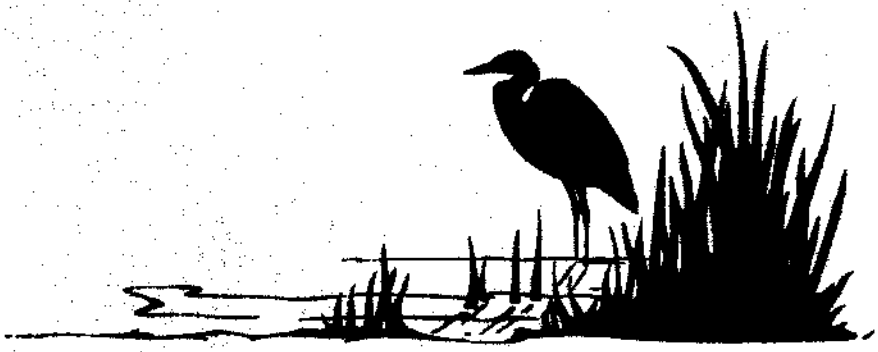
SAN DIEGO COUNTY WETLANDS
HISTORY, INVENTORY, ECOLOGY, and ECONOMIC VALUATION WITH SPECIAL REFERENCE TO AGRICULTURAL NONPOINT SOURCE POLLUTION



Kathleen A. Rager, Program Representative
Clay B. Clifton, Program Representative
Leigh T. Johnson, Marine Advisor

July 1995

University of California Cooperative Extension
County of San Diego Farm & Home Advisor Department
Sea Grant Extension Program
5555 Overland Avenue, Building 4
San Diego, CA 92123 (619) 694-2845

ACKNOWLEDGMENTS

The authors wish to acknowledge the following people who provided extensive assistance:

- Dr. Joy Zedler, San Diego State University
- Bill Daugherty, Buena Vista Audubon Society
- Libby Lucas, Environmental Health Council
- Greig Peters, Regional Water Quality Control Board
- Matt Witman, Witman Ranch
- Robert Hoffman, National Marine Fisheries Service
- Deborah Lee, California Coastal Commission
- Dr. Alan Thum, private consultant

and the many others who also provided advice, encouragement, reference materials and review..

University of California Sea Grant Extension Program - San Diego County
Publication UCSGEP-SD 95-1 July, 1995

Printed on Recycled Paper

This work is sponsored in part by NOAA, National Sea Grant College Program, Department of Commerce, under grant number NA36RG0537, project number A/EA-1, through the California Sea Grant Program, in part by United States Environmental Protection Agency, under grant number X-009864-01-0, in part by the California State Resources Agency, in part by the University of California Division of Agriculture and Natural Resources and in part by the County of San Diego. The views expressed herein are those of the authors and do not necessarily reflect those of the sponsors or any of their sub-agencies. The U.S. government may reproduce and distribute for governmental purposes.

University of California, United States Department of Agriculture, United States Department of Commerce and County of San Diego cooperating.

TABLE OF CONTENTS

TABLES

I. INTRODUCTION

Coastal wetlands are affected by a variety of pollutants, such as sediments, nutrients, bacteria and toxic materials. The federal Coastal Zone Act Reauthorization Amendments of 1990 directed the states to reduce pollution from nonpoint sources, such as agriculture, forestry, urban and boating. This report is part of an educational program designed to assist agricultural producers in reducing nonpoint source pollution by using best management practices.

The primary purpose of this report is to assist agricultural producers and others in understanding:

- coastal wetlands, especially those of San Diego County
- the benefits these wetlands provide
- how the wetlands have been affected by coastal development
- types of nonpoint source pollutants
- that pollution control efforts will thus help to assure the health and productivity of the wetlands and their ability to provide benefits to society.

This report will also serve as a useful reference for educators and for persons with an interest in coastal water quality and wetland issues.

II. WETLAND DEFINITIONS AND ECOLOGY

Wetland Definitions

Wetlands occur between terrestrial and aquatic systems. Several definitions of wetlands are used by different regulatory and resource agencies, i.e., the California Department of Fish and Game, the U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers. Most of the definitions are similar, sharing specific terms or conditions that define wetlands.

The following definition is adapted from a 1995 recommendation by the National Research Council:

> Wetland ecosystems depend on constant or repeated, shallow flooding or saturation of the soil. They typically contain vegetation suited for those areas, i.e., wetland and aquatic plants.[1]

Wetlands include such diverse areas as coastal salt and brackish marshes and lagoons, intertidal mudflats and channels, freshwater marshes, riparian forests and vernal pools.

This definition provides a general understanding of wetlands. When preparing Environmental Impact Statements (EIS) or applying for permits in wetland areas, consult local regulatory agencies for exact definitions.

Types of Wetlands

Salt Marshes: Found along bays and river mouths. The ocean inlet can be opened or closed to tidal water input, and associated plants will vary according to the wetland's salinity.[2] Salt tolerant plants (e.g., grasses, succulents) are dominant all year.[3]

Intertidal Flats: Extending seaward from the vegetated edge of salt marshes. These mud flats are exposed only during lowest tides and are populated by microorganisms and microscopic algae.

Brackish Marsh: Occurring where freshwater input is greater than marine or tidewater input, but salinity usually measures more than 0.5 ppt.[4] These marshes generally support taller plants than salt marshes.[5] Wetland and aquatic plants (e.g., cattails, bulrushes) are dominant all year.[6]

Freshwater Marshes: At one time the most widespread and diverse of all historic wetland types in California, especially in the central valley.[7] These freshwater areas support vegetation characterized by soft-stemmed plants, grasses, sedges, and rushes that emerge above the surface of the marsh.[8]

Riparian Forest: Bordering most rivers and creeks where flows are sufficient to support vegetation on the floodplain.[9] These areas contain scrub and forest vegetation, and are inhabited by a very high number of fish and wildlife species.[10]

Vernal Pools: Small, shallow, seasonally wet depressions, typically occurring in grassland in soils with poor drainage. Rainwater forms ponds in these depressions and leaves a variety of wildflowers after the water evaporates. Unique to this habitat are diverse plant and animal species (e.g., fairy shrimp).[11]

Wetland Productivity, Diversity and Abundance

The dynamics of a coastal wetland or estuary are very complex. This complexity is due to the extensive interactions which occur between the organisms of the estuary or wetland and their environment. These interactions are what make the coastal estuary or wetland a productive system, permitting an array of diverse and abundant vegetation and wildlife.

Productivity

Wetlands have higher rates of primary productivity than most other ecosystems.[12] Salt and freshwater marshes are extremely productive. The primary productivity of an ecosystem can be measured by the amount of plant fiber and algae which grow over an area of ground in a specified time.[13] This productivity supports entire food chains and complex food webs that live within the wetland ecosystem. Given ample light for photosynthesis and the right aquatic conditions, marsh plants and algae (phytoplankton, blue-green algae, diatoms) form a dense cover over wetland mud. Microorganisms that can live with little or no oxygen in the mud process nutrients, thus supporting plant production even when plants are submerged or dormant.[14] Studies in southern California tidal marshes have demonstrated especially high levels of algal productivity.[15]

The decomposed plant material (detritus) is used by invertebrates and fish (clams, ghost shrimp, polychaetes, and arrow gobies) which inhabit the muds and sloughs of the wetland. The decomposed plant material is full of nutrients such as nitrogen. The invertebrates and fish, which filter feed fine material from the tidewater, are part of the "secondary productivity" level of the marsh and contribute to further decomposition and nutrient cycling as they are eaten by larger fish, shore birds and other animals who in turn continue to cycle the nutrients.[16] Thus, each species is dependent upon the existence of another species or certain environmental conditions.

Environmental Interactions

The interaction among the hydrologic processes, the wetland or estuary topography, and its underlying substrata (e.g. soil) largely controls the general characteristics of a wetland and many of the ecological functions it performs.[17] In addition to salinity, the two hydrologic characteristics that have the greatest influence in determining the habitat values of a wetland are the depth of the water and the pattern of fluctuation of water depth.[18]

Alterations in hydrologic processes, such as flooding and closure to tidal action, can impact the dynamics of the ecosystem by changing the salinity of the water. Daily tidal flushing into and out of the coastal estuary or wetland is of vital importance. The sea brings in tidal water with its salts, minerals and sands which shape the wetland's or estuary's channels and shorelines. Tides distribute sediments from the watershed throughout the estuary.

If the estuary or wetland is closed to tidal flushing, the movement of freshwater, eroded soil, and upstream pollutants out of the wetland stops. As a result, higher concentrations of these elements may collect within the estuary or wetland. Freshwater inflows may allow freshwater species to invade the estuary habitat. Eroded soil may fill in the estuary or wetland instead of replenishing coastal beaches. Pollutants may kill off vegetation and wildlife (See chapter III: **Nonpoint Source Pollutants And Their Impacts On Wetlands with Special Reference to Agricultural Nonpoint Source Pollution**). Following a period of unseasonable freshwater inflows from reservoir discharge into the San Diego River, cattails *(Typha domingensis)*, a native of brackish marshes, were able to invade and persist.[19]

The ocean serves as an important link between the many estuaries and wetlands that exist along the coast, especially for wildlife and vegetation which depend on inputs from the ocean or other estuaries or wetlands. When wetlands and estuaries are closed off from other systems, they become isolated systems with unique habitats and species. It is vital that estuaries and wetlands retain connections with other systems to aid in the recovery of sensitive populations. Differences among the coastal estuaries and wetlands of San Diego County can be seen by comparing the lagoon fact sheets in chapter VII: **Appendices**.

Due to the complex interactions of the species which live within the coastal estuary or wetland, a change in one element can have a profound effect on other elements. Without the continuous cycling of nutrients throughout the ecosystem, many plants and animals would cease to exist.

Many factors can inhibit nutrient cycling through the food web. For example, nitrogen can limit plant productivity within the coastal estuary or wetland. Other environmental factors such as climate, freshwater inflows, sediment, salinity, and pollutants can impact the survival of species. These impacts will be discussed later in this document.

Importance of Range of Depths and Elevations

Other than salinity, the two most important hydrologic factors influencing habitats in a coastal wetland or estuary are water depth and patterns of fluctuation.[20] In a progression from deep water to the edge of the watershed, different plant and wildlife species inhabit different elevations. In a typical Southern California salt marsh, for example, *Spartina foliosa* (cordgrass) is common in low marshes with tidal flushing; while *Salicornia virgincia* (pickleweed) is found in low to mid ranges; and *Salicornia subterminalis* (glasswort) is common only in the high marsh. [21]

The sources of water also influence water depth and fluctuation patterns. These include direct surface runoff of snowmelt or rainfall, indirect runoff from storm drains, spring flooding by rivers, or tidal action in coastal areas.[22] Climate influences the source of water (e.g. precipitation, snowmelt, or flooding), and determines seasonal patterns of drying.[23] Impacts will be discussed later in this document.

Vegetation and Wildlife of an Estuary or Wetland

The various types of wetland vegetation provide both food and habitat for wildlife species who utilize coastal estuaries and wetlands. Vegetation also stabilizes the substrate and helps retain the "structure" of the wetlands.[24]

The lower and mid-to-upper bands of wetland vegetation provide protective cover, territory, nesting sites and materials, and access to food. The endangered Belding's Savannah Sparrow (*Passerculus sandwichensis beldingi*), inhabits the mid-to-upper salt marsh, which provides territorial males with singing perches, females with suitable nesting sites and material, and proximity to food supplies.[25]

The upper vegetation band serves as a refuge during times of extreme high sea levels. Salt marshes are used less than mudflats for feeding, but birds seek refuge and food amongst the marsh plants during high tides and storms.[26] The upper areas can also provide open space for the germination of many plant species such as the endangered Salt Marsh Bird's Beak *(Cordylanthus maritimus ssp. maritimus)*.

Many species are habitat-dependent upon wetlands or estuaries. For example, salt marshes provide dense patches of salt grass (*Distichlis spicata)* upon which the larvae of Wandering Skippers (*Panoquina errans*), a rare butterfly, depend upon.[27] Many wetland or estuary dependent species are threatened or endangered. One example is the endangered California Least Tern (*Sterna antillarum browni*) which is dependent upon the shallow waters of wetlands for food.[28] A low tide in a coastal estuary or wetland will bring flocks of shorebirds to the mudflats searching for invertebrates.[29]

Insects and mammals are responsible for many of the functions in an estuary or wetland food web. For example, insects are responsible for pollination, seed dispersal, aerating soils, and controlling herbivorous insects. Insects also serve as food for birds, small mammals, and other carnivores.[30] Mammals feed on plants, serve as prey, disperse seeds, disturb soil surface and open space for seedling establishment by burrowing.[31]

Pacific Flyway

Birds are the most conspicuous form of wildlife in California wetlands.[32] 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.[33] San Diego County attracts 475

different species of birds; more than any other county in the continental United States. It also has more endangered and threatened species than any other county.[34] These migrant birds will follow food supplies and visit many different sites along the coast in one season.[35]

A major impact associated with wetland loss or degradation is the loss of food web support for wetland-dependent plant and animal species. This can lead to decreases in biodiversity given that habitat diversity is related to the size of the wetland system. The impacts associated with loss of food web support and habitat will be discussed later in this document.

