WETLANDS OF THE CALIFORNIA CENTRAL VALLEY:

STATUS AND TRENDS

—1939 to mid-1980's—

ACKNOWLEDGMENTS

Successful completion of any study reflects the efforts of many individuals. This California Central Valley wetland trend study is no exception and we wish to thank all the participants for their assistance.

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DUCKS UNLIMITED

Cover photographs are courtesy of the U.S. Bureau of Reclamation.

Courtesy of Mike Miller

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WETLANDS OF THE CALIFORNIA CENTRAL VALLEY

STATUS AND TRENDS

—1939 to mid-1980's—

Butte Sink

U.S. Fish and Wildlife Service
Region 1
Portland, Oregon
JUNE 1989

by: W. E. Frayer
Dennis D. Peters
H. Ross Pywell

HIGHLIGHTS

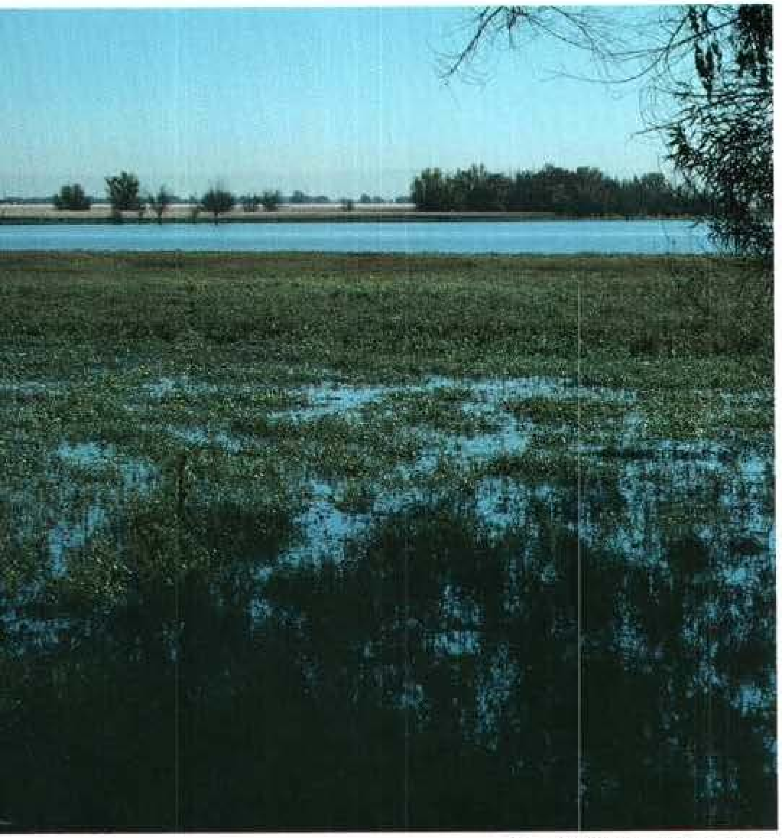
The Central Valley of California encompasses an area of over 13 million acres which included an estimated four million acres of wetlands in the 1850's. Total acreage of wetlands and deepwater habitats in 1939 was 794.8 thousand acres. In the mid-1980's it was 544.6 thousand acres, a net loss of 250.2 thousand acres since 1939. This loss of 31.5% represents an average annual net loss for the 46-year period of over 5.4 thousand acres.

There were 561.5 thousand acres of freshwater wetlands in 1939 and 318.9 thousand acres in the mid-1980's, a net loss of 242.6 thousand acres. Average annual net loss was over 5.2 thousand acres. Almost all of the net loss came from freshwater emergent wetlands, and most of this loss consists of 229.6 thousand acres converted to agricultural crops other than rice.

The acreage in rice increased from 434.5 thousand acres to 658.6 thousand acres during the same period. This is a net gain of 224.1 thousand acres, for an average annual net gain of over 4.8 thousand acres. This change occurred primarily on lands previously used for other agricultural products.

Agricultural lands represented a net increase of 1.2 million acres, or an average annual net increase of over 26 thousand acres. The conversion to agriculture resulted in a net loss of 222.7 thousand acres of wetlands. There was also a conversion to agriculture of almost two million acres originally not classed as wetlands or deepwater habitats. This two million acre change was offset to a degree by conversion of 669.8 thousand acres from agricultural crops by urbanization and 466.9 thousand other acres no longer used for agriculture.

Urban areas accounted for only 151.2 thousand acres in 1939. In the mid-1980's they accounted for 1.1 million acres, a gain of over 600%. Approximately two-thirds of this increase came from agricultural lands, with most of the remainder coming from land other than wetlands or deepwater habitats.



