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Status and Trends of California Wetlands

California Assembly Resources Subcommittee on Status and Trends

FINAL

STATUS AND TRENDS OF CALIFORNIA WETLANDS

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RY GOGGIN, CHAIRMAN

PRINCIPAL AUTHORS

Nona B. Dennis and Mary Laurel Marcus,
assisted by Harriet Hill

GRAPHICS

Yuki Kawaguchi

PRODUCTION

Jill Petralia

ESA/MADRONE,

A division of Environmental Science Associates, Inc.
Novato and San Francisco, California

PROJECT MANAGER

Charles Warren and Associates
Sacramento, California

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FOREWORD

This report to the California Assembly Natural Resources Subcommittee on Status and Trends has as its principal objective a review of the present status and likely future of California wetlands, and documentation of their value and importance. To evaluate the present and propose action requires that one: Study the past - where were wetlands located when California became a state? Document use and changes - where have wetlands been converted to other uses and for what purposes? Identify causes and their effects - what specific kinds of human actions lead to what specific changes to the wetland resource? Distinguish among values - how can conflicting perceptions of wetland values be accommodated and integrated into comprehensive policy? And, finally Consider means of protection - What accomplishments have public agencies and private interests already made in managing the use of wetlands and how can these be buttressed?

The report has a second objective, essential to fulfilling the first: that is, to encompass all of California's wetlands. This is not easily done, because information is variable throughout the state and often scarce, and wetlands themselves are highly variable. It requires generalizing, illustrating with specific instances where data are most abundant, although abundance of data does not necessarily equal importance of the resource.

To accomplish this second objective, the report has been divided into three discrete parts, with an Appendix. In Part I: California's Wetlands - Then and Now the reader can find the general story of the state's wetland resources, and need not read further unless prompted to do so. Part II: Programs and Policies is devoted to the institutions and entities that manage the use of wetlands through regulation or other means. Part III: The Regions of California provides a more detailed review of each region of the state, supplementing Part I. The Appendices contain supporting data: tables and lists that some readers may wish to consult. Together, the text and Bibliography should serve as a "source book" as well as report.

This comprehensive literature review and survey of California's wetlands and programs was made possible in part by a contract with the U.S. Congress Office of Technology Assessment (OTA) in 1982. That study was one of ten regional case studies, nationwide, concerning trends in wetland use and the effectiveness of federal and state management programs. The present report draws heavily on the OTA study and on the contributions of the many reviewers of that study. The report was also made possible by a small grant from the Assembly Natural Resources Committee, with assistance of an informal working group and labor volunteered by ESA/Madrone.

EXECUTIVE SUMMARY

The evidence is overwhelming that the majority of California's historic wetlands no longer exist and that there are continuing pressures on the approximate 9% that remain. Since 1850, the face of California has changed in dramatic ways. Agricultural regions, ports and harbors, and large metropolitan centers have displaced most of this valuable component of the state's natural heritage. Future decisions on how best to manage use of the remaining resource will be better informed if guided by an understanding of the causes and effects of converting wetlands to other uses, of the opportunities and values that are lost as wetlands are diminished, and of effective, workable means by which wetlands can be conservsed.

CALIFORNIA REGIONS AND THEIR WETLANDS

This report traces the history and causes of wetland losses in six geographic subregions: Klamath Lakes Basin and Modoc Plateau in northern California and southern Oregon; the North and Central Coast, extending from the Oregon border to Point Conception; San Francisco Bay; Central Valley; the South Coast, from Point Conception to the Mexican border; and the Desert, encompassing the Great Basin, Mojave, and Colorado desert areas from Mono County to the Colorado River.

These geographic subregions of California contain a variety of wetlands, reflecting the wide range of physiographic and hydrologic conditions that can occur within the Mediterranean climate (dry summers, wet mild winters) that is common to all of them. California's mild wet winter and abundant food attracts millions of birds and waterfowl from northern breeding grounds to California wetlands for overwintering or transient use enroute to southern regions. The Pacific Flyway is one of the major north-south migratory routes in the nation.

The most significant and largest wetland areas that remain in California are in the Klamath Basin, Humboldt Bay, San Francisco Bay, Suisun Marsh, and the Central Valley. The Pacific Coast holds a string of many minor wetlands

within river mouths and estuaries and a few major wetlands (1,000 acres) such as Elkhorn Slough and Tijuana Estuary. The Central Valley, historically the largest resource of freshwater and brackish marshes, now has scattered tracts of managed wetlands in both public and private ownership. (Managed wetlands are maintained by intentional flooding and manipulation of waterlevels.)

Seasonally flooded agricultural lands provide secondary wetland habitat. In the Sacramento-San Joaquin Delta corn fields flooded for leaching of salts, and flooded rice fields in the Sacramento Valley, provide waterfowl habitat. Diked hay and forage crops in northern San Francisco and Humboldt Bays collect winter rains and offer useful if unpredictable habitat. The Klamath Basin holds managed wetlands and agricultural lands ringing the many small lakes in this region, both publicly and privately owned. Small oasis-like washes and riparian woodlands dot the desert region. Their natural rarity rather than their size makes them significant. The Salton Sea and Colorado River offer the largest desert wetlands and riparian forests. San Francisco Bay, the state's largest estuary, has much of the remaining tidal and brackish marshland as well as large areas (up to 50,000 acres) of potentially restorable diked historic tidelands, including agricultural lands.

HISTORY OF LOSSES

Table i summarizes wetland losses in California since 1850 and outlines current trends in uses of wetlands. The history and distribution of wetland losses in California correspond to the history and settlement patterns in the state. Reclamation of marsh and swamplands to agriculture in the 19th and early 20th centuries accounts for the largest area loss of wetlands statewide. The Central Valley and Sacramento-San Joaquin Delta, which once held up to 4,000,000 acres of seasonal and permanent wetlands, became a rich agricultural center, but at the expense of 96% of the valley's native wetlands. Agricultural reclamation, promoted largely by federal water projects, prompted a 60% conversion of wetlands in the Klamath Basin.

Extensive marshe areas have been converted to agricultural use along the coast and in San Francisco Bay, particularly in alluvial and tidal floodplains, where fertile soil is a product of a past flooding and wetland regime.

CALIFORNIA WETLANDS

SUMMARY OF HISTORIC LOSSES AND CURRENT TRENDS

Region	Estimate of Original Acreage and % Reduction	Approximate[1/] Remaining Acreage	Acreage of Public Wetland (where known)	Current Trends
California	5 million	450,000	175,192+	See Regions
Klamath Lakes Basin	189,000 60%	unknown	151,375 total 81,049 wetland	Agricultural reclamation of private and managed wetlands
Modoc Plateau	unknown (acreage has increased in certain areas)	32,240 private 40,000+ public additional unspecified acreage	40,000+	Creation of wetlands in Modoc National Forest Some conversion to agricultural uses
North and Central Coast	unknown	unknown	8,540+ wetlands and tidelands	Sedimentation of wetlands due to logging and agricultural practices in adjacent watershed Agricultural reclamation Preservation as parks and recreation areas
San Francisco Bay	200,000 acres of wetlands 75% loss of original 60% loss when wetlands newly created from sedimentation are considered	37,700 acres original wetlands 80,000 acres total 52,000 acres diked wetlands 57,000 public and private managed wetlands in Suisun Marsh	43,750+	Pressure for filling of diked historic wetlands for urban uses to accommodate large population increases Some losses to port and harbor development Salinity increases in Suisun Marsh due to water diversions Preservation as refuges and parks
Central Valley	4 million 94%	81,184 public 292,400 private	81,184 total 39,200 flooded	Conversion of private wetlands to agriculture Conversion of secondary wetlands habitat (ricelands) to less water-intensive crops Reduction of flooded public acreage due to rising pumping costs and decreased availability of water Degradation of habitat value on secondary wetland areas due to technological advances in farming practices Preservation as National Wildlife Refuges and State Wildlife Management Areas
South Coast	53,000 acres 75%	13,000	5,560	Extreme pressure to develop for urban uses, recreational marinas and port expansion as developable land area in south coast is decreasing and population continues to grow
Desert	unknown	unknown	unknown	Disturbance and removal of riparian vegetation from surface mining Feral burro trampling and grazing of riparian vegetation and desert springs Inundation and dredging of riparian and wetland areas along Colorado River and Salton Sea

[1/] Compiled from Department of Fish and Game, National Wildlife Refuges, San Francisco Bay Conservation and Development Commission, U.S. Fish and Wildlife Service, California Waterfowl Habitat Owners Alliance and the California Waterfowl Association.

Port and harbor development in Los Angeles, Orange County, and San Diego accounted for direct dredging and filling of many large estuaries. Urban developments in coastal watersheds and wetlands, beginning in the 1920s and 1930s and accelerating following World War II, indirectly silted in and directly filled many wetlands. The record of diking and/or filling of portions of each southern California estuary, lagoon, or rivermouth is quite complete; approximately 10% of former tidal wetlands remain in Los Angeles and Orange counties, referred to as "museum pieces" by one observer.

San Francisco Bay tidal marshes and the bay surface have also been dredged for ports and harbors and filled to accommodate urban expansion and industrial development. Of the historic marshes, 25% remain. The north and central coast has been least impacted by dredging and filling of wetlands. Urban pressures are minimal; however, early agricultural conversions and silvicultural practices removed large areas from tidal influence and/or caused massive siltation into estuaries and lagoons.

Flood control and water development projects account for major losses of wetlands, particularly in the Central Valley but throughout the state as well. The necessary association of wetlands and riparian areas with episodic inundation by tides or freshwater dictates that these habitats will be lost as flood flows are regulated or water is diverted. Maintenance of wetlands in the Central Valley now entails competition for scarce and costly water. Control or diversion of Colorado River flood flows eliminated most adjacent riparian areas; a similar condition accompanied flood control in Los Angeles and Orange Counties. Diversion of waters from Mono Basin and Owens Valley dewatered a major part of both basins, eliminating riparian vegetation and wetlands.

VALUE OF WETLANDS

Wetlands have been used and abused in many ways partly because they are viewed in different ways. Regarded as a land resource, wetlands have been drained, leveled, cleared and filled to make them more useful as dry land. Viewed as a water resource, they have been dredged and deepened for navigation or flood control.

Wetlands have inherent values as wet land: 1) decades of observations testify to the function of California wetlands as habitat, especially for shorebirds and waterfowl; 2) wetlands have higher rates of primary productivity than most other ecosystems; 3) species with unique adaptations to wetlands are examples of ecological diversity; many are now endangered; 4) wetlands vegetation can provide protection to shorelines in San Francisco Bay and the Delta; riparian vegetation protects river banks from erosion; 5) wetlands provide capacity for flood detention and regulation, as for example, the Marin County diked agricultural lands on San Pablo Bay; 6) wetlands have demonstrated their ability to trap suspended sediments and transform water quality pollutants by physical, chemical and biological means, thus providing water treatment; 7) tidal wetlands and estuaries support commercial and game fisheries by providing spawning and nursery habitat. Beyond these functional services, wetlands have intrinsic values as open space and special ecosystems for the recreation, enjoyment, education and scientific interest of the residents and visitors to California. The high user-day count of publicly owned refuges, parks and shorelines and of privately owned duck clubs is an index to the important role wetlands play in many daily lives.

EFFECTS OF CONVERSIONS AND OTHER HUMAN ACTIVITIES ON WETLANDS

Effects

While the percentage losses vary from region to region, statewide the estimated native 3,000,000 to 5,000,000 acres have been reduced to less than 500,000 including flooded agricultural lands, with a significant reduction in the wildlife populations that depend on them and in other values. Changes in wildlife species and numbers that have accompanied loss of wetlands is documented in many specific cases. Certain resident species, such as tule elk, have been entirely eliminated from areas due to loss of habitat and overhunting; others are diminished in numbers. Twenty-four animal species are listed as rare, endangered or threatened, in part because their continued survival depends on wetland habitats. Several plant species are listed as endangered for the same reason. Salmon, sturgeon, flounder, smelt, shrimp,

clams, and oysters were intensively harvested from 1850 to 1900. These commercial fisheries declined rapidly after 1900 due in part to loss of intertidal areas and salmon spawning grounds, as well as overfishing, upstream water diversion, and water pollution.

The reduction of waterfowl numbers through loss of habitat and other factors is the best documented case. For example, peak seasonal concentrations of waterfowl in the Klamath basin have fallen from 6 million to 1 million, nearly 80% of waterfowl presently using the Pacific Flyway. Sixty percent of these waterfowl over-winter in the Central Valley. California winter feeding grounds for migratory waterfowl and shorebirds are now more limiting to populations than their northern breeding areas. Migratory shorebirds and waterfowl, once numerous along the south coast, have but a few areas left in which to overwinter. In desert regions removal of even small amounts of isolated groves of riparian vegetation has been significant. Wildlife dependent upon an individual water source or riparian grove (in the Mojave Desert, 76% of all bird species) may not be able to relocate to the next, often distant, grove.

Continuing Pressures on Wetlands

The two greatest pressures on wetland areas continue to come from 1) conversion of inland managed wetlands to intensive agriculture and changes in crop practices; and 2) from urban, industrial, and port development on the south coast and in San Francisco Bay. Agricultural conversion in the Central Valley is encouraged by competition for water and by formidable economic pressures: primarily the high cost of water, energy, and property taxes. The continued maintenance of both public and private managed wetlands requires a range of incentives and subsidies. Sixty-four percent of California's population lives in the coastal counties, including the San Francisco Bay Area. The majority of this population (76%) occurs south of Ventura County, while only 3% is north of Sonoma County. These populations will continue to place unevenly distributed development pressures on remaining wetlands and their watershed lands.

Urban development imposes an indirect pressure on wetlands. Clearing and construction in watersheds continue to produce excessive amounts of sediment in downstream areas. The deposition of sediment in tidal areas not only smothers living plants and organisms but, if great enough, can raise the level of the wetland out of the tidal range. In addition to compounding habitat decline for migratory birds and endangered species, port and harbor development creates deep water environments in the place of tidal mudflats, with the loss of spawning and feeding areas for estuarine and anadromous fish. The productivity of deepwater harbor habitats is lower than intertidal, although some biological use is retained.

AGENCIES, POLICIES AND PROGRAMS THAT AFFECT WETLANDS

California wetlands are governed by a complex network of agencies. Their jurisdictional boundaries form a patchwork that is multi-tiered in some regions (San Francisco and Humboldt Bays; the Coastal Zone) and largely missing in others (the Central Valley; Desert regions). Some avenues are direct; for example a few directives apply to specific wetland areas (Suisun Marsh). Other programs affect wetlands only indirectly, through limited dredge and fill permits, management of water quality or quantity, stream crossings, anadromous fish (steelhead; salmon) management, managed game species, endangered species and their habitats, navigability, floodplain management, public trust, coastal access and general land use. There is no comprehensive policy or approach at either federal or state levels.

This report examines five principal levels or means of managing the use of wetlands. The federal level is dominated by the Corps of Engineers Section 404 program (below), supported by permit authority and various memoranda of agreement. Review of federally aided state and local programs for compliance or consistency (as with the State's Coastal Zone Management Program) provides means of both federal and state control. In addition, management of federal lands in California, such as those owned by the Air Force, Navy, Forest Service and BLM, National Park Service, Bureau of Reclamation (together 45% of California's total land area) as well as territorial waters are subject to the basic environmental charter of the National Environmental Policy Act (NEPA) and the Federal Land Management and Policy Act (FLPMA), among others. These

laws, and the Endangered Species Act and Executive Order 11990 (Wetlands Protection), require federal agencies to specially manage and preserve wetland areas and their wildlife. Of these, the Endangered Species Act is one of the most influential in restricting federal actions in their own wetlands in California.

The principal agency regulating uses and activities in wetlands throughout California is the Corps of Engineers, exercising both Section 10 (Rivers and Harbors Act) and, along with EPA Region IX, Section 404 of the Clean Water Act. The San Francisco, Sacramento, and Los Angeles Districts administer these programs over their regions of the state. The Section 10 program addresses structures, dredging, and other possible intrusions into navigable waterways; Section 404 addresses water quality by regulating discharge of fill and dredge material into "waters of the United States." Through administrative and judicial interpretation, the program has broadened to encompass wetlands, whether within, adjacent to, or isolated from waterways. While numerous values of wetlands are protected in this manner, emphasis has been placed on wildlife habitat, since this value is best documented.

Section 10 jurisdiction is important in California as a distinct authority for projects in "navigable waters". the San Francisco District, for example, asserts Section 10 authority in diked, no longer tidal lands, with or without Section 404, when the test of historic navigability can be fulfilled. In reviewing Section 404 and 10 permits, the Corps Districts weigh all "public interest" factors, including a general wetland policy. Even with recent regulatory reforms, there continues to be a strong Corps "wetland presence," especially on the Coast, in major bays (San Francisco, Humboldt, San Diego), in the Delta, to an extent in the Klamath Basin, and along "project" waterways, as on the Sacramento and San Joaquin Rivers.

Under provisions of the Fish and Wildlife Coordination Act, the U.S. Fish and Wildlife Service and National Marine Fisheries Service both comment on Corps Public Notices. The Department of Fish and Game also plays an active review role under the Coordination Act (below). In California, these agencies together play a very influential role, monitoring all three disricts of the Corps in their administration of the 404 program.

Two federal programs provide incentives for maintaining wetlands in agricultural regions. The U.S. Department of Agriculture Soil Conservation Service administers the Water Bank Program, under which landowners can enter into ten-year agreements and receive payments for conserving wetlands as habitat for nesting waterfowl. The program has been modified in California to protect feeding as well as nesting habitat. About 32,000 acres are thus protected, largely in the Central Valley.

The Conservation Easement Program (USFWS) pays fees to landowners to enter into conservation easement agreements which require that their land be managed as wetlands in perpetuity. Funding, which derives from duck stamps (Migratory Bird Conservation Act), is limited as to the number of acres it can support as easements.

The U.S. Bureau of Reclamation and U.S. Department of Agriculture have encouraged many wetland conversions to agriculture through incentive programs that provide tax deductions, investment tax credits, low interest loans, crop price supports, etc., to assist in clearing, draining, leveling and cultivating former wetlands. This is still a major contibutor to reduction of wetlands nationwide as well as in California. The Bureau and Department of Agriculture also have programs for conservation and restoration of wetlands on their lands and in relation to specific projects.

At the state level, only three statutes in Califonia have direct permit authority over wetlands. These are the Coastal Act, with its regulatory provisions for sensitive wetlands and other wet habitats in the Coastal Zone; the Suisun Marsh Protection Act, which covers a 10% portion of the state's total wetland resource; and the McAteer-Petris Act, which empowers San Francisco Bay Conservation and Development Commission (BCDC) to regulate bay fill up to the "line of highest tidal action and within a 100-foot shoreline band." Fifty-two thousand acres of diked historic tidelands in San Francisco Bay are precluded from direct state authority by the definition of BCDC's jurisdiction. A bistate compact (California and Nevada) rgulates land use in certain wet areas (stream zones and wet meadows) around Lake Tahoe.)

The California Environmental Quality Act (CEQA) is the state's basic charter for protecting the environment and provides the major device (EIR) for examining significant impacts of state and local projects. Most policies are general; specific areas (Suisun Marsh, Sacramento-San Joaquin Delta, Wild and Scenic Rivers) and sensitive resources, including wetlands, are considered significant, thus triggering CEQA review where projects are proposed.

The state's public trust easement is exercised by State Lands Commmssion (SLC) in diked and undiked lands where historic tidal action can be verified and up to the high water mark in Lake Tahoe and Clear Lake. Since the state's interest must be demonstrated on a case-by-case basis, SLC's effectiveness in protecting wetlands has been unpredictable.

Until recently, state agencies were guided by a Basic Wetland Protection Policy, set forth in 1977 by the Secretary of Resources. The policy was never tested in a court of law, but was an effective deterrent to indiscriminate development in wetlands and was instrumental in negotiation of mitigation for some wetland losses. The policy is in process of review and revision (April, 1984); in its present form it functions as a guideline in the state's review of specific applications for projects in wetlands.

The Department of Fish and Game (DFG) is the principal agency charged with protection of the state's fish and wildlife resourcaes. Under the Fish and Game Code, the Department regulates hunting and fishing among its many responsibilities.. The Department also enters into agreements with applicants whose projects will alter streambeds ("1601" agreements). Some of these are in wetlands. The DFG has no direct permit authority over wetlands. DFG's comments on 404 Permit actions, conveyed under the Fish and Wildlife Coordination Act through the Resources Agency, weigh heavily in Corps decisions. DFG has been successful in a variety of ways in protecting specific California wetlands through research, acquisition, dedication, and by active contributions to mitigation proposals.

The state's Porter-Cologne Water Quality Control Act, which established the State Water Resources Control Board and Regional Water Quality Control Boards, comes closest to the Clean Water Act in its authority to regulate

discharge of pollutants into state waters, thus indirectly protecting wetlands. The Regional Boards administer the National Pollution Discharge Elimination System (NPDES) program under Section 402 of the Clean Water Act and are empowered under Section 401 to certify that 404 Permit actions meet the state's water quality objectives. Under Section 208 (Clean Water Act), the Regional Boards have prepared Basin Plans, which identify indirect (nonpoint) sources of pollution to wetlands and water bodies.

The state has indicated concern for wetlands in other ways. The Keene-Nejedly Wetlands Preservation Act (1976) affirmed the need to develop public policy directed at wetlands preservation and restoration, but it was supported by only limited funds for acquisition. Senate Concurrent Resolution 28 (1979) instructed DFG to develop a plan, identifying ways to increase remaining wetlands by 50% by the year 2000. The completed report released on December 1, 1983, suggests many possible economic incentive and funding methods to increase inland waterfowl habitat. The Grasslands Bill (1956) is a federal limited incentive program that provides low cost water for maintenance of wetland habitat in the grasslands area of the San Joaquin Valley.

Local Governments and special districts throughout California are required to implement the California Environmental Quality Act (CEQA) and state planning law; through indirect means, these provide some protection to sensitive habitats such as wetlands. However, few California counties or cities have adopted strong wetland policies; fewer have adopted the ordinances necessary to implement them. In addition, few local governments have ordinances that protect watersheds from erosion and sedimemtation.

A fourth major type of protection in some California wetlands is nonregulatory. The federal government began acquiring and managing wetlands for waterfowl in California in the early 20th century, at the same time that federally sponsored reclamation was actively draining other wet areas for cultivation. National Wildlife Refuges are now concentrated in the Klamath Basin, the Central Valley, Humboldt Bay, San Francisco Bay, certain coastal wetlands, Salton Sea, and the Colorado River. Two national estuarine sanctuaries, managed by DFG, have been established on the coast at Elkhorn Slough and Tijuana Estuary under OCZM's Estuarine Sanctuaries program.

The state began acquiring wetlands as waterfowl refuges and management areas in the 1930s, accelerating these programs in the 1950s. The California Coastal Conservancy administers state and federal grants for restoration of various coastal resources, including wetlands, through public-private redevelopment and other financing techniques.

The most successful private initiatives in wetlands protection have been provided by duck clubs and waterfowl interests. The managed wetlands of Suisun Marsh are protected largely because of their political influence, which has also called for water quality standards for Delta outflow. Most of the remaining wetlands in the Central Valley are owned and managed either as private duck clubs or wildlife refuges. Federal incentive programs for retaining wetlands in private ownerhip have encourged preservation but not fully compensated owners for maintenance costs. Nature Conservancy and Trust for Public Lands have aggressively pursued wetland acquisitions in coastal areas, and the California Waterfowl Association, Audubon Society, Sierra Club, and many local and regional organizations have made important contributions to this effort/

Summary. The Corps Section 10/404 program, despite certain inadequacies (monitoring and enforcement) presents the strongest program statewide for protection of wetland areas. In many situations, it is the only program. The State of California has three statutes which directly protect wetlands: on the coast, in the San Francisco Bay Area, and in Suisun Marsh. These programs, while of geographic importance, are limited in territory or application of authority.

Although the state has expressed a public concern for wetlands in a number of ways, general policies and necssary instruments to carry them out are lacking. The state has come to rely on the federal presence, assuming that the basic charge and authority for wetland protection would be federally directed, secondarily reinforced by state policy. At present, the state is reluctant, as are all other states, to assume delegation of the Section 404 program, even though statutory instruments or administrative mechanisms could be tailored to do so.

Many wetland and riparian areas and activities are essentially ungoverned. Along the coast, processes destructive to wetlands are unregulated by either the Corps or any other federal or state agencies: erosion in coastal watersheds and resulting sedimentation of downstream wetlands; and the removal of riparian vegetation. In inland wetlands, conversion to agriculture can be accomplishd with virtually no local, state, or federal entitlements or conditions required.

The trend toward reducing federal regulatory authority, evidenced by recent Corps of Engineers regulations, places the future of wetlands in California in an uncertain position. However, without a reliable mix of acquisition, regulated protection, and economic incentives it is safe to predict that California's remaining wetlands will continue to dwindle, acre-by-acre.

ISSUES AND NEEDS: ADDENDUM

INTRODUCTION

On December 6, 1983, following distribution of the Draft Report on Status and Trends of California Wetlands, the Assembly Subcommittee on Status and Trends held a Public Hearing in Santa Ana. The purpose was to receive prepared statements concerning the Draft Report and to consider issues for possible legislative action. The following Addendum to the report summarizes the issues presented and implicit recommendations.

The recommendations below are intentionally general, couched in terms of needs for appropriate action. It is not the intent of this report to either supplant or exactly duplicate the detailed recommendations which have been thoroughly studied and set forth in two recent wetland habitat plans (A Plan for Protecting, Enhancing, and Increasing California's Wetlands for Waterfowl (SCR 28 Report), Department of Fish and Game 1983 /151/; and Pacific Flyway Waterfowl in California's Sacramento Valley Wetlands: An Analysis of Habitat and Plan for Protection, Sacramento Valley Waterfowl Habitat Management Committee 1983) /152/, or in any other specific resource studies or plans.

ISSUES AND NEEDS

1. Comprehensive Statewide Policy for Protection of California's Remaining Wetlands.

At the present time, California is dependent in many regions on the Corps of Engineers' 404 Program for regulation of wetland areas. Several statutes provide authority for state protection of wetlands; along the coast, in Suisun Marsh, in tidal portions of San Francisco Bay, and portions of Lake Tahoe shorelands (bistate compact). Major regions of the state have no regulatory protection. Any significant modifications either to the federal program or in state emphasis could weaken the state's ability to protect wetland resources. Even with a strong statutory program on the coast, enormous pressures still

threaten virtually all remaining coastal wetlands not under public ownership; most decisions involving privately owned wetlands on the coast must be regarded as holding actions, pending final disposition. A similar prediction might be rendered for privately owned wetlands in the Central Valley.

The need for a comprehensive statewide policy and program to guide wetland use and conservation decisions is widely recognized. A strong state protection program would be applied to wetland areas not specifically protected by other legislation such as the Coastal Act. Its primary purpose would be to make wetland protection mandatory and uniform for wetlands not presently protected by the state, avoiding needless duplication of effort in those areas already protected.

The second, equally important, purpose of a comprehensive policy and program would be to declare the state's position that wetlands are areas deserving of special treatment and protection. Such a policy would tell landowners that wetlands are important, provide planning guidelines to local jurisdictions, and support local and state efforts to acquire ownership interest in wetlands, thus optimizing the expenditure of public funds in protecting targeted areas. A state policy and an implementing program are viewed as necessary precursors to cost-effective acquisition.

2. Definition of Wetlands

A comprehensive wetland policy requires a concise and workable definition of the resource, sufficient in scope to cover California's diverse wetland conditions. Protective efforts are difficult to bring to fruition without a consistent basis for field identification and design of management and restoration programs.

The United States Fish and wildlife Service definition and classification system /29/ is the most comprehensive and scientifically sound method in current use. It is thoroughly applicable, with some adaptation, to California's wetlands and in fact has already been used extensively. The California Department of Fish and Game is adapting the system into a form that

can be used more easily, substituting common terms for technical ones. When an acceptable definition has been developed, it should be incorporated into a statewide policy (above).

3. Funding of Wetland Conservation and Acquisition Programs

Most wetland conservation interests agree that there are two basic and interdependent methods of protection: regulation, in support of public policy, and acquisition of full or partial interest in resource lands. Acquisition, whether entire or partial, as in easements, offers the only permanent guarantee of protection. Regulation is transitory to the extent that it must rely on the continued political will of elected officials; "...regulation alone is a slim reed on which to base permanent protection." /156/

To be effective, regulation must be coupled with funded programs to: 1) restore or enhance degraded or otherwise altered wetlands; 2) improve management of publicly owned wetlands; 3) conduct necessary research; 4) offer inducements (Economic Incentives, below) to private wetland owners; as well as 5) acquire valuable wetlands. While acquisition is the most desirable form of long-term protection, public funds will always be limited. In evaluating possible land preservation alternatives, agencies are obligated to weigh costs against benefits to be gained in each project that would acquire and/or restore wetlands. Public programs should include a range of actions, tailored to reflect differing wetland values and statewide and regional priorities and designed to encourage innovative preservation techniques and shared public-private commitments. In turn, the state should assist in assuring adequate levels and diverse sources of funds.

Potential sources of funding to augment traditional operating funds and sources of revenue of the Department of Fish and Game are discussed in detail in the SCR 28 Report. These include, among others, increased appropriations from the State Energy Resource Fund and General Fund; increased user charges, such as hunter and nonhunter fees; and increased duck stamp costs.

4. Public Awareness

At various times over the past 15-20 years the California public has been aroused into action over the need to protect wetland resources - for example, by the McAteer-Petris Act when it was proposed in San Francisco Bay, and the Coastal Act. Recently, interest in wetlands has been eclipsed by other pressing environmental issues. Few people are aware of continuing losses of wetlands. If remnants of the once extensive resource are to be preserved, the public and government at all levels must become better informed about the vital role wetlands play among natural ecosystems. More important, protection of wetlands must be realistically viewed as a matter of political will, rather than simply as a reaffirmation of ecological significance.

Public agencies must play a more aggressive role in informing the public and local government of the need to protect wetlands. They should consider, for example, adopting the approach taken by non-profit organizations such as Trust for Public Land (see Economic Incentives, below), which assists local community groups to pursue various alternative methods of protecting wetlands to supplement direct regulation or acquisition. Private wetland owners should be informed more effectively of the options available to them as incentives to maintain their property as protected resource land.

5. Coordination of Programs and Management of Existing Wetlands

A multitude of private and institutional players are involved in what is frequently a case-by-case, often confrontational approach to decision-making over the use of wetlands. Individual cases are viewed generally in isolation; many activities that adversely affect wetlands are unregulated because they lie just outside existing jurisdictions, and minimal attempt is made to integrate control. Coordination and philosophical agreement on how to protect wetlands are lacking on a statewide or in some areas even on a regional basis.

This piecemeal approach to protection is both inefficient and ineffective but might be resolved through an interagency task force, including also important public sector participants. The state has a useful history of

experience of multi-agency interactions in dealing with wetland issues in some regions, notably along the coast, in San Francisco Bay, and in some parts of the Central Valley; little attempt has been made to monitor the status of wetlands throughout the state. This is difficult to do without a periodic, predictable convening of wetland resource managers and private sector interests, especially from those regions that are geographically distant or whose wetlands are dispersed.

On a related issue, viz. management of existing wetlands, several recent studies (SCR 28 Report; Sacramento Valley Waterfowl Habitats) concur that with the limited funds typically available, the physical and ecological systems of publicly owned wetland areas should be more effectively managed for habitat diversification and balance, for both waterfowl and nongame birds. In turn, DFG and USFWS should take the lead in disseminating information and management techniques to the private sector. Increasingly, private wetland owners should be encouraged to assume a greater role in preserving and managing wetland areas. The overall habitat resources of various regions of the state should be more thoroughly inventoried, including riparian areas, grassland habitats, and vernal pools, as well as "traditional" marshes, and master planned through public-private cooperative efforts.

6. Availabily of Dependable Water Supplies and Future Allocations

The most critical long-term need of state and federal wildlife areas is for dependable and affordable water for management of wetlands. The Status and Trends Report documents the problems inherent in present limitations in firm water supply, the low priority status which wildlife presently receive in of state and federal water allocations, and the high energy costs of water delivery.

These problems are also fully examined in the SCR 28 Report and Sacramento Valley Waterfowl Habitats Report, and specific recommendations are made. For example, water rights for wetlands or assurances of delivery to wetlands should be secured as new federal and state incremental water supplies are developed or as State Water Project contracts are renewed. Wildlife should be

put on an equal footing with agriculture as state water rights priorities are set, and federal power from the Central Valley Project should be delivered to wildlife areas (and hatcheries) at project power rates.

7. Economic Incentive Programs : Preservation Alternatives

Nonprofit organizations have played an active role in California in assisting public agencies to acquire wetlands. The Trust for Urban Lands (TPL) outlined their public land program at the December 6 Hearing. The State Coastal Conservancy, also represented at the Hearing, reviewed similar innovative programs that are being developed in various coastal and bay locations to make more effective use of public funds in preserving resource lands.

Using an approach based on encouraging rather than imposing land use controls, TPL and Coastal Conservancy have developed techniques such as training assistance to local community groups in formation of land trusts; use of estate and income tax laws to enable donations of land; encouraging small lot consolidation, transfer of development rights, partial development, land exchanges, and conservation easements to enable wetland preservation in conjunction with appropriate development. These techniques are all designed to gain maximum leverage from public grants, leading eventually to acquisition and enchancement of valuable wetlands.

Federal incentive programs have been in effect in some Central Valley wetlands for a number of years (see Status and Trends Report), but they are neither sufficiently broad, aggressively pursued, nor are they offered at the state level. The Sacramento Valley Report recommends state legislation that would exempt or reduce income and property taxes in exchange for reducing or eliminating the development potential in privately owned wetlands, actively managing or enhancing wetland areas, or simply preserving wetland features.

8. Prevention of Further Reductions in Acreage, and Restoration of Wetland Acreage

It is the adopted policy of the State to increase wetland acreage by 50% by the year 2000, and yet the evident trend in the state is toward continuing loss. For example, along the coast, in spite of the inclusion of mitigation elements in all development proposals, the cumulative result is generally a net reduction in wetlands acreage. The Department of Fish and Game stated at the December 6, 1983, Hearing that further reduction in wetland acreage is unacceptable; the only means of mitigation that are consistent with the goals of SCR 28 are to limit acceptable uses within wetlands and require a minimum of acre-for-acre compensation for wetland losses incurred and/or require creation of new wetlands of equivalent size and quality.

The Coastal Commission's position is similar to DFG's. In evaluating proposals in wetlands, "balancing may not be appropriate - where so much has already been lost, there must be a preservation bias." /156/ Nevertheless, mitigation is the principal focus of controversy among land owners, developers, local govenment and trustee agencies, particularly along the coast and in San Francisco Bay and the Delta. No one has agreed on what constitutes adequate mitigation (1-to-1?; 2-to-1?; 3-to-1?), nor has there been agreement on the level of protection and mitigation to be accorded to "degraded" (modified) wetlands. Opponents to mitigations as conditions of approval complain that mitigation requirements are both upredictable and excessive. Until the state has arrived at a consistent policy and basis for valuing and conserving wetlands, mitigation will continue to be a hotly disputed concept.