Undisturbed

There are no pristine wetland examples for southern California because most have been disturbed. Even in nearby Baja California, where coastal development is less extensive, there are few examples of undisturbed habitat.[36] Morro Bay is the last large relatively undeveloped estuary in southern California.[37]

San Diego County Estuaries and Wetlands

San Diego County has a total of 23 coastal wetlands. The National Wetlands Inventory (NWI) maps developed by the U.S. Fish and Wildlife Service in 1985 list wetland habitat types in southern California. The NWI maps estimate that San Diego County has 13,387 acres of subtidal or bay habitat, 1,869 acres of salt marsh, 2,055 acres of brackish and fresh marsh, 1,222 acres of impounded wetlands, 402 acres of intertidal channel habitats, and 79 acres of other wetland habitat types.[38] Individual fact sheets on San Diego County coastal wetlands are included in the appendix.

Southern California's coastal estuaries and wetlands differ from other estuaries and wetlands in the nation due to the high degree of variability in the hydrological processes which act upon the coast. During most of the year, they are marine-dominated systems, while during the winter rainy season, they may become completely freshwater systems.[39] In some years, there may be no stream flow; in other years, there may be major floods.[40] These wetlands also support fewer commercial and recreational fish and shellfish species compared to wetlands elsewhere in the United States (See chapter V: **Economic Valuation of San Diego County Coastal Wetlands**).

The Pacific Coast Highway, Interstate 5, and the railroad were constructed on land fill across several coastal wetlands. Water flow was reduced to small channels cut through these causeways. Thus, these wetlands became a series of smaller lagoons with restricted water flow.[41] As a result, many San Diego County lagoons are rarely open to the tide. Estuaries and wetlands lacking tidal flow can lose saline tolerant species such as Cordgrass (*Spartina foliosa*), annual pickleweed (*Salicornia bigelovii*) and fasswort (*Batis maritima*).[42] Another example is the endangered Salt Marsh Bird's Beak, found only in the Tijuana Estuary and the Sweetwater Marsh.[43]

ENDNOTES

1. WETLANDS: Characteristics and Boundaries (Prepublication copy), 1995. Page 55.

2. Status and Trends of California Wetlands, 1984. Page 9-10.

3. California Wetlands, 1988. Page 28.

4. California Wetlands, 1988. Page 28.

5. Status and Trends of California Wetlands, 1984. Page 11.

6. California Wetlands, 1988. Page 28.

7. Status and Trends of California Wetlands, 1984. Page 11.

8. California Wetlands, 1988. Page 29.

9. Status and Trends of California Wetlands, 1984. Page 12.

10. California Wetlands, 1988. Page 25.

11. Status and Trends of California Wetlands, 1984. Page 12.

12. Status and Trends of California Wetlands, 1984. Page 16-17.

13. Status and Trends of California Wetlands, 1984. Page 16-17.

14. Status and Trends of California Wetlands, 1984. Page 16-17.

15. The Ecology of Southern California Coastal Salt Marshes: A Community Profile, 1982.

16. Status and Trends of California Wetlands, 1984. Page 16-17.

17. Wetlands: Their Use and Regulation, 1984. Page 28.

18. National Wetlands Technical Council in Wetlands: Their Use and Regulation, 1984. Page 28.

19. Zedler and Beare in A Manual for Assessing Restored and Natural Coastal Wetlands, 1990. Page 9.

20. Wetlands: Their Use and Regulation, 1984. Page 28.

21. San Dieguito Lagoon Restoration Project Regional Coastal Lagoon Resources Summary, 1993. Page 5-6.

22. Wetlands: Their Use and Regulation, 1984. Page 28.

23. Wetlands: Their Use and Regulation, 1984. Page 28.

24. Personal Communication with Libby Lucas, Coastal Waters Subcommittee member.

25. A Manual for Assessing Restored and Natural Coastal Wetlands, 1990. Page 6-7.

26. A Manual for Assessing Restored and Natural Coastal Wetlands, 1990. Page 6-7.

27. A Manual for Assessing Restored and Natural Coastal Wetlands, 1990. Page 6-7.

28. A Manual for Assessing Restored and Natural Coastal Wetlands, 1990. Page 7.

29. The Coastal Wetlands of San Diego County, 1989.

30. A Manual for Assessing Restored and Natural Coastal Wetlands, 1990. Page 65.

31. Cox and Zedler in The Ecology of Southern California Coastal Salt Marshes: A Community Profile, 1990. Page 90.

32. Status and Trends of California Wetlands, 1984. Page 19.

33. Status and Trends of California Wetlands, 1984. Page 19.

34. Field Check List of Birds in San Diego County, 1990.

35. Status and Trends of California Wetlands, 1984.

36. The Coastal Wetlands of San Diego County, 1989.

37. Saving Wetlands: A Citizens' Guide for Action in California, 1992. Page 26.

38. A Manual for Assessing Restored and Natural Coastal Wetlands, 1990. Page 14.

39. Personal communication with Joy Zedler, SDSU.

40. Personal communication with Joy Zedler, SDSU.

41. The Coastal Wetlands of San Diego County, 1989. Page 11-12.

42. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 164.

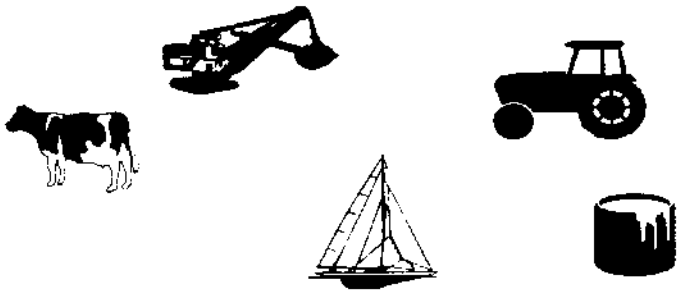
43. The Ecology of Southern California Coastal Salt Marshes: A Community Profile, 1982. Page 38.

III. NONPOINT SOURCE POLLUTANTS AND THEIR IMPACTS ON WETLANDS WITH SPECIAL REFERENCE TO AGRICULTURAL NONPOINT SOURCE POLLUTION

Types of Nonpoint Source Pollutants

Pollutants from agricultural, urban, forestry, marina and boating sources include:

- ♦ Sediments and erosion
- ♦ Animal waste
- ♦ Pesticides
- ♦ Metals
- ♦ Hydrocarbons
- ♦ Salts
- ♦ Organic matter and
- ♦ Pathogens.[1]



The pollutants and their respective sources are shown in Table 1.

Table 1. Pollutants and Sources of Nonpoint Source Pollution

	Agriculture	Urban	Forestry	Marinas and Boating
Sediments / Erosion	X	X	X	X
Nutrients	X	X	X	X
Animal Waste	X			
Pesticide	X		X	
Metals		X		X
Hydrocarbons		X		X
Salts	X	X		
Organic Matter	X	X	X	X
Pathogens	X	X		X

Source: *Guidance Specifying Management Measures For Sources Of Nonpoint Pollution In Coastal Waters*, 1993.

Impacts to Wetlands

The impacts associated with the aforementioned pollutants are summarized below:

Sediment / Erosion - Increases in turbidity, reduced light penetration, reduction of water depth, and decreases in submerged aquatic vegetation. Increased turbidity hinders sight-dependent predators and impairs respiration of fish and aquatic invertebrates.

Nutrients - Eutrophication and depressed dissolved oxygen levels in aquatic habitats. These conditions can cause fish kills, surface algae scum, and destruction of bottom habitat.

Animal Waste - General fouling of affected water bodies, and depressed dissolved oxygen levels. May result in eutrophication of water body and pose health risk to people by exposure to animal diseases and pathogens.

Pesticides - May accumulate in aquatic ecosystems causing the impairment of ground and surface water, the reduction of aquatic vegetation, elimination of food sources for higher organisms, and improper development in young fish.

Metals - Toxic effects on aquatic life. May lead to contamination of ground-water supplies and may accumulate in fish and shellfish which can pass toxins to consumers.

Hydrocarbons - Compounds from petroleum products are toxic to aquatic life. May cause fish kills and destruction of bottom habitat.

Salts - Accumulation in soils may cause soil dispersion, breakdown, and toxicity. May alter freshwater ecosystem and inhibit freshwater or anadromous fish, i.e., salmon.

Organic Matter - Decomposition of organic matter by microorganisms may deplete dissolved oxygen levels in water bodies leading to eutrophication and fish kills.

Pathogens - The presence of pathogens (bacteria, viruses) may result in water body impairment such as closed beaches, contaminated drinking water supplies, and shellfish bed closings.[2]

Agricultural Nonpoint Source Pollution

Because agricultural activities are widespread, agriculture is considered the largest contributor of nonpoint source pollution (NPS) nationwide.[3] Agricultural activities are the primary pollutant source for 64% of impacted river miles, 57% of impacted lake acres, and 19% of impacted estuary square miles.[4]

The major sources of agricultural NPS that affect coastal water quality are: erosion from cropland; confined animal facilities; the application of nutrients to cropland; the application of pesticides to cropland; land used for grazing; and irrigation of cropland.[5] However, the nature and the extent of the impact on water quality varies according to the activity, characteristics of water bodies, and local conditions.[6] The NPS pollutants produced from these activities are nutrients, sediment, animal wastes, salts, bacteria and viruses, and pesticides.[7]

Erosion and Sediment

Sediments may erode from the following types of agricultural lands: dry cropland, irrigated cropland, range and pasture land; orchards; specialty crop production; and nursery crop production.[8] Two types of erosion associated with agriculture produce sediment: (1) sheet and rill erosion, and (2) gully erosion.[9]

Runoff water from these agricultural lands may transport the following types of pollutants:

- Sediment and particulate organic solids
- Particulate bound nutrient, chemicals, metals, and soluble nutrients from fertilizer and pesticides or the like found naturally within the soil
- Salts
- Bacteria, viruses and other microorganisms[10]

Confined Animal Facilities

Confined animal facilities consist of areas used to grow or house animals, equipment and supplies for production, processing and storage of products, the land near the buildings that the animals have access to that does not support vegetative cover; manure and runoff storage areas; and silage storage areas.[11]

Several types of pollutants found in manure and associated with bedding material may be transported by runoff water from confined animal facilities and process wastewater. These pollutants include:

- Nitrogen, phosphorous and many other major and minor nutrients or other deleterious materials
- Salts
- Bacteria, viruses and other microorganisms
- Organic solids
- Oxygen demanding substances
- Sediments[12]

Application of Nutrients

Although nitrogen is a naturally occurring nutrient in soils, it is added to crops to increase productivity.[13] Nutrients can be applied to cropland by commercial fertilizer, animal manure, municipal and/or industrial treatment plant sludge or effluent, irrigation water, and atmospheric deposition of nutrients such as nitrogen and sulphur.[14]

Surface water runoff from nutrient enriched lands can transport the following types of pollutants:

- Particulate bound nutrient, chemicals, metals, and soluble nutrients from fertilizer and pesticides or the like found naturally within the soil;
- Sediment, particulate organic solids, oxygen demanding material
- Salts
- Bacteria, viruses and other microorganisms [15]

Application of Pesticides

Pesticides include any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest or for use as a plant regulator, defoliant, or desiccant. Pesticides can enter ground and surface water in dissolved form or bound to eroded soil particles.

The major source of contamination from pesticide use is direct application. Other sources of pesticide contamination are atmospheric deposition, spray drift during the application process, misuse, spills, leaks, and discharges that may be associated with pesticide storage, handling, and waste disposal.[16]

Land Used for Grazing

Runoff from agricultural pasture lands and range lands may transport the following types of pollutants:

- Sediment and particulate organic solids
- Particulate bound nutrient, chemicals, metals, and soluble nutrients from fertilizer and pesticides or the like found naturally within the soil
- Salts
- Bacteria, viruses and other microorganisms [17]

Irrigation Water

Irrigated agricultural lands include cropland, pasture land, orchards, specialty crop production, and nursery crop production Runoff water and leachate from irrigated land may transport the following types of pollutants:

- Sediment and particulate organic solids
- Particulate bound nutrient, chemicals, metals, and soluble nutrients from fertilizer and pesticides or the like found naturally within the soil
- Bacteria, viruses and other microorganisms [18]

ENDNOTES

1. "g" Guidance, 1993. Agriculture - pp. 2-3 through 2-9; Forestry - page 3-4; Urban - page 4-7; Marinas and Boating - pp. 5-3 through 5-6.