Courtesy of Jini Scammel-Tingling

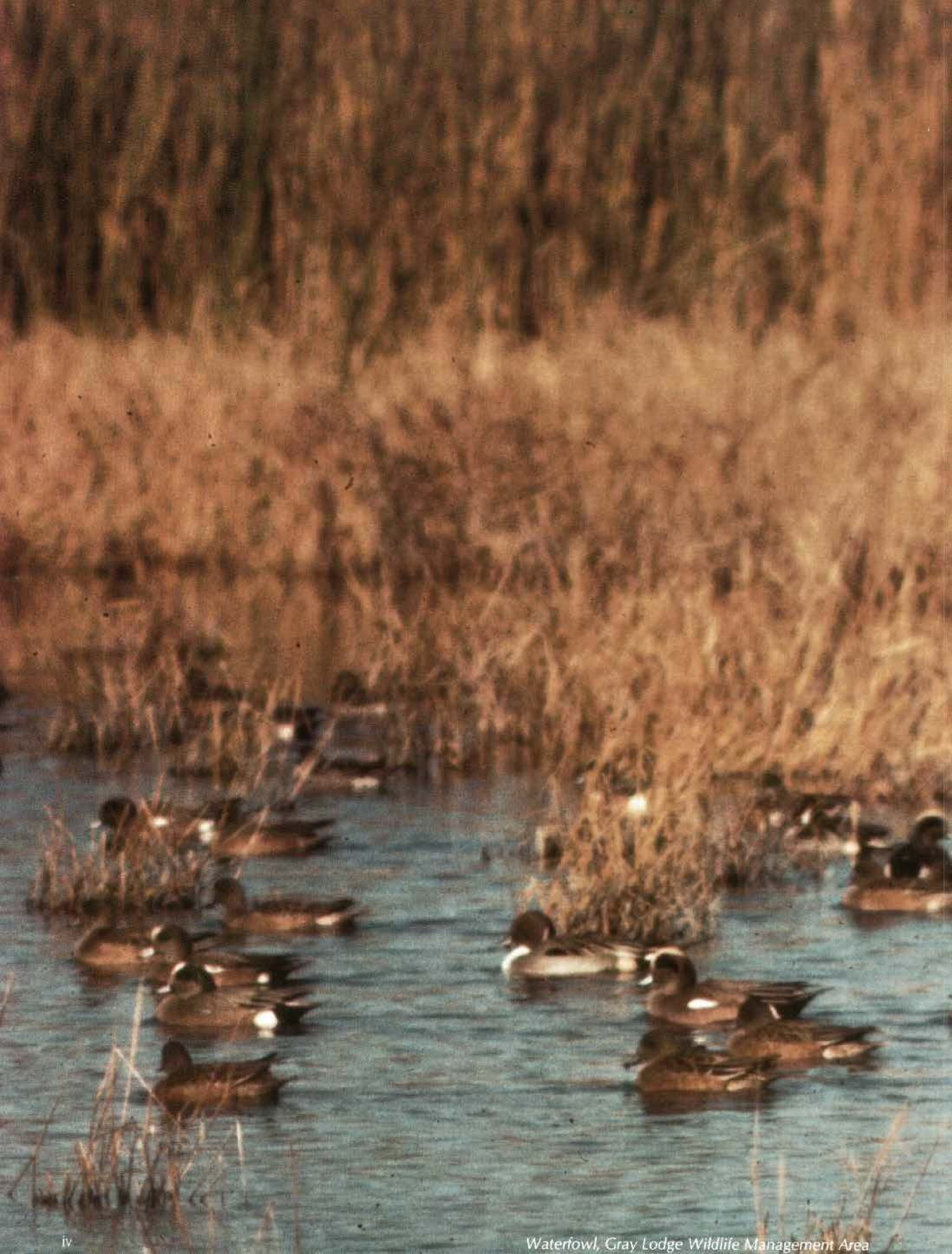
Beach/Stone Lakes Area

Courtesy of Gary Zahm

Vernal pool, Merced County

Courtesy of Bureau of Reclamation

Central Valley agricultural land



Waterfowl, Gray Lodge Wildlife Management Area

CONTENTS

Courtesy of Dan Connelly

CHAPTER ONE

INTRODUCTION

The United States Fish and Wildlife Service has major responsibility for the protection and proper management of migratory and endangered fish and wildlife and their habitats. Of particular concern are wetlands and associated deepwater habitats. Since 1974 the U. S. Fish and Wildlife Service, through its National Wetlands Inventory Project, has been conducting an inventory of the nation's wetlands. The purpose is to develop and disseminate comprehensive data concerning the characteristics and extent of wetlands.

