clam, *Solen sicarius*
California jacknife clam, *Tagelus californianus*
Japanese littleneck, *Tapes semidecussata*
Bodega tellin, *Tellina bodegensis*
Little transennella, *Transennella tantilla*
Gaper, *Tresus capax*
Gaper, *Tresus nuttalli*
Quahog, *Venus mercenaria*
Rough piddock, *Zirfaea pilsbryi*

Octopods (Octopi)

Octopus, *Octopus dofleni*

APPENDIX G

LIST OF FISHES TAKEN IN HUMBOLDT BAY WITH NORMAL HABITAT ASSOCIATION 2/

Species	Mudflats	Channels	Sandy Beaches	Piers	Reefs and Jetties
SHARKS, RAYS					
Sevengill shark, *Notorynchus maculatus* 1/		X			
Soupfin shark, *Galeorhinus zyopterus*					
Brown smoothhound, *Mustelus henlei*	X	X			
Leopard shark, *Triakis semifasciata*	X	X			
Big skate, *Raja binoculata*					
Round stingray, *Urolophus halleri*					
Bat ray, *Myliobatis californica*	X	X			
CHIMAERAS					
Ratfish, *Hydrolagus colliei*					
STURGEONS					
Green sturgeon, *Acipenser medirostris*		X			
SNAKE EELS					
Yellow snake eel, *Ophichthus zophochir*	X	X			
HERRINGS, ANCHOVIES					
American shad, *Alosa sapidissima*		X			
Pacific herring, *Clupea harengus pallasii*	X	X			

1/ Scientific names from Department "Fish Bulletin 157,"
2/ Species not listed from particular habitat are classified as infrequent visitors.

Appendix G (continued)

Species	Mudflats	Channels	Sandy Beaches	Piers	Reefs and Jetties
Threadfin shad, *Dorosoma petenense*					
Northern anchovy, *Engraulis mordax*		X			
SALMON, TROUT					
Silver salmon, *Oncorhynchus kisutch*		X			
King salmon, *Oncorhynchus tshawytscha*		X			
Steelhead rainbow trout, *Salmo gairdnerii*		X			
SMELTS					
Surf smelt, *Hypomesus pretiosus*		X			
Night smelt, *Spirinchus starksi*		X			
Longfin smelt, *Spirinchus thaleichthys*		X			
LIGHTFISHES					
Benttooth bristlemouth, *Cyclothone acclinidens* LJ		X			
LANCETFISHES					
Longnose lancetfish, *Alepisaurus ferox*		X			
LANTERNFISHES					
Northern lampfish, *Stenobrachius leucopsarus*					
Blue lanternfish, *Tarletonbeania crenularis* LJ					
CODFISHES					
Pacific tomcod, *Microgadus proximus*		X			

Appendix G (continued)

Species	Mudflats	Channels	Sandy Beaches	Piers	Reefs and Jetties
CUSK-EELS					
Spotted cusk-eel, *Chilara taylori*					
SILVERSIDES					
Topsmelt, *Atherinops affinis*	X	X	X	X	
Jacksmelt, *Atherinopsis californiensis*	X	X	X	X	
RIBBONFISHES					
King-of-the-salmon, *Trachipterus altivelis*					
STICKLEBACKS					
Threespine stickleback, *Gasterosteus aculeatus*	X	X			
Tube-snout, *Aulorhynchus favidus*	X	X			
PIPEFISHES					
Bay pipefish, *Syngnathus leptorhynchus*					
TEMERATE BASSES					
Striped bass, *Morone saxatilis*					
Giant sea bass, *Stereolepis gigas*					
DRUMS					
White croaker, *Genyonemus lineatus*					
White seabass, *Cynoscion nobilis* LJ			X		X
SURFPERCHES					
Calico surfperch, *Amphistichus koelzi*					X

Appendix G (continued)