2. "g" Guidance, 1993. Agriculture - pp. 2-3 through 2-9; Forestry - page 3-4; Urban - page 4-7; Marinas and Boating - pp. 5-3 through 5-6.

3. The States' Nonpoint Source Assessment, 1985. Page 5.

4. The States' Nonpoint Source Assessment, 1985. Page 5.

5. "g" Guidance, 1993. Page 2-2.

6. The States' Nonpoint Source Assessment, 1985. Page 5.

7. "g" Guidance, 1993. Pages 2-3 through 2-9.

8. "g" Guidance, 1993. Page 2-12.

9. "g" Guidance, 1993. Page 2-6.

10. "g" Guidance, 1993. Page 2-4.

11. "g" Guidance, 1993. Page 2-34.

12. "g" Guidance, 1993. Page 2-7.

13. "g" Guidance, 1993. Page 2-5.

14. "g" Guidance, 1993. Page 2-3, 2-4.

15. "g" Guidance, 1993. Page 2-4.

16. "g" Guidance, 1993. Page 2-9.

17. "g" Guidance, 1993. Page 2-89.

18. "g" Guidance, 1993. Page 2-89.

IV. STATUS OF COASTAL ESTUARIES AND WETLANDS IN SOUTHERN CALIFORNIA AND SAN DIEGO COUNTY

Original Acreage

At the time of colonization of the United States, estimates show there were abut 215 million acres of wetlands.[1] When California became a state in 1850, there were approximately five million acres of wetlands in California.[2] Four million of these were located in the Central Valley and the Sacramento-San Joaquin Delta. The historic record for southern California coastal wetlands and San Diego County has not been well documented.[3] A total of 53,000 acres are estimated as the original south coast acreage.

Percentage Remaining

In 1850, there were 28 estuaries and wetlands along the south coast.[4] The history and distribution of wetland losses in California correspond to the history and settlement patterns in the state.[5] Reclamation of marsh and swamplands for agriculture in the 19th and 20th centuries accounts for the largest area loss of wetlands statewide.[6]

In 1982, estimates indicated that only 450,000 acres of wetlands remained in California, a 91% loss.[7] South coast wetlands have been reduced by 75% to 13,000 acres. Los Angeles and Orange Counties alone have lost 90% of their wetlands.[8] As south coast developable land decreases and the population continues to increase, there is extreme pressure to develop coastal areas for urban uses, recreational marinas, and port expansions.

In San Diego Bay, the largest estuary along the San Diego coastline, 90% of the original salt marshes and 50% of the original mudflats have been filled or dredged for port and urban development.[9]

Filling, construction and agricultural practices have reduced the acreage of vernal pools in San Diego County by 90%.[10]

Percentage Remaining in San Diego County

Around 1900, there were 28 sizable estuaries between Morro Bay, California and Ensenada, Mexico.[11] Since 1900, 15 of the 28 original estuaries have been modified either slightly or moderately, ten have been altered drastically and three have been destroyed. [12] Estimates indicate that San Diego County riparian wetlands have been reduced by as much as 40% in the past decade alone.[13]

San Diego County has a total of 23 coastal wetlands and estuaries. [1] The National Wetlands Inventory maps, based upon the U.S. Fish and Wildlife Service data from 1985, list wetland habitat types and acreage in southern California. Estimates for San Diego County include 13,387 acres of subtidal or bay habitat, 1,869 acres of salt marsh, 2,055 acres of brackish and fresh marsh, 1,222 acres of impounded wetlands,

---

[1] See map of San Diego County Coastal Wetlands in Appendix

402 acres of intertidal channel habitats, and 79 acres of other wetland habitat types. [14]

Private Lands

A total of 74% of all wetlands in the contiguous 48 states are in private ownership.[15]

Most of the remaining wetlands in California are under private ownership[16]. Many changes have permanently eliminated much wetland habitat. Increasing economic pressure to intensify land use will continue to threaten California's remaining wetlands.

Table 2. California Wetland Losses

HABITAT TYPE	YEAR	LOSS ESTIMATE	CAUSE OF LOSS
Riparian Wetlands California	1988	California: 95% San Diego County: 40 % in the last decade alone	Agricultural conversion, urban and industrial development, flood control activities, and hydroelectric development and operation
Freshwater Marshes California	1988	Presumed losses have been well in excess of 90%. Precise magnitude will never be known	N/A
Salt and Brackish Marshes California	1988	80%	Agricultural, commercial, residential, and port-related activities and development in Southern California: Rapid erosion in coastal watersheds and accelerated sedimentation rates in coastal lagoons from rapid population growth
Wetland Flats California	1988	Not possible to determine	N/A

(Source: *California Wetlands*, 1988) [17]

ENDNOTES

1. Saving Wetlands: A Citizens' Guide for Action in California, 1992. Page 1.

2. California Wetlands, 1988. Page 19.

3. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 159.

4. Saving Wetlands: A Citizens' Guide for Action in California, 1992. Page 5.

5. California Wetlands, 1988. Page 18.

6. California Wetlands, 1988. Page 18.

7. California Wetlands, 1988. Page 19.

8. Saving Wetlands: A Citizens' Guide for Action in California, 1992. Page 8.

9. Saving Wetlands: A Citizens' Guide for Action in California, 1992. Page 26.

10. Saving Wetlands: A Citizens' Guide for Action in California, 1992. Page 13.

11. Orme in Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 159.

12. Speth and MacDonald in Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 159.

13. California Wetlands, 1988. Page 26.

14. A Manual For Assessing Natural And Restored Coastal Wetlands, 1990. Page 14.

15. Saving Wetlands: A Citizens' Guide for Action in California, 1992. Page 1.

16. California Wetlands, 1988. Page18.

17. California Wetlands, 1988. Pages 25-30.

V. ECONOMIC VALUATION OF SAN DIEGO COUNTY COASTAL WETLANDS

Introduction

In addition to ecological values, wetlands also have economic values. Wetland values, in terms of dollars per acre, are generated by measuring ecological functions, effects on property values, contribution to fisheries, and recreational values. These values aid property owners, planners, and developers in determining the cost of wetland loss, alteration and conservation. Wetland valuation also includes non-measurable values such as quality of life, erosion control, and recreational fisheries.

The Campaign to Save California Wetlands calculated the value of benefits provided by California's wetlands. Based upon studies in the past 20 years, the permanent value of protecting them is estimated at $124.5 billion. The loss of over 90% of California's original wetlands places even greater value on the remaining 454,000 acres.[1]

The U.S. Fish and Wildlife Service prepared maps of southern California coastal wetlands based on aerial photography from 1985. Although comparative field based studies have shown these estimates to be low, they are used in the National Wetlands Inventory (NWI). NWI lists the following wetland types and acreage for San Diego County.[2]

♦ Subtidal or bay habitat	13,387 ac.
♦ Salt marsh	1,869 ac.
♦ Brackish and fresh marsh	2,055 ac.
♦ Impounded wetlands	1,222 ac.
♦ Intertidal channels	402 ac.
♦ Other wetland types	79 ac.
Total county wetland acreage	19,014 ac.

A 1989 publication by the California State Coastal Conservancy provides a comparative estimate for San Diego County wetland acreage. **Table 3** summarizes wetland location, ownership, and acreage listed in this publication. Acreages are shown for the same wetland types described in the National Wetlands Inventory.[3]

An economic valuation of wetland functions and contributions for the 23 coastal wetlands and estuaries in San Diego County will place an accurate market value on these natural resources. This value will contain a low and high figure based upon the total wetland acreage estimates provided by the National Wetlands Inventory (low) and the Coastal Conservancy publication (high). The following are economic indicators of wetland values in San Diego County:

- Property values for those areas adjacent to or near wetlands Wetlands affect property values aesthetically and functionally, i.e., vistas and flood control
- Water quality and supply
- Wildlife habitat
- Erosion control
- Aquaculture
- Quality of life/employee productivity
- Outdoor activity and recreational opportunities provided by wetland areas or wildlife
- Commercial fisheries productivity
- Recreational fisheries productivity

Table 3. San Diego County Coastal Wetland Ownership and Acreage

Wetland	Ownership	Acreage
Agua Hedionda Lagoon	SDG&E, and Cal Communities Inc., and private	794
Batiquitos Lagoon	State Lands Comm., Dept. Of Fish and Game, and private	1130
Buena Vista	Dept. Of Fish and Game and private	549
Los Penasquitos Lagoon	Dept. Of Parks and Rec., Coastal Conservancy, City of SD, and SDG&E	1225
Mission Bay	City of SD	3751
San Diego Bay	State Lands Comm., SD Port District, U.S. Govt., U.S. Fish and Wildlife Service, and private	13,201
San Dieguito Lagoon	Dept. Of Fish and Game, City of SD, and 22nd District Agricultural Association	909
San Elijo Lagoon	Dept. Of Fish and Game, San Elijo Lagoon Foundation, and private	1877
San Luis Rey River	City of Oceanside and private	211
Santa Margarita River and Estuary	U.S. Marine Corps	1286
Tijuana Estuary	Cities of SD and Imperial Beach, U.S. Fish and Wildlife Service, and private	2762
Total wetland acreage		27,695

(Source: *The Coastal Wetlands of San Diego County*, 1989)

Key: SD - San Diego
SDG&E - San Diego Gas and Electric,
State Lands Comm. - California State Lands Commission
Dept. - California Department of...
Rec. - Recreation
Coastal Conservancy - California State Coastal Conservancy

Property Values

Wetlands provide several benefits to property owners with land abutting wetland areas or nearby. Wetland values to neighboring property owners include flood control ($4,650/acre) and enhanced property value due to "vistas" (5% to 11% more, depending upon proximity to the wetland and other factors). [3]

Wetlands provide flood control by absorbing and detaining excess flows of water associated with storms and winter rains. Wetland vegetation provides an initial buffer to flood waters by reducing their velocity and damage potential. Studies conducted in flood plains by the U.S. Army Corps of Engineers determined that wetlands provide better protection against flood waters than reservoir and dam systems. A dollar amount may be assigned to wetland acreage for their flood control value, based on the amount of damage avoided when the wetland is left intact. The U.S. Army Corps of Engineers estimates this value to be $4,650/acre of California wetland.[4]

Aesthetic values or values gained from property with wetland vistas translate into economic value via higher tax revenues to local governments and increased sales by businesses (restaurants, cafes, etc.) with views of natural areas or wetlands. The proximity of these properties to open space and water, i.e., wetlands, can increase their value by 5% to 11%. Some studies show properties abutting wetlands worth an average of 17% more than comparable properties elsewhere.[5]

Water Quality and Supply

Wetlands act as a recharge mechanism for groundwater systems and aquifers, providing water supplies for population centers and agriculture. A water supply value for wetlands may be shown as the difference between the cost of water from wetland wells and the next cheapest alternative. An estimate for this value is $6,800/acre.[6]

Wetland environments also filter and treat nutrients, bacteria, and some toxic chemicals from agricultural and urban runoff. The best estimate for California of this wetland value is $6,600/acre.[7]

Wildlife Habitat

Wetlands can also be assigned an economic value due to their high biological productivity. Wetlands are unique habitats at the interface between marine and land ecosystems. In semi-arid areas, like San Diego County, wetlands provide an important water source for local wildlife. The wide variety of plant and animal life provides food, habitat, and protection for many aquatic and terrestrial species, including endangered and rare species, such as the California Least Tern. Wetlands provide a cost free habitat for these species that otherwise would have to be protected in a paid program. A survey indicating willingness to pay to preserve California wetland habitat found a value of $3,337/acre.[8]

Erosion Control

Wetland vegetation and root systems play a valuable role as shore and beach stabilizing agents, and reduce property loss in high-water areas. Although wetland erosion and sedimentation functions are considerable, no economic study has been conducted to estimate their value in California.[9]

Aquaculture

Carlsbad Aquafarms, a for-profit aquaculture business, produces mussels, abalone and scallops in the outer basin of Agua Hedionda Lagoon. The owner, John Davis, estimates the value of production and assets at $500,000. Currently, he must depurate the shellfish (purge them of bacteria that indicate pathogens may be present) before they can be sold. If bacteria levels in the lagoon were lower, he could avoid depuration costs and expand his business to other aquaculture products.[10]

Hubbs-Sea World Research Institute, a not-for-profit organization, is opening a hatchery for white seabass and other California marine species in Agua Hedionda Lagoon. This hatchery program will conduct enhancement studies to test the feasibility of stocking lagoons with juvenile fish.[11]

CalBio Marine, a firm producing marine species that yield cancer treatments, and MEC, an environmental consulting firm, have indicated that concerns about sediment, pesticide, and low salinity from runoff prevent them from lowering business costs by drawing filtered water from the lagoon.[12]

Specific economic values associated with aquaculture and the potential for additional aquaculture are not available, because they are proprietary or have not been documented. However, aquaculture in Agua Hedionda Lagoon is clearly providing economic benefits and there is the potential to stimulate further economic growth if pollutant levels in this and other lagoons are reduced.