Results of a National Wetlands Inventory study of wetland gains and losses between the 1950's and 1970's were published by Frayer, et al. (1983) and Tiner (1984). Of the approximately 215 million acres of wetlands at the time of settlement in the area now comprising the 48 contiguous states, only 99 million acres or 46% remained in the mid-1970's. Between the mid-1950's and mid-1970's, there was a loss of about 11 million acres of wetlands. During the same time period, approximately two million acres of new wetlands were created. This 20-year net loss of nine million acres equates to an average annual net loss of 458 thousand acres of wetlands.

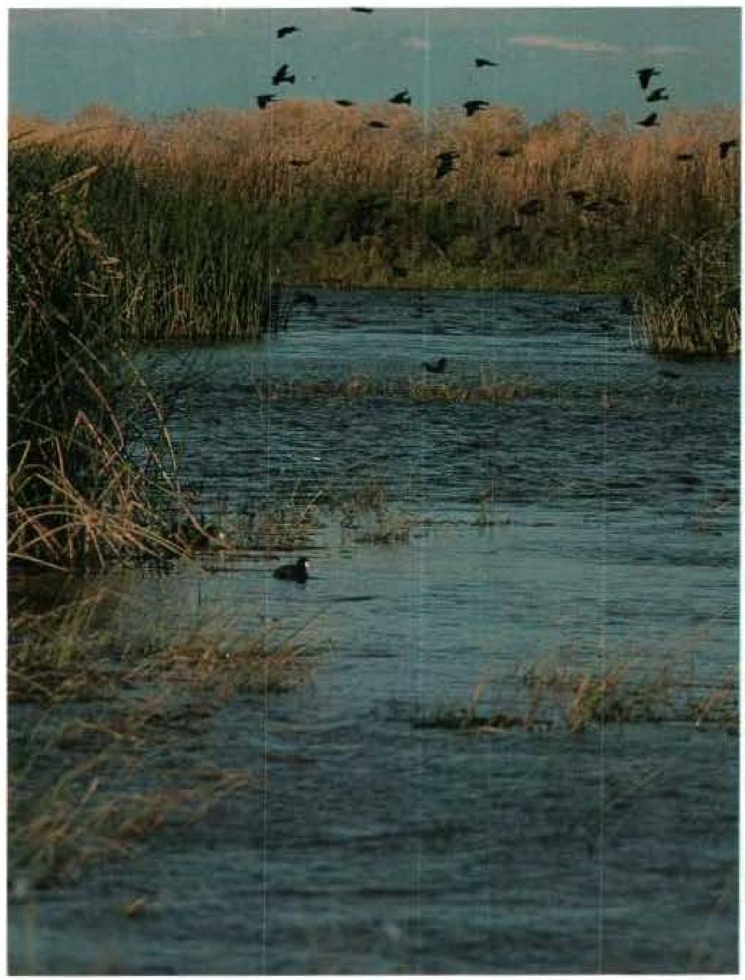
Los Banos area

Vernal pool

Courtesy of Monty Knudsen

The statistical design used in the national trend study can be intensified to obtain reliable estimates for individual states or geographical areas. Because of the importance of wintering habitat in California to Pacific flyway migratory birds, the U. S. Fish and Wildlife Service has completed a similar study specific to the Central Valley of California. Because aerial photography was available, the trend period was lengthened to cover the period 1939 to the mid-1980's. This study does not reveal losses or gains prior to 1939 nor after the mid-1980's. While it provides estimates of abundance of the Central Valley wetlands and deepwater habitats, it does not provide information on their quality.