PART I:

CALIFORNIA WETLANDS: THEN & NOW

PART I: THE WETLAND RESOURCES OF CALIFORNIA

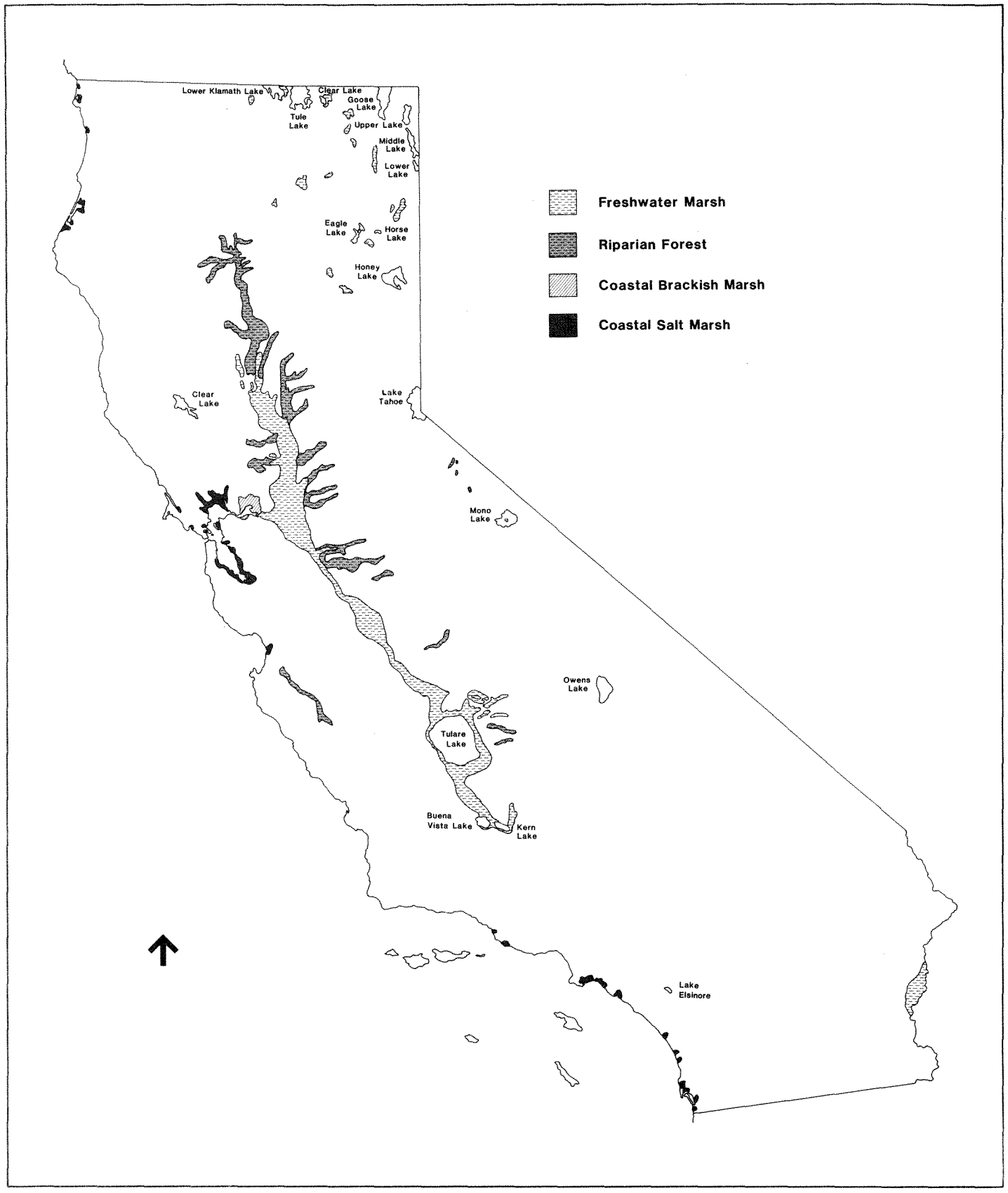
INTRODUCTION

OVERVIEW OF WETLANDS: THEN AND NOW

California once contained between three and five million acres of wetlands and an unknown acreage of riparian forest (Figure 1). In the absence of authentic records and a clear definition of historic wetlands, there is wide variance in current estimates of the total wetland acreage that existed in about 1850, when active settlement of the new state of California began. To the Central Valley alone, some estimates attributed 4 million acres of seasonal wetlands and permanent freshwater marsh and 775,000 acres of riparian forest.

The two largest rivers, the Sacramento and the San Joaquin, carrying runoff from both Sierra Nevada and Coastal Ranges, met in a 400,000+ acre delta of sloughs and marshy islands. Over 380,000 acres of tidal and brackish marshes lay along the 1,072-mile California coastline and the shoreline of San Francisco Bay, geographically discrete but connected functionally by the migrations of shorebirds and waterfowl. The Klamath Basin, which straddles the Oregon-California border, held a series of large inland freshwater lakes in excess of 190,000 acres. Patches of small wetlands dotted the Modoc Plateau in the northeastern corner of the state. The eastern great basin and southern desert with their arid climates accounted for a scattering of small but important "oases" of springs, marshland and riparian forest. Seventy-one thousand acres of riparian forest filled the historic floodplains and ox-bows of the Colorado River. /131,122/

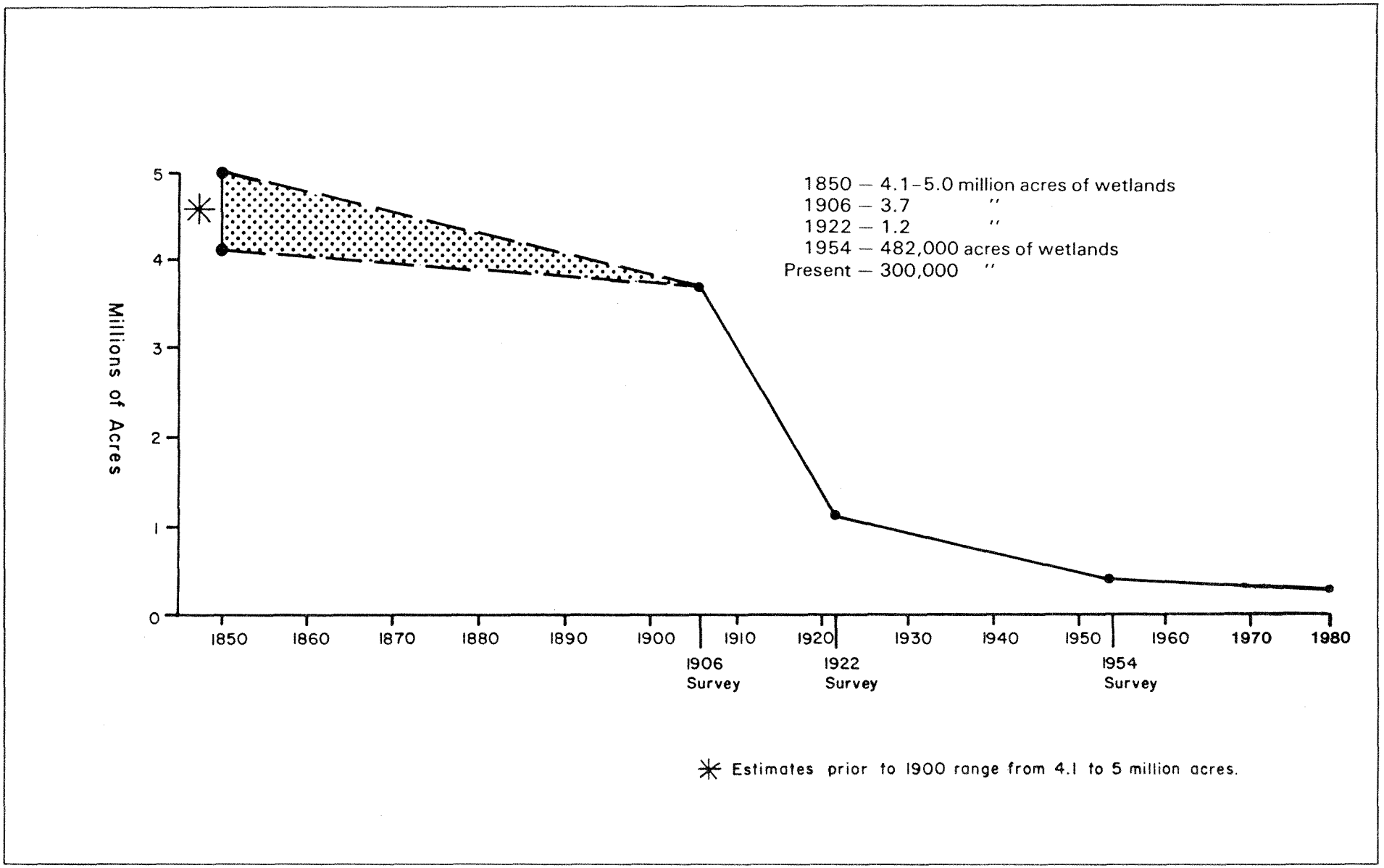
These wetlands are nearly gone, reduced by over 90% statewide (Figure 2). /137,134/ In exchange, the Central Valley became a productive agricultural center through flood control and reclamation of most of its freshwater marshes. The southern coast has but one tenth of its original tidal wetlands; the balance has been filled or dredged for urban uses, ports and harbors, and



SOURCE: The California Water Atlas, 1978.

FIGURE 1

Historic Wetlands



SOURCE: Concept Plan for Wintering Waterfowl Habitat Preservation, U.S. Fish & Wildlife Service, February 1979.
Revised 1983. Pacific Flyway Waterfowl in California's Sacramento Valley Wetlands.

FIGURE 2

Wetland Losses in California

for water, flood control, and transportation systems which support metropolitan centers. Sedimentation from upstream development has contributed to the loss. In San Francisco Bay, 75% of the 313 square miles of historic wetlands have disappeared for similar reasons. /99/

The predominantly rural character of the north and central coasts has spared most wetlands. However, agricultural reclamation, watershed erosion and sedimentation, and harbor development have reduced tidelands and marshes by up to 60% in certain estuaries. Klamath Basin lost nearly 60% of its freshwater wetlands to agricultural reclamation as did certain areas of the Modoc Plateau. Water impoundments have drained or flooded the most extensive of desert riparian forest along the Colorado River.

Throughout California, loss of wetland and riparian areas has induced drastic declines in populations of specially adapted wildlife species, now classified as rare or endangered, and in large populations of migratory waterfowl and shorebirds that follow the Pacific Flyway. Loss of wetlands has also reduced opportunities for hunting, fishing, shellfish digging, and other recreational pursuits as well as functions associated with wetlands such as flood control.

Today, the largest expanses of wetland are in the Klamath Basin, Central Valley, Humboldt Bay, San Francisco Bay, and Suisun Marsh. In the Klamath Basin and Central Valley most remaining wetlands are either artificially maintained ("managed") by public or private ownership, or are seasonally flooded for agricultural purposes. Humboldt and San Francisco Bays both contain tidal and nontidal salt and brackish marshes as well as large areas of reclaimed farmland and other diked historic tideland that offers important bird habitat in the winter. The managed brackish wetlands of Suisun Marsh alone comprise 10% of the state's total resource. Along the Pacific Coast, a string of river mouths and estuaries contain smaller wetlands; on the south coast, marsh remnants have been labelled "museum pieces." A few major (1,000 acres) wetlands remain in Elkhorn Slough, Tijuana Estuary and San Diego Bay. /130,137/

REGIONAL AND HISTORIC FRAMEWORK

California is a single region to the extent that wetlands are connected by the concentrations and movements of waterfowl, shorebird and other wildlife populations that depend on the distribution and capacity of wetlands statewide. The state also can be divided into smaller regions (Figure 3). Each region contains particular types of wetlands within the overall resource; each reveals different physical and biological conditions as well as different economic and political pressures and attitudes toward conservation. The Central Valley region, for example, contains some of the largest remaining acreages of wetlands in the state. These are also among the most significant wintering areas for waterfowl in the country. However, the majority are in private ownership, and in the face of rising taxes, energy costs, competing demands for water, and attractive land markets, the economic and political pressures to convert native or managed marsh to cultivated agriculture or urban development are chronic. Other regions demonstrate similar but distinctive conditions and problems. Part III of this report focuses on the conditions of each of the six regions.

Changes to wetlands are evident throughout the 180-year recent history of California. The destruction of native wetlands began shortly after the 1849 Gold Rush. Reclamation of the Sacramento-San Joaquin Delta began in the 1860s and continued over the ensuing 80 years, ultimately converting about 400,000 acres of tidal and floodplain wetlands to agriculture. The United States government conveyed 2,200,000 acres of "Swamp and Overflow Lands" to the state under the Arkansas Swamp Act of 1850. These lands, which also included some tidal lands, were sold to private owners and for the most part subsequently reclaimed. Urban concentrations and agricultural conversion began to displace shoreline and tidal flats in San Francisco and southern California. Reclamation to agriculture was a continuing trend along the length of the state.

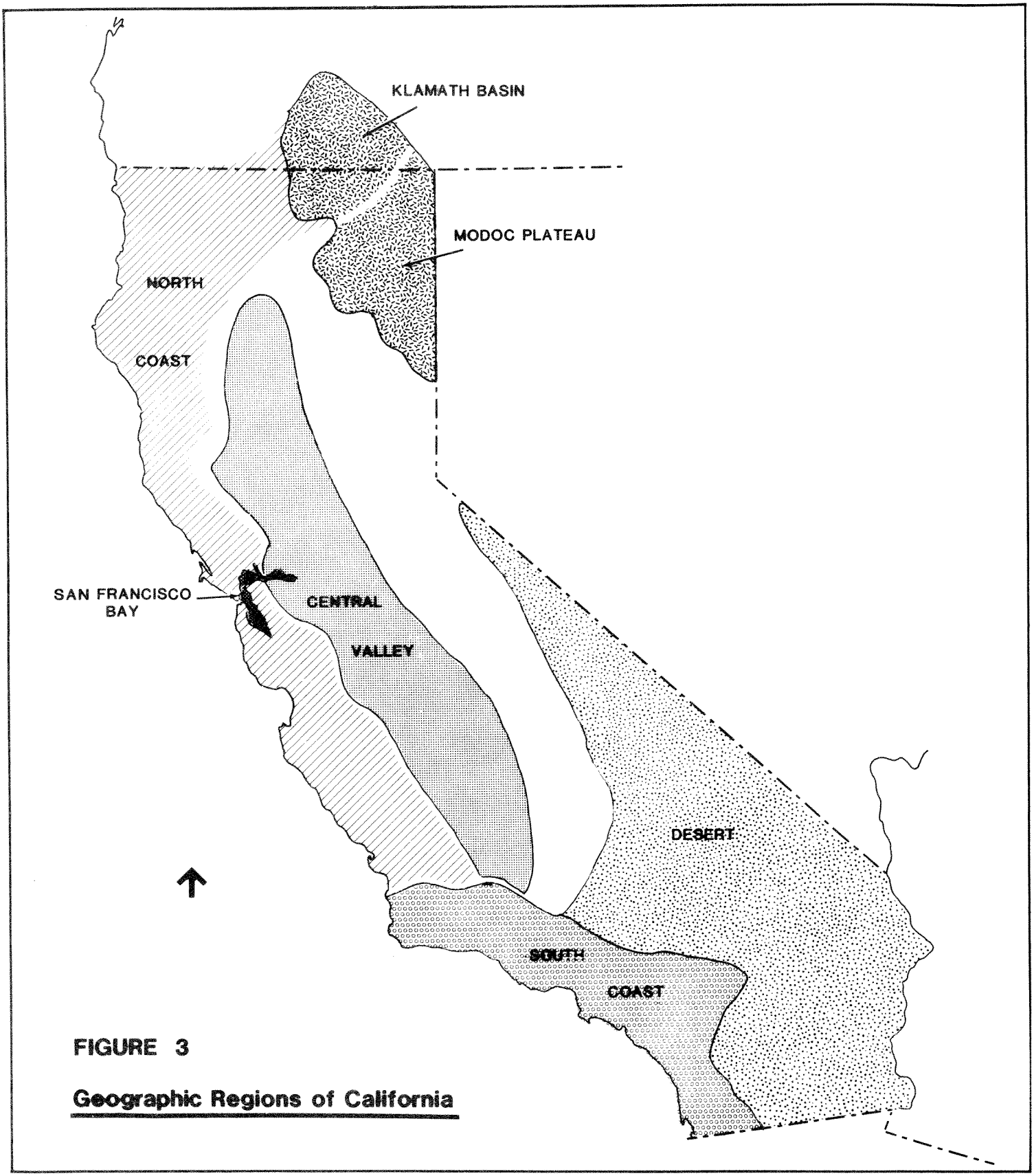


FIGURE 3

Geographic Regions of California

During the 1920s to 1960s, rapid urban and industrial development filled major wetland areas in the growing metropolitan regions of Los Angeles, Orange County, San Diego coast, and San Francisco Bay. A groundswell of environmental concern in the late 1960s supported the enactment of both federal and state environmental laws and regulations. These and other legislative actions and policies in the early 1970s were partially effective in "holding the line", that is in reducing the rate of loss of wetlands, directly or indirectly (Figure 2).

This brief chronology concludes with the present decade of the 1980s, which constitutes a critical period for political and social decisions concerning the future of California's diminishing wetland resources.

STATUS OF KNOWLEDGE

Information on California wetlands is almost as dispersed as the wetlands themselves. Certain bays and particular wetlands are well-studied, and the historic changes in their shorelines and uses are documented. San Francisco, Humboldt, and San Diego Bays are examples. The California Department of Fish and Game, California Coastal Commission, State Coastal Conservancy and universities have conducted research or inventoried many coastal wetlands, but no single comprehensive document covers all of them. The present waterfowl habitats of the Central Valley and Delta have been given thorough examination by the U.S. Fish and Wildlife Service and Department of Fish and Game /19,134,151,152/. However, historic information on many parts of the Central Valley is lacking. The Delta has been investigated in much greater detail in connection with state and federal water projects.

The desert region, Klamath Basin, and Modoc Plateau are particularly poor in wetland inventories. A recent report on riparian resources has helped to fill this gap /144/.The Bureau of Land Management Desert Conservation Plan is informative on existing wetland and riparian areas, but does not describe historic land use changes. In contrast, riparian losses along the Colorado River have been especially well-researched by University of Arizona and Department of Fish and Game.

Overall, the information base on wetlands and riparian resources in California is diffuse and incomplete. This report is the first to compile and distill available data covering all of California's wetlands.

THE RESOURCE

WHAT ARE WETLANDS?

Wetlands are transitional between water and land environments. This ecosystem imposes unusual conditions for survival of plants and animals and demonstrates varied and ingenious strategies for reaping the rich supply of nutrients associated with wetlands. California wetlands include such diverse areas as coastal salt and brackish marshes and lagoons, both tidal and nontidal; intertidal mudflats; inland freshwater marshes and swamps, including relatively rare tidal freshwater marshes; desert springs; riparian forests along creeks and rivers; and vernal pools (small seasonal ponds). For purposes of this report, it is important to begin with a common understanding of what a wetland is.

Wetland boundaries, like the often unpredictable movement of water, vary with topography, with flood and drought cycles, with high and low tides, and with the season. For example, high groundwater levels along rivers and creeks foster the growth of riparian forest. A single year of drought may see die-back of the trees, but a subsequent flood year may renew and expand the forest boundaries. Wetlands that have been altered by humans demonstrate the principle in a different way. Around San Francisco Bay levees separate many historic tidelands from tidal flows. Yet they continue to pond water from winter rains sufficient to maintain wetland plants and support flocks of wintering shorebirds. In a dry year, higher portions of diked wetlands may not pond at all. Ruderal (weedy) vegetation may crop up until the floods of a wet year inundate these "islands," covering them once again with wetland plants. Diked wetlands on the south coast, demonstrating similar seasonal variability, are frequently called "degraded" wetlands. In both examples above, the landward limit of the wetland can vary with the season or with the year.

Various viewpoints on just what a wetland is have produced a variety of scientific and administrative definitions. Most definitions rely on the presence of one or more of three conditions: shallow standing (including tidal) water either year-round or seasonally; hydric or saturated soils; and prevalence of plant species (hydrophytes) adapted to water-logged soil conditions and periodic submergence. The agencies that regulate activities in wetlands or set policy have formulated administrative definitions based on these characteristics. (See Appendix A)

Each agency with jurisdiction must first determine the extent of wetlands in order to act on a proposed change to the wetland. The Army Corps of Engineers' Section 404 program for example, uses all three of these criteria including elevation in relation to tidal datum, to make a wetland determination in both tidal and nontidal areas. The California Coastal Commission guidelines state that only one of the three conditions need be present to determine wetland status. /8/ The U.S. Fish and Wildlife Service has developed the most comprehensive and technically defensible classification of wetlands and applied it to a national wetlands mapping project. /29/ The USFWS system may require adaptation for ready application to all of California wetland types.

TYPES AND DISTRIBUTIONS OF WETLANDS

The types and distributions of wetlands in each region of California are distinctive in plant species, water salinity, topography, and relationship to water bodies. In varying degree, however, they all fulfill the three basic criteria listed above.

Coastal and Bay Wetlands

Along the Pacific coast, salt marshes border quiet sloughs and bays where the freshwater from coastal mountain streams and rivers meets salt water.Many are tidal, some are seaonally cut off from the tides by sandbars, while others, such as the lagoons of the San Diego coast, are now fully closed hypersaline or brackish systems. The diked former tidelands of San Francisco Bay, Humboldt Bay and the south coast exhibit a range of natural and altered conditions.

MacDonald and Barbour (1979) described Pacific coast tidal wetlands as follows:

> Coastal salt marshes represent vegetated portions of the upper intertidal zone. They are usually carpeted with a rather dense cover of salt tolerant plants, including algae, at about Mean Lower High Water (MLHW). While the lower (seaward) limit of a coastal salt marsh is never in doubt, the landward margin is much harder to recognize. It generaly coincides with Extreme High Water (EHW). Often this level is marked by a "debris line" of stranded algae or trash and by abrupt change of slope. Other salt marshes, however, extend well inland on gently rising slopes that reach well above the tides. Their vegetation undergoes changes, and no abrupt upper salt marsh boundary is evident within this transition zone. /61/

On the north and central coast, pickleweed predominates in middle to high salt marsh zones. Cordgrass occupies the lowest vegetated intertidal zone in certain coastal wetlands and around San Francisco Bay. The upper elevations of the pickleweed marsh display a mix of species such as arrowgrass, sea lavender, saltgrass, frankenia, jaumea, and marsh gumplant. (See Appendix B) With the exception of cordgrass, all of these species can survive in diked, nontidal marshes; pickleweed is particularly adaptable to modified conditions. /69,32/

Southern California coastal wetlands are more saline than those on the north and central coast. Marshes with consistent tidal flushing contain cordgrass and pickleweed zones, as in the north. Cordgrass is absent from closed lagoons. /48/ The higher marsh zones have many of the same plant species found in north coast wetlands, with the addition of an annual pickleweed, shore grass, and saltwort.

Intertidal flats extend bayward or seaward from the vegetated edge of salt marshes. These superficially barren flats of mud, exposed only during lowest tides, are actually densely inhabited. Microscopic algae called diatoms form a productive spongy layer on the mud, and a complex of microorganisms peculiarly adapted to low or nonexistent oxygen levels inhabit the sediments. In certain northern coastal estuaries and portions of San Francisco Bay, on subtidal flats are aquatic "forests" of eelgrass, their dense narrow blades harboring a diverse assemblage of organisms.

Brackish marshes typically occur where freshwater predominates over marine influences, as in Suisun Marsh and Napa Marsh, or where tides have been eliminated and saline soils receive winter rains and freshwater runoff from uplands. On the north and central coast, brackish marshes are common in river and creek backwaters, the upstream portions of estuaries, and upper borders of salt marshes. These marshes support a flora of greater variety than salt marshes. Common species include slough sedge, Lyngby's sedge, alkali bulrush, pacific silverweed, and many others.

The natural and managed brackish marshes of Suisun Marsh support a great variety of species, such as alkali bulrush, Olney's bulrush, tules, common reed, brass buttons and cattails. This habitat was at one time extensive in South San Francisco Bay, particularly in the upper reaches of Coyote and Guadalupe Sloughs. Brackish and freshwater marshes may have filled the upper portions of several south coast wetlands which were fed by artesian springs, such as Freeman River at Bolsa Chica Bay. /136/

Inland Wetlands

Freshwater marsh at one time filled large portions of river floodplains, and bordered seasonal ponds and lakes such as Tulare and Buena Vista and other permanent water bodies of the Central Valley and the Delta. This most widespread and diverse of all historic wetland types in California extended from the Klamath Basin in the north to the small marshes of the desert (e.g., San Sebastian Marsh) and floodplains along the Colorado River. The Sacramento-San Joaquin Delta contained a network-mosaic of tidal waterways and island marsh, brackish in the far western Delta and fresh in the central and eastern Delta. A few small pristine tidal marshes remain. The agricultural peatlands which now occupy most of these islands are below sea level; winter flooding of croplands creates seasonal "wetlands" comparable as waterfowl habitat to the native conditions, but with few of the native plant species.

Small, 2-3 acre incidental wetlands dot the agricultural lands of the Central Valley. Tules and cattails are the main components of the vestigial

wetlands. Rushes, water parsley, sedges, water lilies, spike rush, pondweeds, and smartweeds are also common. Backwater marshes along the Colorado River contain similar species as well as riparian trees.

Managed freshwater marshes. Private duck clubs and public wildlife refuges have maintained areas of historic freshwater marsh as habitat for waterfowl through selective flooding and draining to encourage species with high food values, such as alkali bulrush, spike rush, smartweed, and watergrass. Managers must manipulate the hydrologic regime not only to gain the desired plant species but also to maintain sufficient open space within the marsh to attract waterfowl. Many of the freshwater duck clubs in the Klamath Basin, Central Valley, Suisun Marsh, San Francisco Bay, Salton Sea area, and on the north coast have retained wetlands for hunting purposes in spite of extensive reclamation around them. Department of Fish and Game and U.S. Fish and Wildlife Service manage refuges and wildlife management areas in various parts of the state for both hunting and other recreational purposes.

Riparian forest bordered most rivers and creeks in the state where periodic flood flows were sufficient to sustain wide floodplains, and steep river banks didn't hinder forest development. Only remnants are left. Characteristic tree species along rivers on the coast, in the Sierra Nevada, Klamath Basin, and Central Valley are the cottonwood, western sycamore, white alder, valley oak, and willow. Well developed forests contain thickets of wild blackberry, buttonbush, wild rose, wild grape, mugwort and many other species. /97/

The riparian forests that remain along the Colorado River grow in several vegetative zones coinciding with the incidence and extent of flooding, the groundwater table, and the deposition of new sediment. Willows and cottonwoods form a thick and mature forest on the primary floodplain, rapidly colonizing new sediment. Arrowweed grows slightly farther away from the river channel, followed by screwbean mesquite and quailbush on a higher corridor. A second terrace of riparian vegetation requires less water and includes thickets of mesquite and velvet mesquite. /86,87/

Riparian groves of cottonwoods and willows grow along primary water courses in the Mojave Desert. Cheesebush, saltbush, rabbit bush, and catclaw appear in seasonal washes and drier stream beds. Springs are marked by clumps of willow, screwbean mesquite, and common reed. Palm oases, dominated by the Washington palm, occur only in the Colorado Desert. /97/

Vernal pools are small, shallow, seasonally wet depressions, typically occurring in grassland overlying a clay hard pan layer which prohibits downward percolation of water. Rainwater forms ponds in these depressions and over the spring evaporates, leaving a series of blooms of various wildflower species ringing the pool. Many of the diverse plant types and species are unique to this habitat. Commonly called "hog wallows" by farmers, vernal pools have been replaced by cultivated agriculture and grazing. Remaining vernal pools lie along the coastal mesas of San Diego County, in the Jepson Prairie of southern Solano County, and in Contra Costa, Yolo and a few Sierra foothill and Central Valley counties.

WETLAND FUNCTIONS AND VALUES

Although settlers in the new state of California (ca. 1850) recognized the values of wetlands as habitat for game, they viewed the vast reaches in the Central Valley largely as obstacles to their cultivation of the land. Crops had a higher functional value, and marshes were so extensive then that the possibility of their future need for preservation was not evident.

Present day land owners, developers, regulatory agencies, and scientists in California are not in agreement on the value of wetlands. A landowner or developer may see a wetland only as flat, developable real estate, made more valuable by its proximity to a waterfront. Traditionally, communities have viewed wetlands as convenient dumping grounds. Engineers acknowledge the functional uses of wetlands for floodwater regulation or shoreline protection, and are concerned with the potential hazards of building in them.. Scientists and educators place a high value on biological productivity and wildlife habitat of wetlands. A hunter appreciates wetlands for the waterfowl they support, while a farmer may regard a wetland as unproductive unless drained and cultivated.

Differences in perceptions are compounded by the wide variation that exists among individual wetlands in their intrinsic values and functional services. These must be determined on an individual wetland or regional basis. Some can be assigned a dollar value and their loss calculated on this basis. Some cannot.

Intrinsic Values

In a society which typically uses cost/benefit analyses to establish the worth of a resource, supporters of wetland preservation feel they must defend only the utilitarian functions of wetlands. However, wetlands have intrinsic values that are neither functional nor quantifiable; their worth to society cannot be bought or sold in ordinary currency.

Many people have come to recognize the intrinsic qualities of wetlands and their value to society. For instance, travelers along a shoreline highway may enjoy the aesthetic sight and smell of a green expanse of salt marsh. The patterns of wetland vegetation, water, and wildlife add variety to the landscape and give definition to the shore.

Located within crowded urban areas such as San Francisco Bay and the Los Angeles and Orange County coast, the open expansiveness of even a small wetland can provide a refuge to local residents for walking, birdwatching, photographing, digging for clams, or just sitting beside the water. As one study described San Francisco Bay, "The wide surface of the bay and the distant vistas it affords offer relief from the crowded often chaotic urbanized scene and help to create a sense of psychological well being." /99/ In inland wetlands, duck hunters have long sought similar pleasures in their recreational pursuits.

Wetlands hold considerable scientific and educational interest in California. Migratory waterfowl and shorebirds bring seasonal diversity to California wetlands. Plants and animals have unique adaptations for the conditions of these land-water environments, which have been recognized as important natural laboratories for scientific study of ecological

interactions. In the San Francisco Bay area five universities conduct research in wetland areas. Along the south coast and in Humboldt Bay many colleges and universities use wetlands as teaching and research laboratories.

Both conservationists and scientists argue that unaltered ecosystems have a worth beyond any specific benefits which society may gain from them, thus warranting their preservation. Unmodified wetlands serve as models of the native condition for analysis of the impacts wrought by man-induced changes to natural systems. Modified wetlands, for example diked areas, provide opportunities to measure change and to develop techniques for restoration of "natural" conditions. Such knowledge should lead to better planning.

Visitor use of wildlife refuges is one useful means of gauging public attitudes toward wetland areas in the state. Eighteen national wildlife refuges (NWF) in California encompass large wetlands. Visitors to these refuges totalled almost 900,000 in 1981. /68/ There are also eleven state wildlife management areas (WMA) and over 20 state ecological reserves which contain wetlands, in addition to four state parks, two national estuarine sanctuaries, and the Pt. Reyes National Seashore and Golden Gate National Recreation Area, as well as numerous local parks and reserves that include wetland areas.

The national wildlife refuges and state and local parks that are located in metropolitan areas are heavily used by nearby urban residents. For example, in the San Francisco Bay NWR, self-guiding interpretive trails, guided nature walks, and other wetlands-oriented educational experiences for the general public and school groups attracted over 48,000 participants in 1981. Educational programs are also available at Elkhorn Slough and Tijuana Estuary National Estuarine Sanctuaries and in Pescadero Marsh and the Palo Alto Baylands, among others. /68/

Functional Values

Scientists have studied the functional values of physical and biological processes in wetlands. Most thoroughly researched are the extensive tidal

marshes of the southeastern Atlantic and gulf coasts. For many years, scientists and conservationists in California applied the functions of Atlantic salt marshes to Pacific salt marshes without fully appreciating their differences. California wetland researchers are now beginning to recognize and study the distinctive conditions and functions of Pacific coast and interior wetlands.

Primary Productivity

The primary productivity of an ecosystem is measured by the amount of plant fiber and algae which grow over an area of ground in a specified time. This productivity supports entire food chains and complex food webs. Salt and freshwater marshes have higher annual rates of primary productivity than forests and many other ecosystems. Exposed to full light for photosynthesis and supplied with copious water, marsh plants and algae typically form a dense cover over wetland mud, given the proper aquatic regime. Within the mud, microorganisms that can live with little or no oxygen process nutrients, thus supporting plant production even when plants are submerged or dormant.

Studies in southern California tidal marshes have demonstrated especially high levels of algal productivity. /148,149/ Plant productivity in San Francisco Bay salt marshes compares favorably with productivity in Atlantic coast marshes. /142/ As in southern California marshes, algae covering the surfaces of bay mudflats contribute substantially to overall marsh production. /148/

The net movement of plant detritus (decomposed plant material) and nutrients between marshes and adjacent estuaries in California is unknown. Detritus produced in the marsh is used by invertebrates and fish which inhabit muds and sloughs. These filter feeders sieve fine material from the tidewater, thus representing the "secondary productivity" level of the marsh and contributing to further decomposition and nutrient cycling. These consumers, in turn, are eaten by shorebirds and other animals, who, in their migrations and movements, "export" the nutrients of the marsh to other areas. /89/

While the productivity of brackish and freshwater marshes in California has not been investigated in detail except in relation to waterfowl food values, limited measurements of biomass (plant material) of brackish marsh plants indicate a higher annual productivity than salt marshes but yield little information as to the movement (export vs. import) of nutrients and utilization by animals other than waterfowl. /3/ Overall, the salt, brackish, and freshwater marshes in California produce large amounts of plant and algal material and provide a rich food base, as evidenced in their wildlife populations.

Wildlife Habitat

Decades of observations and reports document the function of California wetlands as habitat for wildlife. Annual concentrations of waterfowl on Central Valley wetlands amazed early visitors and settlers of California. Southern California coastal wetlands had some of the finest duck hunting in the state; tule elk and river otter inhabited San Francisco Bay and Delta wetlands. Although the numbers of animals inhabiting wetlands have dramatically decreased, migratory birds and resident species still depend on remaining habitat. Inland wetlands of California continue to be among the most significant freshwater marshes for waterfowl in the United States.

With the exception of the plants, the wetland food base for wildlife is relatively inconspicuous. Dense communities of invertebrates, (worms, clams, crabs, shrimp, amphipods and insects) inhabit the shallow depths of mudflats and sloughs of tidal and brackish marshes, each species adapted to a part of the substrate (sediments). Some invertebrates, such as barnacles and crabs, undergo their early larval stages in tidal sloughs and sheltered shallow water areas. The commercially important Dungeness crab, for example, inhabits north coast estuaries and the San Francisco Bay; immature crabs feed in eelgrass beds, mudflats and marsh sloughs. /47,95,120/

Freshwater wetlands support a different array of invertebrate species; dragonfly and damselfly nymphs, insect larvae, aquatic insects, worms and snails cover stems and roots of submerged plants, and many invertebrates inhabit the substrate. /41/

Most wetlands that contain tidal sloughs or other permanent open water support fish populations. Staghorn sculpin, three-spine stickleback, California killifish, topsmelt and others are common in tidal estuarine marshes. The arrow goby shares a mud burrow with worms and crabs. /76/ Seasonally, fishes such as surfperch, eulachon, flat fish, and rockfish from nearshore waters move into estuaries and marshes to feed or have their young. The Pacific herring, a commercially important species, lay their eggs on eelgrass or submerged rocks in subtidal areasand on and among brown and red algae on intertidal mudflats. California halibut and diamond turbot lay their eggs in the open ocean, and juveniles migrate into estuaries to feed and mature. Striped bass and white and green sturgeon also rely upon the estuarine environment for portions of their life cycle. And tidal rivers of the north coast and San Francisco Bay probably play an important role in anadromous (e.g. steelhead and salmon) fish growth. /88,145/ Juveniles of several anadromous species (migrating between fresh and salt water, such as salmon) may spend several months in river estuaries prior to entering the open ocean. /57,58,63,93/

Although the precise contribution of salt marshes in reproduction and growth of fishes is largely unknown, evidence suggests a chain of dependency of fishes on salt marshes: small resident fish species of sloughs feed on invertebrates in channels and mudflats; these smaller fish are prey to larger, often commercially important species that move out of the estuary into the Pacific Ocean. Highly modified estuaries and lagoons which lack marsh and mudflats have demonstrated significantly lower habitat value for fish. /148/ At least indirectly, and probably directly, wetlands contribute to the habitat needs of both commercial and game fish species.