Quality of Life / Employee Productivity

Natural areas consisting of open space and water, such as wetlands, are important in determining a city's quality of life. Quality of life can be defined as convenient access to natural settings, and recreational and cultural opportunities in open spaces. Wetlands provide these quality of life attributes as discussed in the next section.

San Diego County's ability to attract new business is vital. Quality of life plays a major role in attracting new businesses. Natural areas are important to corporations because they provide relaxation and exercise benefits to employees. After access to markets and availability of skilled labor, quality of life is the third most important factor in corporate location decisions. Office sites located adjacent to natural settings are likely to be more attractive to prospective tenants than the typical urban landscape. Companies also recognize the benefits of healthy employees that use nearby natural settings for exercise. Studies have shown that companies with healthy employees pay 14% less in medical claims and 30% fewer hospital days.[13]

Outdoor Activity and Recreational Opportunities

Californians spend more than $30 billion per year on recreation and leisure. [14] While it may be difficult to determine the extent of recreational use in wetlands, many activities are pursued along these areas.

Recreational opportunities provided by wetlands are the most visible element of wetland values. Wetlands such as Agua Hedionda Lagoon, Torrey Pines State Preserve (Los Penasquitos Lagoon) and the San Elijo Lagoon attract numerous visitors, especially on the weekends. Popular activities include jet skiing, cycling, hiking, bird watching, and fishing. This recreational and educational value is enjoyed by people from all areas of San Diego County, not just nearby property owners. Wetlands also attract tourists who generate revenue for local restaurants and shops. Using the travel cost method, Stol et al. (1989) estimated the recreational value of wetlands at $347/acre.[15]

Wildlife viewing is the most common form of wildlife related recreation in California. Wetlands serve as breeding and nesting grounds for many migratory birds. Birdwatchers alone contributed $27 million dollars to the state's economy in 1987. [16] Wetlands also serve as educational and interpretive classrooms for school children. One example is the California Department of Fish and Game Wildlands Program, in which over 93,000 people participated in educational programs and wildlife photography during its first year. [17]

In San Diego County, there are several parks and natural reserves containing wetlands that conduct tours, and educational / interpretive programs. Some of these areas are listed below:

1. San Elijo Lagoon Ecological Reserve
   40,000-50,000 visitors/year
   900 acres

2. Tijuana River National Estuary
   10,000 visitors/year
   2,500 acres

3. Chula Vista Nature Center
   50,000-60,000 visitors/year
   316 acres

Programs are also currently being designed for the San Dieguito Lagoon which is the focus of a restoration project by Southern California Edison and the Joint Powers Authority of San Diego. [18]

Commercial Fisheries

Commercial fishing represents another element of wetland value. As a major statewide industry, the wholesale value of fish caught in California fisheries in 1990 was over $126 million. Wetlands serve an important role in the productivity of the state's fisheries by providing habitat, food, and nursery grounds for several fish species. It is estimated that 71% of the value of commercially harvested fish consists of species dependent upon wetlands during some stage of their development. [19] Based upon the value added to the California commercial fisheries, the median estimate of wetlands is $199/acre. [20]

In San Diego County, the California Halibut (*Paralichthys californicus*) is the only major commercial species directly dependent upon wetlands. In 1992, over 22,000 lbs. of halibut were landed commercially in San Diego for a value of $53,181. Commercial species that are indirectly dependent upon wetlands include the White Seabass (*Atractoscion nobilis*), with over 12,000 lbs. landed in San Diego in 1992 for a value of $25,998.[21] In addition, many valuable commercial fish feed on non-commercial, wetland dependent species. [22] These forage fish include:

- arrow goby (*Clevelandia ios*)
- shadow goby(*Quietula y-cauda)*
- cheekspot goby *(Ilypnus gilberti)*
- longjaw mudsucker *(Gillicthys mirabilis)*
- deepbody anchovy
- (*Anchoa compressa*)
- slough anchovy *(A. delicatissima)*
- California killfish *(Fundulus parvipinnis)*

Recreational Fisheries

Wetlands also contribute to the state's recreational fisheries industry. In 1989, coastal and non coastal anglers spent $536 million on saltwater fishing in southern California. San Diego County residents contributed $75,040,000 to this total. [23]

One aspect of the recreational fisheries industry is the commercial passenger fishing vessel (CPFV) fleet. The following wetland dependent species were landed aboard CPFVs in San Diego County and south Orange County in 1989.

Species	CPFV landings in 1989
Barred Sandbass	129,176
White Croaker	4,899
White Seabass	495
California Halibut	868

Recreational species that can be found in estuaries, bays, tidal creeks and lagoons include the Spotted Sandbass (*Paralabrax maculatofasciatus*), and the White Croaker (*Genyonemus lineatus*). Other recreational species that are wetland dependent, but typically found outside of wetland areas include: [24]

Barred Sand Bass (*Paralabrax nebulifer*)
Yellowfin Croaker (*Umbrina roncador*)
Spotfin Croaker (*Roncador stearnsi*)
Diamond Turbot (*Hypspsetta guttulata*)
Shiner Surfperch (*Cymatogaster aggregata*)

In San Diego County, four species account for 74% of the total catch by recreational anglers. These species were caught from piers and shorelines in four sampling areas: Shelter Island, Harbor Island, Embarcadero/Coronado Bridge, and the Otay River. [25]

Species	% of Total Catch
Pacific Mackerel	38.8%
California Lizardfish	19.4%
Barred Sand Bass	10.2%
Spotted Sand Bass	4.2%

This data indicates that wetlands are important for over 14% (barred and spotted sandbasses) of the recreational fish catch in San Diego County.

The San Diego County Department of Health Services determined the amount of fish consumed by recreational anglers to be 31.2 grams per person per day. Consumption patterns for specific ethnic groups are below. These rates represent what percentage of San Diego County anglers who eat fish belong to which ethnic group:

Ethnicity	% of total consumers
Filipino	32.6%
Asian	25.6%
Caucasian	24.0%
Hispanic	8.9%
Black	4.7%

This data can be helpful in determining the contribution of wetland associated, recreational fish species that are part of diets of anglers in San Diego County.[19]

Summary of Measurable Economic Values

The documented economic values afforded to San Diego County by its wetlands are summarized in **Table 4**. The variance between the lower and upper values is due to the difference in estimates by the National Wetlands Inventory (19,014 ac.) and the Coastal Conservancy (27,695 ac.) for wetland acreage in San Diego County. The wetland values themselves are based upon the best available data for California, or the nation in lieu of California data. These values also vary depending upon wetland type [saltmarsh, tidal creek, freshwater, etc.], and the condition of the wetland, i.e., pristine, altered, or degraded.

Summary of Non-measurable Values

Some wetland values, such as enhanced property values due to vistas, aquaculture, quality of life, erosion control and recreational fisheries cannot be calculated as a per acre value. Although these values are considerable, they are non-quantifiable, and therefore cannot be assigned a monetary value. A total valuation of wetland functions should include the addition of these non-measurable values.

Conclusions

San Diego County has not had an economic study to fully assess the value of its wetlands. Values for California and for the nation provide the best data for estimating the economic contribution of San Diego County wetlands. The annual, measurable contribution of San Diego County wetlands is estimated between $417 million to $607 million. Non-measurable wetland values can be expected to increase the total considerably.

Table 4. San Diego County Coastal Wetland Values

Annual Values (Acre/1990$)	**SD Low Value 19,014 ac.**	**SD High Value 27,695 ac.**
Flood Control $4,650/ac.	$ 88,415,100	$128,781,750
Water Supply $6,800/ac.	$ 129,295,200	$188,326,000
Water Quality $6,600/ac.	$ 125,492,400	$182,787,000
Wildlife Habitat $3,337/ac.	$ 63,449,718	$ 92,418,215
Recreation $ 347/ac.	$ 6,597,858	$ 9,610,165
Commercial Fisheries $ 199/ac.	$ 3,783,786	$ 5,511,305
Total measurable value for SD County Wetlands	$ 417,034,062	$607,434,435

ENDNOTES

1. The Value of California Wetlands: An Analysis of their Economic Benefits, 1992. Page 14.

2. A Manual For Assessing Natural And Restored Coastal Wetlands, 1990. Page 14.

3. The Coastal Wetlands of San Diego County, 1989. Pages 38 - 63.

4. The Value of California Wetlands: An Analysis of their Economic Benefits.1992, Pages 5, 13.

5. Economic Valuation of Wetlands, 1991. Page 34.

6. The Value of California Wetlands: An Analysis of their Economic Benefits, 1992. Page 6

7. The Value of California Wetlands: An Analysis of their Economic Benefits,1992. Page 8.

8. The Value of California Wetlands: An Analysis of their Economic Benefits,1992. Page 12.

9. The Value of California Wetlands: An Analysis of their Economic Benefits,1992. Page 7.

10. John Davis, Carlsbad Aquafarms. Personal communication with Leigh Johnson on March 29, 1995.

11. Don Kent, Hubbs Sea World Research Institute. Personal communication with Clay Clifton on April 4, 1995.

12. Dr. Janice Thompson, CalBioMarine Marine; and Skip Newton MEC. Personal communication with Leigh Johnson on January 27, 1993.

13. Economic Impacts of Protecting Rivers, Trails and Greenway Corridors. A Resource Book, 1990. Page 6-5.

14. Economic Impacts of Protecting Rivers, Trails and Greenway Corridors. A Resource Book, 1990. Page 2-4.

15. The Value of California Wetlands: An Analysis of their Economic Benefits,1992. Page 9.

16. Economic Impacts of Protecting Rivers, Trails and Greenway Corridors. A Resource Book, 1990. Page 2-7.

17. A Bridge to the Future: The Wildlife Diversity Funding Initiative - A Needs Assessment for the Fish and Wildlife Conservation Act, 1991. Page 4.

18. Personal communications with Fred Andrews, Park Ranger for the Tijuana River National Estuary Research Reserve; Greg Dennis, Director of the San Elijo Lagoon Ecological Reserve; Barbara Moore, Director of the Chula Vista Nature Center; and Vicki Touchstone, Director for the San Dieguito River Valley Regional Open Space Park, 1995.

19. Coastal Degradation and Fish Population Losses, 1991. Cited in Allen et. al., 1992.

20. The Value of California Wetlands: An Analysis of their Economic Benefits,1992. Page 11.

21. Statistics for Fish, Shellfish, and Other - Poundage and Values of Landings by Port, San Diego Area, 1992.

22. Personal communication with Bob Hoffman, Coastal Biologist for the National Marine Fisheries Service, NOAA, 1995.

23. Results of the Southern California Sportfish Economic Survey, 1991. Page 9.

24. Bob Hoffman, Coastal Biologist for the National Marine Fisheries Service, NOAA, 1995, personal communication.

25. San Diego Bay Health Risk Study, 1990. Page xvi.

VI. GLOSSARY

ALGAE
Marine or freshwater plants, including phytoplankton and seaweeds.[1]

ANAEROBIC
Condition in which oxygen is excluded, so that organisms that depend on the presence of oxygen cannot survive. Anaerobic bacteria can live under these conditions.[1]

AQUACULTURE
Cultivation or propagation of water-dwelling organisms.[1]

BEACH
Seaward portion of the shore (limits are approximately the highest and lowest water levels.[2]

BRACKISH[2,3]
A mixture of freshwater and saltwater typically found in estuarine areas. The term should not be applied to inland waters.

CHANNEL[2]
An open conduit, either natural or artificial, which periodically or continuously contains moving water, or which forms a connecting link between two bodies of standing water.

DELTA[1]
Alluvial deposit formed at the mouth of a stream, tidal inlet, or river.

DETRITUS[2]
Small particles of organic matter, largely derived from the breakdown of dead vegetation.

DIKE[3]
A wall or mound built around a low-lying area to prevent flooding.

DRAINAGE BASIN OR WATERSHED[3]
The area within which all surface water runoff will normally gather in a single tributary, stream, river, conduit, or other water body. This area is determined by topography that forms drainage between watersheds.

ECOSYSTEM[3]
The system of interrelationships among plants and animals and their environment.

ENDANGERED[3]
A species that is nearing extinction. Existence of the organism and its environment are in immediate jeopardy. Distribution is usually restricted to highly specific habitats.

ESTUARY[1]
A semienclosed, tidal body of saline water (seawater measurably diluted by freshwater[4]) with free connection to the sea, commonly the seaward end of a river valley.

FLOODPLAIN[2]
A flat expanse of land bordering a river, or an historic river.

FOOD WEB[1]
Food relationships in an ecosystem, including production, consumption, and decomposition, and the energy cycle.

