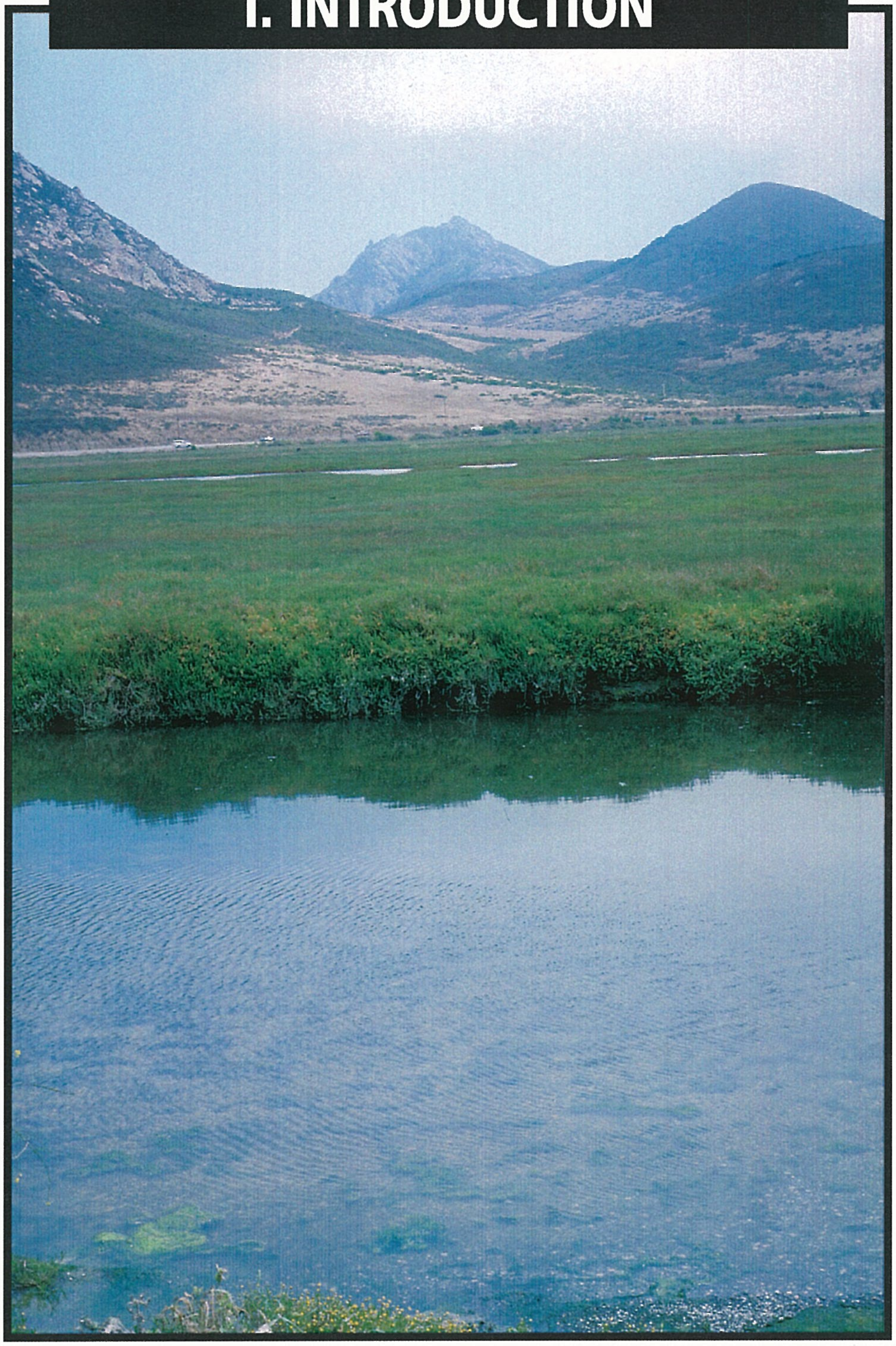
I. INTRODUCTION



California, San Luis Obispo County: Morro Bay

INTRODUCTION

Wayne R. Ferren Jr.[1], Peggy L. Fiedler[2], and Robert A. Leidy[3]

Background. In 1991, the United States Environmental Protection Agency (EPA), Region IX, funded a study to produce a classification, inventory, and description of wetland types along the coast and in coastal watersheds of the Southern Coastal, Transverse, and Peninsular Ranges in central and southern California. This region extends for approximately 400 miles, or about one-half the length of the state, from the Carmel River (ca. 36°30' N lat.) in Monterey County, south to the Tijuana River (ca. 32°30' N lat.) in San Diego County (Fig. I-1).

The investment by EPA was based upon an earlier compilation of wetland information (Ferren 1989) that was gathered in California for more than 10 years and organized according to a modified version of the U.S. Fish and Wildlife Service (FWS) wetland classification, published by Cowardin et al. in 1979. This ten-year effort was initiated because at the time no existing vegetation or habitat classification scheme (e.g., Munz 1959, 1974; Cheatham and Haller 1975; Holland 1986) adequately documented the great richness of wetland types in California or attempted to incorporate the special environmental attributes that occur in the region as a result of the Mediterranean and arid climates. Ferren (1989:3) "... found it necessary for communication purposes to categorize wetlands into some hierarchical system that would delineate the types of wetlands according to physical and biological criteria." The Cowardin et al. (1979) system is such a hierarchical classification, "...progressing from system to subsystems, at the general levels, to classes, subclasses, and dominance types....Modifiers for water regime, water chemistry, and soils are applied to classes, subclasses, and dominance types."