Fish species in inland freshwater wetlands vary greatly with wetland size, amount of vegetation, water flow, and water quality and temperature of the marsh. A greater number and diversity of fish inhabit backwater marshes along the Colorado River than the main channel. In these large marshes, native fish species such as Colorado squaw fish, bonytail and humpback sucker are still resident in limited numbers. /138/ Small freshwater marshes upstream in rivers of the north Pacific coast and in the San Francisco Bay area are habitat to small fish such as three-spine stickleback and gobies.

Riparian forest is important in maintenance of freshwater fish habitat of streams and creeks. The thick forest canopy shades deep pools and riffles from high summer water temperatures, which are fatal to juvenile salmon and trout and to newly hatched young.

Birds are the most conspicuous form of wildlife in California wetlands. The Pacific Flyway, the major western migratory route for waterfowl, shorebirds and small passerines, connects the nesting grounds of Alaska and western Canada with wintering grounds in California and Central and South America. Each fall millions of waterfowl and shorebirds migrate to the wetlands of California to spend the winter months or feed prior to moving south. U.S. Fish and Wildlife Service states that, "the single most important function of remaining United States wetlands is to provide wintering rather than breeding habitat for waterfowl". /134/ Appendix C lists waterfowl population estimates.

The Central Valley alone accommodates more than 90% of the over 6 million migratory waterfowl that overwinter in California. /134/. Dabbling ducks such as American wigeon, pintail, mallard, gadwall, green-winged teal, shoveler as well as geese species feed primarily on marsh plants and invertebrates in the managed wetlands and seasonally flooded agricultural fields of the Delta, Central Valley and Suisun Marsh. The entire populations of tule white-fronted goose, cackling goose, Ross goose and the endangered Aleutian Canada goose winter in California's inland wetlands.

Waterfowl move among various wetlands in search of food and roosting areas. For instance, in a late rain season, waterfowl stay in San Francisco Bay and Suisun Marsh until Central Valley wetlands are flooded. Throughout the winter, waterfowl move among the wetlands within the Central Valley, often in response to the flooding regimes and crop management of agricultural areas.

Coastal wetlands, including San Francisco Bay, are migratory stopover points for several waterfowl species - both dabbling and sea ducks as well as for numerous shorebirds. San Francisco Bay alone hosts millions of waterfowl each year; black brant, canvasbacks, scaup, bufflehead and scoters winter primarily in coastal wetlands.

A low tide in coastal wetlands brings flocks of shorebirds poking up and down in the mudflats or scooping their bills through the mud surface, searching for invertebrates. Salt marshes are less used than mudflats for feeding, but birds seek refuge amongst the marsh plants to wait out high tides and storms. When extreme high tides submerge all of the marsh, adjoining lands - transition zones - provide essential "back-up" food and shelter for both waterfowl and shorebirds. One of the most striking features of California coastal and bay salt marshes, both tidal and nontidal, is their seasonality. Even a summer-dry diked "wetland" comes to life when it is wetted by winter rains; flocks of migratory birds exploit these seasonal resources.

The most important coastal wetland areas for migratory birds are listed in Appendix C. Generally migrants will go to those areas where food is abundant and move to another as food levels decrease, visiting many different sites along the coast in one season. The coastal chain of wetlands thus provides a series of geographically dispersed habitat areas for these migratory species, many of which continue their travel to Central and South America.

In both tidal and inland wetlands, wading birds such as herons, egrets, and bitterns are residents of fresh and brackish marshes. Sandhill cranes migrate inland to the freshwater marshes of the Central Valley and Delta to overwinter. Rails of various types inhabit marshes as do small passerine birds such as marsh wrens, sparrows and red-winged blackbirds. /25/ Raptor species such as marsh hawk, red-tailed hawk, osprey, merlin, peregrine falcon and owls hunt in both coastal and inland wetland areas.

Passerine birds, the small songbirds and warblers, are migrants and residents to riparian forests, which harbor high populations of insects and support numerous species. In the desert, the scattered springs and riparian groves serve as dispersed "islands" of water and food in an otherwise arid environment.

Mammals, both large and small, forage in or are residents of wetlands. Raccoon, muskrat, mink, ring-tailed cat, and deer hunt or graze in salt, brackish and freshwater wetlands. Shrews, harvest mice and pocket mice live in the thick marsh vegetation. Larger mammals live in upland areas but travel to nearby riparian forest and marshland to feed on fish, invertebrates, and other small prey.

Rare and Endangered Species. The loss of wetland and riparian habitats has dramatically reduced the populations of at least 24 animal and 24 plant species that are now listed by state and/or federal governments as endangered or rare (Appendix C). The populations of animals such as the Aleutian Canada goose, California clapper rail, desert pupfish, or California yellow-billed cuckoo have been diminished by reduction of available habitat. Others, such as the salt-marsh harvest mouse, or salt marsh bird's beak (plant) have evolved specialized adaptations to the habitat conditions of marshes, vernal pools or riparian forests. Their narrow adaptability compounds the problem of loss of their habitat. It is not surprising that 20% of federally listed species depend on wetlands. In almost all cases, populations have declined because their habitats have been destroyed or reduced to a size too small to sustain viable populations.

Shoreline and Bank Protection

By interrupting and absorbing the energy in waves, marsh and riparian vegetation in many locations is effective in reducing bank erosion and protecting shoreline structures. This useful function of wetlands is less evident in California than in other coastal locations for two reasons. First, along the high energy Pacific Coast, marshes have developed only in locations already protected within bays and river estuaries. The sites of greatest erosion - coastal bluffs and beaches - are fully exposed to wind and waves and thus are not conducive to marsh establishment. However, within San Francisco Bay and other large bays and estuaries, where the fetch of wind over shallow water may reach several miles, tidal marsh vegetation effectively buffers the shoreline from wave erosion. And where dredgers have permitted berms to remain along the waterside of Delta levees, the dense growth of tules moderates the erosive effects of wind waves and boat wake.

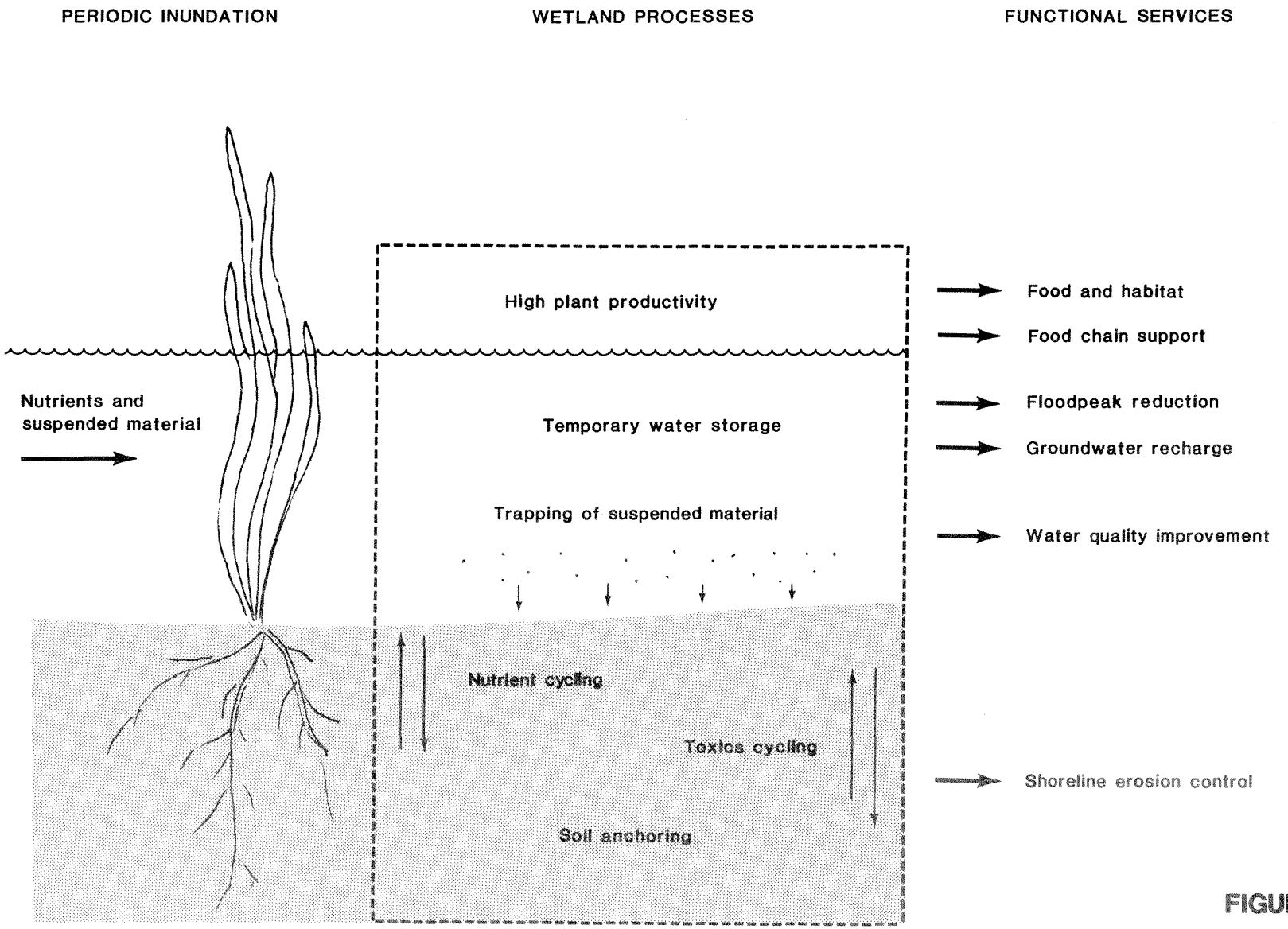
Second, the predominantly fleshy vegetation of California marshes limits its function in shoreline protection. Unlike mangrove swamps, whose expanses of tangled roots and branches bind intertidal soils and serve to quiet storm waves, California coastal marshes contain no woody plants except in higher transition zones infrequently wetted by tides. However, along fresh water streams and in floodplains, riparian thickets of willow and shrubs armor banks by binding soils, slowing flood flows, and trapping sediments and plant debris. /144/

Flood Protection

At one time, freshwater marshes and riparian forests covered the wide floodplains of the Sacramento, San Joaquin, Colorado and other rivers of California. Peak flood water overflowed these wetlands; either they released the water slowly as river levels subsided or the water evaporated. The wetlands of the Delta reduced downstream flood flows by spreading and detaining them before they entered San Francisco Bay. This in turn moderated shoreline flooding around the Bay. Certain areas of the Central Valley and Delta still serve this function, such as the Sutter and Yolo Bypasses, which divert flood water from the Sacramento River. /83/ Through planned manipulation of flood flows, these bypasses are allowed to fill with water and act as spreading basins, providing some winter habitat for waterfowl. After drying in the spring, the basins are farmed.

Similarly, certain of the diked agricultural lands which border San Francisco, San Pablo, and Humboldt Bays function as detention basins for local flood waters, providing at the same time seasonal wetland habitat. Storm runoff floods these low-lying areas at high tide and flows into the bay through tidegates at low tide. In this manner, floodwaters are released gradually through a basin rather than directly through a creek channel, thus avoiding backup over-flow into developed lands that results when storm runoff coincides with high tide inflow.

Along the Pacific Coast, the capacity of estuarine wetlands and lagoons to moderate flooding has been reduced in two ways. First, shallow, wet areas have been either dredged and deepened or filled, in this way removing the



SOURCE:: U.S. Congress Office of Technology Assessment, 1983. Wetlands and their Use and Regulation (Draft)

FIGURE 4

Wetland Processes

"spreading basin" function that would otherwise accomodate both upland and tidal flooding. Second, coastal river systems in recent decades have received large inputs of sediment from logging, farming, and urban land clearing in the watershed. Sediments deposited in estuaries and marshes have effectively raised their elevation, thereby decreasing their capacity to detain flood flows.

Water Purification

Through a variety of mechanisms, both natural and artificially created wetlands have demonstrated their ability to enter into the treatment of municipal wastewater and urban stormwater. Conceptually, the wetland approximates a combination of waste stabilization pond and trickling filter.

The broad, flat surface of wetlands and their saturated condition encourages a number of physical, chemical, and biological transformations to take place: For example, sediments and other suspended material carried into the marsh from storm drains will settle out, and forces of adhesion can bind heavy metals, bacteria, hydrocarbons, and other constituents to the sediments. Microorganisms in shallow sediment will degrade and recycle organic and other compounds. Across the surface, oxidation and photo chemical reactions can participate in removal of such pollutants as the pesticides 2,4-D, malathion, methoxychlor, and DDT. /23,31/ Marsh plants can remove pollutants directly by taking up nutrients and heavy metals (cadmium, copper, lead, zinc, and iron) and indirecty by creating the proper conditions for breakdown of pollutant compounds such as hydrocarbons and other organics.

The Association of San Francisco Bay Area Governments (ABAG) reviewed 14 marsh systems across the nation that treated urban stormwater runoff and municipal wastewater. /23/ Wetland systems removed from urban storm water: nutrients; 85-99% of suspended solids; and up to 50% of Biological Oxygen Demand (BOD is the concentration of organic particles which require oxygen from the water for biodegradation). Data from several California wetlands - Mt. View Sanitary District's Martinez Marsh, Palo Alto Marsh/Flood Water Basin and Lake Tahoe Meadowlands also demonstrated the potential for wetlands to serve as water purification systems for municipal stormwater and wastewater.

In the Central Valley, agricultural return water floods a large number of wetlands managed by duck clubs. /34/ This practice makes inexpensive water available for the club's refuges and contributes to purification of water laden with fertilizer and pesticides. Although marsh vegetation may remove nitrogen and carbon from return water, its ability to remove pesticides is still speculative. The relative effectiveness of each marsh type, species, and location in waste treatment must be investigated individually, but the collective data demonstrate that waste treatment is a functional service of many wetlands. Certain potential problems such as heavy metals, pesticides and other potentially toxic compounds concentrating in marshes used by wildlife will warrant further study.

Groundwater Recharge

In various parts of the United States wetlands are cited as important recharge areas to groundwater basins. Groundwater recharge occurs in riparian areas and floodplains throughout California. In arid regions such as the Owens Valley, streams entering the valley often disappear into coarse alluvial fans and percolate to groundwater aquifers. Springs may be the only surface evidence of the extent of desert groundwater resources. Similarly, in wet mountain meadows, snow melt can slowly percolate into subsurface soils and permeable rock fractures that contain some groundwater. In both cases, wetlands associated with points of recharge or discharge are performing a valuable service in connecting the surface and groundwater hydrologic systems. Managed recharge basins overlying groundwater aquifers offer a further opportunity for combining habitat with function.

There is little research to support a useful groundwater relationship in California's coastal marshes. The very nature of coastal alluvial deposition suggests that wetlands, which form on the flat, quiescent surface of alluvial outwash of streams, will also overlie deeper alluvial sediments. While older sediments are prime sources of groundwater, the fine silts and clays that settle out at the surface, becoming mudflats and marshes, are relatively impermeable. The marsh is, in effect, a perched water table, with little or no water percolating directly into the aquifer(s) below.

In contrast, peat deposits are quite permeable and provide the necessary substrate for recharge in some eastern marshes. The only significant peat lands in California are the Delta islands where flooded agricultural lands must be drained routinely to the surrounding sloughs because of the high groundwater table.

USES AND ABUSES OF WETLANDS

HUMAN ACTIVITIES AFFECTING WETLANDS

Although natural processes of erosion, sedimentation, and subsidence can alter wetlands significantly, almost all wetland losses in California are attributable to human actions. The hybrid nature of wetlands as both land and water resource has promoted conflicting perceptions of their use as well as their value. The history of development of wetlands in California reveals two distinct trends, dominated by a central perception that wetlands in their natural condition have limited function. Should they be treated as land, and filled or drained; or should they be treated as water, and deepened to become navigable or capable of channeling floods or tides?

In the settlement of the state, the majority of conversions of wetlands have demonstrated the former trend, based on the perception of wetlands as a land resource. Wetlands have been leveed, drained, cleared, levelled or filled; or the water entering them has been impounded, diverted, or pumped out, sometimes without the specific intention of dewatering the wetland. These activities have been applied largely to reclaiming wetlands for agriculture and to developing urban centers and their support systems. The impact on wetlands has been significant and permanent.

The latter trend, based on the perception of wetlands as a water resource, has been evident in port, harbor, and marina development, flood control projects, and closely related deposition of dredge materials. Their impacts have also been significant but not always irreversible.

Other human activities, less clear-cut in their impact on wetlands, have taken their toll. Gravel mining, grazing, waste loading, uncontrolled recreation, and salt evaporation have all exploited wetland characteristics with varying degrees of change, damage or loss. Upstream watershed erosion and sedimentation - from urban development, agricultural practices, and logging - have caused significant partial or permanent damage to wetlands.

Agricultural Reclamation

The Central Valley and Delta became the richest agricultural region in the state through reclamation of 94% of its permanent and seasonal wetlands and control and impoundment of its tributaries. Levee building and reclamation irreversibly altered the wetland appearance and functions of the area. The early hand-built "shoe string" levees were replaced by more substantial ones constructed by clam shell dredgers in the late 1900s, by which time half the Delta (approximately 250,000 acres) had been reclaimed. /19/

More efficient dredging, irrigation, and flood control practices in the early twentieth century accelerated the large scale reclamation of wetlands for agriculture throughout the Delta and Central Valley. Flood control and water supply projects enabled the extension of acreage under intensive agriculture. The systems of dams and canals of the Central Valley Project, State Water Project, and local irrigation and reclamation districts harnassed water flows and left numerous swamp and overflow lands dry, resulting in loss of peat soil and lowered land elevations, which in turn necessitated higher levees. Dredging and construction of levees along the Sacramento River and other waterways removed 98% of the historic riparian forest, by 1977 leaving only 12,000 acres largely in the Sacramento Valley, with small remnants along the San Joaquin. /83,110/

Agricultural development has prompted a 60% conversion of wetlands in the Klamath Basin, reducing marshes from 189,000 to the 81,000 acres in national wildlife refuges. Federal water projects supported most of the reclamation projects, the majority of which, both within and outside federal holdings, occurred between 1900-1950. One large area (approximately 14,000 acres) along the northern edge of Upper Klamath Lake was diked and reclaimed as late as the 1960s. /40,131/

North coast marshes in Humboldt Bay, Eel River Delta, Smith River Delta, Garcia River, and others also have been converted to agricultural use. In San Francisco Bay early settlers diked, drained, and farmed large areas of wetland; some 32,000 acres of diked agricultural lands remain, primarily in the north bay and a few other locations in the south bay. Much of the farmland along San Pablo Bay supplies hay to local dairies and doubles as seasonal habitat for wintering waterfowl.

Urban Development

Massive population growth and the attendant needs for housing, commercial and industrial lands, and highways have had a profound influence on wetlands, especially on the south coast and in San Francisco Bay area. Urban development in the Los Angeles Basin, Orange County and later in San Diego, accounted for direct wetland filling, beginning in the 1920s and 1930s and accelerating following World War II. Between 1950-1980, the population of southern California coastal counties increased by 58%. /106/ The record of diking and/or filling of portions of each southern California estuary, lagoon, or rivermouth is quite complete; approximately 10% of former tidal wetlands remain. Of those that remain, several are associated with oil fields, military lands, or other uses which restrict urban growth.

San Francisco Bay Area tidal marshes and bay surface have also been filled to accommodate urban and industrial expansion. During and following World War II, ship-building, and military installations, along with two major airports, were constructed in wetlands. /99/ Population growth soared, experiencing a 48% increase between 1950 and 1980. /107/ Construction of housing tracts and commercial buildings rapidly replaced small bayfront farming communities and agricultural lands that bordered wetlands in the south bay. Housing construction corporations, which emerged in the 1950s, began to dike and develop housing projects on large tracts of historic wetlands. Formerly the high cost of importing fill had prohibited these projects. Developments such as Foster City, Redwood Shores, Bay Farm Island, and Bel Marin Keys replaced large tidal wetlands and in many instances dredged new, deeper channels. This

extensive filling, along with reclamation and port development, has replaced 75% of the original wetlands and unknown amounts of riparian forest. Of the original tidal marshes only 125 square miles remain. /99/

Except in a few instances (e.g., Eureka, Santa Cruz), the north and central coast has been least impacted by dredging and filling of wetlands for urban use. Likewise, the wetlands of Klamath basin, Modoc Plateau, and desert regions have not experienced large losses from urban development.

Port and Harbor Development

Port development for military, commercial and industrial purposes has displaced tidal wetlands, again along the southern coast and in San Francisco Bay. Large bays and estuaries fostered the early growth of cities. Commerce was based on shipping and the natural features of these areas lent themselves to port development. The Los Angeles/Long Beach harbor, Ports of San Diego, San Francisco, and Oakland all necessitated dredging and filling of marshlands. Construction of the Los Angeles/Long Beach harbor required filling and dredging of Wilmington Lagoon (3,450 acres). /90/ The Seal Beach Naval Weapons Center covered over 600 acres of wetlands. Between 1940 and 1946, 25 million cubic yards of sediment were dredged from San Diego Bay and used to fill nearly 90% of the original tidal marshland. /11/ In San Francisco, thirteen different military shipyards, bases, and weapons and supply centers cover tidelands. The Ports of San Francisco and Oakland filled large tidal marshes. /99/ The industrial corridor of the Carquinez Straits also developed refineries, wharves and facilities on wetland habitat.

Maintenance dredging of ports and shipping channels requires sites for spoils disposal. Formerly, the nearest marshland received these spoils and ultimately lost its wetland features. Now spoils are disposed of in deep water or at selected land sites.

Along the north and central coast, fishing and shipping harbors covered tidelands in Crescent City, Humboldt Bay, Noyo River, Albion River, Bodega Bay, Tomales Bay, Santa Cruz, Moss Landing, and Morro Bay. Most harbors serve the local fishing industry or, in Humboldt Bay, the logging industry.

Recreational marinas have proliferated along the south coast and in San Francisco Bay. Huntington Harbor covers 870 acres of wetland; Newport Harbor, Marina del Rey and Oceanside Harbor all cover former tidelands. In San Francisco Bay and the Delta, recreational marinas are numerous; all resulted in some wetlands loss.

Water Development

The water facilities needed to support or protect large population centers and intensive agriculture have had profound though often distant, indirect effects on wetlands and riparian areas. Water diversion and impoundment projects on the Colorado River, Owens River and in Mono Basin enabled urban growth in the Los Angeles, Orange County and San Diego areas. Diversions in the Owens Valley and Mono Basin severely reduced natural water flows, dessicating scarce riparian habitats and endangering populations of desert fishes and birds. Colorado River floodplains, which supported thousands of acres of riparian forest and backwater marshes, were cut off by riprap and levees to stabilize the river channel. Dams and channel alignments have rearranged this waterway to such an extent that a minor fraction of historic riparian and freshwater habitats remains. /122/

Local flood control and water projects have also accompanied urban growth on the south coast. The Los Angeles, San Gabriel, Santa Ana and San Diego Rivers have been rerouted and extensively modified; little riparian forest remains. Water diversions together with highway and railroad construction, have modified both freshwater and tidal regimes of the lagoons of San Diego County, thus reducing the diversity of plant and animal species.

The systems developed to manage the flow and flooding regime of the Central Valley and Delta are now an integral part of the Delta ecosystem. The Delta, strategically located between the major impoundments of the Sacramento River and its tributaries (Shasta and Oroville Dams, for example) and water users to the west and south, became the "water wheel" for a major portion of the state's water resources. Diversion of large amounts of freshwater has contributed to tidal intrusion into the western Delta and significantly

increased salinity in Suisun Marsh. Undoubtedly, Delta freshwater outflows are of biological significance to downstream ecosystems in Suisun, San Pablo and San Francisco Bays. Large winter flood flows are thought to be significant in flushing the bay system.

As in the south, local flood control and diversion projects around San Francisco Bay have become essential to support the extensive urban development on the bay plain. The flood control districts that manage Alameda Creek, Coyote Slough, Guadalupe Slough, Napa River, and others have in varying degree realigned natural channels and floodplains, dewatering adjacent wetlands and riparian areas in the process. Districts have had to maintain regular dredging programs, with attendant effects on wetlands.

Sedimentation

Wetlands typically occupy the lower floodplains of rivers and creek drainages. Erosion induced by human activities within the watersheds can discharge large amounts of topsoil, rock and silt into winter flood water. As these silt-laden waters meet saline tidal waters, they slow in velocity and deposit fine sediment on the estuary or basin flats.

San Francisco Bay provides a most dramatic example of this process. Hydraulic gold mining in the 1880s filled Sierra Nevada rivers and creeks with soil and rock long after the mining had stopped. Estimates indicated build-up of 3.3 feet of mud over Suisun Bay and 2.5 feet over San Pablo Bay, rendering many portions of both bays unnavigable. An estimated 79 square miles of new tidelands developed around San Pablo Bay through this process. Hydraulic mining also raised the Sacramento River bed 15 feet, until it was subjected to regular dredging.

On the north coast, sedimentation has affected nearly all estuaries and wetlands to some extent. The causes of erosion vary with location. In Del Norte, Humboldt, and Mendocino Counties, logging has been a primary cause for more than 100 years. In Sonoma, Marin, San Mateo, Santa Cruz and Monterey

Counties, agriculture is the primary land use in coastal watersheds. Bodega Harbor, for instance, was originally a deepwater port; when surrounding lands were first cultivated, sediment filled the harbor and greatly reduced navigability. /110/ Bolinas Lagoon, Tomales Bay, and Elkhorn Slough have similar histories.

On the south coast sedimentation has come largely from urban development in coastal watersheds. Upper Newport Bay received five feet of sediment deposited in a single year due to housing construction and grading in the watershed. The flash flood cycles and severe fires of south coast drainages aggravate watershed erosion and downstream sedimentation.

Other Developments

Waste loading

Estuaries have long been the recipients of wastewater from California's shoreline communities. The often poor circulation and tendency for suspended solids to settle in shallow waters make estuaries easy targets for water pollution. In San Francisco Bay, for instance, rapid population increases brought great volumes of municipal sewage into many parts of the bay. The year 1950 saw the worst pollution of bay waters. /99/ Consolidation of waste flows and improvement of sewage treatment have vastly improved bay water quality.

South coast estuaries also have received treated wastewater inflows (e.g., San Elijo Lagoon, San Dieguito Lagoon). In the absence of year-round freshwater inflow, wastewater provided a major hydrologic contribution to these particular coastal lagoons. Interestingly, when wastewater flows were removed in this instance, waterfowl use of the wetlands declined. /150/

Wetlands are traditional dumping grounds for wastes of all sorts. More than a dozen solid waste landfills cover an undetermined number of acres of former tidelands in all parts of San Francisco Bay. Added to this are the

sludge lagoons and oxidation ponds of many sewage treatment plants that were constructed on the bay plain. While covering natural bay marshes, oxidation ponds have been able to provide limited substitute bird habitat.

Salt Ponds

The salt industry is fully dependent on use of tidal lands for evaporation of salt from marine water. Salt ponds replaced tidal marshes around San Francisco Bay, San Diego Bay, Elkhorn Slough, Upper Newport Bay, and Batiquitos Lagoon. Some ponds have been abandoned but most of those in San Francisco and San Diego Bays, and Elkhorn Slough are still active. These ponds have proved their value as habitat by providing sheltered water and specialized food resources for certain shorebird and waterfowl species. /46/ The endangered California least tern, for example, nests on unvegetated salt pond levees in San Francisco Bay. /25/ Salt ponds are viewed as likely candidates for restoration to tidal action when their owners discontinue operations. However, abandoned salt ponds in San Francisco Bay (e.g., Bair Island, Redwood City; Bamberg Tract, Hayward) are also prime targets for urban development.

Mining

Water, the determining factor for all wetland and riparian plant growth, is also essential in most other desert land uses. The multiple demand for such a limited resource often puts wetlands in direct confict with mining operations. /140/ The Bureau of Land Management estimates that 10-15% of mining operations on public lands affect riparian groves either through direct vegetation removal or road building. These operations are concentrated in the Inyo, Argus and Panamint Ranges.

Urban construction throughout the state has required large amounts of cement. Gravel mining in south coast rivers and many others increased to keep pace. As a result river channel geometry and flow patterns have changed, often to the detriment of riparian vegetation and wetlands on banks and in the floodplain.

Grazing

Large numbers of feral burrows (10,200 animals) inhabit the northern and eastern Mojave Desert. Herds of 50 to 75 individuals can trample vegetation and soils of a spring and pollute water sources. Grazing by domestic livestock also denudes desert riparian areas and, if overused, riparian vegetation cannot sustain itself. Diked wetlands along the north coast and around San Francisco Bay are used as grazing land for cattle and sheep. While this use is relatively compatible with wildlife habitat and open space values, grazing can change the vegetation composition in marshes, and remove riparian corridors. Vernal pools have been especially vulnerable to grazing and livestock trampling.

Recreation

Recreational use of desert lands has had at least two adverse effects on springs and riparian habitats. Visitors often camp near desert springs and rivers and cut wood for fires, inadvertently damaging riparian groves. In a more deliberate mode, off-road vehicles (ORVS) also drive up washes crushing the sparse vegetation. /140/ Coastal parks have sustained similar effects. In the Nipomo Dunes State Park, ORVs destabilized dunes to such a degree that sand now blows into and fills Pismo Marsh. /106/ Marsh vegetation is easily trampled in heavily visited state and national parks where uncontrolled access to wetland areas is permitted.

Restoration

Scientists and government agencies have recently put increasing effort into developing methods for restoration and enhancement of diked and otherwise altered wetlands as a means of regaining a fraction of the diminished resource. Restoration projects vary from a simple breaching of a dike to regain tidal access, to recontouring, dredging, and flooding of wetland to create a variety of habitat types. Cordgrass plugs have been planted in restored areas to speed establishment, but most plants become established through natural invasion. Pickleweed readily recolonizes a marsh to which tidal water has been returned.

Restoration and enhancement projects most often accompany development proposals. As mitigation for development of a portion of a diked highly modified (partially filled and diked) marsh, remaining areas are restored by the developer to tidal action or higher quality habitat. The California Coastal Conservancy has assisted in funding several restoration projects. Wetland restorations have been successful on the south coast, in San Francisco Bay, and Humboldt Bay. /51/ The primary goal of most restorations is creation of wildlife habitat, particularly for endangered species, equivalent to the area lost to development.

Restoration is not a new concept in the Modoc Plateau. Early ranchers constructed earthen dams across small streams to form marshes around the borders so as to produce better forage than the surrounding juniper and sage range. The Forest Service now owns a majority of these lands, actively improving these wetlands and creating new ones to increase habitat for nesting waterfowl. /139/

CURRENT PRESSURES ON WETLANDS

Wetland areas continue to receive pressure from three principal sources: 1) filling and dredging for urban and maritime uses; 2) further agricultural conversion of managed wetlands, coupled with shortage of water, and 3) continuing sedimentation of wetland areas from development in watersheds.

Urban Development

Sixty-four percent of California's population lives in the coastal counties and San Francisco Bay area, twenty-five percent within six miles of the coast. The majority of this population (76%) is south of Ventura County. /106/ These populations place heavy pressures on remaining wetlands and their watershed lands, and will continue to do so as populations grow. On the south coast, as available space becomes filled and congested, the few remaining wetlands and riparian zones will come under increasing pressure for

development. Shoreline real estate values are already high and will escalate, presenting new obstacles to public acquisition and preservation of wetland areas.

Population projections for the San Francisco Bay Area indicate an increase to 6.2 million inhabitants by the year 2000, a growth rate of 1% per year. This population increase is expected to be borne largely by Santa Clara, Contra Costa, and Alameda counties; all have significant bay frontage containing diked and tidal wetlands. /2/ Most of the privately owned lands are subjects of development proposals.

Other regions (Klamath Basin, North Coast, etc.) are not expected to experience urban growth on the same scale.

Ports and Harbors

Expansion of ports and harbors threatens tidal wetlands as much as urban growth, since these facilities cannot be relocated to upland sites as can housing and industry. The Port of San Diego and Los Angeles/Long Beach harbor both have plans to fill and dredge new areas to create additional wharves. Slips in small craft harbors are also much sought after by pleasure boat owners. In San Francisco Bay 1,000 acres of new terminals are needed, requiring 300 acres of bay fill. /102/ Market studies indicate a demand for 3,500 additional small boat slips. /21/

Agricultural Conversions and Water Shortage

Conversion to agriculture was the major historic factor in eliminating Central Valley wetlands and remains so today. In both the Sacramento Valley and the San Joaquin Valley, large acreages of private duck clubs recently have been converted to agriculture. For example, 7,000 of the 17,000 acres of modified natural wetlands in the Butte Sink have been converted to rice in the past ten years, and private wetlands in the Colusa Basin are steadily being converted to rice. /151/ Losses within the boundaries of the three project

areas of the U.S. Fish and Wildlife Service conservation easement program are substantial. For instance, in the Tulare Basin the flooded acreage held in private duck clubs declined by 14% between 1960 and 1973. /134/ In the 60,000-acre West Grasslands area 8,800 acres (14%) were lost between 1977 and 1982. /134,135/ Wetlands in the Grasslands area of the San Joaquin Valley are being converted to sugar beets, cotton, or other crops that have no waterfowl habitat value. /134/

Higher energy and water costs (below) and fewer ducks have prompted many clubs to convert part of their lands to rice, since this crop will provide revenue as well as attract waterfowl. Ricelands provide some food for waterfowl, but the monoculture quality of the habitat is considered by most to be inferior to native marsh or wetlands managed for more diverse waterfowl foods. /152/ In at least one instance, former duck club lands (near Lambertville) that had been converted to rice were restored to waterfowl habitat to regain habitat quality and improve hunting success. Similar restorations may occur in areas where conversion to rice has diminished hunting success.

The conversion of ricelands to other crops such as orchards is particularly detrimental to water-related wildlife. Not only is wetland habitat lost but also drainage water from the ricelands, which is used to flood other wetlands. For example, the major source of water to the Willow Creek clubs in the Colusa Basin at present is runoff from ricelands. Conversion from rice to other crops in this area could eliminate that water source or alter the timing of water availability. In the upper Butte Basin, both ricelands and the duck clubs which depend on their runoff water are threatened by conversion to orchards.

The major threat to already existing state, federal and privately owned wetlands in the Central Valley is the availability and seasonal dependability of water and its high energy cost. Throughout the Valley, the demand for water for irrigated agriculture and associated uses has increased as cultivated acreages have increased, with no assurrance of major new water supply projects. Water demand in central California is projected to increase by 14% between 1980 and 2000. /108/

Among the publicly owned wetlands, the majority of National Wildlife Refuges (NWRs) and state Wildlife Areas (WAs) receive federal water, but it is delivered through local irrigation districts on an "if and when available" basis. The Central Valley Project (CVP) does not authorize the allocation of water to wildlife management areas. Thus, about 50,000 acres of the 75,000 acres of publicly owned wetland habitat in the Sacramento and San Joaquin Valleys depend on tenuous water supplies, either "if and when available," or as drainage water subject to on-farm conservation or crop conversion, or as (often) overdrafted groundwater. /151/

The problems of distribution and cost of water in the Central Valley vary widely with locality and source of water. For example, in the San Joaquin Basin, agricultural drain water is used in summer for waterfowl food production, and federal water is delivered in the fall. In the Tulare Basin, the Kern NWR relies on groundwater from an overdrafted aquifer. In contrast, the Mendota WA receives surface water but only a quarter of it is under firm contract. /151/ Gray Lodge WA in the Sacramento Valley receives low cost pre and early season water, but must depend on pumped groundwater for late and post season. /152/ The energy cost of pumping groundwater has risen astronomically in the past few years. For instance, the U.S. Fish and Wildlife Services in 1976 spend $46,000 to flood 1,000 acres of habitat on the Merced NWR. Only six years later, a little more than half that acreage (590 acres) was floded on the refuge at a substantially higher cost ($55,000). In 1983, projected allocations would only allow flooding of 320 acres. /135/

Privately managed wetlands obtain water from a variety of sources, including rice and other agricultural drain water, through agreements with irrigation districts. Their supplies may be more secure than the supply to public wetlands, although private clubs are equally affected by the high cost of energy involved in pumping and transporting water. /151/

A related water problem affecting Suisun Marsh duck club owners is that of water quality. Diversions and export of Sacramento River water out of the Delta, especially in low flow years, has contributed to intrusion of saline

waters into the Marsh. As freshwater exports are increased and saline waters encroach from San Pablo Bay, the problem of maintaining high quality brackish habitat for waterfowl will be compounded.