FRESH[2]
Term applied to water with salinity less than 0.5 thousandths (or 0.5 ppt) dissolved salts.

GROUND WATER[3]
Water that penetrates the Earth's surface from precipitation and by infiltration from streams, ponds, and lakes.

HABITAT[3]
The range of environmental factors at a particular location supporting specific plant and animal communities.

HYDRIC[5]
Characterized by, relating to, or requiring an abundance of moisture.

HYDROPHYTE[2]
Any plant growing in water or on a substrate that is at least periodically deficient in oxygen as a result of high water content (plants typically found in wet habitats).

INTERTIDAL ZONE (littoral zone)[1]
Zone between mean high-water and mean low-water levels.

INVERTEBRATES[2]
Organisms that lack a spinal column; includes mollusks, crustaceans, insects, starfish, jellyfish, sponges and worms.

JETTY[1]
A structure built to influence tidal currents, to maintain channel depths, or to protect the entrance to a harbor or river.

LAGOON[1]
Shallow saltwater sound, pond, or lake, generally separated from the open ocean by a barrier beach.

LITTORAL DRIFT[1]
Sand moved parallel to the shore by wave and current action.

MARSH[1,3]
A common term applied to describe treeless wetlands characterized by shallow water and abundant emergent, floating, and submerged wetland flora. Typically found in shallow basins, on lake margins, along low-gradient rivers and in lower-energy tidal areas. Area of soft, wet land. Flat land periodically flooded by saltwater is called a **salt marsh**.

MUDFLAT[3]
Bare, flat bottoms of lakes, rivers, and estuaries, which are largely filled with organic deposits, and periodically exposed by a lowering of the water table.

RECHARGE (ground water)[3]
The percolation of surface water to the water table.

RIPARIAN[2,3]
Habitats adjacent to lakes, rivers and streams.

SALINE[2]
General term for waters containing various dissolved salts. We restrict the term to inland waters where the concentrations of the salts often vary. The term haline is applied to coastal waters where the salts are roughly in the same proportion as found in undiluted sea water.

SALINITY[1,2]
Measure of the quantity of dissolved salts in water. Formally defined as the total amount of dissolved solids in seawater in parts per thousand (ppt) by weight when all the carbonate has been converted to oxide, the bromide and iodide to chloride, and all organic matter is completely oxidized.

SEDIMENT[1]
Particulate organic and inorganic matter that accumulates in a loose, unconsolidated form. It may be chemically precipitated from solution, secreted by organisms, or transported from land by air, ice, wind, or water and deposited.

SEDIMENTATION[1]
Process of breakup and separation of particles from the parent rock, their transportation, deposition, and consolidation into another rock.

SLOUGH[3]
A small body of stagnant water, or a small marshy or swampy tract of land.

SWAMP[3]
A forested wetland.

THREATENED[3]
A species that is nearing endangered status.

TIDAL PRISM[2]
The volume of water that is moved in or out of an embayment with each tide.

WATERSHED[3]
The region drained by or contributing water to a stream, lake, or other body of water.

WATER TABLE[2,3]
The upper surface of ground water zone of saturation. No water table exists where that surface is formed by an impermeable body.

WETLANDS
Transitional between water and land environments. Their boundaries vary with topography, with flood and drought cycles, with high and low tides, and with the season.[6] This is a broad term, covering a variety of habitats and is discussed in more detail in chapter II: **Wetland Definitions and Ecology**.

ENDNOTES

1. Oceanography: A View of the Earth, 1987. Pages 383-396.

2. Saving Wetlands: A Citizens' Guide for Action in California, 1992. Glossary, pages 1-2.

3. Wetlands: Their Use and Regulation, 1984. Pages 199-201.

4. Personal Communication with Greig Peters, RWQCB.

5. Webster's New Collegiate Dictionary, 1979.

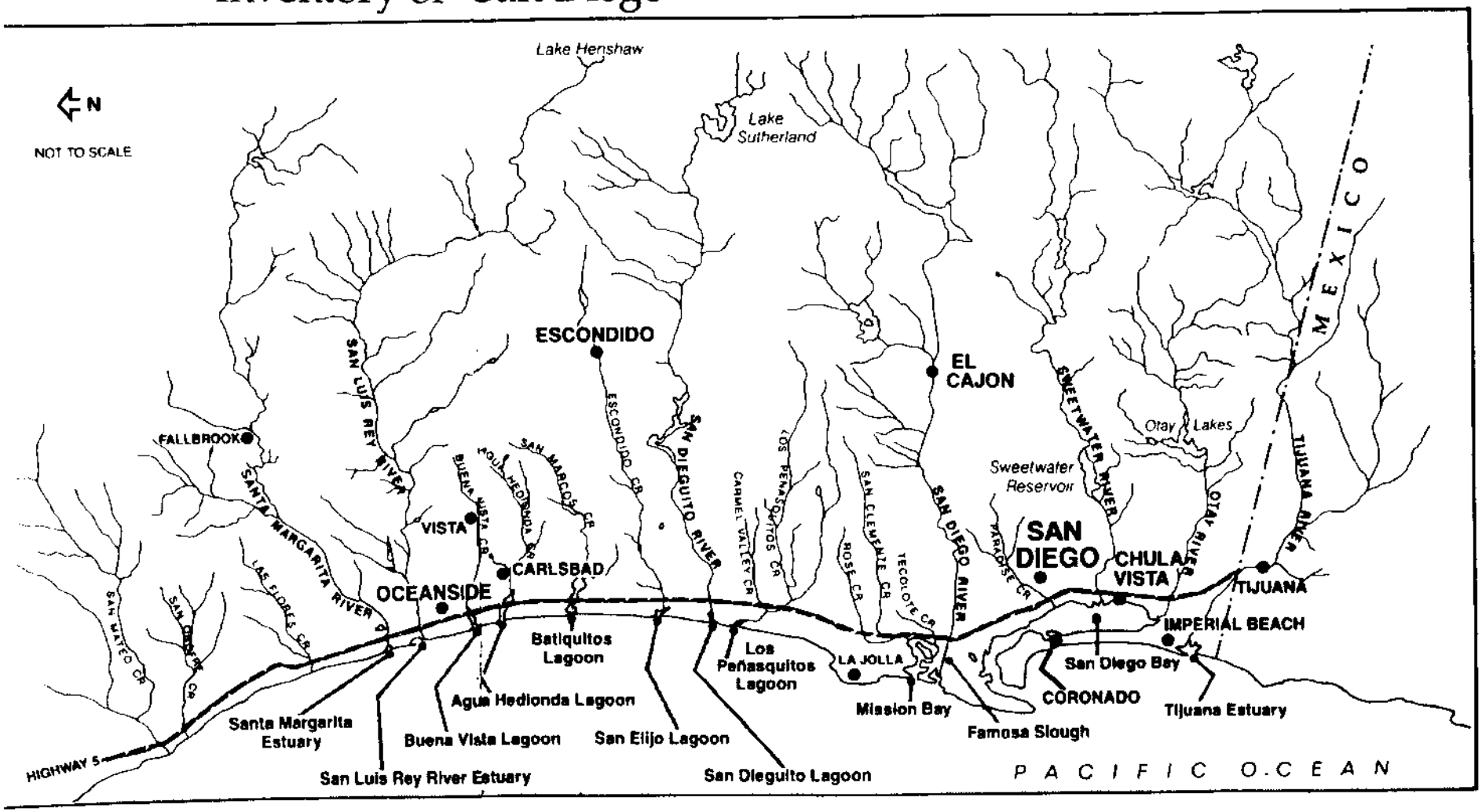
6. California Wetlands, 1988. Page 6.

VII. APPENDICES

Map of San Diego County Wetlands and
Individual Lagoon Fact Sheets

A significant portion of the material in these appendices, including the map, is from *The Coastal Wetlands of San Diego County*, 1989.

Inventory of San Diego Coastal Wetlands



AGUA HEDIONDA LAGOON [1]

Location and Acreage

Lagoon:	City of Carlsbad	- 400 acres
Watershed:	Cities of Carlsbad, Vista, Oceanside and County of San Diego	- 29 square miles

Ownership

Eastern End, South North, West Sides and Encina Power Plant.	Privately Owned	- 200 acres
	San Diego Gas & Electric	- 262 acres[2]
Northeast Side	Cal Communities Inc.	- N/A[3]

Types[4]

Mudflats and Deepwater - 388 acres[5]

Bay	- 262 acres	Channel	- 0.1 hectare
Saline Marsh	- 78 acres	Brackish/Freshwater Marsh	- 66 acres

Watershed Description

Agricultural

Open to Sea or Not

Permanently open due to jetties placed along the mouth of the lagoon.[6]

Depth: N/A

Vegetation:[7]

Eelgrass Beds (*Zostera marina*)
Alkali heath (*Cressa truxillensis*)
Shore grass (*Monanthochloe littoralis*)
Suaeda esteroa
Dodder (*Cuscuta salina*)
Spiny rush (*Juncus acutus*)
Pickleweed (*Salicornia virginica*)
Alkali heath (*Frankenia grandifolia*)
Salt grass (*Distichlis spicata*)
Pickleweed (*Salicornia subterminalis*)
Jaumea (*Jaumea carnosa*)
Suaeda californica

Wildlife:

Belding's Savannah Sparrow
California Least Terns
Diving Ducks
Gulls
Grebes
Pelicans

Human Use

- Mussels are raised by an aquaculture operation in the western basin.
- Water recreation area for boats in the eastern basin.
- Fishing from the western shoreline of the western basin.
- There is a developing abalone farm.[8]

Unique Characteristics

San Diego Gas and Electric owns most of the lagoon. The lagoon is used as a water intake point for the Encina Power Plant.

History

- Road fills have separated the lagoon into three distinct basins.
- 1954 - The lagoon was completely dredged to provide a deep basin and a source of cooling water for the Encina Power Plant. A small portion of the power plant was built on filled wetland.
- A small residential marina development was built on fill in the eastern basin.
- Planned developments include a 1,600-unit residential and commercial development on 433 acres of the eastern shore.[9] Sea World plans to open a fish hatchery in the near future.[10]

ENDNOTES

1. The Coastal Wetlands of San Diego County, 1989.
2. "The Lagoons"
3. "The Lagoons"
4. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 161.
5. "The Lagoons"
6. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 163.
7. The Ecology of Southern California Coastal Salt Marshes: A Community Profile, 1982. Page 16.
8. Personal communication with John Davis, Carlsbad Aqaufarms.
9. "The Lagoons"
10. Personal communication with Leigh Johnson, Marine Advisor for San Diego County.

BATIQUITOS LAGOON [1]

Location and Acreage

Lagoon:	City of Carlsbad	- 600 acres
Watershed:	Cities of Carlsbad, Encinitas, San Marcos, and San Diego County	- 78 square miles[2]

Ownership

Most of Batiquitos Lagoon is owned by the State Lands Commission and the Department of Fish and Game. The land owned by the Fish and Game is managed as an Ecological Reserve. Hunt properties Inc. owns 325 acres on the east shore and Sammis Properties owns 166 acres on the north shore.[3]

Types[4]

Shallow Wetlands - 526 acres[5]

Bay	- 106 acres	Channels -	247 acres
Salt Marsh	- 21 acres	Fresh/Brackish Marsh -	130 acres
Salt Marsh	- 100 acres[6]	Barren Salt Flats -	240 acres[7]

Watershed Description

Agricultural, developed, residential, golf courses, undeveloped ravines, a dam, and a proposed concrete channel through San Marcos.[8]

Open to Sea or Not

Typically closed.[9] Lagoon has been approved for dredging to allow permanent tidal flushing.[10]

Depth: N/A

Vegetation:[11]

Jaumea (*Jaumea carnosa*)
Lasthernia glabrata
Limonium californium
Alkali heath (*Cressa truxillensis*)
Shore grass (*Monanthochloe littoralis*)
Spiny rush (*Juncus acutus*)
Pickleweed (*Salicornia virginica*)
Alkali heath (*Frankenia grandifolia*)
Salt grass (*Distichlis spicata*)
Pickleweed (*Salicornia subterminalis*)

Wildlife:

Migratory Shorebirds
Dabbling Ducks
Diving Ducks
Herons
Egrets
Least Terns
Belding's Savannah Sparrow
Pelicans
Gulls

Human Use

- Nature Study and Fishing.