Concern for the absence of thorough documentation of California wetlands, however, is replaced by alarm when one considers the extensive losses of wetlands that have occurred in the coastal watersheds without previous documentation of the habitat richness, ecosystem functions, and socio-economic values of these wetlands. Extensive agricultural development, rapid

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[1]Department of Biological Sciences, University of California, Santa Barbara, CA 93106

[2]Department of Biology, San Francisco State University, San Francisco, CA 94105

[3]U.S. Environmental Protection Agency, 75 Hawthorne St., San Francisco, CA 94105 and Department of Wildlife and Fisheries Conservation, University of California, Davis 95616

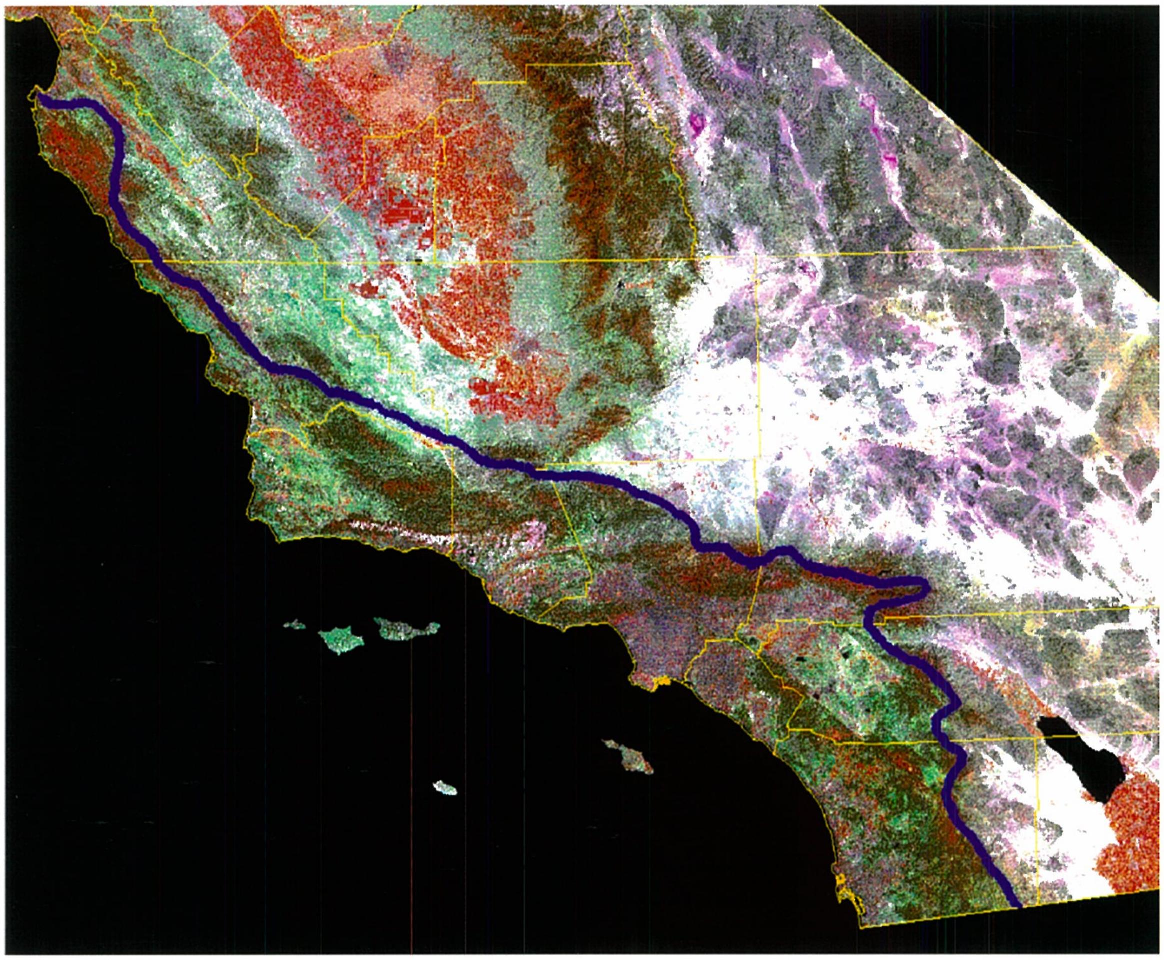

FIG. I-1. WETLANDS OF THE CENTRAL AND SOUTHERN CALIFORNIA COAST AND COASTAL WATERSHEDS: THE STUDY AREA. This Landsat false-color composite illustrates portions of central and southern California. The study area occurs west of the coastal watershed divide (blue line), extending from the Carmel River Watershed in Monterey County, southward to the northern Tijuana River Watershed in San Diego County and the U.S. border with Mexico. Boundaries of California counties appear as yellow lines. Although the wetlands are generally not visible at this resolution, the region contains a rich number of wetland types from each of the five systems of wetlands and deepwater habitats in North America. The mosaic of Landsat Thematic Mapper scenes dates circa 1990. Image processing was done by the Biogeography Lab at UCSB. North is parallel to vertical edge of page.

urbanization, flood control practices, and the continuing extraction of physical resources (such as petrochemicals, gravel, and water) are among the main contributors to these losses and to the degradation of many of the remaining wetlands (California Dept. Parks and Recreation 1988; Sandecki 1989; Dahl 1990; Leidy 1990; DeVries and Conard 1991; National Audubon Society 1992). Furthermore, changes proposed in 1991 to the definition of wetlands as recognized by federal regulatory agencies, would result in the elimination of federal jurisdiction over many types of wetlands in western North America, and would exacerbate the potential threat of additional losses in California (Seraydarian 1991). Thus this study is based upon an urgent need for a mechanism to be able to articulate the scope of the wetland heritage of California, particularly central and southern California, so that conservation efforts can accurately protect these resources.