Courtesy of Bureau of Reclamation



Courtesy of Bureau of Reclamation

Emergent wetland

CHAPTER TWO

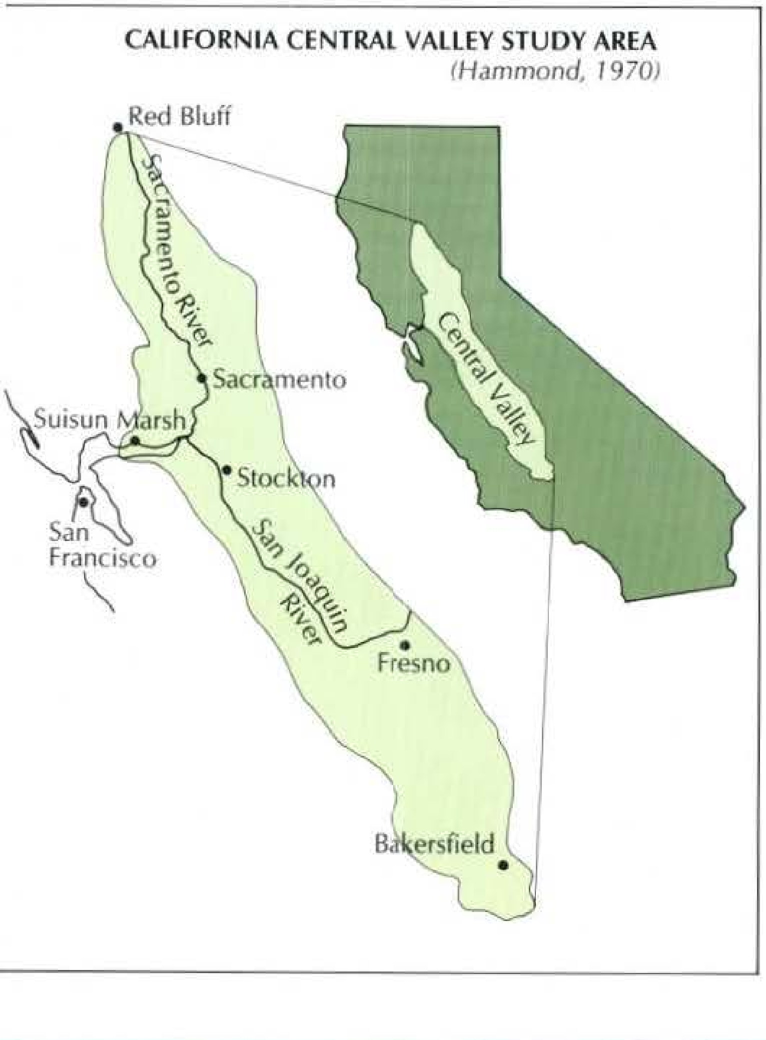
STUDY AREA

Emergent wetland

The Central Valley of California as described by E. H. Hammond (1970) encompasses about 13% (21 thousand square miles) of the state's total area. The Central Valley is located between the Coast Ranges on the west and the Sierra Nevada Mountains on the east and averages about 55 miles in width. It extends from Red Bluff in the north approximately 400 miles south to Bakersfield.

The Central Valley is made up of two lesser valleys, the Sacramento in the north and the San Joaquin in the south. The Sacramento-San Joaquin Delta forms at the junction of the Sacramento and San Joaquin Rivers. For the purpose of this study the coverage also includes Suisun Bay and adjacent areas between the lower end of the Delta and Carquinez Straits.

The rivers of the California Central Valley historically flooded in winter and spread over broad expanses of the Valley floor and Delta creating vast seasonal wetlands estimated to be about four million acres in the 1850's (Dennis, et al. 1984). In their native state the largest concentration of freshwater and brackish wetlands were in the Tulare Basin and the Delta-Suisun areas. Riparian wetlands have been estimated to account for about 1.6 million acres of the four million acres (Warner, 1985). These wetlands were a haven for over 60% of the Pacific flyway waterfowl populations as well as vast flocks of other migratory and resident waterbirds. The rivers provided spawning and rearing habitats for salmon and steelhead which ascended to the upper reaches of the Sacramento and San Joaquin Rivers and their tributaries.



Estimates of remaining wetlands in the California Central Valley have ranged from slightly less than 400 thousand acres (California Dept. Parks and Recreation, 1988 and Dennis, et al. 1984) to 280 thousand acres (U.S. Fish and Wildlife Service, 1987). About 100 thousand acres are included in federal and state refuges and wildlife areas; approximately 36 thousand additional acres are held in wetland easements. Seasonal wetland characteristics may fluctuate within these managed areas because they are generally dependent on available agricultural drain and other water supplies, and water management practices may vary from year to year.

Today there are over 100 dams within the Central Valley drainage basin (about 20 Federal or state and over 80 private) controlling water flows into the Valley. In addition there are thousands of miles of water delivery canals and streambank flood control projects. Project purposes include irrigation, municipal and industrial water supplies, hydroelectric power, flood control, navigation, and recreation.

Over-bank flooding, upper Sacramento River, March 1983

Courtesy of Frank Michny

CHAPTER THREE

HISTORICAL BACKGROUND

At the time California became a state in 1850 there were approximately five million acres of permanent, seasonal, and tidal wetlands (Dennis, et al. 1984). It has been estimated that these wetlands have been reduced by over 90% to approximately 450 thousand acres statewide. The three greatest pressures on wetlands came from: 1) conversion of inland wetlands to intensive agriculture and changes in crop practices; 2) urban, industrial, and port development along the coast; and 3) channelization and maintenance of flood control channels.