Unique Characteristics

This lagoon supports 11.3 % of the waterfowl and migratory shorebird population in San Diego County.[12]

History

- Fully tidal system until the 1800's.
- 1881 - Railroad built across the lagoon mouth, separating the lagoon from the ocean and constricting tidal flows.
- 1901 to 1910 - California Salt Company operated 25 acres of salt evaporator ponds in the far eastern area of the lagoon. A few of the dikes from these ponds remain.
- 1912 - Pacific Coast Highway further separated the lagoon from tidal flows and created another fill across the lagoon mouth.
- Due to constricting the lagoon mouth, sedimentation, and watershed erosion, the lagoon was only open to tidal flows intermittently by 1930. Beginning in the 1940's, the lagoon rarely opened to the tide and was dry most of the year.
- 1952 - San Marcos Creek was dammed, reducing freshwater inflows.
- 1967 to 1974 - Treated wastewater was discharged into the lagoon.
- Duck ponds, visible from a 1934 map of the lagoon, are now filled with sediment and thick marsh.
- Planned developments include a country club, a 611-home development, a college campus, a hotel, and a recreational complex.[13]

ENDNOTES

1.The Coastal Wetlands of San Diego County, 1989.

2. Personal communication with Bill Daugherty, Audubon Society.

3. "The Lagoons"

4. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 161.

5. "The Lagoons"

6. Status and Trends of California Wetlands, 1984. Page 108.

7. Status and Trends of California Wetlands, 1984. Page .

8. Personal communication with Bill Daugherty, Audubon Society.

9. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 163.

10. Personal communication with Bill Daugherty, Audubon Society.

11. The Ecology of Southern California Coastal Salt Marshes: A Community Profile, 1982. Page 16.

12. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 164.

13. "The Lagoons"

BUENA VISTA LAGOON [1]

Location and Acreage

Lagoon:	City of Oceanside and Carlsbad	- 220 acres
Watershed:	Cities of Oceanside, Carlsbad, and Vista	- 20 square miles

Ownership

Most of Buena Vista lagoon is a State Ecological Reserve managed by the Department of Fish and Game. A few small parcels on the lagoon boundaries and the far western basin are privately owned, including 27 acres owned by Hughes Investments.[2]

Types[3]

Salt, Brackish Marsh, Open Water - 350 acres[4]
Fresh/Brackish Marsh - 39 acres
Lacustrine/Impounded - 160 acres

Watershed Description

N/A

Open to Sea or Not

Typically closed.[5]

Depth: Marshland ranges from a few inches to 6 feet.[6]

Vegetation: N/A

Wildlife:
Shorebirds
Waterfowl
Brown Pelicans
Least Terns
Caspian Terns
Herons
Egrets
Cormorants
Fish:Bass

Human Use

- Nature study and fishing.
- Buena Vista Audubon Society provides wildlife demonstrations.

Unique Characteristics

- One of San Diego County's smallest coastal lagoons.
- One of the only freshwater habitats on the Southern California coast.
- Sedimentation in this lagoon has been significant.[7]
- Lagoon supports 7.5 % of San Diego County's waterfowl and migratory shorebird populations.[8]

History

- 1881 - Road fills constructed through the lagoon for the railroad.
- 1912 - Road fills constructed for the Pacific Coast Highway (now Hill Street).
- 1965 - Road fills constructed for Interstate 5. These roads turned the lagoon into four basins.

- 1940 - Weir placed at the mouth of the lagoon and at the beach berm was covered with housing. The weir impounded fresh water, greatly increased water depths, and excluded all tidal influence, turning the lagoon into a calm-water lake.
- Until 1967, treated sewage was discharged directly into the lagoon.
- 1970's - A 100-acre marsh at the eastern end of the lagoon was filled for a shopping center.
- Planned developments include a shopping center and commercial building in the north east area of the lagoon.[9]

ENDNOTES

1. The Coastal Wetlands of San Diego County, 1989.

2. "The Lagoons"

3. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 161.

4. Status and Trends of California Wetlands, 1984. Page 108.

5. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 163.

6. "The Lagoons"

7. Status and Trends of California Wetlands, 1984. Page 103.

8. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 164.

9. "The Lagoons"

LOS PENASQUITOS LAGOON [1]

Location and Acreage

Lagoon:	City of San Diego	- 630 acres
Watershed:	City of San Diego, Poway, and San Diego County	- 98 square miles

Ownership

The State Department of Parks and Recreation owns most of the lagoon (150 acres[2]) and manages it as part of the Torrey Pines State Reserve. The Conservancy owns 20 acres of the upper lagoon near the outlet of Los Penasquitos Creek. The City of San Diego owns much of Los Penasquitos Creek Canyon and manages it as a preserve. SDG&E owns 240 acres.[3]

Types[4]

Saltflats, Marshland and Tidal Channels	- 385 acres[5]	Channels	- 8 acres
Salt Marsh	- 323 acres		
Fresh/Brackish Marsh	- 124 acres	Salt Marsh	- 385 acres[6]

Watershed Description

N/A

Open to Sea or Not

Typically closed.[7]

Depth: N/A

Vegetation:[8]

Jaumea (*Jaumea carnosa*)
Lasthernia glabrata
Atriplex watsonii
Limonium californium
Alkali heath (*Cressa truxillensis*)
Shore grass (*Monanthochloe littoralis*)
Suaeda (*Suaeda esteroa*)
Dodder (*Cuscuta salina*)
Spiny rush (*Juncus acutus*)
Pickleweed *(Salicornia virginica*)
Alkali heath (*Frankenia grandifolia*)
Salt grass (*Distichlis spicata*)
Pickleweed (*Salicornia subterminalis*)

Wildlife:

Aquatic Insects
Invertebrates
Waterfowl
Egrets
Songbirds
Belding's Savannah Sparrows
Clapper Rail
Least Terns
Herons

Shorebird use is low due to limited intertidal or unvegetated shallow water habitat.

Human Use

- Currently, no trails cross or border the lagoon, but there is nearby beach access.

Unique Characteristics

- This lagoon supports 4.4% of the waterfowl and migratory shorebird populations.[9]

History

- 1769 - Lagoon named Los Penasquitos Lagoon by the Spanish who encountered a deep-water estuary that supported numerous kinds of marine animals.
- 1889 - Map shows an open mouth located at the northern edge of the beach berm. Marsh extended up Carmel Valley and far up into Sorrento Valley. At this time, the railroad crossed the eastern edge of the lagoon and followed west along the present course of Carmel Valley road.
- 1925 - A new railroad embankment was built through the center of the lagoon, creating a major impediment to tidal flows.
- 1937 - Highway 1 was built across the mouth of the lagoon. This highway constricted the lagoon mouth and lagoon began closing.
- There has been a substantial increase in the sedimentation rate since the plowing and grading of the lagoon watershed. Before European settlement, the lagoon had been slowly filling in at a rate of 10 cm (4 inches) per century. The sedimentation rate in 1980 had increased to 50 cm (20 inches) per century and may be considerably higher now due to the grading and development in the watershed over the last nine years.
- 1962 to 1972 - Sewage effluent was discharged into the lagoon in quantities ranging from 500,000 to 1 million gallons per day.
- Since 1984 - Accidental spills of millions of gallons of raw sewage have been a continual problem in the lagoon.
- Planned developments include a 100-acre industrial park north of Sorrento Valley.[10]

ENDNOTES

1. The Coastal Wetlands of San Diego County, 1989.

2. "The Lagoons"

3. "The Lagoons"

4. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 161.

5. "The Lagoons"

6. Status and Trends of California Wetlands, 1984. Page 108.

7. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 163.

8. The Ecology of Southern California Coastal Salt Marshes: A Community Profile, 1982. Page 16.

9. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 164.

10. "The Lagoons"

MISSION BAY [1]

Location and Acreage

Mission Bay:	City of San Diego	- 4,600 acres
Watershed:	City of San Diego and County of San Diego	- 53 square miles

Ownership

- City of San Diego owns most of Mission Bay and the lower flood control channel from Interstate 5 to the ocean.
- The University of California Natural Land and Water Reserve System owns the Kendall Frost Marsh Preserve.

Types[2]

Bay - 1532 acres Salt Marsh - 87 acres Fresh/Brackish Marsh - 99 acres
Aquatic habitat: Sandy bottom shallow water, eelgrass beds, rocky shoreline.
Intertidal habitat: Mudflat and marsh.
Continuous Subtidal habitat: 2,033 acres.[3]

Watershed Description

N/A

Open to Sea or Not

Permanently open.[4]

Depth:

Vegetation:[5]

Eelgrass
Pickleweed (*Salicornia subterminalis*)
Triglochin concinnum
Limonium californium
Shore grass (*Monanthochloe littoralis*)
Alkali heath (*Frankenia grandifolia*)
Suaeda esteroa
Batis maritima
Salicornia bigelovii
Spartina foliosa
Dodder (*Cuscuta salina*)
Pickleweed (*Salicornia virginica*)
Salt grass (*Distichlis spicata*)
Jaumea (*Jaumea carnosa*)

Wildlife:

25+ species of marine fish
Invertebrates
Cormorants
Grebes
Loons
Kendall Frost Marsh:
Clapper Rails
Savannah Sparrows
Least Terns
Diving Ducks
Pelicans

Human Use

- Hiking, bicycling, swimming, boating, wind surfing, and bird watching.[6]

Unique Characteristics

- Fiesta Island sludge processing facilities are located on the bay.[7]

History

- Originally called False Bay by the Spanish because its entrance was near enough to San Diego Bay to occasionally fool ship captains.
- 1850 - Army Corps of Engineers rerouted San Diego River to drain into False Bay. As a result, all the sediment from this large watershed began to deposit in False Bay.
- 1940's - Army Corps of Engineers dredged the bay and rerouted the river to use False Bay as a potential small-craft harbor and recreation area.
- Dredge spoils were used to build lands within the bay to construct levees for a new river channel. This created Mission Bay Park, a complex of recreational islands, beaches, waterways, marinas, hotels, and restaurants.[8]
- 1949 - Army Corps of Engineers completed the San Diego River flood control channel, which carries river flows directly out to sea, relieving sediment problems in Mission Bay.[9]
- 1975 - Army Corps of Engineers diverted San Diego River away from San Diego Bay and into Mission Bay.[10]

ENDNOTES

1. The Coastal Wetlands of San Diego County, 1989.
2. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 161.
3. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 162.
4. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 163.
5. The Ecology of Southern California Coastal Salt Marshes: A Community Profile, 1982. Page 16.
6. Personal communication with Libby Lucas, Environmental Health Coalition.
7. Personal communication with Libby Lucas, Environmental Health Coalition.
8. Status and Trends of California Wetlands, 1984. Page 103.
9. Status and Trends of California Wetlands, Page 104.
10. Status and Trends of California Wetlands, 1984. Page 103.

SAN DIEGO BAY [1]

Location and Acreage

San Diego Bay: City of San Diego, Coronado, National City, Chula Vista, and Imperial Beach. - 12,530 acres
Watershed: City of San Diego, Coronado, National City, Chula Vista, Imperial Beach, La Mesa, Lemon Grove, El Cajon, and the County of San Diego - 415 square miles

Ownership

- San Diego Unified Port District administers 37% of the submerged, filled and remaining natural wetlands of San Diego Bay under a grant from the California Legislature.
- State Lands Commission owns 42% of the bay, mostly underwater areas.
- Military controls 20%, and city and county governments have jurisdiction over less than 1% of the bay.
- Over half the salt ponds in the south bay are privately owned, and the remainder is owned by the State Lands Commission and operated under a lease.
- Fish and Wildlife Service owns the entire Sweetwater and Paradise Marsh complex, a 315-acre refuge.

Types[2]

Bay Habitat	- 11,078 acres	Salt Marsh	- 27 acres
Fresh and Brackish Marsh	- 58 acres	Salt Marsh	- 359 acres[3]
Impounded/Lacustrine	- 1065 acres	Salt Ponds	- 1400 acres[4]
Mud Flats	- 614 acres[5]		

Watershed Description

N/A

Open to Sea or Not

Typically open.[6]

Depth: - Deep and shallow subtidal habitats ranging from the low-tide line to 18 feet deep.
- North and Central bay areas have depths varying from 18 to 70 feet.

Vegetation:

Eelgrass beds cover approximately 800 acres throughout the bay, a productive refuge for juvenile fish and crustaceans.

Wildlife:

There are 80 to 90 fish species in the bay. The deeper north bay supports open-ocean fish, while the warmer, shallower south bay supports smaller estuarine fish. Fish species include: Topsmelt, Shiner Surfperch, Pacific Mackerel, California Lizardfish, Barred Sand Bass, Spotted Sand Bass, California Halibut, Striped Mullet[7], small forage fish, and many other recreational and commercial fish. Other wildlife include:

Diving Ducks (Surf Scoter and Scaup)	Brine Shrimp
Shorebirds	Spiny Lobster
Northern Phalaropes	Sea Urchins
Eared Grebes	Green Sea Turtles
Waterfowl	Snowy Plovers
5 species of Terns (Including Least Terns)	Savannah Sparrow (marsh)
Black Skimmers	Clapper Rails

Human Use

- Boating, wind surfing, bird walks, swimming and fishing.[8]
- Navy facilities: Home to nearly 20% of the Navy's active fleet. Other military uses include an amphibious and underwater demolition training base and a Marine Corps recruit base.
- Shipping.
- Tourism.