Species	Mudflats	Channels	Sandy Beaches	Piers	Reefs and Jetties
SURFPERCHES (cont.)					
Redtail surfperch, *Amphistichus rhodoterus*			X	X	X
Shiner surfperch, *Cymatogaster aggregata*	X	X	X	X	X
Striped seaperch, *Embiotoca lateralis*	X	X		X	X
Walleye surfperch, *Hyperprosopon argenteum*	X		X	X	
Silver surfperch, *Hyperprosopon ellipticum*	X		X	X	X
White surfperch, *Phanerodon furcatus*	X	X	X	X	X
Pile surfperch, *Damalichthys vacca*	X			X	X
SANDFISHES					
Pacific sandfish, *Trichodon trichodon*					
Monkeyface-eel, *Cebidichthys violaceus*	X	X			X
PRICKLEBACKS					
High cockscomb, *Anoplarchus purpurescens*					
Snake prickleback, *Lumpenus sagitta*		X			
GUNNELS					
Penpoint gunnel, *Apodichthys flavidus*			X		
Saddleback gunnel, *Pholis ornata*	X	X			X
WOLFISHES					
Wolf-eel, *Anarrhichthys ocellatus*					X

Appendix G (continued)

Species	Mudflats	Channels	Sandy Beaches	Piers	Reefs and Jetties
SAND LANCES					
Pacific sandlance, *Ammodytes hexapterus*		X	X		
GOBIES					
Arrow goby, *Clevelandia ios*					
Tidewater goby, *Eucyclogobius newberryi*					
Bay goby, *Lepidogobius lepidus*	X				
LOUVARS					
Louvar, *Luvarus imperialis*					
BUTTERFISHES					
Pacific butterfish, *Peprilus simillimus*					
ROCKFISHES					
Brown rockfish, *Sebastes auriculatus*				X	X
Copper rockfish, *Sebastes caurinus*					
Black rockfish, *Sebastes melanops*	X	X		X	X
Blue rockfish, *Sebastes mystinus*					X
Bocaccio, *Sebastes paucispinis*					
Grass rockfish, *Sebastes rastrelliger*					X
GREENLINGS					
Kelp greenling, *Hexagrammos decagrammus*	X	X		X	X
Rock greenling, *Hexagrammos superciliosus*					

Species	Mudflats	Channels	Sandy Beaches	Piers	Reefs and Jetties
GREENLINGS (cont.)					
Lingcod, *Ophiodon elongatus*	X	X			X
Painted greenling, *Oxylebius pictus*					X
SCULPINS					
Padded sculpin, *Artedius fenestralis*					X
Scalyhead sculpin, *Artedius harringtoni*					X
Bonyhead sculpin, *Artedius notospilotus*	X				X
Rosylip sculpin, *Ascelichthys rhodorus*					X
Silverspotted sculpin, *Blepsias cirrhosus*		X			
Prickly sculpin, *Cottus asper*				X	X
Buffalo sculpin, *Enophrys bison*				X	X
Red Irish lord, *Hemilepidotus hemilepidotus*					X
Brown Irish lord, *Hemilepidotus spinosus*					X
Pacific staghorn sculpin, *Leptocottus armatus*		X		X	
Sailfin sculpin, *Nautichthys oculofasciatus*					
Cabezon, *Scorpaenichthys marmoratus*		X		X	X
POACHERS					
Pygmy poachers, *Odontopyxis trispinosa*		X			
Tubenose poacher, *Pallasina barbata*		X			
Pricklebreast poacher, *Stellerina xyosterna*		X			

Appendix G (continued)

Species	Mudflats	Channels	Sandy Beaches	Piers	Reefs and Jetties
SNAILFISHES					
Slipskin snailfish, *Liparis fucensis*		X			
Showy snailfish, *Liparis pulchellus*		X			
Ringtail snailfish, *Liparis rutteri*					
LEFTEYE FLOUNDERS					
Speckled sanddab, *Citharichthys stigmaeus*	X	X	X		
California halibut, *Paralichthys californicus*	X	X	X		
RIGHTEYE FLOUNDERS					
Butter sole, *Isopsetta isolepis*		X			
Dover sole, *Microstomus pacificus*	X	X	X		
English sole, *Parophrys vetulus* LJ	X	X			
Starry flounder, *Platichthys stellatus*	X	X	X		
Curlfin turbot, *Pleuronichthys decurrens*	X	X	X		
Sand sole, *Psettichthys melanostictus*	X	X	X		
TONGUE FISHES					
California tonguefish, *Symphurus atricauda*					
MOLAS					
Mola, *Mola mola*		X			