Advances in Agricultural Practices

Technological advances, especially in rice cultivation, have accelerated the rate of loss of wetlands and their value to waterfowl. California produces 25% of the nation's rice; 80% of this is grown north of Sacramento. Acreage expanded from 275,000 to a peak of 590,000 in 1981, averaging 550,000 in recent years. /152/ Harvested fields are significant feeding areas for waterfowl - and in fact many duck clubs consist largely of rice fields. However, through improved water management, intensified land leveling and weed control, and selection of early maturing strains, rice growers have significantly improved their yields at the expense of both waterfowl food value and available drain water.

In Sacramento Valley, most public and private wetlands depend on rice drainage water for early season water supply. As rice growers improve their water management practices by reducing typical water application rates (from 10 acre feet to 8 acre feet), with as little as 2.3 acre feet/acre under experimentation), so will available drainage water be reduced. /152/

Techniques for land leveling have progessively improved in recent years; laser beams are now used to level flood-irrigated land. Rice fields which have been smoothed in this way require less water, may be rapidly drained, and support significantly fewer weedy aquatic plants, such as millet, sedge, rumex, watergrass, and others. The elimination of potholes and other areas of deeper standing water has also eliminated an aquatic habitat for invertebrates such as rice shrimp. Application of herbicides has contributed to eliminating both weeds and animal organisms. Watergrass in particular has high food value for ducks; together, weeds and invertebrates provide a protein-rich food source for post migration replenishment and premigration feeding periods. This food source is growing progressively more scarce.

The practice of "clean farming" is not confined to rice growing. In the Delta, corn fields flooded for periodic leaching, are also "clean farmed." Increasingly less stubble is left in the fields, and efficient leveling eliminates pot holes, vegetated ditches and other incidental "microhabitats" that, in the aggregate, have been an important component of waterfowl and waterbird habitat.

Early maturing rice strains also have been developed which allow rice fields to be plowed during the early fall, and harvesting efficiency of the rice has increased from 65% to 90% in the last 25 years. /111/ An early, "clean" rice harvest has eliminated much of the waste grain on which wintering waterfowl used to feed, although rice growers claim that harvesters will continue to leave 5% of the rice in the fields. /151/

Sedimentation

Erosion and sedimentation from watershed disruption occurs throughout the coast. It is attributable in the north to agricultural and timber harvest practices, and in the south to rapid development of watershed lands. There is no reason to believe sedimentation from these sources will decline. Erosion control ordinanc s are in effect in only a few coastal communities. Use of heavy machinery in both agriculture and logging, in the absence of best soil management practices (BMP), exacerbates erosion of hillsides.

PART II:

PROGRAMS & POLICIES

PART II: PROGRAMS AND POLICIES

Federal and state programs and policies, and judicial decisions, have influenced California wetlands over the past 180 years, but the most effective programs are less than two decades old. A complex network of agencies (see Table 1) forms a patchwork which is multi-tiered in some areas (San Francisco Bay, the Costal Zone) and missing altogether in others (much of the Central Valley). A few statutes and directives address specific wetland areas or wetlands in general. Most, however, are indirect, influencing wetlands through management of water quality or quantity, fish and wildlife species, endangered habitats, water navigability, floodplain management, public trust, coastal resources, and environmental and land use regulations. In short, there is no comprehensive policy or approach to managing use of wetlands at any government level in California except along the coast. Nor is there an integrated, systematic means by which such a policy could be implemented.

This analysis has not attempted to compare California's ability to protect wetlands with that of other states. However, almost all 30 coastal states (including those bordering the Great Lakes), have programs that directly or indirectly regulate the use of coastal wetlands. Most inland states do not have specific wetland programs. Through a combination of the federal 404 program (below) and state programs, most coastal wetlands are regulated reasonably well; inland wetlands, which comprise 95% of the nation's wetlands, generally are not regulated by the states. /153/

FEDERAL LEVEL

The federal "presence" with respect to wetlands and other water-related lands in California is substantial but often conflicting. It is evident in permit authority, such as the Corps of Engineers'; in memoranda of agreement enabling federal agencies to comment on Corps permit actions; in funding of

TABLE 1

CALIFORNIA WETLAND ISSUES AND THEIR REGULATION

Wetland Issue	Specific Region Affected	
Filling of diked wetlands for urban uses	San Francisco Bay, Humboldt Bay and certain coastal estuaries	Corps (limited) Local governments (infrequent)
Filling, dredging of tidal wetlands for urban uses, ports, and harbors	San Francisco Bay, primarily North and Central Coast	Corps Coastal Commission BCDC Humboldt Bay Harbor Recreation and Conservation Disrict
Agricultural conversion of wetlands	Klamath Basin North Coast	Corps (limited)
Sedimentation of wetlands from watershed disturbances, including logging, agriculture, and urban development	North and Central Coasts San Francisco Bay	California State Board of Forestry (limited) Regional Water Quality Control Board (very limited) Local governments through grading ordinances (few in effect)
Salinity increases in wetlands due to upstream water diversion	San Francisco Bay-Suisun Marsh Central Valley-Delta	State Water Resources Control Board Regional Water Quality Control Board State Department of Water Resources Bureau of Reclamation
Covering of wetlands with materials other than "fill" intended for development (i.e., sanitary landfills, logging slash)	San Francisco Bay North Coast	Environmental Protection Agency or Corps - authority unclear Regional Water Quality Control Board
Filling of private, managed wetlands for agriculture or other uses	Central Valley	None, unless entitlement from local government is required and local policies apply
Filling of private, "natural" wetlands for agriculture or other uses	Central Valley	Corps (limited; applies only if wetland considered adjacent to navigable waterway)
Removal of riparian vegetation for levee maintenance, bank stabilization	Sacramento-San Joaquin Delta and Sacramento and San Joaquin Rivers	Corps (project levees only) Bureau of Reclamation State Reclamation Board (on project levees)
Filling of riparian areas above stream headwaters and isolated wetlands covered under nation-wide permits	South Coast	Corps may require an individual permit if water quality, endangered species or cultural resources are a concern at a site; local governments possibly
Filling/dredging of wetlands for urban and port development	South Coast	Corps Coastal Commission Local governments
Sedimentation of wetlands from urban development in watershed	South Coast	Regional Water Quality Control Board (very limited) Local governments through grading ordinances (few in effect)
Removal of riparian forest for desert mining activities and from feral burro grazing	Mojave Desert	Bureau of Land Management, on BLM lands
Removal of riparian vegetation for levee maintenance, bank stabilization	Colorado River	Bureau of Reclamation Corps
Inundation of wetlands and possible disruption from geothermal drilling	Salton Sea	Bureau of Land Management Corps Local governments

state and local grant-in-aid programs and federal works projects; in subsidies, tax incentives, or leases, some of which actually encourage reclamation of wetlands; and in management of federal lands (45% of California).

Several general statutes apply to most federally authorized actions:

National Environmental Policy Act (1969). NEPA and its implementing regulations set forth the basic national charter for protection of the environment. NEPA's importance in wetlands protection rests largely in its broad declaration of national interest in natural resources, in general. NEPA in itself does not assure consistent federal protection to wetlands in California. However, it supports the "public interest review" criteria used by the Corps of Engineers in reviewing permit applications in wetlands and is the general environmental policy guideline for all federal actions.

Executive Order 11990: Protection of Wetlands (1977) E.O. 11990 serves as an overall federal wetland policy for all of the federal agencies that manage federal land in California, sponsor federal projects, or provide funding assistance for state and local projects. The order established several requirements for federal agencies to fulfill before proposing new construction in wetlands: 1) determine whether there is a practicable alternative to the action; 2) include practical measures to minimize harm to wetlands (where no alternative upland locations exist); 3) preserve and enhance the natural and beneficial values of the wetlands; 4) involve the public early in the assessment of any action proposed in wetlands. E.O. 11990 has not been rescinded by the present administration. At the same time, the order is not applied with equal effect by all federal agencies.

Executive Order 11988: Floodplain Management (1977), directs federal agencies to modify their programs and procedures to avoid encroachment in designated floodplains or to mitigate flood losses if encroachment is unavoidable. This protects wetlands only indirectly. The thrust of the order is to reduce hazard risk to humans by controlling use of the floodplain, not to protect the wetland values within the floodplain.

E.O. 11988 should be reviewed in conjunction with the National Flood Insurance Program (NFIP), which involves "nonstructural" approaches to floodplain management through local governments that enter the program. NFIP not only markets floodplain insurance, but also provides an incentive to local governments to plan and regulate the use of land in flood hazard areas. Indirectly, this benefits wetlands.

Coastal Zone Management Act (1972) addresses a range of coastal planning issues, wetland protection among them. (See California Coastal Commission, below.) Funding under the Act assisted California in identifying critical areas within the coastal zone, including wetlands, designating appropriate uses, and establishing state and local programs to regulate coastal land use. /56/ Under Section 306 of the Act, other grants were awarded for carrying out parts of the California Coastal Plan and San Francisco Bay Plan.

Section 306 also helped to fund preparation of Local Coastal Plans through which wetlands and other critical resource areas should continue to receive protection through local permit review. CZMA's influence on wetlands is felt in California in two ways: federally funded projects and projects on federal lands must be consistent with the state Coastal Zone Management Program; and Section 404 (Clean Water Act) (below) permit actions must also be consistent with the state's CZM Programs. Funding of state programs of Office of Coastal Zone Management was cut back in 1981. California's last grant funds were received in fiscal year 1982-83.

U.S. Army Corps of Engineers Section 10/404 Regulatory Program. The Corps of Engineers is probably the most influential public agency regulating California wetlands, with its permit powers and project responsibilities for port maintenance dredging, deep water channel construction, levee construction, flood control, dam construction, shore stablilization, among others. It is also the least known agency to local governments and land owners whose lands may be most affected by Corps jurisdiction.

Two statutes provide principal direction the the Corps:

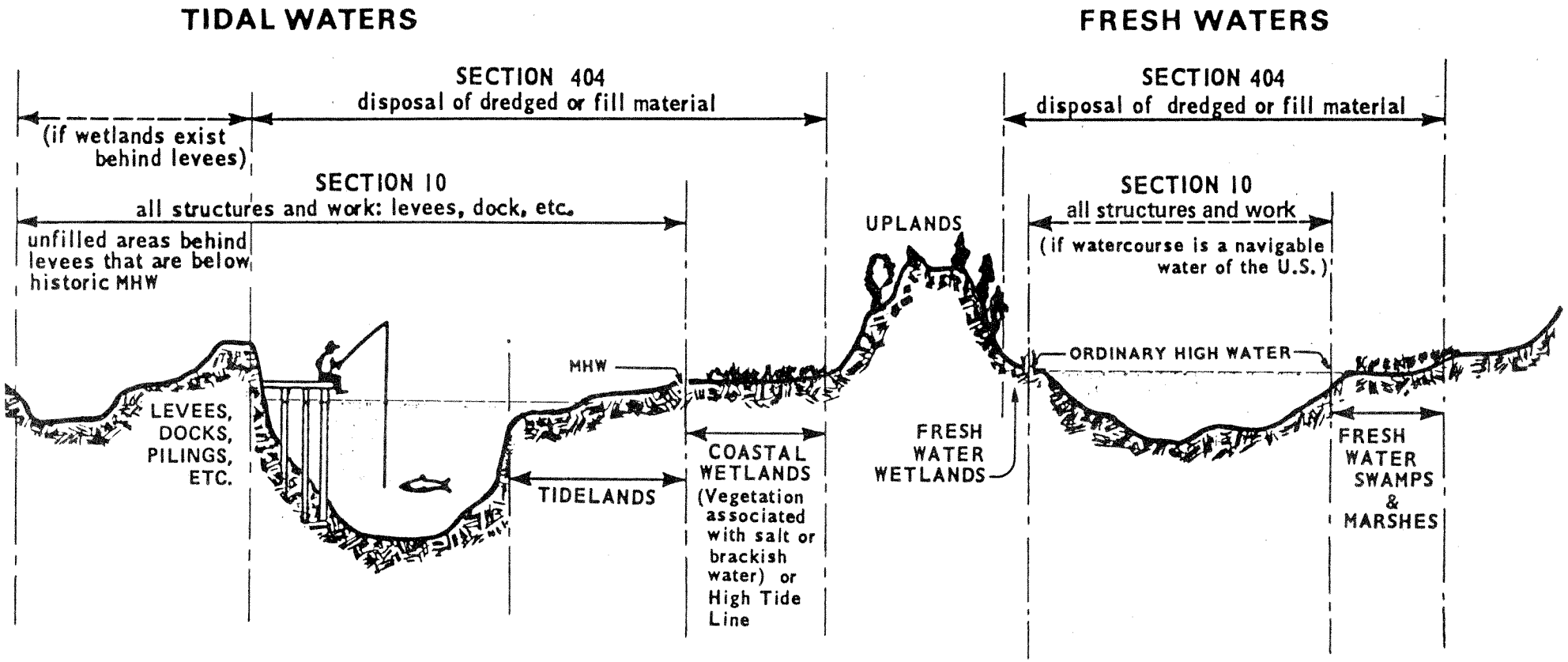
- Section 9-10, Rivers and Harbors Act of 1899, regulates the diking, filling, and placement of structures ("works") in navigable waterways.

- Section 404, Clean Water Act, regulates disposal of dredge and fill materials in the "waters of the United States," including all streams to their headwaters (5 cubic feet per second, average annual water flow); lakes over 10 acres; and contiguous wetlands, including those above the ordinary high water mark in nontidal waters and mean high tide in tidal waters.

The 1899 law originally had the intent of protecting waterway navigability. In 1968, the Corps established "public interest review," which weighs local and regional interests such as land use, economics, and flood control, in addition to fish and wildlife, ecology, pollution, and traditional navigablility. Availability of alternatives, permanence of impacts, and cumulative effects were adopted as criteria in 1974. The Corps also adopted a general wetlands policy.

Section 10 is applied in different kinds of situations by the three Corps districts in California. Los Angeles and Sacramento districts apply Section 10 primarily to protect navigable capacity of waters. San Francisco District has also applied Section 10 behind dikes in areas where elevations fall within their purview (below the plane of Mean High Watwer [MHW]). This brings substantial areas (more than 50,000 acres in San Francisco Bay) under potential Corps jurisdiction.

Like Section 10, Section 404 extends shoreward to mean high water in tidal waters and the ordinary high water mark in nontidal waters. The 1972 amendments of the Federal Water Pollution Control Act (FWPCAA) called for restoring and maintaining the chemical, physical, and biological integrity of the nation's waters. The concepts of "water quality" and "pollution" were established, and "fill" (in various forms) and "dredged material" were defined as pollutants. Wetlands were not specifically referenced, nor are they now.



NOTE:

IN ADDITION TO SECTIONS 10 AND 404 JURISDICTIONS, THE CORPS REGULATES THE TRANSPORTATION OF DREDGING MATERIAL FOR THE PURPOSE OF DISPOSING INTO OCEAN WATERS (SECTION 103).

FIGURE 5

Corps of Engineers Regulatory Jurisdiction

Under 404 regulations, all saline, brackish, or freshwater wetlands which are adjacent to navigable waters (or, in some circumstances, isolated) are subject to Corps jurisdiction. Such lands may occur in both tidal and diked situations in California. The San Francisco District exercises Section 404 authority in the San Francisco Bay diked lands where wetland conditions are evident. In contrast, although a major part of the Delta falls well below MHW and large areas are seasonally flooded, they are excluded from the Sacramento District Corps jurisdiction, since they are reclaimed lands and not "historic navigable waters." /55/ Similarly, the Los Angeles District has been reluctant to assert jurisdiction in marginal (e.g., isolated wetland) situations unless other directives apply (e.g., Endangered Species Act).

Certain activities are excluded from Section 404. These are noteworthy in California wetlands. For example, excavation, clearing, levelling, draining and removal of vegetation, including riparian, are not covered by the 404 program. A "nationwide permit" system for the headwaters of streams (under 5 cfs average annual flow), and lakes under 10 acres, exempts a wide variety of riparian situations and ponds and springs from individual permits and from effective surveillance. The seasonally dry nature of many of California's streams thus precludes many riparian corridors and small freshwater wetlands from Corps jurisdiction.

The Corps Section 404 Program has a complex judicial and administrative history, in which wetlands have become the regulatory focus of "waters of the United States." Fundamental and controversial differences distinguish various interpretations by federal agencies of the intent and administration of the program. The Corps views its primary regulatory function as protecting water quality; the resource agencies like Fish and Wildlife Service who comment on all permit actions regard protecting the integrity of wetlands and their habitat as the primary function. In California, these differences are evident in varying degree in all three Corps districts.

Environmental Protection Agency (EPA) exercises 404 program oversight and has the power of veto over Corps permit decisions. In California, this power has rarely been practiced. EPA has developed 404(b) guidelines for review of

permits and federal projects. EPA also has delegated to the states the authority to certify that permitted actions are consistent with the state's water quality objectives under Section 401, Clean Water Act.

U.S. Fish and Wildlife Service (USFWS) does not have direct permit authority, but carries out basic responsibilities for migratory birds, fish, waterfowl, marine mammals, and endangerd species. In 1976 USFWS developed a national priority list for protection of key areas of waterfowl habitat. California's Central Valley was ranked overall as #4 out of 33 areas, and #1 for protection of wintering waterfowl habitat. /152/

Under the Fish and Wildlife Coordination Act (1958) the USFWS reviews Corps permit applications (404 program) and federally permitted or constructed projects in or near wetlands with the goal of protecting and restoring the fish and wildlife values. In this way, the USFWS Region 1 Ecological Services field offices in California play an important role in influencing Corps permit decisions and conditions placed on projects in wetlands.

The Endangered Species Act requires federal and state agencies and private applicants to consult with Fish and Wildlife Service when a project might affect the habitat of an endangered or threatened species. The fact that California wetlands have been so reduced over the past 180 years classifies many of them as critical habitat for several species whose existence depends on certain wetland features (Appendix B). In marginal cases where wetlands are isolated from main water bodies, the Corps has taken jurisdiction because of the presence of an endangered species, and then largely due to USFWS prompting.

The Land and Water Conservation Fund Act (1977) provided USFWS with funds and authority for a number of years to acquire critical habitats and sensitive resource lands in California, many of them wetlands. Funds for the future protection of wetlands in California are unlikely to emanate from this particular source. (Two companion bills pending in the U.S. Congress [HR 3082 and S 1329] would provide $75 million a year for nation-wide wetland protection.)

Among its research activities, USFWS developed the Classification of Wetlands and Deepwater Habitats of the United States /29/, now the principal basis on which California wetland habitats are classified. USFWS has mapped the wetlands of the United States, using this classification system (National Wetlands Inventory). Areas in California that are mapped as wetlands are not necessarily protected, however. The Service has funded several major planning studies in the Central Valley concerning waterfowl and other wildlife habitat.

USFWS has acquired and manages National Wildlife Refuges in various parts of the state. The first wetlands to be bought by the state or fedeeal government for the purpose of preserving their natural characters were in the Klamath Basin, Central Valley, Delta, Suisun Bay, and Imperial Valley. The national wildlife refuges and state wildlife management areas established habitat for waterfowl in an attempt to reduce crop depredation on nearby agricultural lands. Since the early 1900s, these two systems have expanded their holdings, which are managed primarily to maximize waterfowl habitat and allow hunting and recreational opportunities.

National wildlife refuges also encompass wetlands at Humboldt Bay, south San Francisco Bay, San Pablo Bay, Seal Beach, and Colorado River. Several national parks also enclose wetlands although the parks weren't created specifically to preserve these marshes. The Wild and Scenic River system, of which several California rivers are part, has preservation of riparian habitat as a goal. Two National Estuarine Sanctuaries have been established at Elkhorn Slough and Tijuana Estuary by Office of Coastal Zone Management jointly with the California Wildlife Conservation Board (below).

National Marine Fisheries Service (NMFS - U.S. Department of Commerce) like USFWS, reviews federally pemitted projects which have the potential of altering aquatic environments and their biological resources. In contrast to USFWS, whose traditional emphasis has been waterfowl, NMFS has specific responsibilities for living marine resources, including anadromous fish and marine mammals.

Two important federal government programs provide incentives for landowners to maintain their property as wetlands:

Soil Conservation Service (SCS) administers the Water Bank Program with assistance from the Agricultural Stabilization and Conservation Service (ASCS) and several other state and federal agencies. The major objectives of the program, initiated in 1970 by the Water Bank Act, are to preserve, restore, and improve habitat in important migratory waterfowl nesting and breeding areas and to benefit other wildlife resources. Under the Water Bank Program, landowners with eligible wetlands may enter into ten-year agreements and receive annual payments for conserving the land as wetlands. Water Bank agreements can be renewed for additional ten-year periods upon mutual consent. Technical assistance is provided by SCS, DFG, and USFWS.

The program was originally designed to protect waterfowl nesting habitat. Since the Central Valley offers essential feeding as well as nesting habitat, the program has been expaned to cover wetlands that provide winter food production habitat.

In 1981, 32,121 acres in California were part of the Water Bank Program, almost all of it in Central Valley counties of Merced, Siskiyou, Modoc, Lassen, Plumas, Butte, Sierra, Colusa, Sutter, and Yolo.

The Conservation Easement Program (1978) of the U.S. Fish and Wildlife Service is funded with duck stamp funds authorized by the Migratory Bird Conservation Act. Under the program, a landowner receives a fee to sign his land into easement, such that the landowner cannot alter the land to be detrimental to waterfowl use. Three project areas (66,800 acres), West Grasslands, Butte Sink, and Colusa Basin, were established at the outset. Since inception of the program, easements have been acquired on 18,215 acres (17,500 acres in West Grasslands and 715 acres in Butte Sink). /151/ Twenty percent of the acreage included in the original project areas has been lost. It is likely that a minimum of 27,000 acres in the three project areas will be converted to agriculture within the next six years. /135/ Current funding could provide for a maximum of 38,400 acres under easements in the next six years.

Another action by the federal government to preserve private and public wetlands was the Grassland Water Bill (1954). This incentive program, administered by the Grassland Water District, distributes water to landowners in the San Joaquin Valley. The Grasslands Water District (originally the Grasslands Water Association) began receiving 50,000 acre-feet of federal water per year in the late 1940s as part of a water rights settlement. The Grasslands Bill authorized the use of federal water for recreational purposes and the Grasslands Water Association became a water district in order to distribute water to local duck clubs. Landowners, under the Cooperative Habitat Program of the district, receive cut-rate water ($1.00 to $3.00 per acre-foot) for wetland maintenance. Presently the district services 52,000 acres of seasonally flooded wetland in the San Joaquin Valley, including private landowners, the Kesterson National Wildlife Reserve, and the Los Banos and Mendota WMAs. New members are not being accepted as the district is currently at capacity. A landowner in the San Joaquin Valley could conceivably participate in the Grasslands Water District as well as the Water Bank and conservation easement program of U.S. Fish and Wildlife Service (above).

Both the United States Bureau of Reclamation and U.S. Department of griculture have encouraged wetland conversions to agriculture through various incentive programs, offering tax deductions of a percentage of gross farm income for drainage expense, deductions for depreciation of capital costs or related interest payments for draining or clearing wetlands, and investment tax credits for a portion of drainage tile installation costs. Price supports and target prices for certain crops may also have encouraged conversions from wetland to cropland or from nonintensive farming (which has only moderate adverse effects on wetlands) to intensive cultivation.

Management of Federal Lands and Water in California. Forty-five percent of California's land is in federal ownership. The majority of these land are managed by the Bureau of Land Management and the Forest Service, but the Air Force, Navy, Army (including Corps of Engineers) and Marine Corps also manage extensive lands, many containing small but significant wetlands. The National Park Service manages park lands, and the U.S. Fish and Wildlife Service

maintains National Wildlife Refuges (above). The Bureau of Reclamation manages the Central Valley Project and other water supply, distribution, irrigation, and agricultural return systems.

The opportunity for federal control of actions involving wetlands and riparian areas in the state is substantial. Federal lands are used for mineral production, oil and gas production, grazing, industrial activities, living quarters, timber, and other activities. Many of the major fills in wetlands in California in the 1930s, '40s, and '50s were in fact for military installations. On federal lands throughout the state, the Wetland Protection Executive Order (E.O. 11990), NEPA, Endangered Species Act, and various "multiple use" statutes (Federal Land and Management Act [FLPMA], National Forest Management Act [NFMA], and others) give some assurance that sensitive resources on federal lands, such as wetlands, will receive appropriate protection. However, since the statutes themselves provide little guidance on specific actions, the federal land management agencies can exercise considerable discretion, subject to scrutiny of constituent interests, such as wetland coalitions and state resource ("trustee") agencies.

STATE OF CALIFORNIA

The State of California manages or exercises control over the State's natural resources under a wide variety of general and specific laws and directives, carried out by "resource" departments, commissions, and boards. A recent analysis of the state's role in managing the use of wetlands evaluated the effectiveness of 59 California statutes in protecting wetlands and other water-related lands. /50/ A second analysis reviewed those laws and agencies which govern San Francisco Bay. /109/ Both analyses concluded that the state has limited direct authority in wetlands except in three geographic areas: the Coastal Zone, San Francisco Bay, and Suisun Marsh (below). Thus, the coast is relatively protected; in contrast inland California wetlands are largely unprotected.

The California Environmental Quality Act (1970), patterned after NEPA, sets the state's basic charter for protection of the environment. Among other policies, CEQA policies call for preventing the elimination of fish and wildlife populations. Specific wetland areas are listed as having regional or state-wide significance (e.g., Suisun Marsh, Sacramento-San Joaquin Delta, wild and scenic rivers, etc.), and the resource in general (wetlands and riparian lands) is defined as significant.

Most projects in wetlands will require a use permit of some sort, thus triggering the CEQA process unless the project is exempt. CEQA has had a pervasive impact on local land use decisions and planning process in California by requiring that environmental impact reports be prepared on major projects. However, its effectiveness in protection of those wetlands which are outside federal (Corps) or Coastal Commission jurisdiction, is highly variable, subject to the diligence with which it is exercised in local communities and the nature of the action proposed. For example, most privately owned wetlands in the Central Valley can be converted to agriculture with no CEQA requirements.

Keene-Nejedly California Wetlands Preservation Act (1976), is the only state legislation other than the Coastal Act that defines wetlands in any degree. The act states that there "is a need for an affirmative and sustained public policy and program directed at their (wetlands) preservation, restoration, and enhancement (editorial emphasis), in order that such wetlands shall continue in perpetuity." /19/ The act provided for acquisition of ten important wetlands, using funds from several sources, and was intended to support preparation of a statewide wetlands plan. These funds were not allocated in 1976, however.

Wetlands Resolution - Senate Concurrent Resolution (SCR) 28, 1979, called for a plan to be developed by January 1, 1983, which would identify wetland habitat sites such that the remaining acreage of wetlands in California could be increased by 50% by the year 2000. The plan was released on December 1, 1983, and is cited in this final version of the Status and Trends report. It outlines a range of options and specific recommendations for: 1) protecting

remaining wetlands; 2) improving the value of existing wetlands; and 3) acquiring and developing new wetlands. The resolution in itself does not contain any provisions or authority to protect existing wetlands.

The focus of the plan, prepared by the Department of Fish and Game, is on waterfowl habitat. The plan analyzes numerous innovative economic incentive programs, funding sources, and water sources, designed to encourage private Central Valley wetlands to remain in that use and to restore publicly owned wetlands, emphasizing economic measures and private initiatives, mixed with a variety of public allocations and investments. The most critical needs of inland wetland waterfowl habitat identified by the plan include insuring continued food supply (waste grain); allocation and assurred delivery of adequate water supplies to wildlife purposes and assurrance of moderate pumping costs; research funds; and alternative water supplies such as reclaimed wastewater and agricultural return water.

State Resources Agency. The Resources Agency functions as an "umbrella" agency, setting major resource policy for the state and overseeing programs of member departments such as Departments of Fish and Game and Water Resources. With respect to wetlands, the Agency coordinated the development of a Delta Master Recreation Plan (DMRP) and Waterways Use Program in 1976, which designated certain waterway zones in the Delta as "natural." The few remaining natural tidal and nontidal marshes and riparian areas in the Delta were thus identified and their ecological sensitivity and significance acknowledged in a set of management guidelines. While the DMRP is not backed by the force of law, it has served since its inception as a guide to the Corps permit program, to both state and federal construction programs in the Delta and to the Resources Agency in review of private projects under CEQA.

The Resources Agency also established in 1977 a Policy for Preservation of Wetlands in Perpetuity. This policy coalesced a number of disparate state interests in wetlands into one simple expression of statewide policy to guide departments, boards, and commissions of the Agency not to authorize or approve projects that would fill or otherwise harm coastal, estuarine, or inland wetlands. The policy did not define "wetlands," but it did refer specifically

to San Francisco Bay wetlands, the Sacramento-San Joaquin Delta, and other natural water bodies such as Clear Lake and the Colorado River. The policy recognized that many areas of wetlands in the state are subject to neither federal nor state permit.

Despite the absence of either legislative authority or judicial test of the wetlands policy, the policy lent considerable weight to the comments of Resources Agency member departments in state and federally authorized actions. The policy is now undergoing review and revision (April, 1984); in the interim, it serves as a guide.

State Lands Division and Commission: Public Trust Doctrine. California became the owner of the majority of the tidelands within its borders when it was admitted to the Union on September 9, 1850. Most of California's tidelands still are owned by the state or the legislature's public grantees in trust under the jurisdiction of State Lands Commission.

Also in 1850, under "An Act to Enable the State of Arkansas and Other States to Reclaim Swamplands within their limits," the United States granted "swamp and overflowed lands" to California. The land was surveyed by federal and state surveyors and by 1871 determined to include 2,192,506 acres. Most of the land was sold or "patented" to private citizens for the purpose of agricultural reclamation, much of it in the Sacramento-San Joaquin Delta. The "swampland" which was sold off during the ensuing thirty years also included both navigable tidelands and submerged lands, which were to be held in the public trust for "commerce, navigation and fisheries."

The right to preserve the public trust in tidelands and known historic waterways (even though obscured by subsequent treatment of land) has given the state considerable authority in regulating the appropriate use of these lands and has returned revenues where public trust easements have been sold or exchanged after negotiation. The state's ownership of tidal lands and lands behind levees continues to be uncertain, however. In the Delta many mixed tidal/swampland parcels were surveyed and sold and, subsequently, their landforms altered. The public trust must be determined on a case by case basis.

California's courts have expanded the common-law public trust doctrine. Marks v. Whitney in 1971 interpreted the public trust easement to encompass recreation and preservation of tidelands as ecological units. In two cases, the California Supreme Court in 1981 held that the area between the seasonal high and low water mark of all nontidal navigable waters was also subject to the public trust. Over 4,000 miles of California shoreland along 34 lakes, including Clear Lake and Lake Tahoe, streams, and their contiguous wetlands, are included in such areas.

California Department of Fish and Game. The Department has responsibilities and authorities which directly and indirectly influence projects in wetlands and riparian areas. The California Fish and Wildlife Plan (1966, in revision), states the department's overall objective: to maintain all species of fish and wildlife for their intrinsic and ecological values, and for their direct benefits to man. In particular, the Plan's waterfowl section refers to dwindling habitat, the importance of seasonally flooded lands, and to other related problems that are still unresolved, almost 20 years later.

The Department of Fish and Game has authorities under the Public Resources Code, Fish and Game Code, and federal Fish and Wildlife Coordination Act to regulate or comment on activities in wetlands and riparian areas. DFG has some limited responsibilities with respect to native plant protection, and enforcement of state law concerning taking of endangered and rare animal species; it comments on all projects under consideration by other state and federal agencies which may affect fish and wildlife resources; it enforces state fish and game laws, including those that regulate waterfowl hunting; it administers and/or manages state-owned wildlife management areas, ecological reserves, and two national estuarine sanctuaries; and it is charged with carrying out specific programs authorized by the legislature.

The Streambed Alteration Agreement (Fish and Game Code Section 1601-1603) offers the only direct legal instrument in California for protection of waterways and, to an extent, adjacent wetlands or overflow areas. Local governments are traditionally reluctant to manage these resources; too often

drainage or flood control improvements are made before the Department of Fish and Game has had an opportunity to assist in a design to protect habitat values. /50/ A number of species on the state list of endangered and rare wildlife species inhabit coastal or inland wetlands. In spite of state and federal law prohibiting taking, possession, and sale of these species, the Department does not have direct permit authority over lands on which their habitats are present. However, the department has been acquiring critical habitat areas since 1970, including a number of coastal wetlands. /50/

Department of Fish and Game also comments direcly to the Corps of Engineers concerning fish and wildlife aspects of Section 10 and 404 permit applications and federal flood control and navigation projects. The department consistently advocates the maintenance of existing fish and wildlife resources. If this goal cannot be satisfactorily accomplished, either project denial or approval with mitigative measures is recommended. In commenting on Corps public notices, the department has been a stout defender of the state's basic wetland protection policy, particularly in negotiating mitigations.

Wildlife Conservation Board Acquisition Programs. A funding program is maintained by the Department of Fish and Game's Wildlife Conservation Board to acquire wetlands by purchasing fee title and easements, or leasing land from other agencies. Ecological reserves are designed to protect rare or endangered plant or animal communities, and wildlife management areas allow regulated hunting and fishing. The CDFG has identified 19 coastal wetlands for priority acquisition in California. /7/ The state also manages the Elkhorn Slough Estuarine Sanctuary, the Tijuana River Estuarine Sanctuary, and the Channel Islands and Point Reyes-Farallon Islands Marine Sanctuaries.

San Francisco Bay Conservation and Development Commission (BCDC). The McAteer-Petris Act, which created BCDC in 1965, also authorized the San Francisco Bay Plan. Piecemeal filling had reduced the extent of water and intertidal areas of the bay by more than 75%. The McAteer-Petris Act preceded most of the major federal and state environmental statutes and probably paved the way for an effective federal Section 10 and subsequent Section 404 regulatory program in the bay.

BCDC has permit authority over fill in bay waters up to the "line of highest tidal action," and over uses in a 100' shoreline bank extending around the bay and into some tributaries. BCDC also has jurisdiction over the extensive salt ponds in both north and south bay and over the diked managed wetlands of Suisun Marsh.

Projects involving fill are authorized only when no alternative upland location is available, when the amount of fill proposed is the minimum necessary to achieve the purpose, when harmful effects to water, fish and wildlife resources are minimal, and when the project benefits clearly exceed public detriment. Projects should be limited to water-oriented uses or water-related industry and encourage ample public access to the shoreline.

BCDC was one of the first agencies in the Nation to have an approved Coastal Zone Management Program pursuant to the Coastal Zone Management Act. Thus, BCDC comments on the consistency of federally approved actions with the Bay Plan. BCDC has recently developed strong policies concerning protection of the approximate 52,000 acres of diked historic tidelands around the bay, but lacks permit authority over these lands.