Unique Characteristics

- The mudflats of San Diego Bay are the largest shorebird feeding area in San Diego County and are an important stopover for shorebirds of the Pacific Flyway.
- San Diego Bay is the largest estuary along the San Diego County coastline.[9]

History

- 1768 - Spanish choose San Diego Bay as the site of their first northern colony to make use of the fine natural harbor.
- Gray whales used the bay as a calving ground and Native Americans lived along the shore harvesting fish and shellfish.
- 1830 - Sixteen American whaling ships were operating in the bay.
- 1857 - Army Corps of Engineers diverted the San Diego River away from the bay into Mission Bay because the river deposited silt in San Diego harbor that interfered with shipping. The large marshy river delta was then filled and developed into the City of San Diego.
- 1800s to World War II - 100 million to 140 million cubic yards of bay sediment were dredged and used to fill tidelands and widen beaches along the Silver Strand. Pier and port facilities were created for both domestic and military uses.
- 1887 - Sewage first released into the Bay.[10]
- 1888 - A dam was built on the Sweetwater River to provide drinking and irrigation water.
- 1919 - Otay River was dammed, reducing freshwater inflows to 75% of their historic level causing the bay to become primarily a saline system.
- 1940 to 1946 - 25 million cubic yards of sediment were dredged from the bay and used to fill tidelands.[11] Over 27% of the bay's tidal area has been filled.
- 1943 - Raw or improperly treated sewage was being discharged from 15 outfalls.[12] Industrial and military dumping also contributed to the problem.
- 1960 - Discharge of raw sewage into the Bay ended and the Metropolitan Sewage System and treatment plant on Point Loma were established.
- 1962 - San Diego Unified Port District was created, consolidating the port facilities of five shoreline cities.
- Ninety percent of the original salt marshes and fifty percent of the original mudflats have been filled or dredged for port and urban development.[13]

ENDNOTES

1. The Coastal Wetlands of San Diego County, 1989.

2. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 161.

3. Status and Trends of California Wetlands, 1984. Page 108.

4. Status and Trends of California Wetlands, 1984. Page 108.

5. Status and Trends of California Wetlands, 1984. Page 108.

6. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 163.

7. San Diego Bay Health Risk Study, 1990. Page I-7.

8.
8. Personal Communication with Libby Lucas, Environmental Health Coalition.

9. Status and Trends of California Wetlands, 1984. Page 104.

10. San Diego Bay Health Risk Study, 1990. Page I-7.

11. Status and Trends of California Wetlands. Page 104.

12. San Diego Bay Health Risk Study, 1990. Page I-7.

13. The Natural Resources of San Diego Bay in Status and Trends of California Wetlands, 1984. Page 104.

SAN DIEGUITO LAGOON [1]

Location and Acreage

Lagoon:	City of Del Mar and San Diego	- 300 acres
Watershed:	City and County of San Diego	- 350 square miles

Ownership

Ecological Reserve Department of Fish and Game - 107 acres

City of San Diego - 20-acre abandoned sewage treatment pond now overgrown with riparian trees and 29 acres of wetlands

22nd District Agricultural Association - 23 acres of wetlands and beach in the western lagoon

Remainder of the western lagoon, the river channel and remnant wetlands east of Interstate 5 are privately owned.

Types[2]

Shallow Marshland and Tidal Channels	- 400 acres[3]	Bay	- 74 acres
Salt Marsh	- 71 acres	Salt Marsh	- 269 acres[4]
Fresh/Brackish Marsh	- 91 acres	Other	- 4 acres

Watershed Description

N/A

Open to Sea or Not

Typically open.[5]

Depth: Depth ranges from shallow marshland to tidal channels up to 6 feet deep.[6]

Vegetation:[7]

Salt grass (*Distichlis spicata*)
Lasthernia glabrata
Limonium californium
Alkali heath (*Cressa truxillensis*)
Pickleweed (*Salicornia subterminalis*)
Shore grass (*Monanthochloe littoralis*)
Jaumea (*Jaumea carnosa*)
Suaeda esteroa
Spiny rush (*Juncus acutus*)
Pickleweed (*Salicornia virginica*)
Alkali heath (*Frankenia grandifolia*)
Spartina foliosa

Wildlife:

Shorebird
Osprey
Canada Geese
(eastern river valley in winter)
Least Tern
Belding's Savannah Sparrow
(pickleweed marsh)
Fish:
Mullet
Mudsucker
Topsmelt
Invertebrate Species

Human Use

- Nature Study, fishing and hiking (park).

Unique Characteristics

- Department of Fish and Game Ecological Reserve.

History

- Was the largest lagoon and watershed of the six San Diego coastal lagoons.
- Railroad, Highway 1 and Jimmy Durante Boulevard were built on fill in the lagoon. The wetlands east and west of Jimmy Durante boulevard were progressively filled or developed.
- 1905 - Early development by the South Coast Land Company filled the southern lagoon between the highway and the railroad.
- 1935 - Del Mar Fairgrounds were built on a 200-acre section of the northern lagoon.
- World War II - Del Mar Airport was built on lagoon wetlands.
- 1966 - Interstate 5 was constructed through the middle of the lagoon and isolated the wetlands on the eastern edge.
- 1970's - Fill for a shopping center further reduced the wetland acreage.
- 1949 to 1974 - 200,000 to 300,000 gallons of sewage effluent were discharged daily into treatment ponds in the western area, creating a thick layer of sludge on the lagoon bottom.
- 1940's - Two large dams were constructed on the San Dieguito River which greatly reduced freshwater inflows and as a result, the lagoon mouth began closing, only to open during large winter floods.
- 1978 - Due to conservancy enhancement efforts, a tidal basin was dredged in a 70-acre area of the southern lagoon and an enormous gully in Crest Canyon was restored with the dredge spoils. The lagoon mouth was then reopened.
- Planned developments include using the land north of the lagoon adjacent to the park for parking and building a hotel north east of the lagoon.[8]

ENDNOTES

1. The Coastal Wetlands of San Diego County, 1989.

2. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 161.

3. "The Lagoons"

4. Status and Trends of California Wetlands, 1984. Page 108.

5. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 163.

6. "The Lagoons"

7. The Ecology of Southern California Coastal Salt Marshes: A Community Profile, 1982. Page 16.

8. "The Lagoons"

SAN ELIJO LAGOON [1]

Location and Acreage

Lagoon:	City of Encinitas	- 530 acres
Watershed:	City of Encinitas, Solana Beach, Escondido, and San Diego County	- 77 square miles

Ownership

Middle basin and portion of the western basin is owned by the Department of Fish and Game.
Middle and eastern basins are managed as an Ecological reserve.
Western basin is owned by the San Elijo Lagoon Foundation and Private Owners.

Types[2]

Mudflats, Marshland and Open Water	- 900 acres[3]	Salt Marsh and Open Water	- 500 acres[4]
Channels	- 78 acres	Salt Marsh	- 216 acres
Fresh/Brackish Marsh	- 183 acres		

Watershed Description

N/A

Open to Sea or Not

Although San Elijo Lagoon was once a fully tidal system, the lagoon mouth is now closed most of the year. San Elijo Lagoon is primarily a shallow-water brackish wetland that rarely experiences tidal flows. Following winter storms, water levels in the lagoon increase and the mouth opens, draining the stormwater and allowing tidal inflows for a short time.

Depth: Depths have been measured up to 4 feet deep.[5]

Vegetation:[6]

Jaumea (*Jaumea carnosa*)
Alkali heath (*Cressa truxillensis*)
Pickleweed (*Salicornia virginica*)
Alkali heath (*Frankenia grandifolia*)
Salt grass (*Distichlis spicata)*
Pickleweed (*Salicornia subterminalis*)

Other Wildlife:

Invertebrates
Aquatic Insects
Small Fish

Birds:

Migratory Shorebirds
Waterfowl
Terns
(7 species including Least Terns)
Clapper Rails
Belding's Savannah Sparrow
Brown Pelicans
Herons
Egrets

Human Use

- Hiking and fishing.

Unique Characteristics

- 9 endangered species visit or reside in San Elijo Lagoon.
- This lagoon supports 8.2% of San Diego County's waterfowl and migratory shorebird populations.[7]
- As of 1984, this lagoon had lost only 10% of its wetlands.[8]

History

- 1887 - Year round tidal inflows stopped but the lagoon mouth remained open.
- Railroad, set mostly on fill with a small bridge and a 1000-foot-long levee across the middle of the lagoon, obstructed tidal flow.
- 1800's to 1940's - Numerous dikes and levees were built for duck ponds, roads, and sewage treatment plants reducing stormwater velocities and increasing the rate of sediment deposition.
- 1935 - Race track, farming operations and other filling had reduced the 604-acre salt marsh one-third.[9]
- Several large reservoirs on Escondido Creek have reduced freshwater inflows.
- Highway 1 has created a large dike along the lagoon's western boundary and severely restricts the entrance channel and tidal inflows.
- Interstate 5 has isolated a 300-acre parcel of the upper marsh.[10]
- 1940 to 1973 - Wastewater was discharged into the lagoon from the City of Escondido.
- Planned developments include a college campus on the north east shore.[11]

ENDNOTES

1. The Coastal Wetlands of San Diego County, 1989.

2. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 161.

3. "The Lagoons"

4. Status and Trends of California Wetlands, 1984. Page

5. "The Lagoons"

6. The Ecology of Southern California Coastal Salt Marshes: A Community Profile, 1982. Page 16.

7. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 164.

8. Status and Trends of California Wetlands, 1984. Page 103.

9. Status and Trends of California Wetlands, 1984. Page 103.

10. Metz, E. in Status and Trends of California Wetlands, 1984. Page 103.

11. "The Lagoons"

SAN LUIS REY RIVER [1]

Location and Acreage

Lagoon:	City of Oceanside	- 40 acres
Watershed:	City of Oceanside and County of San Diego	- 558 square miles

Ownership

Oceanside Harbor	City of Oceanside
Lower River Channel	City of Oceanside
San Luis Rey River Floodplain	Majority is Privately Owned

Types[2]

Channel - 2 acres	Brackish/Freshwater Marsh - 204 acres
Other - 5 acres	Riparian Forest - 1700 acres

Watershed Description

N/A

Open to Sea or Not

Diked with Culverts.[3]

Depth: N/A

Vegetation:[4]	**Wildlife:**
Juncus acutus	Shorebirds
Jaumea (*Jaumea carnosa*)	Waterfowl
Pickleweed (*Salicornia virginica*)	Water Birds
Alkali heath (*Frankenia grandifolia*)	Least Terns
Salt grass (*Distichlis spicata*)	Brown Pelicans

Human Use

- Currently there is very little public land and no access trails.
- Bike path.

Unique Characteristics

- Third largest vireo population in San Diego County.

History

- 1798 - Establishment of the Mission San Luis Rey de Francia and the beginning of reclamation of floodplain wetlands for agriculture.
- Early 1960's - Groundwater level drops to an extreme low due to water pumped for agriculture and for export to Carlsbad and Oceanside.
- 1958 to 1974 - City of Oceanside discharged treated wastewater into the river to compensate for the drop in groundwater levels. Additional irrigation water was also released.
- 1964 - Estuary at the mouth of the river was dredged to create the Oceanside Harbor for recreational boats.
- A road now crosses the beach berm at the mouth, further restricting tidal flows.

ENDNOTES

1. The Coastal Wetlands of San Diego County, 1989.

2. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 161.

3. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 163.

4. The Ecology of Southern California Coastal Salt Marshes: A Community Profile, 1982. Page 16.

SANTA MARGARITA RIVER AND ESTUARY

Location and Acreage

Estuary:	Camp Pendleton Marine Base	- 268 acres
Watershed:	Camp Pendleton Marine Base, and San Diego and Riverside Counties	- 740 square miles

Ownership
U.S. Marine Corps owns the Santa Margarita Estuary, lower watershed, and the lower 17 miles of the river. The Marines manage the estuary as a natural preserve.

Types[1]

Salt Marsh and Open Water	- 800 acres[2]	Bay	- 75 acres
Salt Marsh	- 216 acres	Fresh/Brackish Marsh	- 195 acres

A well-developed riparian forest lines much of the watercourse.[3]

The lower 1.7 miles of the river channel are a tidal estuary.