LJ Found as larva or juveniles

APPENDIX H

AVERAGE ANNUAL CATCH BY NUMBERS AND EFFORT OF SHORE, PIER AND SPEAR FISHERMEN IN HUMBOLDT BAY, 1957-1960 1/

Species	Skiff	Shore	Pier	Skin-diving	Total	Percent Comp.
ROCKFISH						
Black	520	1,328	361	133	2,342	3.03
Blue		891			891	1.15
Copper	13	101	40	12	166	0.21
Grass	15	135		7	157	0.20
FLATFISH						
Sand sole	21	116			137	0.18
Starry flounder	31	103			134	0.17
SURFPERCH						
Calico		8			8	0.01
Pile	97	42	155	7	301	0.39
Redtail	61	4,568	123	326	5,078	6.57
Shiner		201	10,371		10,572	13.69
Silver	104	675			779	1.01
Striped	1,225	2,754	317	7	4,303	5.57
Walleye	965	371	16,686		18,022	23.32
White	1,351	60	245		1,656	2.14
MISCELLANEOUS						
Brown Irish lord		53			53	0.07
Buffalo sculpin	15	48			63	0.08
Cabezon		413	65	20	498	0.64
Jacksmelt	15	2,040	16,228		18,283	23.66
Kelp greenling	20	4,968	256	40	5,284	6.84

1/ From Gotshall (1966). Data from study performed as part of a Dingle-Johnson project. Calif. F-12-R, "Northern California Marine Sport Fish Survey," supported by Federal Aid to Fish Restoration Funds.

APPENDIX H
(continued)

Species	Skiff	Shore	Pier	Skin-diving	Total	Percent Comp.
MISCELLANEOUS (continued)						
King salmon	808	11			819	1.06
Lingcod	193	254		48	495	0.64
Northern anchovy		5,654			5,654	7.32
Pacific staghorn sculpin		128	583		711	0.92
Red Irish lord	5	85			90	0.12
Rock greenling		596		2	598	0.77
Silver salmon	42	13			55	0.07
White croaker		22			22	0.03
Wolf eel				7	7	0.01
Sharks 1/	20	28	50		98	0.13
Totals	5,521	25,666	45,480	609	77,276	100.00
Angler Days	5,997	12,495	8,402	250	27,144	
Catch per Day	.92	2.05	5.41	2.44	10.82	

APPENDIX I

TOTAL CATCH AND EFFORT OF SPORT CRAB FISHERMEN IN HUMBOLDT BAY - DECEMBER-MARCH, 1965 2/

	Number	Percent Comp.	Catch per Day
Market Crab	400	15.2	0.5
Red Crab	1,956	74.6	2.4
Rock Crab	267	10.2	0.3
Total	2,623	100.0	3.2

Angler Days - 800

1/ Includes more than one species.

2/ From Gotshall (1966).

APPENDIX J

PARTYBOAT CATCH PER ANGLER, SPECIES BY PORT OF LANDING
NORTHERN CALIFORNIA AREA, 1963 1/

	Species Caught											
	Sal-mon no.	Catch per Angler	Rock-fish no.	Catch per Angler	Ling-cod no.	Catch per Angler	Cabe-zon no.	Catch per Angler	Misc. no.	Total Fish	Total Anglers	Catch per Angler All Species
Crescent City-Albion	446	.70	331	.56	4	--	--	--	1	782	588	1.33
Eureka	2,505	1.64	396	.26	1	--	--	--	32	2,924	1,531	1.91
Fort Bragg	2,821	1.24	908	.40	78	--	21	--	59	3,887	2,282	1.70
Trinidad	1,555	1.33	76	--	2	--	--	--	3	1,636	1,173	1.39
Bodega Bay-Dillon Beach	447	.19	18,242	7.59	562	.23	115	--	184	19,550	2,404	8.13

1/ From Young (1969).