Although natural processes of erosion, sedimentation, and subsidence can alter wetlands, the major losses of Central Valley wetlands are attributable to human actions. They have been leveed, drained, cleared, leveled, or filled; or the water entering them has been impounded, diverted, or pumped out. The Valley has become a rich agricultural center but at the expense of native wetlands and associated fish and wildlife populations. Levee building and reclamation activities irreversibly altered the wetland appearance and functions of the area.

Historical trends for the Central Valley parallel those for the state as a whole. Through the 1800's wetlands changed due to burning, grazing, granting of swamp-and-overflow lands to the state for drainage and conversion, hydraulic mining, and piecemeal flood control and irrigation. Between 1850 and the 1920's, about 70% of the original wetland acreage was modified largely by levee and drainage activities and local water diversion projects (U. S. Fish and Wildlife Service, 1977 and Dennis, et al. 1984). By 1939 85% of the original wetland acreage had been lost.

Widespread conversion of seasonal wetlands began in the Sacramento Valley in the 1850's when farmers diked the floodplains for cultivation. However, these areas continued to flood each winter, and in the early 1910's the Sacramento Flood Control Project greatly expedited the conversion of wetlands in the Sacramento Valley.

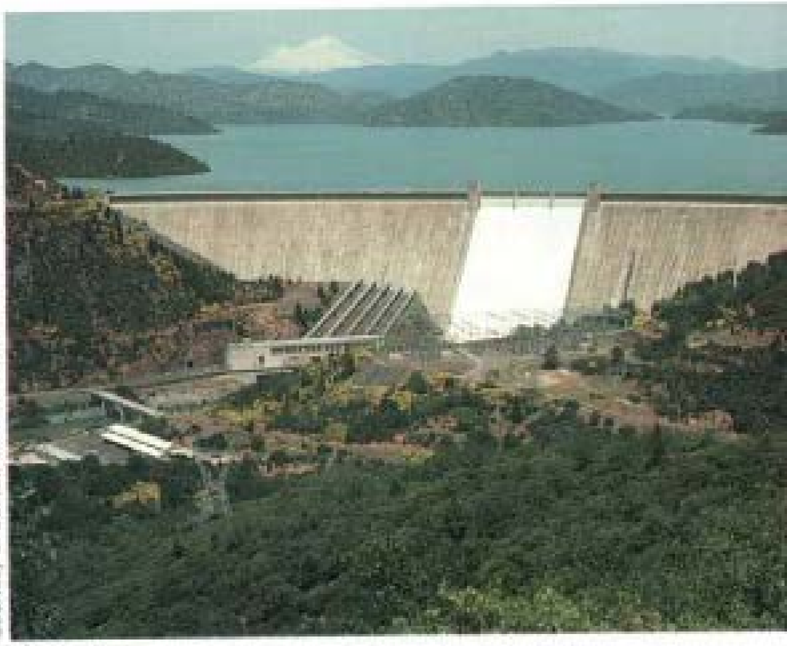
Conversion of the wetlands in the Delta resulted in most of the inlets and islands being leveed and put into cultivation by 1930. Because the San Joaquin Valley was drier than the Sacramento Valley, intensive conversion to agriculture followed development of efficient groundwater pumping systems. Groundwater continued to be the primary source of irrigation water in the San Joaquin Valley through 1940. As groundwater tables were lowered, as water quality was diminished, and as pumping costs rose, there emerged a need for a comprehensive program of water importation.

Courtesy of California Department of Fish and Game

Gray Lodge Wildlife Management Area

Early channelization

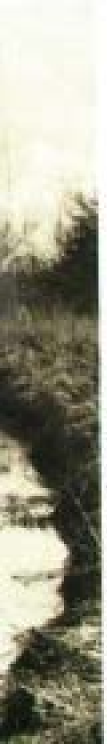
By the 1930's it was recognized that a large-scale system was required to control flooding in the Sacramento Valley and the Delta. Such a system could also provide needed irrigation water to the San Joaquin Valley. In 1938 the Bureau of Reclamation began construction of the Central Valley Project (CVP) with work on Shasta Dam. Shasta Reservoir water storage and delivery began in 1944. In 1951 Delta pumping facilities began delivering Sacramento River water through the Delta into the upper San Joaquin Valley. While there are numerous CVP canals, power plants, and diversion dams, the major water control structures on the tributary rivers to the Central Valley are Shasta Dam on the Sacramento River, Whiskeytown Dam on Clear Creek, Folsom Dam on the American River, New Melones Dam on the Stanislaus River, San Luis Dam on San Luis Creek, and Friant Dam on the San Joaquin River.