In several respects, the BCDC and Corps permit processes are duplicative without being congruent. BCDC covers a wider range of activities than the Corps, but authority extends only to an indefinite "line of highest tidal action and the 100 foot shoreline band." The Corps' jurisdiction under Section 10 is tied to elevations and under Section 404 to various forms of wetland evidence, including diked lands. Nor are mitigation requirements always similar for the two agencies.

Suisun Marsh Preservation Act. The California Legislature passed the Suisun Marsh Preservation Act of 1977. Policies and programs are set forth in the Suisun Marsh Protection Plan. The plan is administered by local authorities, but BCDC retains right of appeal.

Local governments and disricts in Solano County prepared Local Protection Programs (LPPs) to bring their policies and ordinances into conformity with

the provisons of the act. This process enjoyed the cooperation of local government agencies, private landowners, and other private interests, such as duck hunting clubs. Solano County developed new marsh protection policies and ordinances for the protection of water quality and riparian habitat within and adjacent to the marsh, a grading and erosion control ordinance, and an ordinance regulating development directly adjacent to designated watercourses within the county.

Together with the Coastal Act, this is one of the few laws in California that protects a specific geographic area of wetlands, riparian vegetation, and streams. Its effectiveness in protecting the largest single wetland area in the state (10% of total total resource) is in large part due to the interest and political pressure of waterfowl hunting interests. This case also presents one of the relatively few examples of successful collaborative planning in California wetlands.

California Coastal Commission. In 1972, 55% of the voters apppoved Proposition 20 and created the California Costal Zone Conservation Commission. In 1975 the California Coastal Plan designated a coastal zone and presented findings and policies concerning topics ranging from natural habitats and wetlands to energy facility siting along the 1,000+ mile coast. /8/ During the next eight years the regional and state commissions processed more than 50,000 permit applications for development projects within the coastal zone. California communities prepared local Coastal Programs (LCPs) to apply coastal zone management policies at the local level. /43/

The Coastal Plan addresses such land use questions as scenic and visual qualities of the coast, natural land forms, environmentally sensitive areas, coastal access for the public, siting critical energy facilities, hazard areas, commercial fishing and recreational boating, and wetlands.

The terms "wetlands, "biological productivity," etc. are cited and defined in the statute, along with policies for dredging and filling. The Interpretive Guidelines for Wetlands and Other Wet Environmentally Sensitive Habitat Areas, adopted in 1981, were designed to assist local governments in

protection, restoration and mitigation efforts in wetlands and adjacent areas undergoing development. The Guidelines contain technical definitions for wetlands and riparian habitats, permitted development and conditions in these areas, and means of restoration and maintenance of wetland areas. Wetlands are defined in terms of hydric soils, hydrology, and hydrophytic plant species criteria developed by U.S. Fish and Wildlife Service.

The review process which the Coastal Act authorizes in areas of "degraded" (diked and modified) wetlands is fairly stringent and has been regularly contested by land developers. In the context of historic wetland losses on the Southern California coast, the clear intent of the Act is to halt the rate of loss and, where feasible, restore the resource in small increments. The points most often at issue are the identification of wetlands and the determination of what constitutes "degraded condition." Much scientific expertise in soils, marsh plant ecology and physiology, and hydrology, has been brought to bear on these questions in California coastal wetlands, often without resolution. Somewhere between the precise technical criteria of the scientist and the practical needs of the planner, there is a need for definitions that will be useful and understandable to all parties. There is no one definition of wetland that will fit all cases in California.

The regulation of wetlands by the Coastal Commission and by BCDC partially overlaps the Corps Section 404 program. BCDC's authority and the Corps' in San Francisco Bay are somewhat duplicative but the Corps has generally greater authority in wetlands. On the coast, state regulation is more rigorous than the federal. In both instances federal actions must demonstrate consistency with the appropriate Coastal Zone Management Programs. In both instances, from the viewpoint of resource protection, the federal and state programs are mutually reinforcing.

California State Coastal Conservancy, 1976. The State Coastal Conservancy has as its broad goals the protection of coastal agricultural lands, restoration of coastal zone areas, and enhancement of coastal resources. Conservancy operations differ significantly from the regulatory functions of

the California Coastal Commission. The Conservancy works with local and state agencies to work out coastal restoration projects which produce both private revenues and public benefits. Typical approaches make use of local planning tools, tax incentives, redevelopment methods, and acquisiton of fee and less-than-fee interests in sensitive wetland areas. This authority is supported by a $10 million bond act for general acquisition purposes, $5 million for conservancy action in the San Francisco Bay area (one-half to be used for wetland enhancement), and $20 million for LCP improvement relating to coastal access, and preservation and rehabilitdation of wetlands.

Several specific marsh restoration projects are either planned or completed: the Bracut Marsh restoration in Humboldt Bay, which compensated for the filling of some of the City of Eureka's urban "pocket" marshes; San Dieguito Lagoon restoration of 85 acres of a 200-acre degraded lagoon and marsh system; and Los Cerritos restoration of 130 acres of a 170-acre degraded wetland presently used for oil extraction. The Conservancy is in the fortunate position of having funds with which to accomplish some of its goals, unlike its sister agencies, the Coastal Commission and BCDC.

State Water Resources Control Board and the Regional Water Quality Control Board. The State Board and nine Regional Boards were designated in 1973 to exercise powers set forth in the Federal Water Pollution Control Act Amendments (FWPCAA), and later the Clean Water Act (CWA). The Boards are also responsible for exercising powers contained in the state Porter-Cologne Water Quality Control Act, amended 1969.

The Regional Boards may issue certificates or place conditions on Section 404 permit applications to ensure that projects will comply with standards in the Clean Water Act, EPA regulations, and with state standards for water quality. The State and Regional Boards have independent authority over water quality, including discharges of dredge and fill material in wetlands. The Porter-Cologne Water Quality Control Act actually has broader authority than the federal law. It also is the only statewide law that presently can function, at least indirectly, to protect wetlands. While the primary responsibility of the Boards is protection of water quality, wetlands have

received protection as an indirect recipient, in part because of the Boards' dual involvement with the Clean Water Act and with the recently rescinded state wetlands policy. Where water quality is clearly not an issue in wetlands, the Porter-Cologne Act has limited application.

Section 404 (g-k), CWA, provides for delegation to the states of a 404 program, qualified by a number of conditions, such as EPA overview and limitation to waters not covered by federal navigation servitude. No state has accepted this offered delegation, largely because funding does not accompany the offer. It has been suggested that the California State and Regional Boards would be likely candidates for delegation if California chose to pursue it.

LOCAL GOVERNMENTS

Many communities, counties, and special districts in California have within their boundaries shorelines, bayfront lands, and agricultural "wetlands." Local governments in California have available to them an array of planning instruments (general plans, zoning ordinances, etc.) and tools (technical data, review procedures) for protection and management of natural resources, but their influence over wetlands is largely governed by local political and economic priorities.

Local land use management in California begins with general plans, required by law. These are implemented by zoning ordinances to regulate the use of lands. Policies of the local general plan that can protect or preserve wildlife habitats, including wetlands, are contained primarily in the Open Space and Conservation Elements which address the conservation, development, and use of natural resources and provisions for open space to preserve natural resources, among other things.

Most California cities and counties have adopted policies in their general plans or special area plans for the conservation of wildlife habitats, which might include wetlands. Habitat protection varies greatly, however; specific

guidelines and action programs for potecting wildlife resources are usually lacking. Ordinances concerning grading or dredging and filling (of wetlands), where they do exist, rarely consider environmental consequences.

Local land use decisions are also guided by several other statutes, including the California Environmental Quality Act. The State Subdivision Map Act requires that findings be made where subdivisions and proposed improvements are likely to damage fish or wildlife habitats. However, the Act neither defines the habitats nor the studies necessary to ascertain impact.

Using these and other tools, a few local governments have become effective wetland resource managers by inventorying significant wetland areas and defining specific policy; dedicating wetland habitat areas; requiring performance bonds for development within wetland areas; applying effective conditions to use permits; and defining and zoning special (wetland) "resource management districts."

An informal survey of 32 San Francisco Bay Area cities and counties with identified diked baylands revealed that, while a number had dredge and fill ordinances in tidal waters, only five or six had adopted some form of diked bayland protection. Others impose use restrictions to protect agricultural uses only. Some local governments have Williamson Act contracts (below) for some of the baylands but these may be terminated with appropriate notice. Sixteen cities and counties have no provisions that protect baylands from being filled or otherwise altered. Local governments in California will not likely have the planning resources to prepare the studies, plans, and ordinances necessary to impose additional restrictions to protect baylands. /103/

The California Land Conservation Act of 1965 (Williamson Act) was established to relieve the tax burden on land owners engaged in commercial agricultural operations through signing of contracts to maintain "agricultural preserves." The contract period is 10 years, renewable annually unless cancelled through a public hearing process. In 1969, the act was amended to include areas of wildlife value as well as other open space lands. The

habitat areas must have been designated important for the protection or ehnancement of the wildlife resources of the state. Included in this definition are salt ponds, managed wetland areas (e.g., areas maintained for waterfowl hunting), submerged areas, and open space.

The Williamson Act does offer one means to reduce landowners' taxes on wetlands, but since most wetlands and riparian corridors are already taxed at a low rate, there is not a significant relief. The amendment, to be effective, also requires the local legislative body to make findings of "great importance" of the habitat which is being protected.

PRIVATE AND LOCAL INITIATIVES

Duck clubs have been a dominant force in preservation of California wetlands. Private duck clubs own the majority of Central Valley and Suisun wetlands and manage these areas for waterfowl. These areas are not open to the general public, and club memberships are much in demand.

Local and regional parks, districts and private foundations such as California Waterfowl Association, The Nature Conservancy, Trust for Public Land, and Audubon Society have acquired wetland areas both for habitat preservation and recreation. Hundreds of acres of wetlands have been thus protected through direct acquisition, partial interest (easements), and through innovative techniques for leveraging the limited public funds available for land acquisition. For example, the Richard King Mellon Foundation recently gave the Nature Conservancy a $25 million grant toward its efforts to conserve wetland ecosystems in the United States. Other environmental organizations and many local or regional "wetland coalitions," including fish and game clubs, have also been active in protecting California wetlands.

PART III:

THE REGIONS OF CALIFORNIA

PART III: THE REGIONS OF CALIFORNIA WETLANDS

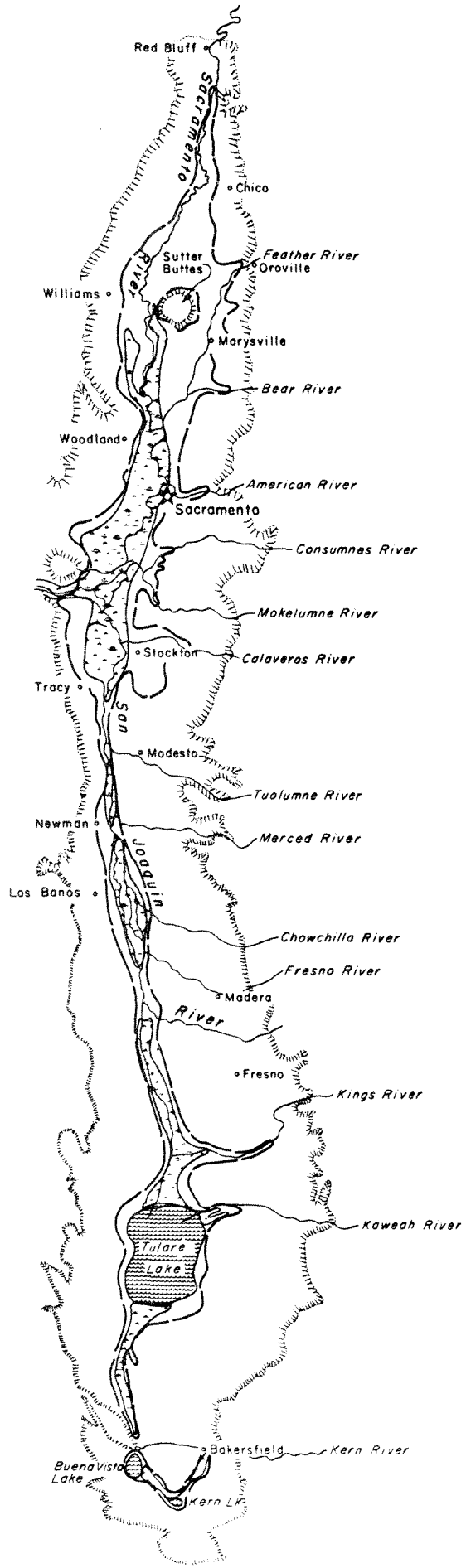
CENTRAL VALLEY

HISTORIC WETLANDS

The Central Valley of California extends 400 miles from the City of Red Bluff in the north to Bakersfield in the south. It includes all or parts of 22 counties and encompasses 16,000 square miles. In their native state, the largest concentrations of freshwater and brackish wetlands were in the Tulare Lake Basin and the Delta-Suisun regions (Figure 1). Some were "overflow" lands, seasonally flooded by adjacent rivers, while others were large areas of permanent marshes. /111,134/

The Central Valley is a pair of lesser valleys - the Sacramento in the north, and the San Joaquin in the south. Through each the water of a major river and its tributaries flows toward the Sacramento-San Joaquin Delta where the valleys and their rivers meet, forming the 1,100-square-mile junction. The two valleys can, in turn, be divided into a series of drainage basins, each receiving the runoff of rivers from bordering mountains. There are five basins in the Sacramento Valley, two in the San Joaquin.

The Sacramento Valley contains the Butte, Colusa, Sutter, Yolo and American Basins. The present distribution of wetlands still reflects to a degree the historic distribution described here. The Butte Basin, sandwiched between the Sacramento and Feather Rivers, contained the Butte sink, a wetland of permanent ponds and marshes as well as winter overflow swamps fed by the Sacramento River and Butte Creek. West of the Butte Basin, the Colusa Basin extends from Stony Creek to Cache Creek. It contained primarily overflow marshes. The Sutter Basin was filled with water from the Sacramento and Feather Rivers during winter and spring. Large areas of this basin were permanently flooded. The Yolo Basin borders the Delta on the north and the Sacramento River on the west. Both tidal and freshwater marshes filled this basin. The low, central portion held a large permanent marsh, while perimeter



LEGEND

SEASONAL OR PERMANENT FLOODING - 3,119,000 ACRES

TULE MARSH LANDS - 500,000 ACRES

CENTRAL VALLEY BOUNDARY

SOURCES:

Overflow - Bulletins 26 and 29 DWR 1931

Marshlands - State Geological Survey of California 1874

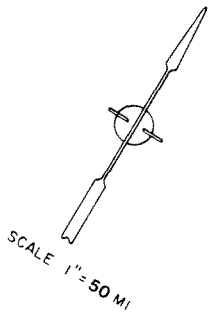


FIGURE 6

Central Valley Marshes and Lands Historically Subject to Overflow

areas were flooded. Historic maps show tidal marshes extending up the Sacramento River nearly to the City of Sacramento. The American Basin, east of the City of Sacramento, formerly had two permanent lakes, Bush and Fisherman's, as well as many permanent wetlands.

The Sacramento-San Joaquin Delta lies south of the Yolo and American Basins and generally north of the Stanislaus River's junction with the San Joaquin. The pristine Delta was largely a tidal marshland, surrounded by slightly higher lands. Shallow backswamps flooded in winter and spring behind natural alluvial levees. In the spring, virtually all of the Delta become a vast inland lake, covered by high tides from the San Francisco Bay and runoff from the Sacramento and San Joaquin Rivers and the smaller Mokelumne and Cosumnes Rivers. /19/

The San Joaquin Basin, located south of the Delta in the upper San Joaquin Valley, received overflow water from a number of rivers (San Joaquin, Fresno, Chowchilla, Merced, Tuolumne and Stanislaus). It had an extensive complex of permanent lakes, sloughs, ponds, marshes and seasonal wetlands. The Tulare Basin forms the southern end of the San Joaquin Valley. Three large lakes, Tulare, Buena Vista and Kern provided the largest single block of wetland habitat in California. Overall several million acres of wetlands, lakes and seasonal marshes and an unknown acreage of riparian forest filled the two valleys.

The most distinctive attribute of the Central Valley wetlands was their great wealth of wildlife. One observer described the southern valley, "...throughout the length and about the rim of the San Joaquin were a hundred or more oases, every one a veritable paradise, abundantly watered, shaded with beautiful trees, and filled to overflowing with game of all kinds...At all times these lakes and connecting sloughs as well as the San Joaquin River, were bounded with an almost impassable barrier of tules, willows, and mudflats."/134/

Along with millions of waterfowl, the wetlands of the Central Valley and Delta were inhabited by other water-associated species, such as wading birds,

shorebirds, mink and river otter; tule elk were abundant. Both resident and anadromous fish species lived in the marsh sloughs, lakes, creeks and river channels.

CHANGES

The history of change to wetlands in the Central Valley is bound up in the history of reclamation, flood control, and water develoment. Hundreds of thousands of acres of land were transformed over a period of about 100 years from "wet" land to "fast" land. Massive gains for a growing agricultural economy were accompanied by massive losses of wetland habitat. The greatest rate of wetland loss occurred in the Central Valley from 1906 to 1922, when extensive reclamation and effective flood control combined to accelerate the conversion to irrigated and agricultural lands.

The history of wetlands reclamation and flood control differs somewhat for the Sacramento Valley, the Delta, and San Joaquin Valley. In the Sacramento Valley widespread reclamation began in the 1850s, when early farmers diked the flood and tidal plains for cultivation to meet the demands for farm products of the burgeoning gold rush population. The reclaimed areas flooded extensively each winter. Hydraulic mining upstream in the Sierras left heavy deposits of sediment in the waterways, exacerbating flooding problems. For example, alluviation of Sacramento river channels between 1860 and 1914 raised the riverbed by 15 feet. In 1927, after a decade of dredging along the Sacramento River, "normal" streambed levels were restored. The inception of the Sacramento Flood Control Project in the 1910s greatly expedited the continuing reclamation of the Sacramento Valley. /83/

Reclamation in the Delta, which began in 1850, continued until by 1930 most of the present 886 inlets and islands had been leveed and were being cultivated. The permanent wetlands that were being reclaimed in the Delta differed from those in the Sacramento Valley, which were largely overflow lands, flooded only sporadically.

In the San Joaquin Valley, agricultural development proceeded in a somewhat different fashion. The San Joaquin was drier than the Sacramento Valley, and intensive agriculture in this area did not become widespread until the turn of the century. More efficient pumping systems provided groundwater for widespread irrigation, enabling farmers to convert large parts of the San Joaquin Valley to intensive agriculture. Groundwater continued to be the primary source of irrigation water in the valley through 1940. As groundwater tables were depleted, the need for a comprehensive program of water importation became apparent. Local irrigation districts formed to appropriate and import water. /83/

By the 1930s, it had become obvious that a large scale system was required in the Central Valley primarily to control flooding in the Delta and Sacramento Valley. Such a system could also provide the needed irrigation water to supplement groundwater in the San Joaquin Valley. The federal government took over a plan conceived by the State and in 1933 began construction of the Central Valley Project (CVP). Shasta Lake, the most prominent of the upstream storage reservoirs in the CVP, was completed in 1949. In August, 1951 the pumping station at Tracy in the southern Delta began delivering Sacramento River water from the Delta into the Delta-Mendota Canal for transportation south into the upper San Joaquin Valley.

By the 1950s, the need arose for additional water for irrigation and urban use in southern California, for more extensive flood control in the Sacramento Valley, and for control over salt intrusion into the Delta. The Burns-Porter Act of 1951 authorized the State Water Project (SWP), with initial construction of the Oroville dam and reservoir. The State Water Project was implemented in stages throughout the 1960s and now carries water from the Sacramento River and the Delta into the southern San Joaquin Valley and to the Los Angeles area. /26/

Reclamation and flood control were largely responsible for gradual elimination of meandering sloughs, oxbow lakes, and the permanent and seasonal wetlands of the Central Valley. For example, in the Sacramento Valley, the estimated 775,000 acres of native riparian woodland present in 1850 were reduced by 1952 to about 20,000 acres, and by 1977 to 12,000 acres or

less. /134/ Much of the original woodland was cleared for levee construction and maintenance or conversion to agriculture. Riparian vegetation was never as extensive along the drainages and smaller floodplains of the San Joaquin Valley as it was on the large rivers of the Sacramento Valley. Most of the riparian habitat in the San Joaquin Valley has been cleared and the land converted to agriculture. /110/

PRESENT WETLANDS

The present distribution of wetlands in the Central Valley bears limited resemblance to the historic distribution. The location and availability of water and arable land have determined present wetland locations. Of the 240,000 acres of wetlands (6% of the original estimated four million) that remain, virtually all are "managed", so-called because they must be maintained by the seasonal or controlled application of water. /111,134/ The majority of wetland habitat within the Central Valley is publicly owned as federal National Wildlife Refuges (NWRs), or state Wildlife Areas (WAs). Private wetlands are owned or leased by organized duck hunting clubs, ranchers, or farmers. Managed wetland areas were originally created to reduce waterfowl depredation of agricultural croplands and, later, to provide hunting opportunities. Acres of managed wetlands in the valley are listed below. Figures include associated uplands in addition to the 240,000 acres of actual wetlands.

TABLE 2

ACRES OF MANAGED WETLANDS AND ASSOCIATED UPLANDS IN THE CENTRAL VALLEY

Area	Federal	State	Private
Butte Basin	(440)*	8,375	52,115
Colusa Basin	20,450	0	23,580
Sutter Basin	2,590	0	1,500
American Basin	0	0	12,277
Yolo Basin	0	0	34,473
Delta	0	3,100	39,000
San Joaquin Basin	15,561	6,000	109,910
Tulare Basin	14,944	9,444	27,591
TOTAL:	53,545	34,306	298,946

SOURCE: U.S. Fish and Wildlife Service 1978 Concept Plan for Wintering Waterfowl Habitat Preservation, Central Valley, California. *Butte Sink ("Bean Land") NWR added in 1979.

A significant amount of wetlands habitat in the Central Valley is in privately owned duck clubs. In the Sacramento Valley, 305 clubs comprise 111,094 acres. /37/ The Sacramento-San Joaquin Delta contains 25 clubs totaling 25,249 acres; 348 clubs (156,068 acres) are located in the San Joaquin Valley. Thus, the approximate total acreage of Central Valley duck clubs is 292,400 acres; however, only about half of this acreage is retained as "natural" wetland habitat; the remainder is farmed. /37/

Agricultural lands of the Delta and Central Valley serve as secondary waterflow habitat. Farmlands in the Delta, principally corn, are subject to irrigation salt buildup; they are periodically leached by flooding, creating seasonal "wetlands" which resemble the pristine condition and attract large numbers of migratory waterfowl. The cultivation of rice, a major crop in the Sacramento Valley, requires flooding; these fields support waterfowl which feed on rice left after the harvest and on aquatic weeds and organisms, and water used for flooding is used a second time for maintaining adjacent wetlands. (See also Part I)

SAN FRANCISCO BAY

HISTORIC WETLANDS

The San Francisco Bay is the largest combined estuarine and wetland area in the state. (Figure 4) Freshwater from a 50,000 square mile watershed extending from the southern Cascades to the southern San Joaquin Valley flows into the bay. The large drainage area and expanse of the bay itself confer on it world significance as a natural harbor and estuary.

Prior to development, the bay surface covered about 300,000 acres. Marshland, including the large brackish Suisun Marsh on the northeastern periphery of the bay, added another 200,000 acres. The bay and wetlands together comprised approximately 500,000 acres. /16/

The bayfront, even prior to early settlement in the 1800s, was not completely ringed by marshes. Near the present site of the San Francisco Airport and extending southward, the marshlands became a wide corridor, lining the San Mateo peninsula. The large Alviso marshes, ranging from a quarter mile to seven miles wide, bordered the east bay as far north as Richmond.

To the northwest, the mouths of creeks of the Marin bayfront held delta-like wetlands, and brackish marshes extended several miles upstream from the mouth of the Petaluma and Napa Rivers. Northern San Pablo Bay, which receives these drainages as well as the Sacramento-San Joaquin, was bordered by extensive salt and brackish marsh. Suisun Bay, inland from Carquinez Strait, also held large tracts. The San Francisco waterfront had only scattered areas of salt marsh. The three largest marshes were the Napa, Suisun, and Alviso.

CHANGES

Earliest settlement of the bay area began in the late 1700s with the founding of Spanish missions, forts, and rancheros. Most farms were inland from the bayfront, and San Francisco was little more than a village on Yerba

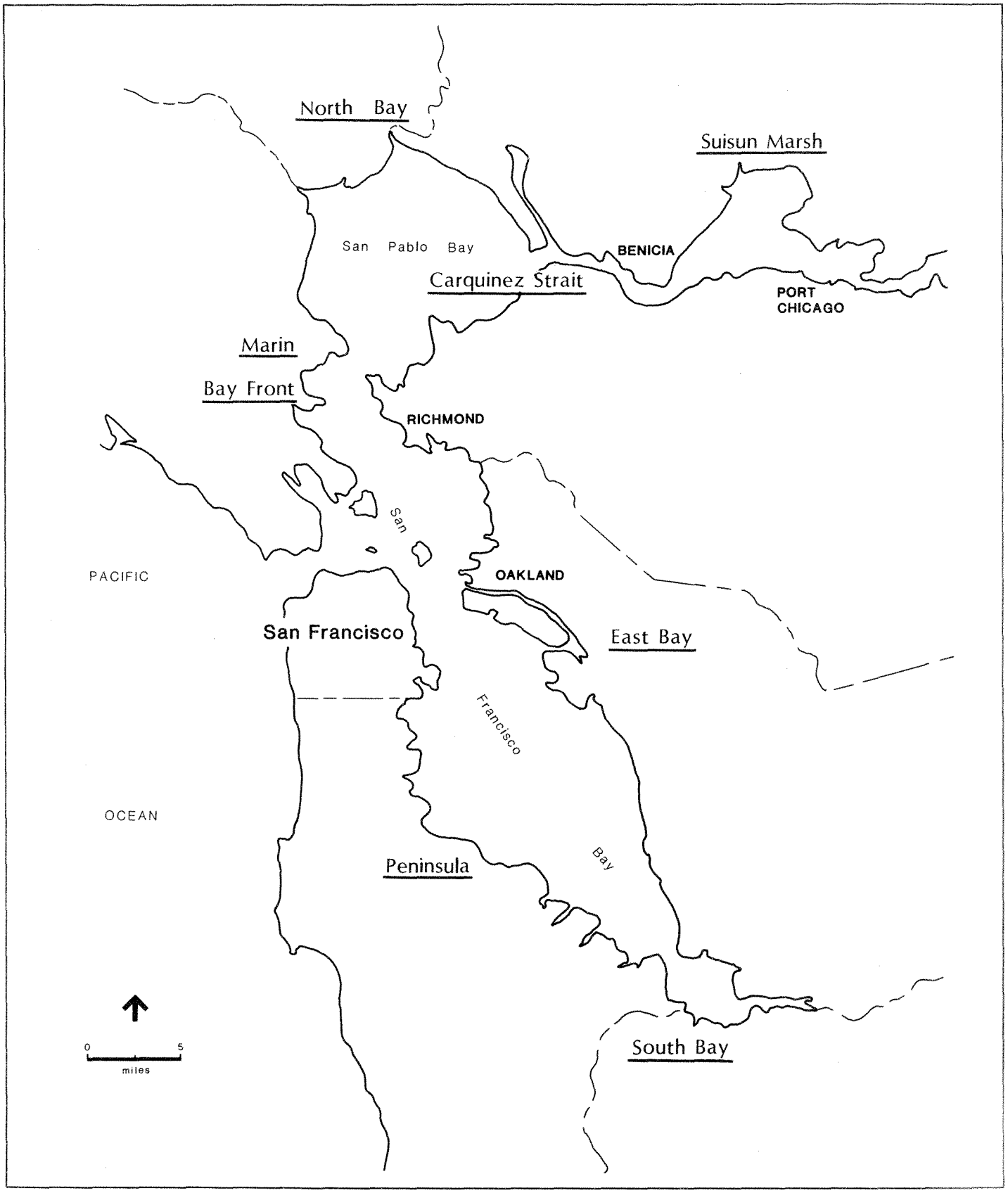


FIGURE 7

San Francisco Bay Region

Buena cove. The large expanses of tidelands along the east and south bay precluded their choice as harbor locations. The less vegetated, more abrupt shoreline of San Francisco was used instead. /16/

Following the Gold Rush of 1849, American settlement of the bay ballooned. The bay is a natural harbor and became a major shipping center for both California products and imports from the Pacific. The railroad reached the bay area in 1869, further stimulating shipping of products from the interior western region. San Francisco's waterfront and interior city rapidly expanded.

Major bayfront towns expanded around other natural harbors, landings, and railroad facilities such as at Benicia, Antioch, Redwood City, Port Costa, Port Chicago, Vallejo, and Sausalito. By 1898, Oakland had expanded its port facilities along the San Antonio Slough and held over 20 miles of bay frontage. Towns along the Carquinez Straits were industrial, food processing, and shipping centers for Central Valley and Pacific products.

Between 1850 and 1930, large areas of wetlands were filled for port and military facilities, marshes were diked and reclaimed for agriculture along the northern San Pablo bayfront, southeastern (San Lorenzo and Fremont), and south (Milpitas, Alviso, and Sunnyvale) bayfronts. /16/ Tidelands were transformed into salt evaporator ponds in the south bay, peninsula, and Napa River areas, beginning in 1860. The exact acreage of marshes diked and/or filled during this period is unknown.

Hydraulic gold mining in the Sierra Nevada between 1880 and 1890 released massive amounts of sediment into the Sierra rivers, which was eventually deposited in the bay and, in part, carried out to sea. An estimated 79 square miles of tidal marshlands and mudflats were built up through this process, making many areas of the north bay shallow and difficult to navigate. /27/

The second World War stimulated more growth and change in the bay area with the establishment of military reservations. Thirteen of the twenty-five military establishments in the nine-county region cover tide or wetland areas to some extent, and many are oriented toward water transport. /99/

Bay area population increased rapidly in the post World War II years. Extensive housing tracts, associated flood control projects, industrial and commercial centers, and highways were constructed. By 1967, 4.5 million people inhabited the bay area, an increase of 3 million in 35 years. Prior to the 1950s, little construction had occurred on tidal or diked bayfront lands due to the great cost of fill, even though the land was considered cheap. When large development corporations entered the home-building market they were able to support the necessary capital investments.

Population in the nine-county bay region increased by 0.9% annually between 1970 and 1979. /107/ Housing and employment centers for this increase in inhabitants are now distributed over a wide geographic area. Information on the specific acreage losses from this population increase on the filling and development of wetlands is not available.

All of the many marinas and ports established in the early years of the bay development have required maintenance dredging and periodic expansion and renovation. Dredge spoils were formerly disposed of on marshlands or used to fill bay lands for development. For example, the Port of Oakland filled 140 acres for their Seventh Street Terminal, and in 1967 the Port of San Francisco created their Army Street Terminal on 68 acres. /99/

The two major and other smaller airports overlie tidelands largely because of their need for flat topography and unimpeded access. San Francisco airport filled approximately 4,000 acres and Oakland 1,500 acres. Municipal landfills account for some wetland loss; 38% of bay area landfills are on tide and marshland, but the rate of filling is declining. Power plants and energy facilities are also located along the shoreline. Six Pacific Gas and Electric power plants collectively cover 650 acres of former wetlands. /99/

The visible presence of the bay to residents and tourists has inspired in many a deep concern for its welfare. This public concern prompted the passage of the McAteer-Petris Act and formation of the San Francisco Bay Conservation and Development Commission. Regulation of bay filling by BCDC began in 1965. Filling slowed considerably, as evidenced by the following breakdown: average loss of tidelands was about 1,500 acres/year between 1850 and 1940, 2,300 acres/year between 1940 and 1965, 94 acres/year between 1965 and 1969, and 29 acres in 1970. /100/ Data are not available for 1970 to 1982.

Federal, state, and local governments acquired some of the remaining wetland and tideland areas as parks and wildlife areas. These include San Francisco Bay National Wildlife Refuge (16,000 acres, currently authorized for 22,947 acres), San Pablo National Wildlife Refuge (11,700 acres), Grizzly Island State Wildlife Area, and other state and local wildlife areas (14,250 acres). /103/

Several restoration projects have returned about 500 acres of diked lands to tidal action; other projects are planned. Completed projects include the Faber Tract in Palo Alto, portions of Alameda Creek flood control project, Muzzi Marsh in Marin County, Hayward Shoreline Area Marsh, and other small mitigation projects. Planned projects are in Fremont, San Leandro, and Marin County.

PRESENT CONDITIONS

Only 125 square miles of tidal wetlands remain in San Francisco, San Pablo, and Suisun Bays. /81/ This figure includes managed wetlands and the 79 square miles of accreted sediments. If only the original tidal marshes are taken into account, of which 59 square miles remain, the bay has experienced a 75% net loss. The remaining tidal marshes are along the Napa and Petaluma Rivers, southern San Francisco/San Mateo Peninsula and the south bay, north Richmond, Gallinas and San Rafael Creeks, and Suisun Bay. The Suisun Marsh is the largest remaining area of continuous wetland in the state, with 57,000 acres of managed and tidal wetlands. /101/ Although private duck clubs have decreased in acreage around the bay since 1950, Suisun Marsh still holds approximately half of California's managed wetlands, with 160 clubs.

A large percentage of former tidal wetlands are now salt evaporator ponds (63 square miles) with 28,000 acres in the south bay and 9,000 acres in Napa. Salt production, begun in the 1870's, continues to be a viable industry. These ponds demonstrate a specialized "wetland" character. Other diked areas, despite their nontidal condition, retain many wetland characters. /64/ Of these 52,000 acres of diked former tidelands, 32,000 acres (62%) are in agricultural use, growing hay and forage crops. /103/ Their low elevation (in San Pablo Bay average elevation is three to five feet below mean sea level) permits ponding to occur during winter months unless regularly pumped dry. Seasonal wetland habitat for water-associated bird species can develop, even though cultivation has eliminated typical wetland plants. The remaining 20,000 acres of diked historic wetlands are highly variable in condition. Typically they are open, undeveloped lands partially filled and/or covered by marsh plant species such as pickleweed.

The most obvious effects of wetland losses, coupled with over-hunting in the 19th Century, have been to fish and wildlife use of the bay. Prior to 1850, sea otters inhabited the bay and migratory waterfowl were present in vast numbers. Both tule elk and bear, as well as other terrestrial mammals, once frequented marshlands. The tidal flats had a fauna of native benthic organisms which have largely been supplanted by introduced species. Migratory waterfowl use is still extensive, but feeding and resting areas are vastly reduced.

Salmon, sturgeon, flounder and smelt, and benthic animals such as shrimp, clam, and oysters were intensively harvested from 1850 to 1900. In 1869, the oyster industry thrived in San Leandro Bay next to Oakland. These commercial fisheries declined rapidly after 1900 due in part to loss of intertidal and wetland habitats. Over-fishing, upstream diversions, and water pollution were major contibuting factors. There is no longer a commercial crab, clam, mussel, or oyster fishery within the bay. /16/

KLAMATH LAKES BASIN AND MODOC PLATEAU

KLAMATH LAKES BASIN

The Klamath Lakes Basin extends from southern central Oregon into northern California and lies within the Klamath River watershed. Several large freshwater lakes, upper and lower Klamath Lake, Tule Lake, Clear Lake and other smaller water bodies constitute the primary wetland areas. Freshwater wetlands and lakes totaled 189,000 acres in 1899 and served as a major nesting area for waterfowl and as summer habitat for numerous other migratory species. /131/ Located at the junction of two major migration routes in the Pacific Flyway, the Basin still serves as a stopover for from 3 to 7 million ducks and geese annually. /151/

The advent of white settlement in the 1850s prompted reclamation of wetlands for agricultural use; grain and pasture land predominated, and there was limited production of crops such as barley and potatoes. Reclaimed agricultural lands surround the managed wetlands that remain. Native freshwater wetlands are largely gone.