Methods. Our starting point for this study was a draft classification prepared by Ferren (1989), which was a previous compilation of information on Santa Barbara regional wetlands, organized into an expanded hierarchical version of Cowardin et al. (1979). For the current study, we designed a data sheet onto which we recorded information or otherwise compiled notes regarding the descriptive physical and biological attributes from "reference site" wetlands. Our original goal was to locate and visit examples of all types of wetlands we would be able to classify for the study region. From a combination of team field experience, references, assistance from others, and reconnaissance trips we compiled the information resource from which we developed the classification and determined the types. The scope of our project changed during the course of the three year effort because we realized that what appeared to be nearly limitless variation of habitats and dominance types would make it difficult for us to complete an inventory of wetland types. Thus we narrowed our focus to include: (1) the development of a methodology to identify and classify wetlands in the study region according to a modified Cowardin et al. approach; and, (2) a presentation of illustrated examples organized according to this hierarchical classification.

Our field work was initiated on October 12, 1991, and continued at various intervals into Summer 1994. The field work focused on: (1) visits to known sites of interest; (2) reconnaissance trips into poorly explored regions; and, (3) generalized transects from the intertidal marine shoreline to the crest of the coastal watershed divides, extending from the Carmel River Watershed at the northern limit of the study region to the Tijuana River Watershed at the southern limit of the region. Many of the numerous physiographic areas of the region, such as mountain ranges and valleys, and prominent bodies of water including estuaries, rivers, and various lakes and reservoirs were included in the survey. Botanical vouchers of taxa unknown to us or important records for sites or habitats were prepared and deposited at UCSB as part of the inventory of dominant and characteristic species. Photographs were taken of virtually all sites, a selection of which are included in this volume. Field notes and photographs were arranged partially for access by trip, county, and system of classification. A literature and other resource review, and interviews with regional and local specialists, contributed to the information base we have compiled. Early versions of the new methodology were tested by various users and modifications were made over the course of three years, including the addition of a numerical hierarchy and wetland code number. Although the functional assessment of the Ventura River watershed was an important component of this effort and included use of the classification produced by this team, it was conducted somewhat independent of the larger effort, and thus the methods for the study are contained within the relevant part (Section X) of this volume.

The Study Region. California is climatically, topographically, and geologically diverse, which contributes to its great habitat richness. Factors that influence the formation and differentiation of wetlands can include, for example, elevation, exposure, bedrock, soil, rates of erosion or sedimentation, temperature, rainfall, accumulation of salts, distance from the ocean, tidal regimes, energy of water flow, and artificial disturbances. The study region extends topographically from marine wetlands exposed irregularly at extreme low tide, to glacial ponds at approximately 3000 m (9000 ft) elevation in the San Gorgonio Wilderness Area. The breadth of the study region extends from its narrowest at approximately 16 km (10 mi) along the Santa Lucia Mountains in Monterey County, to its broadest at approximately 128 km (80 mi) in the San Bernardino Mountains. The great richness of habitat types and environmental parameters, including potentially large seasonal variation in local weather patterns, have undoubtedly contributed to the evolution of equally rich and often unique biological resources that occur in particular groupings of habitats in California. Biological endemism is a characteristic of wetlands with special hydrogeochemical features, such as alkali meadows, serpentine and tar seeps, vernal pools, and salt marshes.

Wetlands in central and southern California occur in various ecosystem contexts (e.g., lagoons, rivers, lakes, ponds), but have origins related to several major physical processes. Wetlands that develop as a result of fluvial processes occur in riparian corridors, such as along the Santa Clara River (Fig. I-2). Here riverine and palustrine wetlands occur in proximity to estuarine and marine wetlands when a river reaches the coast and tidally-influenced water regimes bearing ocean-derived salts meet waters and habitats of continental origin. Elsewhere, structural basins with high or perched water tables may serve as sediment sinks and support the development of alkali flats, as in the Temescal Wash and Lake Elsinore area along the eastern margin of the Santa Ana Mountains (Fig. I-3). Other basinal hydrogeomorphic units and their associated wetlands can develop as a result of: (1) eolian processes that form dune swale wetlands (Fig. I-4); (2) earthquake

FIG. I-2. **VENTURA CO., SANTA CLARA RIVER AND ESTUARY**. Oblique aerial view (Dec 1992) of the lower Santa Clara River and the associated hydrogeomorphic units and wetlands. Major rivers that reach the coast of central and southern California support a rich complex of wetlands and deepwater habitats. As shown here, four of the five systems (marine, estuarine, riverine, and palustrine) of wetlands and deepwater habitats occur in proximity. Also evident is the encroachment on those coastal wetlands from agricultural development on the Oxnard Plain and urbanization of the coast. For example, to the northwest (left) of the river mouth, sewage treatment ponds and a portion of the Ventura Harbor are visible.

FIG. I-3. **RIVERSIDE CO., LAKE ELSINORE AND TEMESCAL WASH AREA**. The strong seasonal pattern of wet and dry periods that characterize the region's Mediterranean climate has resulted in the formation of many specialized hydrogeomorphic units and associated wetlands. In this view to the west, alkali-vernal-flats have formed in a structural basin, developed along an earthquake fault, that support a form of nonpersistent-emergent-wetland, shown here dominated by an annual member of the Aster Family, *Lasthenia californica* (Goldfields).

faults along which can form "sag-ponds" (Fig. I-5); and, (3) artificial creation of basins such as the impoundment of lacustrine reservoirs (Fig. I-6).

The creation of wetlands and deepwater habitats wetlands associated with reservoirs and other artificial structures can have significant socio-economic values. However, various impacts to ecosystems can result in the conversion of wetlands from one type with apparent higher ecosystem functions and greater socioeconomic values to another with lesser importance. For example, at Ballona Wetlands (Playa Vista) in Los Angeles County, intertidal estuarine wetlands were converted to nontidal, disked, palustrine wetlands when tide gates were installed and wetlands were temporarily used for agricultural purposes (Fig. I-7). The resulting degraded wetlands support a mixture of native hydrophytes and exotic weedy species. Fortunately, a large-scale restoration project has been approved for the site, which will return tidal circulation to some previously estuarine habitats (National Audubon Society 1986).