Courtesy of Bureau of Reclamation

Shasta Dam

Through the early 1950's there was a continuing need for additional water for irrigation and urban use in southern California, for more extensive flood control in the Sacramento Valley, and for control over saltwater intrusion into the Delta. In 1951 the State Water Project (SWP) was authorized to address these and other needs; Oroville Dam on the Feather River is the cornerstone of the SWP. This project now carries water from the Sacramento River and Delta into southern San Joaquin Valley and southern California.



Courtesy of Bureau of Reclamation

Union School Slough, Yolo County

Courtesy of Fish and Wildlife Service

Flood control and water development projects account for major losses of wetlands in the Valley. The necessary association of wetlands with periodic flooding dictates that these habitats will be lost as flood flows are regulated or water is diverted. Maintenance of wetlands in the Central Valley now entails competition for scarce and costly water. The major threat to already existing state, Federal, and privately owned wetlands in the Valley is the availability and seasonal dependability of water and the high cost of energy to pump it. Throughout the Valley, the demand for water for irrigated agriculture and associated uses has increased as cultivated acreages have increased, with no assurance of major new water supply projects.

Central Valley wetlands and the values they provide compete directly for water and space with agriculture. As agricultural, municipal, and industrial demands for the finite supply of water continue to increase and unallocated water is directed to these uses, wetlands continue to decline.

Courtesy of The Holt Atherton Center for Western Studies, University of the Pacific

Flood control party, San Joaquin County, ca. 1935

The Corps of Engineers operates over 20 flood control projects on tributaries to the Central Valley in addition to dredging, clearing, snagging, and levee projects in the Valley. These perpetuate wetland losses by reducing the chances for flooding in ancestral overflow basins and allowing riparian areas to be converted to other uses.

The Bureau of Reclamation and U. S. Department of Agriculture have encouraged wetland conversions to agriculture through various incentive programs: subsidization of water costs, commodity price supports, tax deductions for draining expenses, depreciation of capital costs for draining or clearing wetlands, and tax credits for drainage tile installation costs. Price supports for certain crops may also have encouraged conversions from wetland to cropland or from nonintensive farming to intensive cultivation. The Food Security Act of 1985 includes several conservation provisions (swampbuster, sodbuster, conservation reserve program, farm debt restructure) which offer opportunities to reduce wetland conversion to agriculture and to restore wetlands.

The state of California manages or exercises control over the state's natural resources under a wide variety of general and specific laws and directives. The state has limited direct authority in wetlands except in three geographic areas: the coastal zone, San Francisco Bay, and Suisun Marsh. Thus inland California wetlands are largely unprotected.

Colusa Trough

Courtesy of John B. Cowan

Willow Creek Ranch Duck Club

Local governments and special districts throughout the Central Valley are required to implement the California Environmental Quality Act and various planning laws. These provide some indirect means of protection for wetlands. Few local entities have adopted strong wetland policies or ordinances to implement them.

Duck clubs have been a dominant force in preservation of California wetlands. Private duck clubs own the majority of Central Valley and Suisun Marsh wetlands and manage large tracts of these areas as waterfowl habitat and for sport hunting. Local and regional parks and private foundations such as the California Waterfowl Association, Ducks Unlimited Inc., The Nature Conservancy, Trust for Public Land, and Audubon Society have acquired wetlands for both habitat preservation and recreation.

This is only a brief discussion of historical wetland changes in the Central Valley. More detailed discussions, including wetland legislation, are available in "Status and Trends of California Wetlands" (Dennis, et al. 1984); "Riparian Resources of the Central Valley and California Desert" (Warner and Hendrix 1985); "California Wetlands, An Element of the California Outdoor Recreation Plan, Public Review Draft" (California Department of Parks and Recreation, 1988); "Concept Plan for Waterfowl Wintering Habitat Preservation: Central Valley, California" (U. S. Fish and Wildlife Service, 1978); and "Concept Plan for Waterfowl Wintering Habitat Preservation: an update, Central Valley, California" (U. S. Fish and Wildlife Service, 1987).

Courtesy of Mike Miller

CHAPTER FOUR

CLASSIFICATION SYSTEM

The definitions, classifications, and categories of wetlands and deepwater habitats used are those described by Cowardin, et al. (1979).

In general terms, wetland is land where saturation with water is the dominant factor determining the nature of soil development and the types of plant and animal communities living in the soil and on its surface. Technically, 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. Wetlands must have one or more of the following three attributes: 1) at least periodically, the land supports predominantly hydrophytes; 2) the substrate is predominantly undrained hydric soil, and 3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year. Common terms used to describe various Central Valley wetlands include marshes, swamps, small ponds, sloughs, vernal pools, river overflows, mud flats, and wet meadows.