APPENDIX K

PARTYBOAT CATCH AND EFFORT FOR EUREKA AND FIELDS LANDING, 1947-1967 1/

Species	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	1957
Salmon	14	49	432	314	2,356	3,982	5,240	5,093	4,707	2,513	2,231
Rockfishes	14	77	54	48	50	160	271	35	45	325	938
Lingcod	--	4	3	--	3	2	3	1	--	1	12
Misc. flatfish	23	--	3	7	1	5	2	--	1	--	--
Albacore	--	--	--	--	--	--	--	--	--	70	32
Misc.	1	--	3	1	2	7	8	1	7	6	7
Total	52	130	495	370	2,412	4,156	5,524	5,130	4,760	2,915	3,220
Angler days	16	55	623	363	1,552	1,961	2,481	2,471	2,830	1,898	1,394
Anglers	*	*	*	*	*	*	*	*	*	*	*

Species	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967
Salmon	386	777	1,879	1,102	2,135	2,504	2,335	1,811	1,373	972
Rockfishes	558	332	456	173	513	393	335	1,059	126	380
Lingcod	--	3	5	2	--	1	--	--	--	1
Misc. flatfish	--	2	12	7	41	21	23	38	9	3
Albacore	--	18	--	--	--	--	--	--	--	--
Misc.	--	--	25	1	9	5	5	4	7	30
Total	944	1,132	2,377	1,285	2,698	2,924	2,698	2,912	1,515	1,385
Angler days	489	1,020	1,941	1,278	--	--	--	--	--	--
Anglers	*	*	1,941	1,278	1,418	1,531	1,537	1,506	1,305	1,373

1/ From Young (1969).

* Not available until 1960.

APPENDIX L

COMMERCIAL LANDINGS, EUREKA AND FIELDS LANDING, TEN YEAR AVERAGE (1960-1969)*

	Pounds	Value 1/
Albacore	1,948,000	$312,000
Dover sole	5,985,000	388,000
English sole	1,187,000	98,000
Giant Pacific oyster	3,140,000	156,000
Lingcod	297,000	23,000
Market crab	3,234,000	605,000
Ocean shrimp	513,000	54,000
Perch	22,000	3,000
Petrale sole	924,000	113,000
Rex sole	638,000	52,000
Rockfish	1,574,000	76,000
Sablefish	726,000	65,000
Salmon	1,817,000	945,000
Smelt	126,000	8,000
All other species	1,505,000	56,000
Totals	23,636,000	$2,954,000

1/ Value is computed from prices paid to the fishermen.

* Marine fish catch statistics from Calif. Dept. Fish & Game Fish Bulletin Series, 1960-69.

APPENDIX M

HUMBOLDT BAY AND STATEWIDE OYSTER MEAT PRODUCTION IN POUNDS I/ BY YEAR, 1955-1971 WITH PERCENT OF STATEWIDE TOTAL FROM HUMBOLDT BAY*

YEAR	STATEWIDE TOTAL	HUMBOLDT BAY	PERCENT
1955	278,000	0	0
1956	971,000	683,000	70
1957	1,730,000	1,470,000	85
1958	1,500,000	1,150,000	77
1959	2,140,000	1,850,000	86
1960	1,660,000	1,430,000	86
1961	1,570,000	1,300,000	83
1962	1,720,000	1,480,000	86
1963	1,270,000	940,000	74
1964	1,350,000	900,000	67
1965	1,060,000	690,000	65
1966	800,000	540,000	68
1967	740,000	460,000	62
1968	670,000	360,000	54
1969	720,000	350,000	49
1970	1,119,000	663,000	59
1971	991,000	693,000	70

I/ All species figures prior to 1963 have been converted from live weight (in the shell) to meat weight. The meat weight is estimated to be 15.5 percent of live weight for giant Pacific oysters and 10.9 percent for eastern oysters.

* Marine fish catch statistics from Calif. Dept. Fish & Game Bulletin Series, 1955 - 1971.