Watershed Description
N/A

Open to Sea or Not
Typically closed.[4]

Depth: N/A

Vegetation:[5]
Salicornia bigelovii
Alkali heath (*Cressa truxillensis*)
Shore grass (*Monanthochloe littoralis*)
Suaeda (*Suaeda esteroa*)
Dodder (*Cuscuta salina*)
Spiny rush (*Juncus acutus*)
Pickleweed (*Salicornia virginica*)
Alkali heath (*Frankenia grandifolia*)
Salt grass (*Distichlis spicata*)
Pickleweed (*Salicornia subterminalis*)
Jaumea (*Jaumea carnosa*)
Lasthenia glabrata
Atriplex watsonii
Limonium californicum

Wildlife:
Shorebirds
California Least Terns
Waterfowl
Gulls
Clapper Rails (brackish)
Savannah Sparrows (pickleweed marsh)
Least Bell's Vireos
Brown Pelicans (brackish)
16 Invertebrate Species:
- Tube Worms
- Horn Snails
- Crabs
- Mollusks

16 Species of Fish
Goby

Human Use

- Camp Pendleton owns and manages the Santa Margarita Estuary for protection of its natural resources.
- Public access is allowed only for scientific research purposes by written permission of the commanding general.
- Horseback riding, agriculture, County Parks.[6]

Unique Characteristics

- Largest concentration of nesting Least Terns in the world.
- Largest remaining population of the Least Bell's Vireo.
- Most extensive corridor of riparian habitat in the county.
- The Santa Margarita River is the longest free-flowing river in coastal Southern California. Over 27 miles of the main river are undammed.

History

- 1941 - Estuary mouth began to close periodically.
- 1942 - Camp Pendleton was established.
- 1942 - Del Mar Boat basin was carved out of 153 acres of the southern Santa Margarita Estuary.
- 1965 - River channel was dredged deeper for waterfowl.
- Until 1970, U.S. Marines used the salt flats of the estuary for tank training exercises and amphibious landing practices. During this same period, wastewater was discharged into the estuary.
- 1971 - Brackish marsh along the north side of the estuary was dredged turning it into a salt marsh.
- 1985 - One-acre Least Tern nesting island was constructed in the estuary.

ENDNOTES

1. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 161.

2. Status and Trends of California Wetlands, 1984. Page 100.

3. Mudie, P. in Status and Trends in California Wetlands, 1984. Page 102.

4. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 163.

5. The Ecology of Southern California Coastal Salt Marshes: A Community Profile, 1982. Page 16.

6. Personal communication with Barbara Simmons, San Diego County Department of Parks and Recreation.

TIJUANA ESTUARY

Location/Ownership/Acreage

Estuary:	Cities of San Diego and Imperial Beach	- 1320 acres
Watershed:	Cities of San Diego, Imperial Beach, County of San Diego, and State of Baja California Norte, Mexico	- 1730 square miles
Tijuana River National Estuarine Research Reserve (NERR):	Private and public owners include: City and County of San Diego,. Cal. Dept of Parks and Recreation, US Fish & Wildlife Service, US Navy	- 2,530 acres

Types[1]

Salt Marsh, Mudflats. and Open Water	- 1182 acres[2]	Channel	- 553 acres
Brackish/Freshwater Marsh	- 218 acres	Salt Marsh	- 423 acres
Other	- 4 acres	Intertidal Mudflats	- 33 acres[3]
Tidal Channels and Ponds	- 173 acres[4]	Intertidal Salt Marsh Wetlands	- 176 acres[5]

Watershed Description

N/A

Open to Sea or Not

Typically open.[6] The entrance channel measures 100 feet wide and is susceptible to closure.

Depth: N/A

Vegetation:[7]

Salt wort (*Batis maritima*)
Annual Pickleweed (*Salicornia bigelovii*)
Cordgrass (*Spartina foliosa*)
Lasthenia (*Lasthernia glabrata*)
Arrow grass (*Triglochin concinnum*)
Salt bush (*Atriplex watsonii*)
Sea Lavender (*Limonium californium*)
Alkali heath (*Cressa truxillensis*)
Shore grass (*Monanthochloe littoralis*)
Suaeda (*Suaeda esteroa*)
Dodder (*Cuscuta salina*)
Pickleweed (*Salicornia virginica*)
Alkali heath (*Frankenia grandifolia*)
Salt grass (*Distichlis spicata*)
Pickleweed (*Salicornia subterminalis*)
Jaumea (*Jaumea carnosa*), Salt marsh bird's beak (Cordylanthus maritimus ssp. maritimus)

Wildlife:[8]

Arrow goby
Cheekspot goby
California killfish
Topsmelt
Striped mullet
Diamond turbot
Kelp bass
Spotted sand bass
California halibut
Barred sand bass

Birds:

Rails

Human Use[9]

- The National Estuarine Research Reserve serves as an educational and learning facility.
- Nature walks and horseback riding.
- Agriculture.
- County Parks and Recreation have some activities.

Unique Characteristics

- Three-fourths of the watershed lies within Mexico and the estuary lies entirely within the United States.
- The estuary is not dissected by highways or railroads.
- The estuary supports 5.8% of San Diego County's waterfowl and migratory shorebird population.[10]
- The estuary supports San Diego County's largest percent of rail population.[11]

History

- Originally called Oneonta Lagoon or Slough.
- Between 1852 and 1986, the Tijuana River flooded severely seven times and 200 acres of the estuary was filled with sediment. The southern arm lost 250 acres due to sedimentation and agricultural reclamation.
- Since 1852, the estuary has lost 80 percent of its tidal prism.
- Early 1900's - Sewage disposal practices led to the dredging of an east-west channel to connect the estuary to an adjacent lagoon.
- Later dikes were constructed to subdivide the lagoon into three waste water receiving ponds, which were subsequently abandoned and the dikes breached to improve tidal flushing.
- 1960's and 1970's - Apartment buildings were erected on most of the northern dunes, the beach, and some filled marshlands.
- 1980 - Natural flooding has broadened the riverbed and changed its course.
- 1983 - Two salt marsh islands (northern marsh and entrance channel) obliterated by winter storms washing the sand dunes into the main channels.
- April, 1984 - Sand caused the mouth of the estuary and the northern marsh to close to tidal flushing until dredged eight months later.
- Scars remain from past activities such as gravel extraction, dike construction, long-term dumping and filling, off-road vehicles, military, agricultural, and horse-raising.
- Present-day sewage spills from Mexico change the quantity and quality of inflowing waters.

ENDNOTES

1. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 161.
2. Status and Trends of California Wetlands, 1984. Page 108.
3. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 159.
4. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 159.
5. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 159.
6. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 163.
7. The Ecology of Southern California Coastal Salt Marshes: A Community Profile, 1982. Page 16.

8. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 167.

9. Personal communication with Barbara Simmons, San Diego County Department of Parks and Recreation, and Pat Flanagan, Tijuana River National Estuarine Research Reserve.

10. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 167.

11. Draft Environmental Impact Report/Environmental Impact Statement, 1991. Page 167.

VIII. REFERENCES CITED

Allen, J., M. Cunningham, A. Greenwood, L. Rosenthal, 1992. *The Value of California Wetlands: An Analysis of Their Economic Benefits.* The Campaign to Save California Wetlands, Berkeley, CA

Anderson, R. and M. Rockel. 1991. *Economic Valuation of Wetlands.* Discussion Paper #065 American Petroleum Institute. Washington D.C.

ASIWPCA and US EPA, 1985. *America's Clean Water, The States' Nonpoint Source Assessment, 1985.* Association of State and Interstate Water Pollution Control Administrators and U.S. Environmental Protection Agency, Washington, D.C.

Baczkowski, Stacey. 1993. *San Dieguito Lagoon Restoration Project Regional Coastal Lagoon Resources Summary.* Submitted by MEC Analytical Systems, Inc. to Southern California Edison Company as part of the San Onofre Marine Mitigation Program. Carlsbad, CA.

Baker, L.A., 1992. Introduction to NPS Pollution in the U.S., *Ecological Engineering*, 1:1-26.

California State Coastal Conservancy, 1989. *The Coastal Wetlands of San Diego County.* San Diego, CA

Chambers, J. 1991. *Coastal Degradation and Fish Population Losses.* In: Proceedings of the National Symposium on Fish Habitat Conservation. Baltimore, MD, March 7-9, 1991.

Dennis, N.B. and M.L. Marcus, 1984. *Status and Trends of California Wetlands.* California Assembly, Resources Subcommittee on Status and Trends, Sacramento, CA

Department of Parks and Recreation [State of California], 1988. *California Wetlands.* An element of the California Outdoor Recreation Planning Program, Department of Parks and Recreation, Sacramento, CA

Dewees, Christopher M., E.M. Strange, and G. Guagnano. 1990. "Competing for the Recreational Dollar: An Analysis of the California Commercial Passenger-Carrying Fishing Vessel Industry". *Marine Fisheries Review.* 52: 1-6.

Draft Environmental Impact Report/Environmental Impact Statement, 1991. California Coastal Conservancy and U.S. Fish and Wildlife Service, Tijuana Estuary Tidal Restoration Program.

Duda, Mark D. 1991. *A Bridge To The Future: The Wildlife Diversity Funding Initiative - A Needs Assessment For The Fish And Wildlife Conservation Act.* Western Association of Fish and Wildlife Agencies.

Eres, Joan S. 1992. *Statistics for Fish, Shellfish, and Other: Poundage and Values of Landings by Port, San Diego Area.* State of California, Department of Fish and Game. Long Beach, CA.

Fields, S., 1992. Regulations and policies relating to the use of wetlands for nonpoint source pollution control, Ecological Engineering, 1:135-141.

Gross, M.G., 1987. *Oceanography, A View of the Earth.* Prentice-Hall, Englewood Cliffs, N.J.

Haugen, C., editor. 1990. *The California Halibut, Paralichthys californicus, Resources and Fisheries.* State of California, Department of Fish and Game. Fish Bulletin 174. Long Beach, CA.

Leet, William S., Christopher Dewees, and Charles W. Haugen. 1992. *California's Living Marine Resources And Their Utilization.* Sea Grant Extension Publication UCSGEP-92-12, UC Davis, CA.

Los Angeles Times, The. 1985. "The Lagoons", March 31, 1985. 5 pp.

Martin, Ken, coordinator. 1988. *California Wetlands.* State of California, Department of Parks and Recreation. Sacramento, CA.

Monaco, M., D. Nelson, R. Emmett, and S. Hinton. 1990. *Distribution and Abundance of Fishes and Invertebrates in West Coast Estuaries.* Volume I: Data Summaries. NOAA. Rockville, MD.

National Audubon Society Western Regional Office, 1992. *Saving Wetlands: A Citizens' Guide for Action in California*, Sacramento, CA

National Research Council, 1995. *WETLANDS: Characteristics and Boundaries* (Prepublication Draft). National Academy Press, Washington, D.C.

National Park Service. 1990. *Economic Impacts of Protecting Rivers, Trails, and Greenway Corridors.* A Resource Book. U.S. Department of the Interior. National Park Service, Rivers and Trails Conservation Assistance Program. Washington D.C.

SANDAG, 1993. San Diego Association of Governments. *Shoreline Preservation Strategy for the San Diego Region*, San Diego Association Of Governments, San Diego, CA

San Diego County Department of Parks and Recreation, 1990. *Field Check List of Birds in San Diego County.* San Diego, CA

San Diego County Department of Health Services, Environmental Health Services, 1990. *San Diego Bay Health Risk Study*, San Diego, CA

Thomas, Cynthia J., and Stephen J. Crooke. 1991. *Results of the Southern California Sportfish Economic Survey.* NOAA. National Marine Fisheries Service, Southwest Fisheries Center. La Jolla, CA.

United States Environmental Protection Agency. 1991. *Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters.* USEPA. Washington, D.C.

United States Environmental Protection Agency. 1990. *Beyond the Estuary: The Importance of Upstream Wetlands In Estuarine Processes.* USEPA. Washington, D.C.

Walsh, R., D. Johnson, and J. McKean. 1988. *Review of Outdoor Recreation Economic Demand Studies With NonMarket Benefit Estimates, 1968-1988.* Technical report #54. Colorado Water Resources Research Institute, Colorado State University. Ft. Collins, CO.

Webster's New Collegiate Dictionary, 1973. G. and C. Merriam Co, Springfield, M.A.

Wetlands: Their Use and Regulation (Washington, D.C.: U.S. Congress, Office of Technology Assessment, OTA-O-206, March 1984).

Zedler, J.B, C.S. Nordby, and B.E. Kus, 1992. *The Ecology of Tijuana Estuary, California: A national Estuarine Research Reserve.* NOAA Office of Coastal Resource Management, Sanctuaries and Reserves Division, Washington, D.C.

Zedler, J.B., and R. Langis. 1990. *A Manual For Assessing Restored and Natural Coastal Wetlands, with Examples from Southern California.* Pacific Estuarine Research Laboratory, Sea Grant Report No. T-CSGCP-021. La Jolla, CA.

Zedler, J.B., 1982. *The Ecology of Southern California Coastal Salt Marshes: A Community Profile.* U.S. Fish Wildlife Service, FWS/OBS-81/54, 110 pp.