Deepwater habitats consist of certain permanently flooded lands. In saltwater areas, the separation between wetland and deepwater habitat coincides with the elevation of the extreme low water of spring tide. In other areas, the separation is at a depth of two meters (6.6 feet) below low water. This is the maximum depth in which emergent plants normally grow.

Within the classification structure that follows, wetlands and deepwater habitats are grouped according to systems.

Estuarine wetlands, Suisun Marsh

Courtesy of Mike Miller

Courtesy of Dennis D. Peters

Palustrine emergent wetland

A system consists of environments of similar hydrological, geomorphological, chemical and biological influences. Each system is further divided by the driving ecological force, such as ebb and flow of tide, and by substrate material and flooding regimes, or on vegetative life form. Groupings of categories were made to accommodate the special interests of the study and the detail to which aerial photography could be interpreted.

The **marine system** extends from the outer edge of the continental shelf to the high water of spring tides or to the boundary of other systems as defined later. **Marine subtidal** includes that portion that is continuously submerged. **Marine intertidal** includes areas in which the substrate is exposed and flooded by tides, including the associated splash zone. There are no marine wetlands or deepwater habitats in the study area.

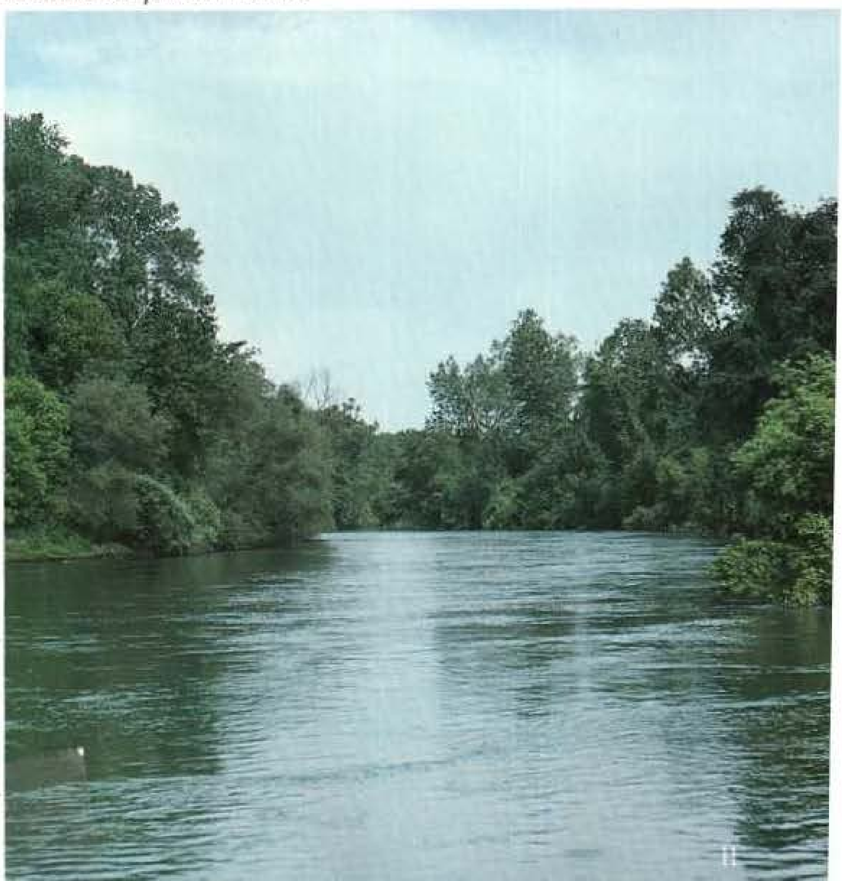
INDIVIDUAL CLASSIFICATIONS	*CATEGORIES USED IN THIS STUDY*
Marine subtidal Marine intertidal	not in study area
Estuarine subtidal Estuarine intertidal	Estuarine
Palustrine forested Palustrine scrub/shrub	Palustrine forested & scrub/shrub
Palustrine emergent	Palustrine emergent
Palustrine aquatic bed Palustrine unconsolidated bottom Palustrine unconsolidated shore	Palustrine other
Lacustrine limnetic Lacustrine littoral	Lacustrine
Riverine tidal Riverine lower perennial Riverine upper perennial Riverine intermittent	Riverine

Wetland and deepwater habitats classifications and study categories.