Superimposed on the origin (e.g., fluvial, structural, eolian) and ecosystem context of wetlands (e.g., estuaries, streambeds, lake margins) are the influential attributes of strongly seasonal wet and dry periods and a wide range of edaphic differences among sites, all of which result in the formation of a truly vast number of hydrogeomorphic units and their corresponding wetlands. This is the origin of the rich wetland heritage of coastal California.

Scarcity and Losses. Because of the generally dry climate of ecoregions of southern California, dogma apparently has developed in many professional and lay circles that suggests wetlands of the region are uncommon and by inference are limited in type, numbers, and importance. Generalizations abound. For example, "...marshes and swamps are scarce throughout the [Californian estuary] province" (Cowardin et al. 1979:28). Recent evidence, such as that presented herein, demonstrates that wetlands of the California province are neither scarce nor limited in types. Some, however, are common, whereas others are rare. The problem of wetland interpretation in California generally has developed from a lack of recognition and appreciation of habitat functions and values, resulting from too few scientists studying wetlands and from too little information reaching planners and politicians. This problem has led to difficulties in the protection and management of wetlands, delimitation of their boundaries, and determination of their jurisdiction.

As might be expected, we are finding that many examples of wetland types have been destroyed before they were identified, studied, and protected. In the United States during the past 200 years, the lower 48 states have lost an estimated 53% of the original 221 million acres of

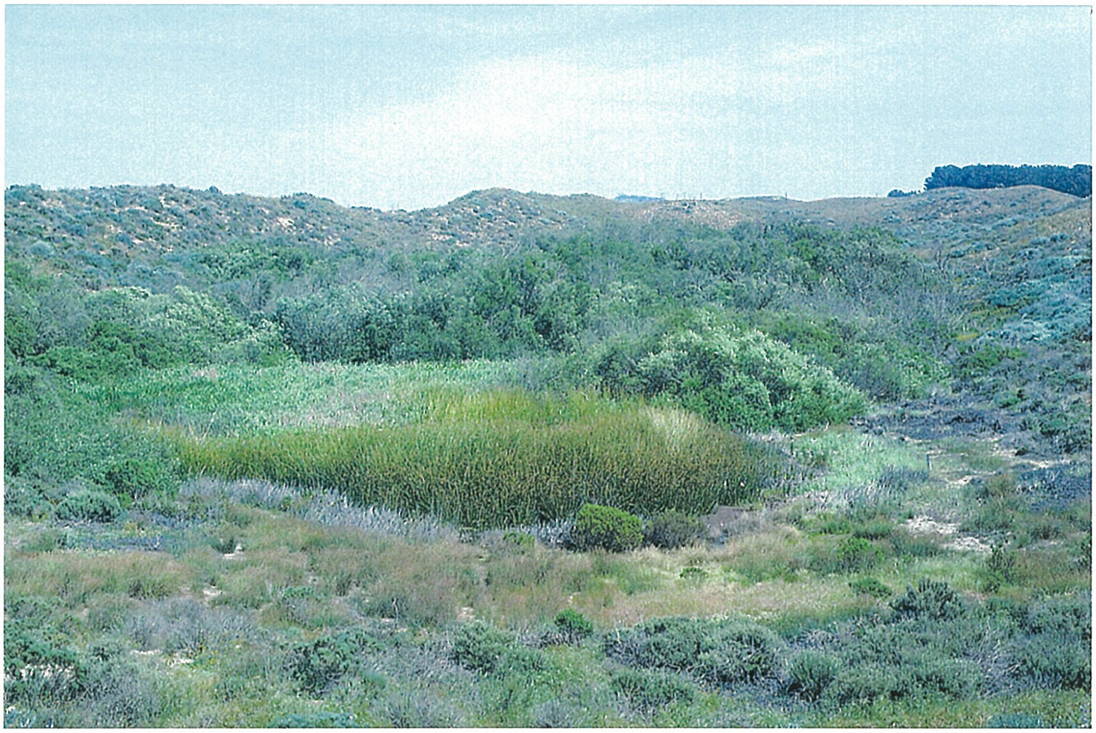

FIG. I-4. **SANTA BARBARA CO., VANDENBERG AIR FORCE BASE, SAN ANTONIO TERRACE DUNES**. View northward toward a dune swale wetland, a type of natural basin that supports various types of palustrine wetlands, including examples of the wetland classes aquatic-bed, emergent, and scrub-shrub.

FIG. I-5. **SAN BERNARDINO CO., SAN BERNARDINO NATIONAL FOREST, LOST LAKE**. View northwestward toward Lost Lake, a natural fault-sag-pond in the San Andreas Rift Zone. Many palustrine wetlands in coastal watersheds of central and southern California have a structural origin rather than a fluvial origin. Lost Lake occurs along the San Andreas Fault. Most natural ponds in the region are structural wetlands.

wetlands; 22 of these states have lost 50% or more of their original wetland acreage (Dennis and Marcus 1984; Dahl 1990). Dennis and Marcus (1984) estimated nearly a decade ago that only about 9% (ca. 450,000 acres) of California's wetland resources remain as compared to when it became a state in 1850 (ca. 5 million acres). This means a loss of 91% of the state's wetlands, and a reduction of total surface of the state in wetlands from approximately 5% of the land to less than one-half of one percent of the land (Dahl 1990).

The California Department of Parks and Recreation (CDPR 1988) reports that at the statewide level, California has lost approximately 80% of the coastal salt marshes, 95% of the riparian wetlands, 90% of freshwater marshes, and 90% of the vernal pools. Along the southern coast of California they estimate there has been a 75% reduction in wetlands, from approximately 53,000 acres to 13,000 acres. Notable examples of wetland types that largely have been eliminated in southern California include: (1) estuarine wetlands (i.e., salt marshes) as an entire subsystem at 75-90% (J. Zedler 1982; California Department of Fish and Game 1983; California Coastal Commission 1989), (2) "the riparian community" at 90-95% (Faber et al. 1989) including loss of 40% of the riparian wetlands in San Diego County during the last decade alone (CDPR 1988); and, (3) vernal pools at 90% (P. Zedler 1987). These losses have contributed directly to the endangerment of the biological resources of California, as evidenced by estimates that 55% of the animals and 25% of the plants designated as threatened or endangered by the State depend on wetland habitats for their survival. Refer to Appendix I for an annotated catalogue of the wetland-dependent species of special concern that inhabit the study region.