The early 1900s brought an era of both preservation and reclamation of the Klamath basin. Beginning in 1908, the federal government took an active role in setting aside wetland areas as national wildlife refuges (NWR). In 1908 President Theodore Roosevelt established the Lower Klamath Lake NWR by executive order. Originally encompassing 81,619 acres the refuge held great numbers of nesting waterfowl which previously had been annually harvested for export to San Francisco. Five refuges were created between 1908 and 1960. Tule Lake, Lower Klamath, Upper Klamath, Klamath Forest, and Clear Lake (Table 3).

Conflicting with the federal effort to preserve wetlands was the charge of the Bureau of Reclamation to manage the water resources in the basin to create additional agricultural lands. For instance, in 1915 and 1921 presidential executive orders withdrew large areas of wetland and lake from the Lower

TABLE 3

KLAMATH BASIN NATIONAL WILDLIFE REFUGES

	Flooded Wetland Habitat	Agricultural Land	Waterfowl Production 1977-81	Total Visitor Use Days 1981	Hunter Visitor Days 1981
Lower Klamath NWR	17,583	47,583	27,634	144,700	11,743
Upper Klamath NWR	14,850	--	7,554	3,695	875
Klamath Forest NWR	14,776	--	4,615	3,975	90
Tule Lake NWR	13,200	17,400	15,091	187,550	11,818
Clear Lake NWR	33,400+	--	997	470	100
TOTAL:	93,809	64,983			

SOURCE: Robert Field, Manger, Klamath NWR

Klamath Refuge for reclamation to agriculture. The Bureau of Reclamation diverted the Klamath River away from Lower Klamath Lake; within 44 years the lake had dried up. Subsequent partial reflooding in 1942 by water pumped from Tule Lake has created a 17,000 acre managed wetland. Croplands within the refuge are now left unharvested for waterfowl food. The 14,850 acre Upper Klamath Lake NWR lies along the northwestern side of the lake. Extensive reclaimed agricultural lands partially surround the lake. As recently as 1960, 14,000 acres of private wetland on the lake was diked off for agricultural usage.

Tule Lake, which once held 90,000 acres of water and wetlands, was largely reclaimed in the early 1900s for agricultural use through diversion and impoundment of Lost River, the lake's water source. A considerable proportion of the Tule Lake refuge, 17,400 acres, is now leased as crop and grazing land, with 13,200 acres of marsh and water and 7,518 acres of upland remaining.

Clear Lake National Wildlife Refuge includes 33,400 acres and lies in the dry grasslands of Modoc County. Established as a national wildlife refuge in 1911, the lake has been used for irrigation, causing water levels to fluctuate sufficiently to preclude shoreline emergent vegetation. Waterfowl production consequently is quite low, but gulls, terns and cormorants nest on islands in the lake.

The California Department of Fish and Game acquired in 1981 a wildlife area at Meiss Lake. This 13,000-acre reserve has several hundred acres of freshwater marsh; the reserve manager has just completed a plan to create managed wetlands on the lake. Several large areas of marshland are held in private ownership: Miller Lake, Swan Lake, Aspen Lake, Alkali Lake and areas around the Lower Klamath. In addition, numerous small, unmapped wetlands dot the basin area.

Of the 150,000 acres in publicly owned NWRS in the Klamath River Basin, 93,000 are in wetland and water acreage. There is an unspecified acreage of privately owned wetlands. Approximately half of the national wildlife refuge holdings are in croplands or are uplands with limited use to waterfowl. The peak seasonal concentrations of 6 million waterfowl present in 1899 have dwindled to about 1 million. Present concentrations are still among the greatest in the United States, and over 80% of the waterfowl population of the Pacific Flyway use the basin wetlands during their migrations.

MODOC PLATEAU

The Modoc Plateau is a semi-arid region of lava flows, high mountains and alkaline lake beds. Major wetland and riparian areas are found in a few specific ares: the Devil's Garden Plateau of the Modoc National Forest, the Honey Lake plain and other large alkali lakes. The Devil's Garden Plateau historically held 3,400 acres of wetlands, permanent and intermittent freshwater marshes occuring in depressions in the lava rock of the plateau. /139/ Ranchers who settled the region in the 1850s constructed earthen dams across small streams, thus impounding water for irrigation and livestock and to create better forage than offered by the natural vegetative

cover of juniper and silver sage. The emergent marshes created around these impoundments contained rushes and spike rush, which are more desirable grazing plants.

Since the early 1900's the Forest Service has acquired many of these areas. Although not originally intended as waterfowl enchancement projects, these wetlands serve as nesting areas for many species. In 1965, the Forest Service began to improve many of the existing wetlands and to construct new impoundments for waterfowl habitat. This program continues today under both private and federal funding. An average of one wetland per year is being created for a total of 8-10,000 acres of newly created wetlands. The 34,000 acres of wetland in the Modoc Forest include 15,000 acres of permanent water and 19,000 acres of intermittent wetlands. Sizes range from the 6,000-acre Big Sage Reservoir to 5-acre ponds.

Several other large water bodies on the Modoc Plateau have limited areas of wetlands. Goose Lake has bulrush marsh along its western shore, and the three Alkali Lakes in Surprise Valley are lined by salt grass. Doris Reservoir and Pitt River in Modoc National Wildlilfe Refuge provide marsh habitat for waterfowl. /139/ Some of the lakes are alkaline, dominated by salts of calcium rather than sodium, and are not conducive to extensive vegetative growth. Honey Lake, a large alkali lake in southern Lassen County, is filled by agricultural irrigation return water. The California Department of Fish and Game maintains a 6,000-acre wildlife area near the shore of Honey Lake and raises grain for waterfowl./44/ Duck clubs in the Modoc Plateau number 22 covering 43,256 acres. Of these, 10,080 acres are farmed, and 32,236 acres provide marshland habitat. /37/

Riparian vegetation lines the larger rivers in the Modoc area where year-round water flows are sufficient to support this vegetation. The Pitt and Susan rivers have riparian borders. Flood control impoundments and channels on the Pitt River have eliminated some woodlands.

NORTH AND CENTRAL COAST

HISTORIC WETLANDS AND CHANGES

This coastal region extends from the Oregon border to Monterey County. Four subregions, corresponding to counties, provide convenient geographic units for a discussion of wetland resources. (Figure 5) Table 4 lists the major wetland areas and their attributes.

Del Norte and Humboldt Counties

Large embayments, wide floodplains and coastal lagoons comprise the wetlands of these two counties. Most river systems are large, carrying water from extensive mountainous watersheds and forming deltas at their tidal mouths. The floodplain of the Smith River, northernmost in the state, contained an 8,300-acre tidal delta and freshwater Lake Earl of 2,300 acres. The Eel River delta in southern Humboldt County, extends upriver for seven miles, encompassing 33,000 acres. /72,73/ Agricultural reclamation replaced most of these wetlands with pastureland. In the early years of mining in Trinity County, shipping at Crescent City and logging in the region, these alluvial lands provided the only level, fertile lands on the coast. /73/

The Klamath River, unlike the Smith or Eel, never developed a sizeable delta; the large freshwater outflows scour the mouth and preclude deltaic formation. However, riparian forest lines over 300 miles of the channel as it winds from Oregon through California. /45/

Humboldt Bay is the largest estuary and wetlands complex north of San Francisco. The bay consists of two wide shallow northern and southern arms connected by a relatively narrow channel. The bay surface and its surrounding wetlands once covered 27,000 acres. Beginning with the founding of the town of Eureka in 1850, Humboldt Bay has been the shipping center for the north coast region. As early as 1880 the Army Corps of Engineers had dredged several deepwater shipping channels. The completion of the railroad in 1901 spurred agricultural reclamation by functionally diking off certain tidal

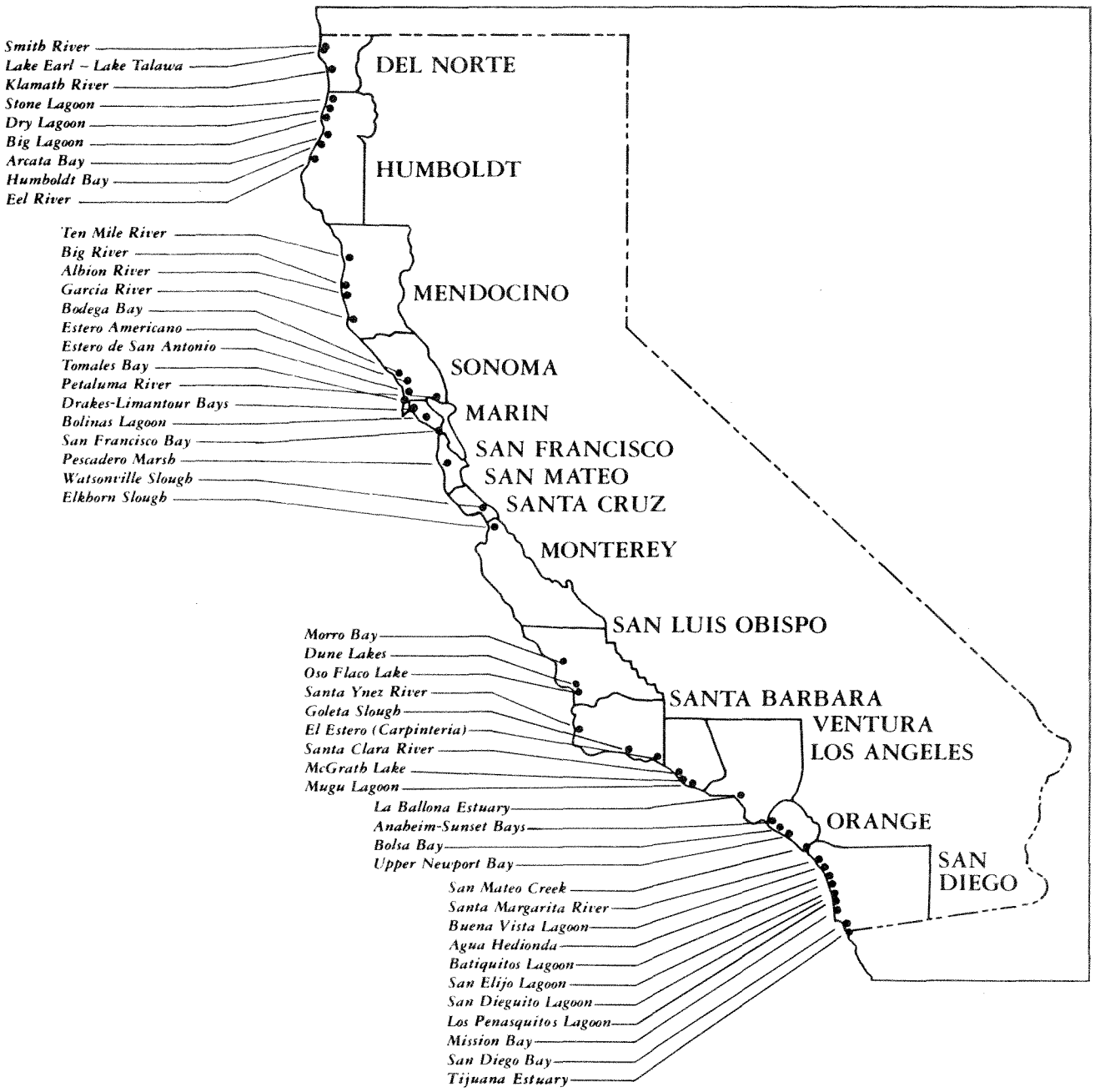


FIGURE 8

Major California Coastal Wetlands

SOURCE: California's Coastal Wetlands, Institute of Marine Resources, 1979

wetlands. In the northern and eastern bay, large areas of tidal marsh were diked off and converted to pastureland by 1930. /125/ Oyster mariculture began in the intertidal flats of the north bay in the late 1800s and continues to be a viable industry. The changing land uses around Humboldt Bay present an informative profile:

LAND USES IN ACRES

Year	Open Space	Agriculture	Wetland	Commercial & Industrial	Residential
1871	17,269	3,049	8,738	0*	250
1948	8,574	17,302	1,337	1,048	2,332
1958	8,467	14,905	1,136	1,595	3,616
1969	8,650	13,657	1,128	2,265	3,977
1978	8,372	13,750	1,108	2,239	4,171

*There were probably some mills in existence in 1871, but none are identified on the 1871 map.

SOURCE: U.S. Army Corps of Engineers. 1980. Humboldt Bay Wetlands Review and Baylands Analysis. Vol. I.

Diked agricultural lands in both Humboldt Bay and the Smith and Eel River Deltas are of low elevation and often pond water during the rainy season. This "secondary" habitat, although not as high quality as wetlands themselves, does provide food and resting area for wintering waterfowl.

Mendocino County

The jagged rocky Mendocino coastline contains no large embayments or deltas. However, a number of narrow, v-shaped river canyons open into tidal river mouths containing wetlands and mudflats, and small creeks incise the coast, each containing two to twenty acres of wetlands and mudflats. The Ten-Mile and Big Rivers have the largest areas of wetland. The Ten-Mile River drains a small watershed and a tract of salt and brackish marsh occupies the last bend in the river. The Big River has a large watershed and eight-mile-long estuary. The river in its lower four miles occupies a broad floodplain lined with salt and brackish marshes and mudflats totalling over 200 acres. /67,145/

The Albion River drains steep-sided canyons of coniferous forest. Characterized by extensive eelgrass beds, the small saltmarshes extend upstream for three miles. /13/ Noyo River has no large areas of wetlands; a fishing harbor replaced twenty acres of salt marsh. /13/ The Navarro River descends from the narrow canyons of its upper tributaries and stretches out over a wide floodplain in its lower reaches (3.5 miles). Large areas of riparian forest and narrow strips of salt marsh border the river. /13/ Early settlement and construction of the coast highway modified the estuary somewhat.

The Garcia River, which divides Mendocino from from Sonoma County, contains a large area of dunes and marsh at its mouth and over 200 acres of riparian woodlands in its lower three miles. Much of the former wetland has been converted to grazing land; remaining salt and brackish marshes are grazed during summer months. /13/ Tidal inflows extend two miles upstream, and freshwater and brackish marsh are scattered over the lower floodplain and amongst the sand dunes at the mouth.

The estuaries of the Mendocino coast have been significantly altered by sedimentation associated with logging. The hydrologic regime of these rivers appears to foster sediment deposition within the tidal portion of the river /52,66/, in contrast to the larger rivers (e.g., Klamath, Eel) which tend to deposit sediment loads in upper freshwater reaches. For example, in the Big River watershed, logging has been the primary land use for the past 130 years. Sedimentation from timber harvesting has shrunk the estuarine channel width by as much as forty feet, and over half of the original salt marsh acreage has been silted in and isolated from tide water. Siltation on the Ten-Mile and Albion Rivers has had similar effects. /67/

Sonoma and Marin Counties

The wetlands of Sonoma and Marin Counties are primarily large embayments or small lagoons fed by coastal streams and rivers. Bodega Harbor, Tomales Bay and Bolinas Lagoon, all large bays lined by wetlands, historically had important fishing grounds. Sedimentation resulting from overgrazing and tillage in surrounding agricultural lands has had a great effect on each.

Bodega Harbor is an 880-acre embayment fed by a 7 square mile watershed. The harbor was originally a deep water port; facilities built around 1841 exported agricultural products and lumber. During the late 1860s, accelerated sedimentation from upstream farming practices, coupled with depletion of local forest stock, filled in the harbor. By 1862 tidal flats covered more than half of the embayment. The harbor is now a shallow bay with mudflat comprising nearly 60% of the harbor water surface. A small amount of marsh may have been present along the shoreline in 1840, but many creek deltas formed by 1931. Dredge spoil disposal and shoreline developments have since filled some of these wetlands and about 100 acres of tidal flats. Eelgrass beds cover over half of the tidal channels. /115/

Tomales Bay, a 13-mile finger of bay formed along the San Andreas Fault, is fed by two creeks, Walker and Lagunitas. Its history resembles that of Bodega Bay. The first harbor was built at Walker Creek, and local farm products were shipped by steamer to San Francisco. Potato cultivation caused severe erosion of hillsides, and the bay began to silt in. By 1870, the Walker Creek harbor was no longer navigable. The bay then developed as a center for the local fishing industry, shipping fresh fish to San Francisco by railroad. Oyster mariculture thrived in the bay tidal flats after planting of non-native species before 1907.

The original acreage of tidal flats and salt marsh in Tomales Bay is not known. Sediment has been accreting at the mouth of the two tributaries, and salt marsh plants colonize these deltas. Scattered wetlands along the eastern shoreline bring the total to 405 acres. Few of these marshes have been filled; some were isolated by the railroad berm, constructed in 1875, and remain as pocket marshes. Mudflats are extensive; when exposed at extremely low tides these flats are invaded by both feeding shorebirds and humans collecting clams. /15/ Eelgrass beds grow in the bay's subtidal zone and provide spawning habitat to the herring which are commercially harvested there.

Bolinas Lagoon is also situated on the San Andreas Fault and was once a deepwater embayment. Extensive timber harvesting, potato cultivation and grazing in the watershed, silted in the lagoon until by the early 1900s only small craft could navigate the shallow channels. The 1,400-acre triangular lagoon is bordered by mudflat and salt marsh. Eelgrass beds line the subtidal zone. The original acreage of wetlands in the lagoon is not documented. Despite its proximity to San Francisco, the Bolinas shoreline has not undergone great urban or rereational development. Subdivisions line the western sand spit, but the majority of the shoreline is in public ownership. /39/ The lagoon is well-known for the egret and blue herring rookery in adjacent redwood canyons.

Smaller lagoon wetlands are scattered up the coast, over the Pt. Reyes Peninsula, and on Golden Gate Headlands. Drakes Estero is the largest of these and supports an oyster farm.. Two fiord-like estuaries, Estero Americano and Estero de San Antonio lie near and along the border of the Marin and Sonoma counties. Table 4 lists the features of these various wetlands.

San Francisco, San Mateo, Santa Cruz and Monterey Counties

The wetlands that once existed along the oceanfront of San Francisco have been filled. San Mateo, Santa Cruz and Monterey Counties, however, contain many small creeks and rivers with tidal wetlands in their lower reaches and riparian vegetation upstream. Along the San Mateo coast, south of Half Moon Bay, are nine lagoons and ponds which contain some wetlands vegetation. Although the historic condition of these wetlands and recent changes are not documented, this coastline has not been greatly affected by development; agricultural lands surround many marshes. /18/

Pescadero Marsh is the most significant of these wetlands and of major importance to migratory birds as a stop-over between Bolinas Lagoon and Elkhorn Slough. Some areas of the historic fresh and brackish marsh were converted to agricultural use in the early 1900s. The shoreline highway at the creek mouth and siltation from logging and agriculture in the drainage account for the creek's present relative shallowness. /12/

Santa Cruz County has many small creek mouth marshes surrounded by agricultural land in its northern region, a series of coastal lagoons in the City of Santa Cruz, and a larger river system in its southern region. /18/

Urban development has displaced wetlands surrounding several of these lagoons and estuaries. Aptos and Soquel Creeks are examples. The Santa Cruz Yacht Harbor replaced tidal areas in Wood's Lagoon. A flood control project on the San Lorenzo River, a major steelhead and salmon spawning stream, created levees and recontoured the channel, diminishing tidal influence to floodplain lands. The Pajaro River, separating Santa Cruz and Monterey Counties, has been leveed and its wetlands reclaimed for agriculture. This river once meandered over the Pajaro Valley; remnant tributary sloughs such as Watsonville, Harkins and McClusky, still drain the floodplain.

Monterey County contains one large wetland area in Elkhorn Slough, and many small remnant lakes and river estuaries. Elkhorn and its tributary sloughs Moro Cojo and Tembladero were isolated from freshwater inflow from the Salinas River when the river changed course during a large flood. A wharf, built near the ocean outlet of Elkhorn Slough at Moss Landing, was a center for the whaling industry from 1852 until 1888 in Monterey Bay. The Port of Watsonville, in the upper reach of the long sinuous slough, shipped grain from the Pajaro Valley farms to Moss Landing, but was abandoned after the railroad reached the area in 1874. Construction of the railroad across the upper slough and along its eastern edge necessitated large amounts of fill on the wetlands. /6/ Near Moss Landing, wetlands were diked off for salt evaporation ponds during the early 1900s. Agricultural reclamation occurred to some degree along Elkhorn Slough and to a much greater extent on the Moro Cojo and Tembladero Sloughs.

Moss Landing Harbor was built in 1946 to accommodate sardine and other fishery production. By 1952, 30 to 40 fishing vessels were berthed in the harbor, and eight canneries developed in the vicinity. The canneries are no longer in production. Industrial development, including a PG&E power plant and Kaiser magnesium refractory, began along the slough mouth after WW II. An outer wharf and pipeline were constructed for off-loading oil for the power

plant. Moss Landing has been suggested frequently as a likely candidate for major port development.

Original marsh acreages are not well documented; approximately half of the tideland was reclaimed for agricultural land. /6/ Formerly eelgrass beds lined the lower slough channel; most of these were removed with the dredging of Moss Landing Harbor. /17/ Elkhorn Slough is one of the most significant wetland habitats on the coast; much of it is now a national estuarine sanctuary.

The Salinas River valley once held a series of freshwater lakes and swamps bordering the river channel. Tules and riparian vegetation lined these lakes and the river's floodplain and swamps. Beginning with Spanish settlement and continuing into the American era, these lakes were drained and diked for agricultural lands. A mile long reclamation ditch drained the lakebeds into the ocean; the town of Salinas covers a former swamp. Very few remnants of these riverine marshes remain. /42/

The remaining portion of the Monterey coastline contains small lagoons and river estuaries. (see Table 4) Along the Monterey Peninsula are several lakes with wetland fringes; many are city parks surrounded by urban developments, and their water regimes are controlled. /24,42/

Wetland losses in this region are well below other regions of the state. Harbor development, sedimentation from logging and farming, and agricultural reclamation in north and central coastal watersheds reflect the resource-based economy of the region and its inevitable effects on wetlands. Although residential developments have replaced wetlands in a few areas, urbanization has not been a major factor in wetland losses.

Wetland and riparian losses have correspondingly reduced many wildlife species' populations: formerly, grey whales and sea otters inhabited the deep water bays and lagoons; tule elk foraged over marshlands in Point Reyes and Tomales Bay. The fall and spring spawning runs of salmon and steelhead in the northern rivers were famous.

TABLE 4

MAJOR NORTH AND CENTRAL COASTAL WETLANDS

AREA	TYPE OF WETLAND	APPROX. CURRENT WETLAND ACREAGE	MAJOR CAUSES OF WETLAND LOSS	OWNERSHIP	ADDITIONAL COMMENTS
Del Norte County					
Smith River Delta	Freshwater Marsh	115	Agricultural reclamation	Private	Adjacent 6,400 acres of flooded agricultural fields provide "secondary" wetland habitat to waterfowl. Waterfowl hunting, sport fishing, major anadromous fish stream.
	Mudflat	300			
Lake Earl	Freshwater Marsh	1,357	Sedimentation, urban development	California Department of Fish and Game - State Wildlife Area	
	Open Water	933			
Klamath River	Brackish Salt Marsh	300		Private and Limited Public	Extensive riparian forest along 270 miles of main channel. Anadromous fish habitat, sport fishing.
	Mudflat	100			
Humboldt County					
Freshwater Lagoon	Freshwater Marsh	75	Sedimentation from logging	California Department of Parks and Recreation	
	Open Water	170			
Stone Lagoon	Brackish Marsh	170	Sedimentation from logging	California Depatment of Parks and Recreation	
	Open Water	351			
Dry Lagoon	Brackish Marsh	80	Sedimentation from logging	California Department of Parks and Recreation	
Big Lagoon	Brackish Marsh	520	Sedimentation from logging	California Department of Parks and Recreation Ecological Reserve	
	Freshwater Marsh	50			
	Open Water	900			
Redwood Creek	Brackish Marsh	5	Agricultural reclamation	Private, National Park Service	
Little River	Brackish Marsh	Unknown			
Espa Lagoon	Brackish Marsh	Unknown			
Mad River	Tidal Estuary	100	Agricultural reclamation	Unknown	

TABLE 4 (continued)

AREA	TYPE OF WETLAND	APPROX. CURRENT WETLAND ACREAGE	MAJOR CAUSES OF WETLAND LOSS	OWNERSHIP	ADDITIONAL COMMENTS
Humboldt Bay	Salt Marshes	600 to 970	Agricultural reclamation, railroad construction, port and industrial development, urban development, dredging, sedimentation.	Private; Humboldt Bay NWR - authorized for 7,814 acres has acquired 531.	13,750 acres of agricultural lands many of which provide "secondary" waterfowl habitat. Waterfowl hunting, sport and commercial fishing, major anadromous fish stream.
	Brackish Marsh	250			
	Freshwater Marsh	170			
	Mudflats	7,200			
	Eelgrass Beds	2,935			
Eel River Delta	Salt and Freshwater Marshes	1,050	Agricultural reclamation, sedimentation from logging	Private, California Department of Fish and Game, State Wildlife Area - 170 acres	10,800 acres of poorly drained agricultural lands serve as secondary waterfowl habitat. Waterfowl hunting, sportfishing, major anadromous fish stream.
	Riparian Woodland	2,500			
	Mudflats	500			
	Open Water	2,300			
Mendocino County					
Ten-mile River	Salt and Brackish Marsh	100	Sedimentation from logging, grazing	Private	Extensive riparian forest
	Salt Marsh	9	Harbor construction	Private	
Big River	Salt and Brackish Marhes/Mudflats	200	Sedimentation from logging, logging mill construction	Private	Large riparian forest
	Eelgrass Beds	15			
Albion River	Tidal Marsh and Mudflat	100	Harbor construction, sedimentation from logging	Private	
	Eelgrass	28			
Navarro River	Salt Marsh and Mudflat	20	Homesite construction, highway construction	Private; California Department of Fish and Game - 77 acre ecological Reserve	Large acreages of riparian forest
Garcia River	Salt and Brackish Marshes	64	Agricultural reclamation, grazing, sedimentation from logging	Private	Large riparian forest
	Riparian Forest	200			
Gualala River	Fresh and Brackish Marsh	20	Recreational development, water diversion, sedimentation from logging	Private; Sonoma County Regional Parks	Large riparian forest

TABLE 4 (continued)

AREA	TYPE OF WETLAND	APPROX. CURRENT WETLAND ACREAGE	MAJOR CAUSES OF WETLAND LOSS	OWNERSHIP	ADDITIONAL COMMENTS
Sonoma County					
Russian River	Salt Marsh	100	Gravel mining	Private	Extensive riparian forest along river channel.
Bodega Harbor	Salt Marsh	72	Sedimentation from agriculture, dredge spoil disposal, urban development	Private	Sport and commercial fishing
	Mudflat	500			
	Eelgrass	184			
Estero Americano	Brackish Marsh	391	Unknown	Private	
	Open Water	301			
	Riparian Forest	49			
Marin County					
Estero de San Antonio	Brackish Marsh	213	Unknown	Private	
	Mudflat	13			
	Open Water	93			
	Riparian Forest	62			
Tomales Bay	Salt Marsh	405	Sedimentation from agriculture, harbor development	Private; California Department of Fish and Game - ecological reserve of 542 acres; California Department of Parks and Recreation, National Park Service	Oyster mariculture on 800 acres of tidlands, sport and commercial fishing, large recreational use
	Mudflats	1,500			
	Eelgrass beds				
Pt. Reyes Penninsula (Abbots Lagoon; D-Ranch, Drake's and Limantour Esteros; Wildcat, Ocean, Crystal, Pelican and Bass Lakes)	Salt and Freshwater Marsh/Mudflats	2,330	Unknown	Primarily National Park Service	Oyster mariculture in Drakes Estero, large recreational use
Bolinas Lagoon	Salt Marsh	150	Sedimentation from agriculture, urban development	Public and private	Large eelgrass beds, sportfishing
	Mudflat	700			

TABLE 4 (continued)

AREA	TYPE OF WETLAND	APPROX. CURRENT WETLAND ACREAGE	MAJOR CAUSES OF WETLAND LOSS	OWNERSHIP	ADDITIONAL COMMENTS
Rodeo Lagoon	Brackish Marsh and Open Water	38	Unknown	National Park Service	
San Francisco County					
Nearly all filled			Urban development		
San Mateo County					
Pillar Marsh	Brackish Marsh/ Open Water	30	Unknown	Private	
Tunitas Creek Lagoon	Brackish Marsh/ Open Water	11	Unknown	Private	
San Gregorio Creek Lagoon	Brackish Marsh/ Open Water	6	Unknown	Private	
Pomponio Creek Lagoon	Brackish Marsh/ Open Water	1	Unknown	Private	
Pescadero Marsh	Fresh and Brackish Marsh	465	Agricultural reclamation, highway construction, sedimentation from logging and agriculture	Private; California Department of Parks and Recreation, San Mateo County	Important stop-over for migratory birds, large recreation use.
	Open Water	55			
Lake Lucerne	Brackish Marsh/Open Water	80	Unknown	Private	
Gazos Creek Lagoon	Brackish Marsh/Open Water	2	Unknown		
Cascade Creek Lagoon	Brackish Marsh/Open Water	9	Unknown		
Green Oaks Creek Lagoon	Brackish Marsh/Open Water	31	Unknown	Private	
Santa Cruz County					
Wadell Creek	Brackish Marsh/Open Water	11	Unknown	Private	
Scott Creek	Brackish Marsh/Open Water	30	Unknown	Private	
Wilder Creek	Brackish Marsh/Open Water	18	Unknown	Public	
Baldwin Creek	Brackish Marsh/Open Water	3	Unknown	Private	
Terrace Point Pond	Brackish Marsh/Open Water	1	Unknown	Private	

TABLE 4 (continued)

AREA	TYPE OF WETLAND	APPROX. CURRENT WETLAND ACREAGE	MAJOR CAUSES OF WETLAND LOSS	OWNERSHIP	ADDITIONAL COMMENTS
Antonelli's Pond	Brackish Marsh/Open Water	2	Unknown	Private	
San Lorenzo River	Brackish Marsh/Open Water	2	Urban development, flood control	Private	
Wood's Lagoon	Brackish Marsh/Open Water	6	Harbor development	Private	
Schwann Lake	Brackish Marsh/Open Water	4	Unknown	Private	
Corcoran Lagoon	Brackish Marsh/Open Water	6	Unknown	Private	
Moran Lake	Brackish Marsh/Open Water	2	Unknown	Private	
Soquel Creek	Brackish Marsh/Open Water	1	Urban development	Private	
Aptos Creek	Brackish Marsh/Open Water	1	Urban development	Private	
Pajaro River	Salt Marsh, Mudflat and Riparian Forest	Unknown	Agricultural reclamation, flood control	Public	
Watsonville Slough	Brackish Marsh	Unknown	Agricultural reclamation	Public	
Monterey County					
McClusky Slough	Brackish Marsh/Open Water	250	Agricultural reclamation	Private	
Elkhorn Slough	Salt Marsh	1,440	Harbor development, agricultural reclamation, salt pond construction, railroad and industrial construction	Private; California Department of Fish and Game - 1,000 acre estuarine sanctuary, Moss Landing Harbor District	Waterfowl hunting, recreational use
	Mudflat	420			
	Salt Ponds	190			
	Open Water	450			
Moro Cojo Slough	Salt Marsh/Open Water	150	Agricultural reclamation	California Department of Fish and Game - 73 acre wildlife area	
Tembladero Slough	Salt Marsh/Open Water	10	Agricultural reclamation	Private	
Salinas River Slough	Brackish Marsh/Open Water	50	Sedimentation	Private	
Salinas River Valley	Freshwater	Unknown	Agricultural reclamation	Private	
Marina Ponds	Brackish Marsh/Open Water	5	Urban development	Private	

TABLE 4 (continued)

AREA	TYPE OF WETLAND	APPROX. CURRENT WETLAND ACREAGE	MAJOR CAUSES OF WETLAND LOSS	OWNERSHIP	ADDITIONAL COMMENTS
Robert's Lake/ Laguna Grande	Brackish Marsh/Open Water	40	Urban development	Private	
Del Monte Lake	Brackish Marsh/Open Water	6	Urban development	Private and Public	
El Estero	Brackish Marsh/Open Water	15	Urban development	Public	
Carmel River	Salt Marsh	4	Unknown	Private	Loss of riparian forest from ground-water overdraft
Little Sur River	Salt Marsh	7	Unknown	Private	
Big Sur River	Salt Marsh	4	Unknown	Private	

SOUTH COAST REGION

HISTORIC WETLANDS AND CHANGES

The south coast region includes six counties: San Luis Obispo, Santa Barbara, Ventura, Los Angeles, Orange and San Diego. A series of discontinuous wetlands occur at the tidal mouths of rivers and bays and around coastal lagoons, each associated with a separate river system. There were twenty-eight estuaries and wetlands along the south coast in 1850 prior to development of the coast. /130/ The size and character of each was a product of its particular hydrologic regime, degree of protection, and location on the coast. /148/

Most south coastal marshes experience high salinity levels in summer as freshwater runoff slackens, sandbars block river mouths, or closed lagoons become hypersaline. Brackish and freshwater marsh may have occurred at one time in the upper portions of some large estuaries and in wetlands fed by artesian springs (e.g., Freeman River at Bolsa Chica Bay) or those with large river inflows. /136/ The width of riparian vegetation lining most of the coastal rivers was a reflection of the summer water levels rather than flood flows; consequently, the wide floodplains of many rivers held but a narrow strip of riparian vegetation. /146/ No estimates of original or current riparian acreage exist. Table 5 lists the south coastal wetlands and some of their features.