It is with general interest in our California wetland heritage and with concern for the rate and extent of habitat loss that we have integrated a compilation of information into a hierarchical classification based on a modified version of Cowardin et al. (1979). The scope of this classification includes all wetlands from the five wetland systems identified for North America (i.e., marine, estuarine, riverine, lacustrine, palustrine), each of which occurs in California. Only through detailed analysis can we fully appreciate the richness of wetland habitats and biota in California, and can we hope to protect and manage those wetlands that remain.

Wetlands Definition

Wetlands in California vary widely in topographic setting, hydrology, chemistry, substrate, vegetation physiognomy, and persistence. Before we precede with the examination of the Mediterranean-climate wetlands of California, acceptance and consistent application of a wetland definition is essential. We endorse for use in California the definition proposed by Cowardin et al.

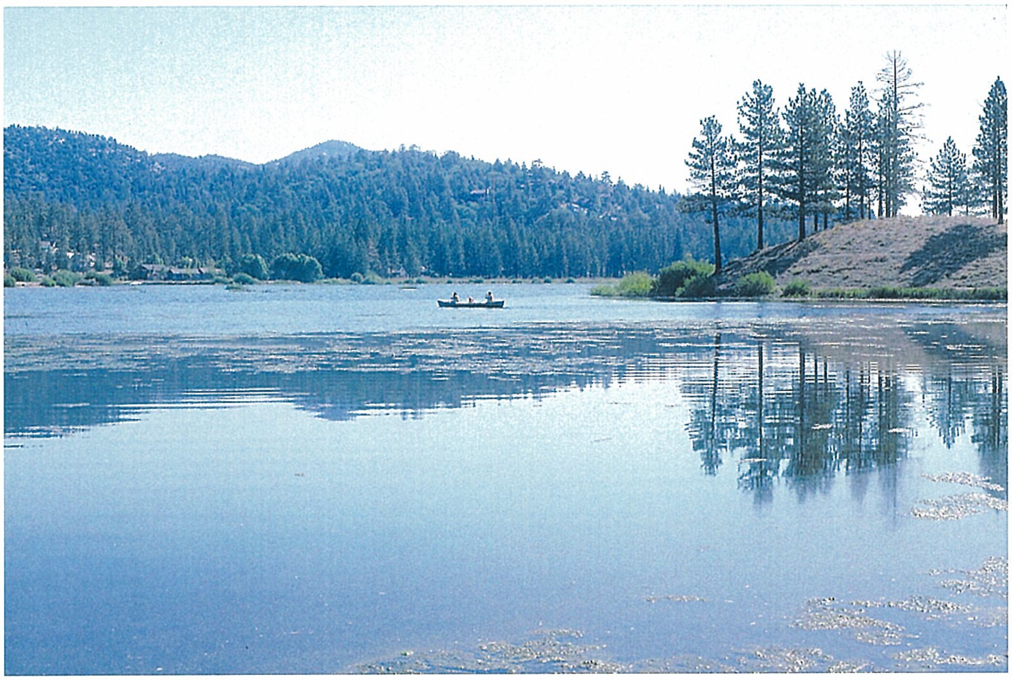

FIG. I-6. **SAN BERNARDINO CO., SAN BERNARDINO MOUNTAINS, BIG BEAR LAKE**. View eastward across Big Bear Lake, an artificial lacustrine reservoir. Many types of hydrogeomorphic units in coastal watersheds of central and southern California are artificial and have been created as a result of or in response to the agricultural development and urbanization of the region. All of the lacustrine wetlands associated with Big Bear Lake, and their various ecosystem functions and socio-economic values, are the result of the creation of this montane reservoir. The palustrine wetlands that had occurred in the montane valley were destroyed or severely impacted as a result of the creation of the lacustrine ecosystem.

FIG. I-7. **LOS ANGELES CO., BALLONA WETLAND.** View southeastward across a portion of Ballona Wetland. This salt-affected palustrine wetland was historically a part of the estuary at the mouth of the Los Angeles River. As shown here, the wetland has been disked for agricultural purposes and tidal flushing is controlled by tide gates. Restoration of the estuarine ecosystem is proposed in association with a large-scale residential and commercial development approved for adjacent properties.

(1979). At the state level, the California Fish and Game Commission, Department of Fish and Game, and the California Coastal Commission also accept this definition and the associated technique for the classification of wetlands (Gibbons 1992). At the regional level, the county of Santa Barbara and the city of San Diego are examples of governments that accept this definition. Cowardin et al. (1979) have provided some helpful insights concerning the definition of wetlands. They suggest that the term **wetlands**, "...has grown out of a need to understand and describe the characteristics and values of all types of land, and to wisely and effectively manage wetland ecosystems. There is no single, correct, indisputable, ecologically sound definition for wetlands because of the diversity of wetlands and because the demarcation between dry and wet environments occurs along a continuum....The primary objective of this classification is to impose boundaries on natural systems for the purposes of inventory, evaluation, and management" (Cowardin et al. 1979:3). Their definition follows:

> *Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For the purpose of this classification, wetlands must have one or more of the following attributes: (1) at least periodically, the land supports predominantly hydrophytes; (2) the substrate is predominantly undrained hydric soil; (3) the substrate is nonsoil and is saturated or covered with shallow water at some time during the growing season of each year* (Cowardin et al. 1979:3).