San Luis Obispo County

San Luis Obispo County has two important wetlands and several smaller ones. Morro Bay is the last large relatively undeveloped estuary in southern California. /38/ It has not sustained great losses of wetlands despite the surrounding settlements. The Morro Bay area was settled first by the Spanish and later by Americans, who founded the town of Morro Bay. The town became a small shipping and fishing center in the late 1800s. In the 1940s the Army Corps of Engineers constructed a harbor, and a prosperous fishing industry

became established. The greatest impact on the bay wetlands has come not from the bay but from siltation resulting from erosion on overgrazed lands and other land uses in the watershed. /137/ Sedimentation has added 280-420 acres of vegetated wetlands and tidal flats in replacement of open water. /38/

Nipomo Dunes in the southern county is a complex of sand dunes, freshwater lakes, and tidal salt marsh. There are five principal wetlands in the complex: Pismo Marsh, Oceano Lagoon, Dune Lakes, Oso Flaco Lakes, and the Santa Maria River mouth. With the exception of the tidal river mouth, these are all freshwater, tucked in depressions amongst the sand dunes. The freshwater wetlands and lakes have not been changed greatly by settlement of the surrounding area. The Pismo Dunes, however, is a recreational area for off-road vehicles (ORVs) as well as a state park. Dune buggies and other vehicles destablilize sand, which drifts into the lakes and has threatened their continuance. /112/

Santa Barbara County

The wetlands of this county consist of small marshes at the mouths of creeks and rivers and several larger lagoon systems. One series of five wetlands is contained almost entirely within the boundaries of Vandenberg Air Force Base. They have escaped major disturbance. /165/

Goleta Slough is a large wetland area sandwiched between the town of Goleta (near Santa Barbara) and the ocean. This marsh was once a deep water harbor until a massive flood in 1861 filled the slough with silt from the coastal mountains. A shallow lagoon was left, and salt marsh invaded the new tidal flats. Filling along the slough's periphery in the 1940s for the University of California, Santa Barbara Airport and other properties has reduced the area of the marsh by 88%. Most of the slough is salt marsh, dissected with open water channels. /114/ The Santa Barbara City Flood Control District periodically dredges the channel to prevent flooding on adjacent lands. Catchment basins have been excavated on two of the main tributaries to the slough to retard continuing siltation from watershed development and agriculture. /123/

Carpinteria Marsh surrounds a lagoon formed at the confluence of two creeks. The periphery of the marsh has been filled; the original acreage was approximately 270 acres. The first development was the construction of a rail line in the upper area of the marsh. In 1925 the southern spit marsh became the "Sandyland" housing tract, and by the 1970s urban development surrounded the marsh. In the 1960s the County Flood control District dredged drainage channels through the marsh and stabilized a permanent ocean outlet with riprap. Siltation has been a continuing problem in the marsh, which experiences many floods. /59/

Ventura County

Primary wetland areas in Ventura County lie at the mouths of the Ventura and Santa Clara Rivers and at Mugu Lagoon. The majority of the former wetlands at the Ventura River mouth have been filled, and only 10 acres remain. The Santa Clara River has an estuary and several associated wetlands, McGrath Lake and Ormand Beach. Riparian vegetation is common along the two rivers. /24/

During the late 1800s, Mugu Lagoon covered nearly 3,000 acres, paralleling the coast for four miles. The lagoon and wetlands remained undisturbed until the 1940s, when the Navy acquired the area, dredged the central lagoon 30 feet deeper, and filled adjacent salt marsh and uplands. The lagoon's acreage has been reduced by 50% but remains within the Navy's Pacific Missile Test Center. Access to the lagoon is restricted except for hunting by Center personnel. Six hundred and twenty acres of freshwater managed wetlands lie outside the Navy property near the lagoon. Sedimentation is occurring in the lagoon partly from urbanization of the watershed. /60/

Los Angeles and Orange Counties

These two counties have sustained the greatest wetland losses of any region of coastal California; only 10% remain. /136/ Historically, there were seven major coastal wetlands totalling 17,300 acres. The coastline from Long Beach to Newport Beach was "one of the greatest habitats for wildlife and game

birds in the world." /113/ Twenty-three duck clubs dotted the coastline by 1900. Each wetland has been partially or totally filled or dredged and developed for urban use, military reservations, or harbor facilities. /130/

The railroad arrived in the 1880s, and during the 1890s Los Angeles doubled in population. The next boom period, 1902-1914, saw Los Angeles triple in size and San Pedro become the principal seaport. The appropriation of an adequate water supply via the Los Angeles Aqueduct furthered the city's growth, and shipbuilding became a principal industry during WW II. Oil fields were discovered between 1917 and 1929, and in the 1930s the Los Angeles area added a half million new residents. The construction of the Colorado Aqueduct in 1941 further stimulated metropolitan growth. A fourth growth period occurred between 1945 and 1969, with a vast proliferation of housing tracts and shopping centers as the aerospace industry grew, bringing workers and housing. By 1970 the City of Los Angeles had a population of 9 million and a contiguous metropolis extending 10 miles around the city.

In Orange County, urbanization began in the 1950s as communities replaced citrus groves. Although oil had been discovered in the coastal plain in the 1920s, the boom of the aerospace industry in the 1950s triggered urban growth. Between 1950 and 1960 the counties' population tripled. The last decade shows an addition of 500,000 new residents. Wetland losses accompanied the rapid expansion of Los angeles and Orange Counties.

The Ballona Creek marsh in northern Los Angeles County was originally 1,550 acres until 1928 when the major lagoons were drained and the land was reclaimed for agriculture and the installation of oil and gas wells. During the 1960s a residential marina project, Marina Del Rey, was created out of 800-900 acres of the salt marsh. /35/ The remaining 200-300 acres of wetland have been isolated from tidal flows by levees, roads and other fill. /35/ Los Cerritos Lagoon, originally composed of 2,400 acres, was reduced by piecemeal filling for residential uses to 188 acres.

Wilmington Lagoon of 3,450 acres was situated at the mouth of the Los Angeles River and former mouth of the San Gabriel River. Along its shores grew the cities of San Pedro and Wilmington. Reclamation began in 1841, and the federal government constructed a breakwater at San Pedro in 1891. The major reclamation of the marsh and construction of the Los Angeles/Long Beach Harbor proceeded between 1890 and 1930. The Corps of Engineers completed a large flood control project and re-routing of the Los Angeles River in 1923 to decrease sedimentation of the port. The port continued to enlarge though the 1970s, as shipping demands increased. /90/ Presently there are 5-6 acres of wetland left of the Wilmington Lagoon.

Alamitos Bay had 2,400 acres of wetland at the San Gabriel River mouth. Begining in 1907 with the City of Naples and through the 1920s it was filled for urban development. About 50 acres remain in a degraded condition along New River Slough. The San Gabriel River has been channelized and developed for much of its length, with concomitant losses of riparian vegetation. In certain portions of the river, Los Angeles Municipal Water District cuts the riparian forest from borders of their groundwater recharge gravels in order to reduce water losses.

Anaheim Bay, a coastal wetland of 2,300 acres, was first affected by the expansion of the oil industry in Huntington Beach and a loss of acreage for fill. In 1944 the Navy acquired 5,000 acres of the area, including the bay, and built the Seal Beach Naval Weapons Station. The harbor, wharves, bunkers, roads, dikes, islands and other general development of the ammunition depot reclaimed approximately 600 acres. When lands for the base were condemned by the federal government, mineral rights were retained by the former owner, the Alamitos Land Company. In 1954 the first oil well was drilled atop fills in the marsh. The next big change occurred in 1960, when 868 acres, primarily marshland behind Sunset Beach, were acquired by the Huntington Harbor Corporation to build a marina-oriented residential community. In 1962 a strip of marshland at the south end of the Naval Weapons Station was declared surplus by the Navy and offered to Orange County. The 63-acre parcel was bought and developed by the county for a marina and park. /113/

In 1964 Anaheim Bay was designated a Navy Wildlife Refuge. The same year, the U.S. Navy, U.S. Fish and Wildlife Service and the Department of Fish and Game worked out a cooperative agreement providing for preservation of fish and wildlife resources in the refuge. The refuge was eventually transferred to the Fish and Wildlife Service with no public access allowed. /113/

Bolsa Bay originally was not connected to Anaheim Bay, but had a separate ocean outlet and contained a marsh of 2,300 acres. Fed by artesian springs of the Freeman River, extensive freshwater marshes filled the interior portion of the bay. Marshes were first part of a sheep and cattle ranch but in 1900 came under the ownership of a duck club. The club constructed a dam to limit tidal flows, created dikes and levees to manage the marsh, and connected Bolsa Bay to Anaheim Bay via a new channel.

Oil was discovered throughout the southern section of Bolsa Bay in the 1920s. In 1920, the first well, Bolsa Chica 1, was completed and ten years later the Signal Oil Company began to slant drill from the Bolsa Chica property in order to tap offshore oil deposits. By 1949, a system of levees, dikes, culverts, and roads were built over much of the area that had previously experienced tidal action. /136/

In 1973 the state was deeded 327 acres of the wetland and leased 320 acres for 14 years from the area's owners, Signal Landmark, Inc. in exchange for termination of state public trust over the area. The Department of Fish and Game restored tidal action to 150 acres in 1978 and 275 additional acres of wetland were developed into a housing complex by Signal. Presently 1,200 acres of historic former tidelands and restored wetlands remain undeveloped, representing a wide range of wetland conditions.

The Santa Ana River mouth was the site of an extensive marsh, well in excess of the 3,000 acres recorded by Department of Fish and Game, which was drained for agriculture around the turn of the century and filled in increments from 1950 to 1969 for urban development and a flood control project. Scattered parcels totalling approximately 270 acres of wetland remain. /153/ Riparian forests have largely been lost along the river channel.

Newport Bay once contained 13,500 acres of estuary and marsh. The lower bay was dredged during the 1940s to create Newport Harbor. Piecemeal filling around the bay occurred in the 1950s. The Upper Bay was diked off for salt evaporation ponds, but the ponds were destroyed in 1969 by a flood and never re-built. The central portion of the bay was also dredged periodically during the 1950s to maintain a water ski area. This practice was stopped in 1974. /33/ The Upper Bay currently has 912 acres of fresh and salt water marsh and 300 acres of mudflats. Sedimentation from urbanization in the large, 145-square-mile watershed has filled in 70% of the salt marsh. Up to 5 feet of sediment has been deposited on the tidal flats.

San Diego County

The wetland and riparian resources of San Diego County include several large bays in the southernmost region, a series of coastal lagoons, and several rivers with small estuaries and substantial riparian areas.

In the northern county several small creeks (San Mateo and Las Flores) contain riparian and freshwater habitats. The larger Santa Marguerita River mouth holds a lagoon and marshes and has a well-developed riparian forest lining much of the watercourse. /77/ The lagoon extends inland for about one mile; approximately 300 acres in the marsh have been denuded by military operations at the Camp Pendleton Marine Corps Base. /77/

The San Luis Rey River contains a significant area of riparian vegetation and a tidal lagoon at the mouth. The wetlands at the mouth were developed into Oceanside Harbor and associated resort facilities in the early 1960s and few are remaining. Brackish marsh covers upstream areas, many of which have been filled for urban uses. /126/

Loma Alta Slough in the City of Oceanside is a small coastal lagoon with 6 to 8 acres remaining of its original 40. /54/ A recreational vehicle park and emergency holding ponds for the city sewage treatment plants now cover former wetlands.

The next series of wetlands are all lagoons formed at the coastal terminus of various creeks. Development on adjacent lands and watershed lands has caused sedimentation in varying degree in all the lagoons. Some have been filled, and the tidal regime of all has been modified by the construction of the shoreline highway and railroad across the lagoon outlets. Buena Vista Lagoon, now a Department of Fish and Game ecological reserve, has lost a total of 75 to 100 acres to commercial and residential developments. /36/ Sedimentation in this lagoon has been significant. Of the 340 acre Agua Hedionda Lagoon, 90 acres of wetland are privately owned by the San Diego Gas and ELectric Company. The lagoon has not been filled substantially and is used as a water intake point for the adjacent power plant. /24/

The 340-acre Batiquitos Lagoon is mostly barren salt flats, with 100 acres of marsh. Both the railroad and highway pass over the lagoon, but little additional filling has occurred. In 1901, 25 acres of salt ponds were operated but have since been abandoned. Some sediment accumulated in the lagoon from farming activities; a delta at the interior end has enlarged since upstream development began. /79/

San Elijo Lagoon is a 500-acre lagoon and marsh which has lost only 10% of its wetlands. The water level is maintained artificially through wastewater discharge. San Diequito Lagoon had an extensive 604-acre salt marsh which was reduced primarily through filling. In 1935, a racetrack covered 200 acres; farming operations and other filling further reduced acreage by one-third. In addition, the construction of Highway 5 isolated a 300-acre parcel of the upper marsh. /70/ Wastewater has been discharged into the lagoon for 35 years. Los Penasquitos Lagoon contains 385 acres of tidal wetlands. /78/ Recent development of the watershed has increased sedimentation rates fivefold.

Mission Bay may once have held as much as 4,500 acres of wetland. In 1975, the Army Corps of Engineers diverted the San Diego River away from San Diego Bay and into Mission Bay. The majority of the bay was dredged and filled for an aquatic park with marinas, hotels, restaurants, and beaches. In

1949, the Army Corps completed the San Diego River flood channel which diverted the river water directly into the ocean and relieved sedimentation problems in Mission Bay. A few wetlands remain at Famosa Slough (25 acre), Kendall-Frost Mission Bay Marsh, and at the mouth of the river channel. /117/

San Diego Bay, the largest estuary along the San Diego coastline, has been extensively developed as a port. The crescent-shaped bay stretches for 14 miles along the coast. Formerly, the San Diego River (rerouted in 1849), Sweetwater, and Otay Rivers flowed into the bay. Ninety percent of the original salt marshes and 50% of the original mudflats have been filled or dredged for port and urban development. /11/

In the early 1900s the Navy began developing harbor facilities and greatly expanded the harbor's operations in the 1940s. Between 1940 and 1946, 25 million cubic yards of sediment were dredged from the bay and used to fill tidelands. Salt evaporator ponds were created in the southern portion of the bay. The San Diego Unified Port District, founded in 1962, made a substantial increase in wharves. /91/ Remaining wetland habitats are concentrated in the southern bay at the river deltas and southern shoreline.

Tijuana River estuary covers about 1,182 acres and represents 10% of the remaining estuarine habitat in California. /118,148/ Little filling has occurred, and in 1981 the Fish and Wildlife Service acquired the area as an estuarine sanctuary through the federal Office of Coastal Zone Management. The local jurisdiction, City of Imperial Beach, had wanted to develop a marina. /118/

Vernal pools, small isolated depressions which seasonally fill with water, are another wetland type found in San Diego County. They are distributed over the mesa tops which separate watersheds in the northern and central areas of the county; many of them host endangered plant species. Filling and agricultural practices have reduced their acreage by 90%. /147/

Overall, the coastal wetlands of southern California have experienced a 75% reduction. Of the 28 original estuaries along the coast, 15 have been modified slightly, 10 have been greatly altered, and 3 have been destroyed. There are now 31,700 acres of estuarine habitat; less than 13,100 is marshland and tidal flats, and 18,600 is open water.

The areas that remain are largely in regions of moderate-to-low population, state or federal refuges or military ownership, or were previously oil fields. The value of privately held real estate in coastal lands has allowed few ares to remain undeveloped.

Two results of wetland losses and removal of riparian vegetation are particularly evident: the habitat of water-associated wildlife and migratory birds has been dramatically reduced; and the natural flow characteristics and channel geometry of coastal streams has been largely replaced. As the capacity of wetland areas has declined in area, waterfowl populations have decreased correspondingly.

TABLE 5

MAJOR SOUTH COAST WETLANDS

AREA	TYPE OF WETLAND	APPROX. CURRENT WETLAND ACREAGE	MAJOR CAUSES OF WETLAND LOSS	OWNERSHIP	ADDITIONAL COMMENTS
San Luis Obisbo County					
Morro Bay	Salt Marsh	472	Sedimentation from agriculture, harbor construction	Private; California Department of Parks and Recreation, California Department of Fish and Game	Sportfishing
	Mudflat	1,452			
Nipomo Dunes - Pismo Marsh, Oceano Lagoon, Dune Lakes, Oso Flaco Lakes	Freshwater Marsh and Open Water	1,285	Off-road vehicle use of adjacent dunes	Private, California Department of Fish and Game, California Department of Parks and Recreation	
Santa Maria River	Salt Marsh	35	Agricultural reclamation	Private	
	Mudflat	90			
	Freshwater Marsh	20			
	Riparian Forest	170			
Santa Barbara County					
Shuman Creek, San Antonio Creek, Canada Honda Creek, Jalama Creek	Salt and Freshwater Marsh	7	Some loss from grazing	Air Force	
	Riparian Forest	379			
Santa Ynez River	Salt Marsh, Mudflats, Open Water	400	Some loss from grazing	Air Force	
Goleta Slough	Salt Marsh, Mudflat, Open Water	360	Urban development, sedimentation from agriculture, and urbanization	City of Santa Barbara, California Department of Fish and Game	
Carpinteria Marsh	Salt Marsh, Mudflat, Open Water	~200	Urban development, dredging for flood control, sedimentation from urban development	Private, University of California Natural Land and Water Reserve System	
Ventura County					
Ventura River		10	Urban development, oil production, flood control project	Private	Riparian forest along river
Santa Clara River Including McGrath Lake and Ormand Beach	Salt Marsh and Open Water	100	Urban development, oil production, flood control project	Private	Riparian forest along river

TABLE 5(continued)

AREA	TYPE OF WETLAND	APPROX. CURRENT WETLAND ACREAGE	MAJOR CAUSES OF WETLAND LOSS	OWNERSHIP	ADDITIONAL COMMENTS
Mugu Lagoon	Salt and Brackish Marsh and Open Water	880	Dredging and filling for military installation, sedimentation from urban development	Navy, private	Duck clubs adjacent to Navy property
	Freshwater Marsh	620			
Los Angeles County					
Ballona Creek	Diked Salt Marsh	200-300	Agricultural reclamation, oil and gas production, harbor construction	Private	
Los Cerritos Lagoon	Salt Marsh	188	Urban development	Private	
Wilmington Lagoon (Los Angeles River mouth)	Salt Marsh	5-6	Dredging and filling for harbor construction, re-routing of Los Angeles River	Private	Little to no riparian forest borders former river
Alamitos Bay (San Gabriel River Mouth)	Salt and Brackish Marsh	50	Urban development, flood control projects	Private	Little riparian forest remains along river
Anaheim Bay	Salt Marsh	750	Oil production, construction of naval installation, urban development, urban park and marina construction	Navy - Navy Wildlife Refuge, managed by U.S. Fish and Wildlife Service	
Bolsa Bay	Salt Marsh	1,200+	Oil production, urban development	Private, California Department of Fish and Game	Salt marsh restoration project of 150 acres
Santa Ana River Mouth	Salt Marsh	270	Urban development and flood control projects		Little riparian forest remains along river
Newport Bay					
Upper Bay -	Salt and Freshwater Marsh	912	Harbor construction, urban development, salt evaporation ponds, dredging, sedimentation from urban development	Private, California Department of Fish and Game - 741 acre ecological reserve	
	Mudflats	300			
Lower Bay -	Unknown				
San Diego County					
San Mateo Creek	Freshwater Marsh and Riparian Forest	125	Unknown	Marine Corps	
Las Flores Creek	Freshwater Marsh and Riparian Forest	Unknown			

TABLE 5(continued)

AREA	TYPE OF WETLAND	APPROX. CURRENT WETLAND ACREAGE	MAJOR CAUSES OF WETLAND LOSS	OWNERSHIP	ADDITIONAL COMMENTS
Santa Marguerita River	Salt Marsh and Open Water	800	Military operations	Marine Corps	Extensive riparian forest along river
San Luis Rey River	Open Water and Salt Marsh	Unknown	Harbor construction, urban development	Private	Extensive riparian forest along river
Loma Alta Slough	Salt Marsh and Open Water	6-8	Urban development	Private	
Buena Vista Lagoon	Salt and Brackish Marsh, Open Water	350	Urban development, sedimentation from urban development	California Department of Fish and Game - ecological reserve	
Aqua Hedionda Lagoon	Salt Marsh and Open Water	340	Not substantially filled	Private and public	
Batiquitos Lagoon	Salt Marsh	100	Salt pond construction sedimentation from urban development	Private, California Department of Fish and Game - ecological reserve	
	Barren Salt Flats	240			
San Elijo Lagoon	Salt Marsh and Open Water	500	Not substantially filled	Private, California Department of Fish and Game - ecological reserve	Restoration plan underway
San Diequito Lagoon	Salt Marsh	269	Racetrack construction, agricultural reclamation, urban development	Private, California Department of Fish and Game - ecological reserve	Restoration plan underway
Los Penasquitos Lagoon	Salt Marsh	385	Sedimentation from urban development	Private, California Department of Parks and Recreation	Restoration plan proposed
Mission Bay - Famosa Slough, Kendall-Frost Marsh	Salt Marsh	25+	Dredging and filling for aquatic park	City of San Diego	Riparian forest along San Diego River, marsh restoration project completed
San Diego Bay	Salt Ponds	1,400	Dreging and filling for harbor construction, salt pond construction, Naval installation	San Diego Unified Port District, Navy, private	Restoration project on dredge spoils disposal site
	Salt Marsh	359			
	Mudflats	614			
Tijuana River	Salt Marsh, Mudflats and Open Water	1,182	Sedimentation from upstream land uses, illegal filling	U.S. Fish and Wildlife Service - estuarine sanctuary	
Vernal Pools - Mesa tops in northern and central county	Vernal Pool Flora - including endangered mesa mint	Unknown	Urban development, agricultural reclamation	Private	

DESERT REGION

HISTORIC WETLANDS AND RIPARIAN FORESTS AND CHANGES

The California Desert region encompasses a large geographic area as well as sections of the three distinct desert systems in California: the Great Basin, the Mojave, and the Colorado (Sonoran). The wetland and riparian areas of each desert vary in vegetative composition, size, and abundance. Generally, these habitats are concentrated along perennial streams, springs, lakes, and washes. The rarity of this vegetation type over the entire desert region makes each grove and spring significant to wildlife.

Mojave and Colorado Deserts

Bounded on the west by the Sierra Nevada and on the south and east by Tehachapi and San Gabriel and other ranges, the Mojave Desert includes one-sixth of California's land area. The Colorado Desert includes the desert sinks and mountains south of these ranges and stretches into Mexico and east into Arizona. The Colorado River forms the eastern boundary and the international border defines the southern boundary of the California portion of this desert.

The greatest concentrations of riparian vegetation lie along larger streams of the moister mountain ranges: the eastern Sierra slope, Inyo Mountains, Panamint Range, Argus Mountains, Santa Rosa Mountains, and the New York-Providence Mountains. Major rivers such as the Amaragosa, Mojave, Whitewater, New, and Alamo are bordered with riparian groves. /87/ Springs and washes exist throughout the desert mountains. Freshwater marshes are quite rare; Harper Dry Lake in the northern Mojave and San Sebastian Marsh on San Felipe Creek are the only relatively large freshwater marshes.

The scattered and varying nature of wetlands and riparian areas in the desert makes acreage estimates difficult. At present, there are no reliable data; nor is information on previous wetland distribution and losses in the desert area available.

Water, the determining factor to all wetland and riparian plant growth, is also the all-important requirement to most other desert land uses. This multiple demand for such a limited resource often puts wetland areas in direct conflict with mining operations, recreational uses, agriculture, and grazing by both feral and domestic animals. /140/

The most significant of these conflicting uses in the desert region is surface mining operations with their demands for water and severity of land disruption. Forty-six different minerals occur within the CDCA California Desert Conservation Area (which roughly encompases our defined desert region); over 50% of the minerals produced in California come from this area. The Bureau of Land Management (BLM) calculates a total of 34,000 acres of land have been disturbed through historic and present mining activities. The BLM estimates that currently there are 360 approved mining operations on public lands. Of these, 10-15% are impacting a riparian area either by direct mining in riparian zones or by road building. /140/ These mining operations are primarily small, two to five-acre, gold mines which are concentrated in the Inyo, Argus and Panamint Rangs of the northern Mojave Desert. Although direct removal of two to five acres of vegetation for mining may seem a small impact, the limitations and disparity of the riparian resource make each loss a significant one, especially in areas of highly isolated groves. Wildlife dependent upon an individual spring or water source or the nesting habitat of a riparian forest may not be able to relocate to the next nearest grove./87/ Neither the cumulative nor individual effect of these losses has been studied. Herds of feral burros, largely concentrated in the northern Mojave area, can trample both the vegetation and soils of springs and pollute water sources, leaving the site unusable for other wildlife.

The CDCA has recorded 16 million visitor use-days per year. Over 44% of the work force in the desert region are employed in tourist serving industries. Recreationists, needing water and shade, camp near desert springs and rivers, cut wood for fires, litter, and generally damage the vulnerable riparian groves. Off-road vehicles travel down washes, crushing riparian vegetation.

Grazing by domestic livestock has both direct and indirect effects in different desert regions. Direct grazing of riparian vegetation and seedlings denudes these areas; overgrazed riparian vegetation cannot sustain itself. Overgrazing in desert watersheds, combined with loss of stream and wash vegetation, in turn induces erosion and entrenchment of downstream water courses. About 4.5 million acres of the Bureau of Land Management desert holdings in California (over 12 million acres total) are in grazing allotments; however, livestock use in this region is declining. /140/

Groundwater pumping for ranching has had or threatens to affect wetlands in a few isolated localities. For example, a jojoba ranch proposed for private lands adjacent to the San Sebastian Marsh would pump wells for irrigation, potentially effecting the marsh by lowering groundwater levels.

Colorado River

The Colorado River forms the 250-mile-long, jagged border of southeastern California. The lower reaches of this extensive river system once contained large areas of riparian forest and several marshlands. The meandering river channel created transient (lasting 50-75 years) backwater areas and isolated "ox-bow" lakes as it transformed and scoured at flood state and redeposited sediments along the shifting floodplains.

Ox-bow lakes and backwater swamps along many stretches of the lower Colorado, specifically in the Mojave, Palo Verde, Cibola, and Yuma Valleys varied from 32 acres to 1,314 acres and were formed in periodically flooded areas. For example, in 1910 Lake Su-ta-nah, Duck Lake, and Powell Slough existed in the Mojave Valley between Needles, California, and Topock, Arizona. They were 121 acres, 420 acres, and 234 acres, respectively, and located one to three miles distant from the main river channel. Their orientation parallel to the channel indicates that they were scoured by the river during flood stages and abandoned at low water. The rising waters of Lake Havasu inundated these areas in 1938.

Riparian vegetation was more abundant along the river than marshland. Various studies, based on historic surveys, estimate up to 70% of the lower Colorado floodplain was covered with riparian forests. Cottonwood forest, specifically, along 200 miles of lower Colorado may have totalled 5,000 acres. Between the Park and Palo Verde Dams (near Blythe) lie 108,000 acres of floodplain, of which 71,000 acres supported riparian species. /86/ The great fluctuations in the river flow both flooded and destroyed riparian forests and wetlands as in 1905-1907, and drought periods dried them, as during 1855-1890.

American exploration and use of the Colorado began in the 1800s with the river serving as a major transportation route for the southwest. Steamboat transport on the lower river necessitated cutting of the virgin cottonwood gallery forest for steampower. Large areas of cottonwood were completely cut during this early period. Clearing of mesquite for agriculture and grazing of livestock along the floodplain somewhat reduced secondary riparian forests. /85/ However, the development and control of the Colorado River flows has had the greatest effect upon wetlands and riparian areas.

Major flood control projects entailing riprap and levee building along the river banks began in 1920 and still continue. Between 1906 and 1924, $10.25 million were spent for levee construction and maintenance on the lower Colorado, primarily to protect developments on floodplains and adjacent farmlands. In 1946, the Bureau of Reclamation, under the Colorado River Front Work and Levee System Act, began channelizing the streambed for flood control purposes. The channelization and dredging of the river eliminated existing backwater marshes through filling and isolation from water supply, and bank armor (riprap) replaced riparian vegetation. Post-construction condition and maintenance activities largely precluded reestablishment of vegetation. /86/

The Colorado River supplies many of the urban areas of Los Angeles and San Diego through the Colorado Aquaduct as well as the agricultural lands of the Imperial, Coachella, and Palo Verde Valleys. The construction of the large dams on the Colorado and regulation of water and sediment movement has had various effects on the riparian and wetland areas. Five dams and their

impoundments occur on the California portion of the Colorado. Beginning in the north they are: Parker Dam and Lake Havasu, Headgate Rock Dam, Palo Verde Dam, Imperial Dam, and Laguna Dam. Many backwater marshlands were flooded behind dams or left dry as overflows out of the main river channel were controlled; few historic backwater areas remain. However, as sediment-laden flood waters enter the large reservoirs such as Lake Havasu, the silt deposits out, forming deltas which eventually develop as marshes. At Blackenship Bend on Lake Havasu, nearly 123 acres of freshwater marsh has formed in 20 years. Recent river channel projects have incorporated designs for artificial backwaters and restoration of degraded areas such as Topock Marsh.

Connected with control of the river's floods and creation of a stable source of irrigation water, the floodplains surrounding the Colorado have been cleared of riparian vegetation for agriculture. The dams stopped the seasonal flooding and silt deposition of the river, eliminating new alluvial plains for primary cottonwood establishemnt. In addition, the introduction of salt cedar (Tamarix chinensis) in the 1800s from Europe brought a hardy riparian species into the Colorado which now successfully outcompetes cottonwood seedlings. Along with the physical changes in hydrologic and sediment regime on the river and grazing pressures, salt cedar has been responsible for replacement of the cottonwoods. The remains of cottonwood forest are now isolated trees or sparse rows intermixed with willow. Less than 500 acres of pure stands of cottonwood and only 2,800 acres of mixed cottonwood and willow now exist on the lower Colorado River.

Salton Sea

The Salton Sea was a perennially dry lake bed during most of the 1800s. The Salton Sink, which now holds the sea, was irrigated by water delivered via the All-American Canal from the Colorado River; by 1904, 75,000 acres of desert land were under irrigation and producing crops. The Colorado River in 1905 reached an extreme flood stage. In keeping with its past habits of migrating channel alignments, the river flooded into the sink through the channel of the canal. The entire flow of the river entered the valley for 16 months, transforming the Salton Sink and the irrigated farms into the present

Salton Sea. In 1907, the river was returned back to its original course, leaving behind a sea 76 feet deep and covering 488 square miles.

Since the time of its formation, the level of the Salton Sea has fluctuated. The original acreage of wetlands which developed around the Salton Sea, beginning in 1907, has changed with the sea level. With continuing net increase in sea level, many wetland areas have been inundated. Previous agricultural development of lands bordering the evolving new shoreline has limited continuous natural development of new marshes in these same shoreline areas. Presently, the wetlands that do exist lie along the southern shore adjacent to and covering the deltas of the New and Alamo Rivers. The delta of the Whitewater River along the northwest shore and Salt Creek on the eastern side contain freshwater marshland.

The Salton Sea National Wildlife Refuge, established in 1930, encompasses 35,000 acres, which were subsequently inundated. Imperial Irrigation District leased another 24,000 acres to the U.S. Fish and Wildlife Service, of this area 1,565 acres remain above water. Approximately 800 acres are managed marsh and open water for waterfowl, and 700 acres are alfalfa and rye grass fields.

The California Department of Fish and Game maintains several wetland areas: the 535-acre Hazard Tract, and the Wister Waterfowl Management Area of 5,255 acres. The Wister Reserve contains grain pastures, open water, and marshland. In addition, the Department of Fish and Game manages the 2,600-acre Finney-Ramer Wildlife Area southeast of the sea on the Alamo River. Approximately 50 private duck clubs of unknown acreage are concentrated along the southern shore.

The New, Alamo, and Whitewater Rivers have riparian forests of significant size lining their banks. These desert riparian woodlands of salt cedar, common reed, and arrowweed are inhabited by many types of wildlife and act as migration corridors to waterfowl and bird species moving between the sea and river areas. /87/

REFERENCES CITED

REFERENCES CITED

/1/ Anderson, Bertin W., and Robert D. Ohmart. 1976. Vegetation type maps of the lower Colorado River from David Dam to the southerly international boundary. Bureau of Reclamation, Lower Colorado Region.

/2/ Association of Bay Area Governments. 1980. Projections '79. 1980-2000 population, employment, and housing.

/3/ Atwater, B. F. et al. 1979. History, landforms and vegetation of the estuary's tidal marshes. In T. J. Conomos (ed.) San Francisco Bay: the urbanized estuary. Pacific Division, American Association for the Advancement of Science, San Francisco.

/4/ Blumm, Michael C. 1980. The clean water act's section 404 permit program enters its adolescence: an institutional and programmatic perspective. Ecol. Law Quarterly. Vol. 8: 409, 1980.

/5/ Bradshaw, J. 1976. Natural resources of Aqua Hedionda Lagoon. California Department of Fish and Game.

/6/ Browning, B. 1972. The natural resources of Elkhorn Slough. California Department of Fish and Game.

/7/ Bureau of Sport Fisheries and Wildlife, and the California Department of Fish and Game. 1974. Acquisition priorities for the coastal wetlands of California.

/8/ California Coastal Zone Conservation Commission. 1975. California coastal plan.

/9/ California Department of Fish and Game. 1969. Coastal Wetland Surveys. Humboldt County.

/10/ California Department of Fish and Game. 1969. Status report on the coastal wetlands of sourthern California.

/11/ California Department of Fish and Game. 1973. The natural resources of San Diego Bay.

/12/ California Department of Fish and Game. 1975. The natural resources of Pescadero Marsh, draft report.

/13/ California Department of Fish and Game. 1978. Coastal wetland surveys, Mendocino County.

/14/ California Department of Fish and Game. 1978. At the crossroads, 1980: a report on California's endangered and rare fish and wildlife. California State Resources Agency.

/15/ California Department of Fish and Game. 1979. The natural resources of Tomales Bay, draft report.

/16/ California Department of Fish and Game. 1979. Protection and restoration of San Francisco Bay, fish and wildlife habitat. Vols. 1 and 2. Jones and Stokes Associates.

/17/ California Department of Fish and Game. 1979. Preacquisition planning study: Elkhorn Slough. Prepared by Madrone Associates.

/18/ California Department of Fish and Game. 1979. Coastal wetland surveys, Santa Cruz County.

/19/ California Department of Fish and Game. 1980. Sacramento-San Joaquin Delta wildlife habitat protection and restoration plan. Prepared by Madrone Associates.

/20/ California State Department of Fish and Game. May, 1982. Designated endangered or rare plants.

/21/ California State Department of Navigation and Ocean Development. 1977. Inventory of California boating facilities.

/22/ California State Department of Water Resources Central District. 1980. Plan of protection for the Suisun Marsh.

/23/ Chan, Emy, and Teras Bursztynsky. 1981. The use of wetlands for water pollution control. Association of Bay Area Governments Technical Report.

/24/ Clark, Judy. 1980. Preliminary draft-notes on the enhancement potential of California's coastal wetlands. California State Coastal Conservancy.

/25/ Cogswell, Howard L. 1977. Water birds of California. University of California Press, Berkeley.

/26/ Connelly, D. P. n.d. Propagation of selected native marsh plants in the San Joaquin Valley. California Department of Fish and Game. Wildlife Management Leaflet No. 15.

/27/ Conomos, T. J. (ed.). 1979. San Francisco Bay: the urbanized estuary. Pacific Division of American Association for the Advancement of Science, San Francisco, California.

/28/ Conservation Planning Collaborative Inc. 1975. A coastal watershed environmental management system, Morro Bay, California. San Luis Obispo.

/29/ Cowardin, Lewis, et al. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Fish and Wildlife Service, Office of Biological Services, Washington, D.C.

/30/ Crosswhite, Frank S., and Carol D. Crosswhite. 1982. The Sonoran Desert. In Gordon L. Bender (ed.) Reference handbook on the deserts of North America. Greenwood Press, Westport, Connecticut.

/31/ Demgen, Francesca and J. Warren Nute Inc. 1977. Marsh enhancement program conceptual plan. Mt. View Sanitary District, Contra Costa County, California.

/32/ Faber, Phyllis. 1982. Common wetland plants of coastal California. Pickleweed Press, Mill Valley, California.

/33/ Frey, H., et al. 1970. Natural resources of upper Newport Bay. California Department of Fish and Game. Coastal Wetland Series.

/34/ Fullerton, Charles D. 1982. Letter to Bruce Jones dated June 24, 1982.

/35/ Gates, Susa. 1978. Ballona Creek Wetlands. California Coastal Commission working paper.

/36/ Gates, Susa. 1978. Buena Vista Lagoon. California Coastal Commission working paper.

/37/ George, H. A. 1979. Waterfowl studies: duck club survey. U.S. Fish and Wildlife Service Project No. W-30R-26 to W-30R-31; Job No. V-4.1.

/38/ Gerdes, G., et al. 1974. Natural resources of Morro Bay. California Department of Fish and Game.

/39/ Giguere, Paul, et al. 1970. The natural resources of Bolinas Lagoon. California Department of Fish and Game.

/40/ Gilbert, G. K. 1917. Hydraulic mining debris in the Sierra Nevada. USGS Professional Paper 105.

/41/ Good, Ralph E., Dennis F. Whigham, Robert L. Simpson. 1978. Freshwater wetlands ecological processes and management potential. Academic Press, New York.

/42/ Gordon, Burton L. 1977. Monterey Bay Area: natural history and cultural imprints, second edition. The Box Wood Press, Pacific Grove, California.

/43/ Graber, Peter H. F. 1981. The law of the coast in a clamshell: part III: the California approach. Shore and Beach, April 1981.

/44/ Hanzlik, Floyd. n.d. The Honey Lake wildlife area. California Department of Fish and Game.