This definition is broad enough to include the special nature of wetlands in the California Chaparral and Estuarine Provinces, and the Colorado Plateau and Desert Provinces in California. In addition to the definition of wetlands, the following definition for **deepwater habitat** has been presented by the U.S. Fish and Wildlife Service in Cowardin et al. (1979:3):

> *[Deepwater habitats are] permanently flooded lands lying below the deepwater boundary of wetlands. Deepwater habitats include environments where surface water is permanent and often deep, so that water, rather than air, is the principal medium within which the dominant organisms live...As in wetlands, the dominant plants are hydrophytes; however, the substrates are considered nonsoil because the water is too deep to support emergent vegetation...*"

Use of these definitions in association with the modified hierarchical classification to systems of wetlands and deepwater habitats requires some additional explanation. The FWS classification is hierarchical and progresses from systems and subsystems at general levels to classes, subclasses, dominance types, and habitat modifiers (Cowardin et al. 1979). Systems and subsystems (Table I-1) are delineated according to major physical attributes such as tidal flushing, ocean-derived salts, and the energy of flowing water or waves. Classes and subclasses describe the type of substrate and habitat or the physiognomy of the vegetation or faunal assemblage. Wetland classes are divided into physical types (i.e., rock bottom, unconsolidated bottom, streambed, rocky shore, and unconsolidated shore) and biotic types (i.e., aquatic bed, reef, moss-lichen wetland, emergent wetland, scrub-shrub wetland, and forested wetland). For the purposes of this classification and partial inventory of California wetlands, we have provided: (1) keys to the wetland subclasses; (2) classifications of the hydrogeomorphic types; (3) a catalogue of selected types for each system; and, (4) a selection of illustrated and described types from the catalogue. Hierarchical information for each of the illustrated types or group of types has been organized in tabular form, and additional information (e.g., description, functions and values, characteristic species, examples, impacts, and literature) is categorized and presented on sample data pages for selected wetland types.

We do not intend this classification and inventory of types to be exhaustive. We realize that the vastness of the study region and complexity of the environment limit our ability to include all types, particularly at the rank of dominance type. Thus we suggest this treatment be considered open-ended, as Cowardin et al. (1979) was intended to be open-ended and expandable. Additional field work and research will reveal more types below the level of subclass.

Clean Water Act Section 404 Jurisdiction

The purpose of the Clean Water Act is "to restore and maintain the chemical, physical, and biological integrity of the Nation's waters." Section 404 of the Clean water Act regulates the discharge of dredged and fill material into "waters of the United States", and establishes a permit program to ensure that discharges comply with environmental regulations. Section 404 is administered jointly at the federal level by the U.S. Army Corps of Engineers and U.S. Environmental protection Agency.

The term "Waters of the United States" is defined at 33 CFR 328.3 as:

"(1) All waters which are currently used, or were used in the past, or may be susceptible to use in interstate or foreign commerce, including all waters which are subject to the ebb and flow of the tide;

(2) All interstate waters including interstate wetlands;

(3) All other waters such as intrastate lakes, rivers, streams (including intermittent

streams), mudflats, sand flats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds, the use, degradation or destruction of which could affect interstate or foreign commerce including and such waters:

(i) Which are or could be used by interstate or foreign travellers for recreational or other purposes; or

(ii) From which fish or shellfish are or could be taken and sold in interstate or foreign commerce; or

(iii) Which are used or could be used for industrial purposes by industries in interstate commerce;

(4) All impoundments of waters otherwise defined as waters of the United States under the definition;

(5) Tributaries of waters identified in Paragraphs (a)(1-4) of this section;

(6) The territorial seas;

(7) Wetlands adjacent to waters (other than waters that are themselves wetlands) identified in Paragraphs (a)(1-6) of this section.

Waste treatment systems, including treatment ponds or lagoons designed to meet the requirements of the CWA (other than cooling ponds as defined in 40 CFR 123.11(m) which also meet the criteria of this definition) are not waters of the United States.

The limits of jurisdiction for waters of the United States under 33 CFR 328.4 are as follows:

(a) Territorial Seas. The limit of jurisdiction is measured from the baseline in a seaward direction a distance of three nautical miles.

(b) Tidal Waters of the United States. The landward limits of jurisdiction in tidal waters extends to the high tide line, or when adjacent non-tidal waters of the United States are preset, the jurisdiction extends to the limits identified in paragraph (c) of this section, below.

(c) Non-tidal Waters of the United States. The limits of jurisdiction in non-tidal waters, in the absence of adjacent wetlands, extends to the ordinary high water mark, or when adjacent wetlands are present, the jurisdiction extends beyond the ordinary high water mark to the limit of the adjacent wetlands. When the water of the United States consists only of wetlands, the jurisdiction extends to the limit of the wetland.

The term "wetlands" means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas.

EPA and the Corps use the 1987 Corps of Engineers Wetlands Delineation Manual as the technical basis for identifying jurisdictional wetlands. The EPA and Corps definition of wetland requires positive evidence of three parameters: wetland hydrology, hydrophytic vegetation, and hydric soil. This is in contrast to the Cowardin et al. (1979) wetland defintion that was prepared for the U.S. Fish and Wildlife service, which requires only the presence of one or more indicators of wetland hydrology, hydrophytic vegetation, or hydric soils. Thus, Cowardin et al. (1979) wetlands include both vegetated and nonvegetated wetlands, recognizing that some types of wetlands lack vegetation (*e.g.*, mud flats, sand flats, rocky shores, gravel beaches, and sand bars). As a practical matter this means that wetlands as defined under Cowardin et al. (1979) will almost always apply to a larger area for a given site when compared to the Corps and EPA criteria. Areas that do not meet all three Corps/EPA technical criteria for wetlands may be nevertheless regulated as "other waters" of the United States, as defined above.

Hydrogeomorphic Units

We have developed a numerical, hierarchical presentation of the modified Cowardin et al. approach to provide a method to organize the wetland types. Our nomenclature for the wetlands is derived from the orderly presentation of names for the various categories of wetland information provided in the wetland type number. Details of the methodology are presented in Chapter III: Classification. To describe the rich variation in wetlands of the study region, we added several categories of information to the hierarchy by Cowardin et al. that aid in the characterization of California wetlands. Perhaps the most important categories are the site-specific "geomorphic" type we designate as **hydrogeomorphic units** (e.g., flats, slopes, pools, channels, beds), many of which are defined in the Glossary. Use of hydrogeomorphic units results in the ability to differentiate wetlands of similar hydrology, chemistry, or dominance type that occur in different topographic landforms and that may have different ecosystem functions and socio-economic values. We also use or support the use of ecosystem functions and socio-economic values to differentiate among wetlands that may be similar in physical and physiognomic features, but are different or unique in the role they play in an ecosystem or in the way they are viewed by various anthropogenic interests.

TABLE I-1. **SYSTEMS AND SUBSYSTEMS OF WETLANDS AND DEEPWATER HABITATS (ADAPTED FROM COWARDIN ET AL. 1979).**

- **Marine System**: The open ocean overlying the continental shelf and the adjacent coastline. Water regimes are determined by oceanic tides and salinities from NaCl (halite) exceed 30 ppt (parts per thousand). Subsystems include intertidal wetlands and subtidal deepwater habitats.
- **Estuarine System**: Estuaries are coastal embayments that have at least occasional access to the ocean, and thus water with ocean-derived salts enters with the tides, and in which the ocean water is at least occasionally diluted by freshwater runoff from the adjacent land. Subsystems include intertidal wetlands and subtidal deepwater habitats.
- **Riverine System**: The wetlands and deepwater habitats within a channel that are influenced strongly by the energy of flowing water. The Riverine System excludes (1) stands of persistent vegetation such as trees, shrubs, and some forms of emergent vegetation; and (2) channels with ocean-derived salts in excess of 0.5 ppt (i.e., estuarine channels). Subsystems include tidal; upper, mid, and lower perennial; and upper, mid, and lower intermittent catgories.
- **Lacustrine System**: The wetlands and deepwater habitats located in large, at least intermittenly-flooded depressions, or dammed canyons, river valleys, or montane valleys. Shoreline features and vegetation are influenced by the energy of waves and lack stands of trees, shrubs, persistent emergents, and mosses and lichens that exceed 30% cover. Total area generally exceeds 8 hectares (20 acres); in smaller examples the limnetic subsystem is present. Subsystems include littoral (wetland) and limnetic (deepwater habitat) types.
- **Palustrine System**: The nontidal wetlands dominated by trees, shrubs, persistent or nonpersisent emergents, mosses or lichens, and such wetlands in tidal areas where salinity from ocean-derived salts is below 0.5 ppt. Also included are wetlands that lack vegetation but (1) are less than 8 hectares, (2) lack wave-formed shorelines, (3) have water depths less than 2 meters (6.6 feet) at low water, and (4) have salinity due to ocean derived salts less than 0.5 ppt. Thus palustrine wetlands lack the physical and biological attributes of the other four systems but often are in proximity to examples of those systems. The Palustrine System lacks subsystems, and thus all palustrine types are classified directly into classes and subclasses.

Ecosystem Functions and Socio-economic Values

There are four major categories of *ecosystem functions* and the four major categories of *socio-economic values* recognized in part by the U.S Fish and Wildlife Service (Sather and Stuber 1984; Sather and Smith 1984), preceded by (e.g., Greeson et al. 1978; Adamus and Stockwell 1983), and added to or modified by others (e.g., Faber et al. 1989; Zedler et al. 1990; Ferren and Fiedler 1993; L. C. Lee & Associates 1993), including the authors. The categories of ecosystem functions are: (1) **Food chain support and nutrient cycling** functions, including primary production, decomposition, nutrient export, and nutrient utilization; (2) **Habitat** functions, including habitat for endangered, rare, and other "sensitive" species, native plants, invertebrates, fisheries such as anadromous fish, birds including resident and migratory species, and mammals and herpetofauna; (3) **Hydrology**, including flood conveyance, sediment control, ground water recharge and discharge, and shoreline protection; and, (4) **Water quality** functions, including water supply, wastewater treatment, detoxification of toxic substances, and modification of pollution from nutrient enrichment.

Categories of socio-economic value are: (1) **Non-Consumptive values** such as recreation, research, and education; (2) **Consumptive values** of "harvestable" physical resources such as water, gravel, and petrochemicals and biotic resources such as fisheries, lumber, and crops; (3) **Cultural values** by Native Americans, including activities such as basketry, gathering of food and medicinal plants, and acquisition of house building materials; and, (4) **Aesthetic and Natural Heritage values** including natural landscape features, setting, and other aspects of natural California heritage.

Although the aesthetic and natural heritage values clearly derive their importance from other categories of ecosystem functions and socio-economic values, the sum of these categories can produce an effect of greater significance that is worthy of separate recognition. For example, sunset over an estuary that provides habitats for various endangered species and food chain support for migratory birds, but that also occurs in an otherwise urbanized coastline, may have an aesthetic and natural heritage value that exceeds the individual benefits provided by the other categories. Classifying the wetland richness of California and identifying the ecosystem functions and socio-economic values of the wetland types will be an important step toward conserving the unique natural wetland heritage and landscape aesthetics that help provide a sense of place and separate the study region from other places on earth.

How To Use This Volume

We have designed this volume to serve as a methodology for the classification and description of the wetlands of the central and southern California coast and coastal watersheds. Although it may be useful beyond this region, there may be wetland types from other regions that do not fit into the classification as provided within. Information on the environmental setting of the study region and the physical parameters that influence the origin and development of wetlands is presented in Chapter II.