/45/ Harris, Thomas. 1975. Navigability study on the Klamath, Trinity, Salmon, Scott, Shasta and Smith Rivers. U.S. Army Corps of Engineers, San Francisco District.

/46/ Harvey, H. T., H. L. Mason, R. Gill and T. W. Wooster. 1977. The marshes of San Francisco Bay: their attributes and values. San Francisco Bay Conservation and Development Commission.

/47/ Hedgepeth, Joel. 1975. Seashore life of the San Francisco Bay region and the coast of northern California. University of California Press, Berkeley.

/48/ Horn, Thomas C. 1957. History of the Klamath Basin national wildlife refuge. U.S. Fish and Wildlife Service.

/49/ Huffman, Robert Terry. 1981. Technical delineation of wetland boundaries within California riparian systems. In Proceedings of California riparian systems conference. University of California at Davis, 17-10 September 1981. In press.

/50/ Jones, Bruce E. 1981. California legislation affecting water-related resources: landmark acts with emphasis on regulation of fill. Prepared for the Resouces Agency, State of California by Environmental Projects.

/51/ Josselyn, Michael and James Bucholz. 1982. Summary of past wetland restoration projects in California. In Wetland restoration and enhancement in California. California Sea Grant College Program.

/52/ Kelsey, Harvey M. 1980. A sediment budget and an analysis of geomorphic process in the Van Duzen River basin, north coastal California, 1941-1975. Geological Society of America Bulletin 91(4): 1119-1211.

/53/ Kraft, Clifford. 1978. Santa Ana River Mouth. California Coastal Commission working paper.

/54/ Kraft, Clifford. 1978. Loma Alta Slough. California Coastal Commission working paper.

/55/ Kramer, John. 1982. The state's participation in the Section 404 permit process. Summary, presented to American Bar Association Legal Institute on floodplains and wetlands, San Francisco, May 28-29, 1982.

/56/ Kusler, Jon A. and Rutherford H. Platt. 1982. The law of floodplains and wetlands; cases and materials. Prepared for American Bar Association Legal Institute, San Francisco, California.

/57/ Levy, D. A., T. G. Northcote and G. J. Birch. 1979. Juvenile salmon utilization of tidal channels in the Fraser River estuary. University of B. C. Westwater Res. Cent. Tech. Rep. 23.

/58/ Levy, D. A. and T. G. Northcote. 1982. Juvenile salmon residency in a marsh area of the Fraser River Estuary. Canadian Journal of Fisheries and Aquatic Sciences 39(2): 270-276.

/59/ MacDonald, K. B. 1976. Natural resources of Carpinteria Marsh. California Department of Fish and Game.

/60/ MacDonald, K. B. 1976. Natural resources of Mugu Lagoon. California Department of Fish and Game.

/61/ MacDonald, Keith and Michael Barbour. 1974. Beach and salt marsh vegetation of the North American Pacific Coast. In Robert Reinold (ed.) Ecology of halophytes. Academic Press, New York.

/62/ MacDonald, Keith B., Edward G. Wolf and Nacy Savage. 1980. Coastal wetland studies, Cook Inlet Alaska. U.S. Environmental Protection Agency, Corvallis Environmental Research Laboratory.

/63/ Madrone Associates. 1977. The natural resources of Esteros Americano and de San Antonio. California Department of Fish and Game.

/64/ Madrone Associates. 1977. Natural resources of the Napa Marsh. California Department of Fish and Game.

/65/ Mahrdt, C., et al. 1976. Natural resources of coastal wetlands in northern Santa Barbara County. California Department of Fish and Game.

/66/ Marcus, Laurie, and Steve Reneau. 1981. Historic sedimentation in an estuary: salt marsh succession and change, Big River estuary, Mendocino County, California. In Proceedings of a conference on watershed restoration rehabilitation. National Park Service.

/67/ Marcus, Laurie, and Steve Reneau. 1982. Field survey of the Ten-Mile and Albion Rivers, Mendocino County, with emphasis on recent geomorphic changes. Unpublished paper.

/68/ Marcus, M. L., N. B. Dennis, and H. Hill. 1982. Wetlands policy assessment: California case study. Office of Technology Assessment, U.S. Congress, Washington, D.C. Environmental Science Associates.

/69/ Mason, Herbert L. 1957. Flora of the marshes of California. University of California Press, Berkeley.

/70/ Metz, Eric. 1978. San Elijo Lagoon. California Coastal Commission working paper.

/71/ Monroe, G. 1973. The natural resources of Humboldt Bay. California Department of Fish and Game.

/72/ Monroe, G., and F. Reynolds. 1974. The natural resouces of the Eel River Delta. California Department of Fish and Game.

/73/ Monroe, G., et al. 1975. The natural resources of Lake Earl and the Smith River Delta. California Department of Fish and Game.

/74/ Monroe, G., et al. 1976. The natural resources of Humboldt and Del Norte Counties. California Department of Fish and Game.

/75/ Moss Landing Harbor District. 1976. Biological assessment, proposed Moss Landing Harbor expansion. Prepared by Madrone Associates.

/76/ Moyle, Peter B. 1976. Inland fishes of California. University of California Press, Berkeley.

/77/ Mudie, Peter. 1969. A survey of coastal wetland vegetation of northern San Diego County. California Department of Fish and Game.

/78/ Mudie, P. 1974. The natural resources of Los Penasquitos Lagoon. California Department of Fish and Game.

/79/ Mudie, P., et al. 1976. The natural resources of San Dieguito and Batiquitos Lagoons. California Department of Fish and Game.

/80/ National Park Service. 1982. Natural resources management plan and environmental assessment. Golden Gate National Recreation Area.

/81/ Nichols, D. R., and N. A. Wright. 1971. Preliminary map of historic margins of marshland. San Francisco Bay, California. U.S. Geologic Survey open file report.

/82/ Nixon, S. W. 1980. Between coastal marshes and coastal waters - a review of twenty years of speculation and research on the role of salt marshes. In P. Hamilton and K. MacDonald (eds.) Estuarine and wetland processes. Plenum Press, N. Y.

/83/ Kahrl, W. 1979. The California water atlas. Prepared by the California Department of Water Resources and Office of Planning and Research. State of California Department of General Services.

/84/ Office of Technology Assessment. 1983. Wetlands: their use and regulation. Report to U.S. Senate Committee on Environment and Public Works.

/85/ Ohmart, Robert D., Wayne Deason and Stan J. Freeland. 1975. Dynamics of marshland formation and succession along the lower Colorado River and their importance and management problems as related to wildlife in the arid Southwest. In Transactions on the 40th North American Wildlife and Natural Resouces Conference.

/86/ Ohmart, Robert D., Wayne Deason, and Constance Burke. 1977. A riparian case history: the Colorado River. In Proceedings of a symposium on importance of preservation and management of riparian habitat, Tucson, Arizona.

/87/ Ohmart, Robert D., and Bertin W. Anderson. 1982. North American desert riparian ecosystems. In Gordon L. Bender (ed.) Reference handbook on the deserts of North America. Greenwood Press, Westport, Connecticut.

/88/ Onuf, C. P., et al. 1979. An analysis of the values of central and southern California coastal wetlands. pp. 186-194. In J. R. Clark (ed.) Wetlands functions and values. American Water Resources Research Association.

/89/ Pomeroy, L. R. and R. G. Wiegert (eds.). 1981. The ecology of a salt marsh. Springer-Verlag, New York.

/90/ Port of Los Angeles/Long Beach. 1975. General plan. Appendix II San Pedro Bay and Port history.

/91/ Port of San Diego. 1980. Environmental impact master plan, report on San Diego Unified Port District.

/92/ Prestegaard, K. 1979. Stream and lagoon channels of the Los Penasquitos watershed, California with an evaluation of possible effects of proposed urbanization. California Coastal Commission, San Francisco.

/93/ Reiners, P. E. 1973. The length of residences of juvenile fall chinook salmon in Sixes River, Oregon. Oregon Fish Comm. Res. Rep. 4(2)1-43.

/94/ Reppert, R. T., et al. 1979. Wetland values: concepts and methods for wetland evaluation. U.S. Army Corps of Engineers, Institute for Water Resources.

/95/ Ricketts, Edward, Jack Calvin and Joel Hedgepeth. 1948. Between Pacific tides. Stanford University Press, Stanford, California.

/96/ Russell, Peter P., Taras Bursztynsky, Lorene Jackson and Eugene Leong. 1982. Water and waste inputs to San Francisco estuary - an historical perspective. In San Francisco Bay: use and protection. Pacific Division, American Association for the Advancement of Science.

/97/ Roberts, W. G., J. G. Howe, and J. Major. 1977. A survey of riparian forest flora and fauna in California. p. 3-19. In A Sands (ed.) Riparian forests in California. Unst. Ecol. Publ. No. 15, University of California, Davis.

/98/ Rowlands, Peter, Hyram Johnson, Erick Ritter, and Albert Endo. 1982. The Mojave Desert. In Gordon L. Bender (ed.) Reference handbook on the deserts of North America. Greenwood Press, Westport, Connecticut.

/99/ San Francisco Bay Conservation and Development Commission. 1969. San Francisco Bay plan and supplement.

/100/ San Francisco Bay Conservation and Development Commission. Progress reports, 1969-1981.

/101/ San Francisco Bay Conservation and Development Commission. 1976. Suisun Marsh protection plan supplement.

/102/ San Francisco Bay Conservation and Development Commission and the Metropolitan Transportation Commission. 1982. Draft seaport plan.

/103/ San Francisco Bay Conservation and Development Commission. 1982. Diked historic wetlands study.

/104/ San Francisco Bay Conservation and Development Commission. 1982. Staff recommendation on the diked historic baylands study.

/105/ Schulenberg, Robert W. 1979. The biological reserves of California. Department of Fish and Game, Wildlife Management Information Bulletin No. 1. May 1979.

/106/ Security Pacific Bank. 1981. Economic trends for the eighties: southern California.

/107/ Security Pacific Bank. 1982. Economic issues in the eighties: northern coastal California.

/108/ Security Pacific Bank. 1981. Economic issues in the eighties, central California.

/109/ Shute, E. Clement, Jr., and Marc B. Mihaly. 1982. Analysis of powers exercised by regulatory agencies over diked historic baylands, and recommendations. Prepared for San Francisco Bay Conservation and Development Commission. April, 1982.

/110/ Smith, F. 1977. A short review of the status of riparian forests in California. pp. 102. In A. Sands (ed.) Riparian forests in California. Inst. Ecol. Publ. No. 15, University of California, Davis.

/111/ Smith, F. E. 1981. The great Central Valley. Outdoor California 42: 10-12.

/112/ Smith, K. 1976. Natural resources of the Nipomo Dunes and wetlands. California Department of Fish and Game.

/113/ Speth, J., et al. 1976. The natural resources of Anaheim Bay. California Department of Fish and Game.

/114/ Speth, J., et al. 1970. The natural resources of Goleta Slough. California Department of Fish and Game.

/115/ Standing, J., et al. 1975. The natural resources of Bodega Harbor. California Department of Fish and Game.

/116/ Stevenson, Mark. 1978. Upper Newport Bay. California Coastal Commission working paper.

/117/ Stevenson, Mark. 1978. Mission Bay. California Coastal Commission working paper.

/118/ Stevenson, Mark. 1978. Tijuana Estuary. California Coastal Commission working paper.

/119/ Stevenson, Mark. 1978. San Diego Bay wetlands. California Coastal Commission working paper.

/120/ Tasto, R. N. 1979. San Francisco Bay: critical to the dungeness crab? In T. J. Conomos (ed.) San Francisco Bay: the urbanized estuary. Pacific Division, American Association for the Advancement of Science, San Francisco.

/121/ Tonsfeldt, H. Ward, and Gale C. Corson. 1981. History of northern California and southern Oregon rivers, Volume 1: Mad, Noyo, and Napa Rivers. U.S. Army Corps of Engineers, San Francisco District.

/122/ Ulmer, Linda. 1981. An historic overview of the lower Colorado River and Delta. California Department of Fish and Game. Unpublished ms.

/123/ U.S. Army Corps of Engineers, et al. 1968. Goleta watershed study.

/124/ U.S. Army Corps of Engineers, Waterways Experiment Station. 1978. Preliminary guide to wetlands of the west coastal states. Tech. Rpt. Y-78-4.

/125/ U.S. Army Corps of Engineers, San Francisco District. 1980. Humboldt Bay wetlands review and baylands analysis, Volumes 1-3. Prepared by Shapiro and Associates, Inc.

/126/ U.S. Army Corps of Engineers. 1981. San Luis Rey River, Phase I. Technical Appendices B-H.

/127/ U.S. Army Corps of Engineers. 1981. Analysis of methodologies used for assessment of wetlands values. Environmental Laboratory, Waterway Experiment Station, Vicksburg.

/128/ U.S. Army Corps of Engineers, San Francisco District. 1982. Russian River basin study; northern California streams investigation.

/129/ U.S. Bureau of the Census. Population data 1950-1980. San Francisco Bay Area Counties.

/130/ U.S. Fish and Wildlife Service. n.d. Endangered environments, southern California estuaries and coast environments.

/131/ U.S. Fish and Wildlife Service. n.d. Klamath Basin national wildlife refuge. California-Oregon information brochure.

/132/ U.S. Fish and Wildlife Service. n.d. San Joaquin Valley national wildlife refuges. Pamphlet RL-557.

/133/ U.S. Fish and Wildlife Service. 1981. Memorandum to Colonel Gwynne Teague, District Engineer, Los Angeles District, Corps of Engineers. April 1981.

/134/ U.S. Fish and Wildlife Service. 1978. Concept plan for waterfowl wintering habitat preservation: Central Valley, California. Priority category 4. U.S. Fish and Wildlife Service, Portland, Oregon.

/135/ U.S. Fish and Wildlife Service. 1982. Memoranda from J. H. Shaw to Ed Collins, and from Larry deBates to acquisition program manager, Portland, concerning wetland losses in easement program. May 17, 1982.

/136/ U.S. Fish and Wildlife Service. 1979. Special report: Bolsa Chica area.

/137/ U.S. Fish and Wildlife Service, Region I. 1979. Concept plan for waterfowl wintering habitat preservation, California coast.

/138/ U.S. Fish and Wildlife Service. 1981. Aquatic study of the lower Colorado River. Water and Power Resources Service.

/139/ U.S. Forest Service. 1980. Wetland development plan, 1979-1984, Devils Garden Ranger District, Modoc National Forest.

/140/ U.S. Department of Interior, Bureau of Land Management. 1980. Final EIR and proposed plan, California desert conservation area.

/141/ University of California, Division of Agricultural Sciences. 1982. Agricultural resources of California counties. Special Pub. 3275.

/142/ Van Veldhuizen, H. D. n.d. The contribution of California salt marshes to estuarine habitats and marine resources: a simple mathematical model of estuarine productivity. Marine Research Branch, California Department of Fish and Game.

/143/ Veiluva, Michael. 1981. The fish and wildlife coordination act in environmental litigation. Ecol. Law Quarterly, Vol. 9 No. 3.

/144/ Warner, Richard E., and Kathleen M. Hendrix. 1984. Riparian resources of California's central valley and desert: a report on their nature, history, status, and future. Praepared for California Department of Fish and Game.

/145/ Warrick, S. F. and E. D. Wilcox. 1980. Big River the natural history of an endangered northern California estuary. Environmental Field Program Publication No. 6, University of California, Santa Cruz.

/146/ Wheeler, Gary P., and Jack M. Fancher. 1981. San Diego County riparian systems: current threats and statutory protection efforts. California Riparian Systems Conference Proceeding. Unpublished ms.

/147/ Zedler, Paul H., Thomas A. Ebert and Mary Lee Balko. 1979. A survey of vernal pools of Kearny Mesa, San Diego Co., California Dept. of Transportation.

/148/ Zedler, Joy B. 1982. Ecology of Southern California coastal salt marshes, a community profile. U.S. Fish and Wildlife Service, Biological Services Program.

/149/ Zedler, Joy B., et al. 1980. Salt marsh productivity with natural and altered tidal circulation. Oecologia 44:236-244.

/150/ Zentner, John. 1982. Development of regional wetland restoration goals: California wetlands. In Wetland restoration and enhancement in California. California Sea Grant College Program.

Added References Cited

/151/ California Department of Fish and Game. 1983 A plan for protecting, enhancing, and increasing California's wetlands for waterfowl (SCR 28 Report).

/152/ Sacramento Valley Waterfowl Habitat Management Committee. 1983. Pacific Flyway waterfowl in California's Sacramento Valley wetlands: an analysis of habitat...a plan for protection. Available from California Waterfowl Association.

/153/ U.S. Congress Office of Technology Assessment (see Citation 84).

/154/ U.S. Army Corps of Engineers. 1984. California State and local programs regulating discharge of dredged and fill materials: evaluation and comparison to C.O.E. 404 program. Prepared by Jones and Stokes.

APPENDICES

APPENDIX A

WETLAND DEFINITIONS*

President Carter's E.O. 11990 (May 24, 1977) defines wetlands as follows: "The term wetlands means those areas that are inundated by surface or ground water with a frequency sufficient to support and under normal circumstances do or would support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. Wetlands generally include swamps, marshes, bogs, and similar areas such as sloughs, potholes, wet meadows, river overflows, mudflats, and natural ponds."(emphasis added)

The joint Corps-EPA 404(b) permit regulations (July 19, 1977) define wetlands as follows: "The term wetlands means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas." (emphasis added)

The Fish and Wildlife Service's wetland classification system (December, 1979) defines wetlands as follows: "Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; and (3) the substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year."

The California Coastal Act (1976) defines wetlands as follows: "Land which may be covered periodically or permanently with shallow water and include saltwater marshes, freshwater marshes, open or closed brackish water marshes, swamps, mudflats, and fens." (Sec. 30121) Definition is broad in scope; the Act declares that it shall be liberally construed...to accomplish objectives (Sec. 30009). The Commission relies on the presence of hydrophytes and/or the presence of hydric soils.

The Keene-Nejedly California Wetlands Preservation Act (1976) defines wetlands as follows: "'Wetlands' means streams, channels, lakes, reservoirs, bays, estuaries, lagoons, marshes, and the lands underlying and adjoining such waters, whether permanently or intermittently submerged, to the extent that such waters and lands support and contain significant fish, wildlife, recreational, aesthetic, or scientific resources."(Sec. 5812[a])

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*Note: No court has specifically considered the sufficiency of a particular analytic technique or delineation methodology for determining wetland status. Courts generally defer to expert agencies or scientists on technical matters and will likely not disturb a selected methodology.

APPENDIX B

CHARACTERISTIC WETLAND PLANT SPECIES

SALT MARSH

North and Central California

Alkali heath	*Frankenia grandifolia*
Pickleweed	*Salicornia virginiana*
Cordgrass	*Spartina foliosa*
Arrowgrass	*Triglochin maritima*
Pickleweed	*Salicornia subterminalis*
Fat hen	*Atriplex patula* var. *hastata*
Australian salt ush	*Atriplex semibaccata*
Sea lavender	*Limonium californicum*
Salt grass	*Distichlis spicata*
Jaumea	*Jaumea carnosa*
Sand spurrey	*Spergularia marina*
Marsh gumplant	*Grindelia stricta*
Dodder	*Cuscuta salina*
Sea milkwort	*Glaux maritima*
Salt rush	*Juncus leseurii*
Sedge	*Carex lygnbyei*
Lasthenia	*Lasthenia glabrata*
Salt marsh fleabane	*Pluchea purpurascens*
Seaside heliotrope	*Heliotropium curassvicum* var. *oculatum*
Salt marsh bird's beak	*Cordylanthus mollis*
Low club rush	*Scirpus cernuus* var. *californicus*

Southern California

Spiny rush	*Juncus acutus*
Alkali heath	*Frankenia palmeri*
Lasthenia	*Lasthenia glabrata*
Alkali weed	*Cressa truxillensis*
Salt bush	*Atriplex watsonii*
Pickleweed	*Salicornia subterminalis*
Salt marsh bird's beak	*Cordylanthus maritimus*
Sea lavender	*Limonium californicum*
Shore grass	*Monanthochloe littoralis*
Alkali heath	*Frankenia gradifolia*
Arrow grass	*Triglochin concinnum*
Sea blite	*Suaeda californica*
Salt grass	*Distichlis spicata*
Dodder	*Cuscuta salina*
Jaumea	*Jaumea carnosa*
Salt wort	*Batis maritima*
Annual pickleweed	*Salicornia bigelovii*

Southern California (continued)

Pickleweed	*Salicornia virginica*
Cordgrass	*Spartina foliosa*
Low club rush	*Scirpus cernuus* var. *californicus*
Composite	*Ambylopappus pusillus*
Marsh gumweed	*Grindelia robusta*

SUBTIDAL VEGETATION

Surfgrass	*Phyllospadix* sp.
Eelgrass	*Zostera marina*

BRACKISH MARSH

Alkali bulrush	*Scirpus robustus*
Three square	*Scirpus americanus*
Olney's bulrush	*Scirpus Olneyi*
California bulrush	*Scirpus californicus*
Tule	*Scirpus acutus*
Cattail	*Typha angustifolia*
Bur reed	*Sparganium* spp.
Pondweed	*Potamogeton pusillus*
Sego pondweed	*Potamogeton pectinatus*
Ditch grass	*Ruppia maritima*
Grass wrack	*Zannichellia palustris*
Common reed	*Phragmites communis*
Fescue	*Festuca rubra*
Slough sedge	*Carex obnupta*
Rush	*Juncus* spp.
Dock	*Rumex crassus*
Salt bush	*Atriplex* spp.
Pacific silverweed	*Potentilla pacifica*
Groundsel	*Senecio* spp.
Sneezeweed	*Helenium* spp.
Goldenrod	*Solidago* spp.
Haplopappus	*Haplopappus racemosus*
Yarrow	*Achillea borealis*
Plantain	*Plantago hirtella*
Lilaeopsis	*Lilaeopsis occidentalis*
Brass buttons	*Cotula coronopifolia*
Alkali grass	*Puccinella* spp.
Canary grass	*Phalaris* spp.

FRESHWATER MARSHES, PONDS, SWAMPS AND BOGS

Three square	*Scirpus americanus*
California bulrush	*Scirpus californicus*
Tule	*Scirpus acutus*
Water cress	*Rorippa nasturtium-aquatica*
Water buttercup	*Ranunculus* spp.
Cattail	*Typha domingensis*
Cattail	*Typha latifolia*

FRESHWATER MARSHES, PONDS, SWAMPS, AND BOGS (continued)

Pondweed	Potomogeton spp.
Water plantain	Alisma Plantago-aquatica
Tule-potatoe	Sagittaria spp.
Waterweed	Elodea spp.
Reed grass	Calamagrostis spp.
Manna grass	Glyceria spp.
Swamp timothy	Heleochloa schoenoides
Common reed	Phragmites communis
Sedge	Carex spp.
Nut grass	Cyperus spp.
Spike rush	Eleocharis spp.
Beaked rush	Rynchospora spp.
Duckweed	Lemna spp.
Wolfia	Wolfia spp.
Rush	Juncus spp.
Smartweed	Polygonum spp.
Dock	Rumex spp.
Yellow pond lily	Nuphar polysepalum
Marsh potentilla	Potentilla palustris
Tule pea	Lathyrus palustris
Water parsley	Oenanthe sarmentosa
Common loosestife	Lythrum californicum
Milfoil	Myriophyllum spp.
Water hemlock	Cicuta spp.
Marsh pennywort	Hydrocotyle spp.
Brooklime	Veronica spp.
Bladderwort	Utricularia spp.
River bulrush	Scirpus fluviatilis

RIPARIAN TREES OR STREAMSIDE VEGETATION

Quaking aspens	Populus tremuloides
Cottonwood	Populus Fremontii
Willow	Salix spp.
Wax myrtle	Myrica spp.
Alder	Alnus spp.
Water birch	Betula fontinalis
California laurel	Umbellaria californica
Valley oak	Quercus lobata
Western sycamore	Platanus racemosa
Box elder	Acer negundo spp. californicum
Big leaf maple	Acer macrophyllum
Black walnut	Juglans californica
Ash	Fraxinus spp.

UNDERSTORY

Love grass	Eragrostis spp.
Polypogon grass	Polypogon spp.
Sedge	Carex spp.
Nut grass	Cyperus spp.

UNDERSTORY (continued)

Spike rush	*Eleocharis* spp.
Rush	*Juncus* spp.
Leopard lilly	*Lillium pardalinum*
Smartweed	*Polygonum* spp.
Buttercup	*Ranunculus* spp.
Nettle	*Urtica* spp.
Salmonberry	*Rubus spectabilis*
California wild grape	*Vitis californicus*
California hibiscus	*Hibiscus californicus*
Wild rose	*Rosa* spp.
Mugwort	*Artemesia douglassi*
Blackberry	*Rubus procerus*
Hedge nettle	*Stachys* spp.
Elderberry	*Sambucus* spp.
Dogwood	*Cornus stolinifera*
Gooseberry	*Ribes menziesii*
Twinberry	*Lonicera involucrata* var. *pedebourii*

DESERT RIPARIAN

Arroweed	*Tessaria sericea*
Screwbean mesquite	*Prosopis pubescens*
Quailbush	*Atriplex lentiformes*
Honey mesquite	*Prosopis glandulosa*
Velvet mesquite	*Prosopis velutina*
Creosote bush	*Garrea divaricata*
Salt cedar	*Tamarix chinensis*
Blue palo verde	*Cericidium floridum*
Cheesebush	*Hymenocea salsola*
Cat claw	*Acacia greggi*
Rabbitbush	*Chrysothamnus paniculatus*
Washington palm	*Washingtonia filifera*

VERNAL POOLS

Myosaurus	*Myosaurus minimus*
Buttercup	*Ranunculus* spp.
Star water plantain	*Damasonium californicum*
Orcut grass	*Orcuttia* spp.
Alkaline echinopsilon	*Echinopsilon hyssopifolium*
Waterwort	*Elatine* spp.
Button snakeroot	*Eryngium* spp.
Skunkweed	*Navarretia* spp.
Vernal pool mint	*Pogogyne* spp.
Downingia	*Downingia* spp.
Legenere	*Legenere limosa*
Gold fields	*Baeria fremontii*
Wooly marbles	*Psilocarphus* spp.
Meadowfoam	*Limnanthes douglasii*
Popcorn flower	*Plagiobothyrs acanthocarpus*

APPENDIX C

CURRENT MIDWINTER WATERFOWL USE OF CALIFORNIA WETLANDS

The Central Valley and Basins

Area	Average Population
Central Valley	5,652,191
Butte Basin	1,419,724
Sutter Basin	388,321
District 10	47,657
Colusa Basin	961,466
Yolo Basin	295,927
American Basin	38,273
Delta	477,117
San Joaquin Basin	1,687,662
Tulare Basin	208,056
Suisun Marsh	127,688
Total California:	6,228,486
Total Pacific Flyway:	9,348,006

SOURCE: U.S. Fish and Wildlife Service, 1978. Concept Plan for Waterfowl Wintering Habitat Preservation, Central Valley, California

San Francisco Bay

Area	Average Annual Waterfowl Use-days	
South San Francisco Bay*	8,400,000	
Corte Madera Marsh*	1,600,000	
Napa Marshes	1,400,000	
San Rafael Marsh*	1,300,000	
North Richmond Marsh*	300,000	
Petaluma Marsh	65,000	(November and December only)

* Includes adjacent open bay water.

SOURCE: U.S. Fish and Wildlife Service, 1978. Concept plan for Waterfowl Wintering Habitat Preservation, California Coast California.

APPENDIX C

MIGRATORY BIRD USE OF COASTAL WETLANDS

	Average Annual Use Days	
	Waterfowl	Shorebirds, Waders, etc.
Lake Earl	1,800,000	1,235,000
Smith River	170,000	132,000
Humboldt Bay	5,800,000	7,673,000
Eel River	1,400,000	1,315,000
Stone Lagoon	670,000	100,000
Dry Lagoon	166,000	90,000
Freshwater Lagoon	235,000	395,000
Mad River Estuary	15,000	22,000
Mattole	15,000	142,000
Ten-mile River	Low waterfowl use	
Big River	Limited records but of importance	
Albion River	Limited records but of importance	
Garcia River	Limited records but of importance	
Gualala River	Low waterfowl use	
Bolinas Lagoon	190,000	
Tomales Bay	640,000 (November and December only)	
Estero Americano	40,000	
Estero de San Antonio	17,000	
Bodega Harbor	113,000 (November and December only)	
Limantour Estero	220,000	
Drake's Estero	272,000	
Abbott's Lagoon	113,000	
Pescadero Marsh	70,000	
Elkhorn Slough	375,000	2,900,000
Morro Bay Lakes	1,833,000	
Dunes Complex		1,550,000
Santa Maria River mouth	21,000	250,000
Goleta Slough	150,000	
Carpinteria Marsh	61,000	194,000
Mugu Lagoon	314,000	
Anaheim Bay	784,000	
Bolsa Chica	200,000	
Upper Newport Bay	1,000,000	
Santa Marguerita River mouth	500,000	
Buena Vista Lagoon	70,000 birds observed at one time	
Batiquitos Lagoon	550,000	
San Diequito Lagoon	120,000	
Los Penasquitos lagoon	215,000	
San Elijo Lagoon	400,000	
South San Diego Bay	2,700,000	

SOURCE: U.S. Fish and Wildlife Service, Region 1. 1979. Concept Plan for waterfowl wintering habitat preservation, California coast.

APPENDIX C

RARE AND ENDANGERED SPECIES OF WETLAND HABITATS

Species	Habitat Type	Region	Status
Animals			
Thicktail chub (*Gila crassicanda*)	Freshwater marsh and sloughs	Clear Lake, Delta San Francisco Bay	Believed extinct
Shortnose sucker (*Chasmistes brevirostris*)	Shallow pools and sloughs	Klamath Basin	State listed - endangered
Modoc sucker (*Catostomus microps*)	Pools shaded with riparian forest	Modoc Plateau and Klamath Basin	State listed - endangered
Desert pupfish (*Cyprinodon macularius*)	Desert springs	Desert	State listed - endangered
Cottonball marsh pupfish (*Cyprinodon milleri*)	Desert marsh	Death Valley	State listed - rare
Owens pupfish (*Cyprinodon radiosus*)	Desert marsh	Owens Valley	State and federal listed - endangered
Santa Cruz long-toed salamander (*Ambystoma macrodactylum croceum*)	Seasonal ponds	Santa Cruz and Monterey County	State and federal listed - endangered
Black toad (*Bufo exsul*)	Desert springs and marshes	Inyo County	State listed - rare
San Francisco garter snake (*Thamnophis sirtalis tetrataenia*)	Riparian forest	Western San Francisco Bay and San Mateo County Coast	State and federal listed - endangered
Giant Garter Snake (*Thamnophis couchi gigas*)	Permanent freshwater marshes and lakes	Central Valley	State listed - rare
Aleutian Canada goose (*Branta canadensis leucopareia*)	Winters in coastal marsh	North Coast	Federal listed - endangered
California clapper rail (*Rallus longirostris obsoletus*)	Salt marsh	San Francisco Bay and Elkhorn Slough	State and federal listed - endangered
Light footed clapper rail (*Rallus longirostris levipes*)	Salt marsh	South Coast	State and federal listed - endangered
Yuma clapper rail (*Rallus longirostris yumanensis*)	Freshwater marsh	Colorado River	State listed - rare
California black rail (*Laterallus jamaicensis coturiculus*)	Brackish and fresh-water marshes	Colorado River, San Francisco Bay, Delta, several south coast marshes	State listed - rare
California least tern (*Sterna albifrons browni*)	Feeds in salt marsh and estuary areas	South Coast and San Francisco Bay	State and federal listed - endangered
California yellow-billed Cuckoo (*Coccyzus americanus occidentalis*)	Riparian forest	Scattered locations on inland rivers	State listed - rare
Elf owl (*Micrathene whitneyi*)	Desert riparian forest	Colorado River	State listed - endangered
Least Bell's vireo (*Vireo bellii pusillus*)	Riparian forest and desert springs	South coast and desert regions	State listed - endangered
Inyo brown towhee (*Pipilo fuscus eremophilus*)	Desert riparian habitat	Argus range, Inyo County	State listed - endangered

(continued)

Species	Habitat Type	Region	Status
Animals (continued)			
Belding's Savannah sparrow (Passerculus sandwichensis beldingi)	Coastal salt marsh	South Coast	State listed - endangered
Salt marsh harvest mouse (Reithrodontomys raviventris)	Salt marsh	San Francisco Bay	State and federal listed - endangered
Amargosa vole (Microtus californicus scirpensis)	Freshwater bulrush marshes	Amargosa River, Inyo County	State listed - endangered
Plants			
White sedge (Carex albida)	Open marshy areas in mixed evergreen forest	Sonoma County	State listed - endangered
Pitkin marsh indian paintbrush (Castilleja uliginosa)	Freshwater marsh	Pitkin Marsh, Sonoma County	State listed - endangered
Salt marsh bird's beak (Cordylanthus maritimus ssp. maritimus)	Salt marsh	South Coast	State and federal listed - endangered
Soft-haired bird's beak (Cordylanthus mollis spp. mollis)	Salt marsh	Northern San Francisco Bay	State listed - rare
Cuyamaca Lake downingia (Downingia concolor var. bevior)	Vernal pools	Coastl San Diego County	State listed - rare
San Diego coyote thistle (Eryngium aristulatum var. parishii)	Vernal pools	San Diego County	State listed - rare
Delta coyote thistle (Eryngium racemosum)	Freshwater marsh	Delta	State listed - rare
Burke's baeria (Lasthenia burkei)	Vernal pools	Central Valley, Coast	State listed - rare
Mudflat quill plant (Lilaeopsis masonii)	Mudflats	Suisun Marsh and San Francisco Bay	State listed - rare
Pitkin marsh lily (Lilium pitkinese)	Freshwater marsh	Pitkin Marsh, Sonoma County	State listed - endangered
Colusa grass (Neostapfia colusana)	Vernal pools	Colusa, Stanislaus and Merced Counties	State listed - endangered
California orcutt grass (Orcuttia californica)	Vernal pools and drying mudflats in grassland areas	Southern California	State listed - endangered
Greene's orcutt grass (Orcuttia greenei)	Vernal pools and drying mudflats	Central Valley	State listed - endangered
San Joaquin Valley Orcutt grass (Orcuttia inaequalis)	Vernal pools and drying mudflats	San Joaquin Valley	State listed - endangered
Crampton's orcutt grass (Orcuttia mucronata)	Drying mudflats	Dixon, Solano County	State and federal listed - endangered
Hairy orcutt grass (Orcuttia pilosa)	Vernal pools	Central Valley	State listed - endangered
Slender orcutt grass (Orcuttia tenuis)	Vernal pools	Shasta, Tehama and Lake Counties	State listed - endangered

(continued)

Species	Habitat Type	Region	Status
Plants (continued)			
Sticky orcutt grass (*Orcuttia viscida*)	Drying mudflats	Sacramento County	State listed - endangered
San Diego mesa mint (*Pogogyne abramsii*)	Vernal pools	Coastal San Diego County	State and federal listed - endangered
Hickmans cinquefoil (*Potentilla hickmanii*)	Freshwater marsh	Coast - Sonoma to Monterey Counties	State listed - endangered
Tahoe yellowcress (*Rorippa subumbellata*)	Wet meadows	Tahoe Basin	State listed - endangered
Kenwood Marsh ckecker-bloom (*Sidalcea oregana* ssp. *valida*)	Freshwater marsh	Kenwood, Sonoma County	State listed - endangered
Pedate checker-bloom (*Sidalcea pedata*)	Wet meadows	San Bernadino Mountains	State listed - endangered

SOURCES: California Department of Fish and Game. 1980. At the crossroads; California Department of Fish and Game. May, 1982. Designated endangered or rare plants.