An explanation of the classification is presented in Section III, followed by keys to the wetland systems, subsystems, and classes in Section IV, which in turn leads to and is followed by sections for each of the five systems of wetlands and deepwater habitats (Sections V-IX). Section III: Classification, contains tables on the numerical hierarchies of (1) the systems, subsystems, classes, and subclasses of wetlands; (2) water regime and water chemistry categories; (3) hydrogeomorphic units for marine and estuarine systems; (4) hydrogeomorphic units for riverine, lacustrine, and palustrine systems; (5) substrate, dominance, and/or characteristic types for the marine and estuarine systems; and, (6) substrate, dominance, and/or characteristic types for the riverine, lacustrine, and palustrine systems. These tables are not repeated for each system but are to be used for each system during the classification process for wetlands from any of the five systems (see Section III). The system sections however, each have a table of combined water regimes and hydrogeomorphic units that is unique to each system and that provides a mechanism to identify and name the various wetlands in each system. The keys in Section IV and partially repeated in the five wetland system sections (V-IX) lead the user to a catalogue of wetland types in each system section, many of which are then illustrated and selectively described following the catalogue. Section X, The Ventura River Watershed, presents an assessment of all wetlands from a watershed perspective rather than a system perspective. The wetland system sections are designed to be used with the keys and tables in Section IV, but otherwise stand alone and be used independently of the rest of the volume. Thus, those users interested in wetlands from only one system can use a particular section independent of the others.

When a wetland has been chosen for classification, a series of questions can be raised and answered that will assist the classifier in collecting information that will be necessary for the development of a wetland name and numerical code. We suggest consideration of the following list of questions, and the accompanying brief discussion of each, when confronted with the issues of classification.

1. ***What are the goals of the project or task? Why is there a need to classify and describe wetlands?*** Having a clear statement and understanding of the goals of a project or task will help determine the scope, scale, and detail that a wetland classification must include.

2. ***What is the ecosystem context of the wetland under consideration?*** It is important to consider which of the five systems of wetlands and deepwater habitats, and the corresponding subsystems, that most influences the site. For example, a littoral lacustrine ecosystem may include a combination of lacustrine and palustrine wetlands, a situation that would influence the nomenclature of each type.

3. ***At what scale will the classification be applied? Will the scale include, for example, an entire river channel or only a bar and/or back-bar channel within the main channel?*** Scale is an important and often perplexing issue that can result in confusion over what is being classified. We have allowed for coarser-scale, higher orders of classification as well as finer-scale, lower orders of classification. This arrangement provides flexibility to describe a specific wetland within the goals of a particular project. This flexibility may result in confusion or even differences of application to similar sites. We believe, however, that it is more useful and a better reflection of the field experience to incorporate a series of choices than to limit scale and miss opportunities to identify particular types of wetlands. This belief has guided the development of the classification hierarchy.

4. ***If the context and scale have been decided, what are the class(es) and subclass(es) of wetlands that characterize the site? Is the site in question dominated by abiotic and/or biotic wetland classes?*** Although in general a particular wetland is characterized by one wetland class and subclass, in many cases, sites of larger scale will have several attributes or mixtures of attributes. Thus, it is important to determine the dominant characteristic of the scale you have chosen. In general, the finer the scale of the ecosystem or site context, the more homogeneous the wetland habitat will be. For example, a dune swale wetland is a type of hydrogeomorphic unit that, if sufficiently large and flooded seasonally, may support examples of wetlands from palustrine aquatic bed, emergent, scrub-shrub, and forested wetland classes.

5. ***What are the various hydrogeomorphic and geochemical attributes of the wetland, such as water regimes, chemistry regimes, and hydrogeomorphic units? Are more than one combination of the attributes identifiable at the site?*** Although the system, subsystem, class, and subclass provide the context and structure to a wetland, it is the combination of hydrology (e.g., seasonally flooded), chemistry (e.g., alkaline), and geomorphology (e.g., flat, plain, or marsh) that

provide the distinguishing features among many wetland types.

6. ***What are the dominant substrate(s) or organism(s) of the wetland that contribute to the character of the site?*** Wetlands that are not dominated by organisms are usually described by the character of the exposed substrate (e.g., bedrock pool and cobble shore), whereas wetlands that are dominated by organisms also may be characterized by the types or identity of the organism. In the latter case, sites dominated by cottonwood trees (*Populus* spp.), for example, may be classified as woodlands or forests.

7. ***What are the observed or inferred ecosystem functions and socio-economic values of the wetland and/or the ecosystem context within which the wetland occurs?*** Because many wetlands are distinguished by their varied functions and values, it is important to include these as attributes of the wetland, and thus components in the classification process. Some wetlands that are visually similar in hydrogeomorphology and dominance type may in fact support significantly different ecosystem functions and socio-economic values. This difference may be a reflection of the ecosystem context, disturbance history, or regional location, but none-the-less can be an important factor in the classification process. For example, wetland riparian forests occur through out the region along rivers and streams and on margins of ponds and lakes of coastal watersheds, but some of those associated with similar hydrogeomorphic units (e.g., floodplains, banks, and bars) and dominated by the same combination of tree species (e.g., alders, willows, and cottonwoods) support different groupings of riparian-dependent migratory or resident bird species. The presence of various rare and endangered species (e.g., Least Bell's Vireo, *Vireo bellii pusillus*; Yellow-breasted Chat, *Icteria virens*; Willow Fly Catcher, *Empidomax traillii*; and Western Yellow-billed Cuckoo, *Coccyzus americanus occidentalis*) apparently reflects the importance of site characteristics that are not present in most of the riparian forests extant in the region. In this example, habitat function for riparian birds species is an important component of the classification that results in the differentiation of some forested wetlands from others, particularly is those sites also are nesting habitat for the birds.

Although this classification methodology provides extensive and detailed information, and requires many choices for a user to make, we believe the hierarchical approach provided herein can accurately portray the wetland resources and can provide a mechanism for consistent communication. The additional numerical code provides a mechanism for standardization of nomenclature and for potential data analysis, including changes of wetland types through time, should extensive mapping and classification of all wetlands occur in the region. If a mechanism has been achieved for standardization, communication, and analysis, then the goal of the project and this volume has been achieved. Identification and conservation of the rich and complex nature of the wetlands of the central and southern California coast and coastal watersheds will require the use of a detailed classification methodology such as the one we present here.