The **estuarine system** consists of deepwater tidal habitats and adjacent tidal wetlands which are usually semi-enclosed by land, but have open, partially obstructed, or sporadic access to the open ocean and in which ocean water is at least occasionally diluted by fresh water runoff from the land. **Estuarine subtidal** is that portion that is continuously submerged (considered deepwater habitat), while **estuarine intertidal** is the portion exposed and flooded by tides, including the splash zone. Estuarine intertidal wetlands can be shown in various groupings (e.g. vegetated or unvegetated). Because of the small amount of estuarine wetlands in the study area, they are all grouped together under the heading estuarine wetlands.

The **lacustrine system** includes wetlands (littoral) and deepwater habitats (limnetic) situated in topographic depressions or dammed river channels. Each area must exceed 20 acres or be deeper than 6.6 feet or have an active wave-formed or bedrock shoreline feature. Lacustrine areas are grouped together as deepwater habitats in this study.

Riverine deepwater habitat

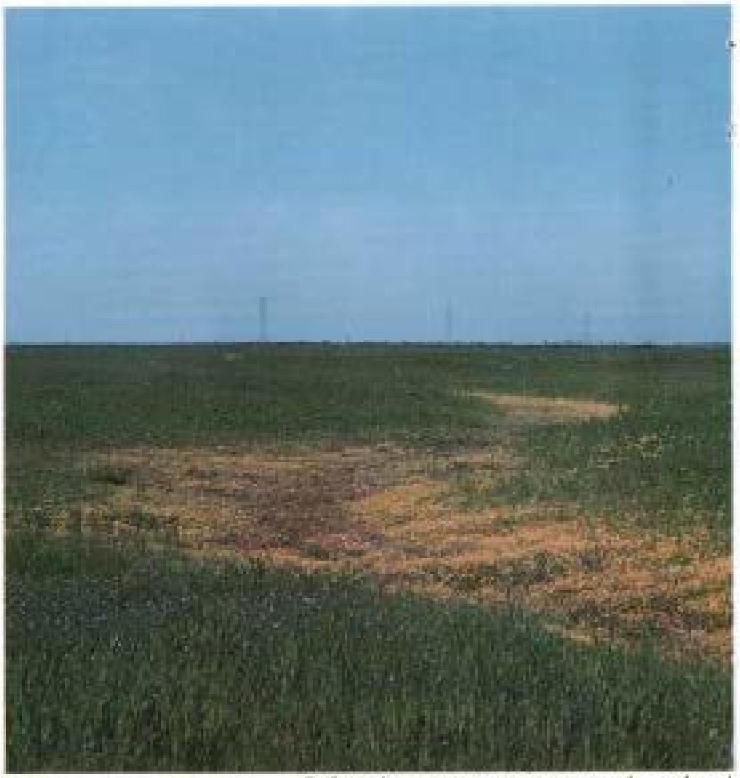


Courtesy of Frank Michny

CLASSIFICATION SYSTEM

Courtesy of Bureau of Reclamation

Palustrine forested wetland



Courtesy of California Department of Fish and Game

Palustrine emergent seasonal wetland

Courtesy of Bureau of Reclamation

Palustrine aquatic bed

The **riverine system** includes wetlands and deepwater habitats contained within a channel. For this study riverine subsystems (tidal, lower perennial, upper perennial, and intermittent) were grouped together as deepwater habitats.

The **palustrine system** includes all nontidal wetlands not included within any of the other four systems and does not include any deepwater habitats. For this study, palustrine wetlands are shown by the following groups: **forested and scrub/shrub** - wetlands dominated by the presence of woody vegetation; **emergent** - wetlands with primarily erect, rooted herbaceous plants typically found in wet environments; and **other palustrine areas** - nonvegetated wetlands, small inland open water bodies, and wetlands dominated by aquatic beds.

All remaining surface area (area not classed as wetland or deepwater habitats) was placed in four categories. These are **rice, other agriculture, urban,** and **other.** The latter three categories correspond to classes described by Anderson, et al. (1976) at their Classification Level I. **Other** includes Anderson's Level I classes of forest land, rangeland, and barren land.

Courtesy of Bureau of Reclamation

Palustrine emergent wetland

This is only a brief discussion of the classification used in this study. It is difficult to differentiate the categories further without introducing highly technical terms. More detailed discussions, exact definitions, and fuller descriptions are presented by Cowardin, et al. (1979) and Anderson, et al. (1976).

CHAPTER FIVE

SURVEY PROCEDURE

The objectives of this study were to develop statistical estimates of acreage for categories of wetlands and deepwater habitats for: as early a date as possible using aerial photography, the mid-1980's, and the change for the period.

A stratified random sampling design was used with two strata being formed based on expected proportions of land coverage by wetlands and deepwater habitats. Sample units were allocated to strata in proportion to these expected amounts estimated by U. S. Fish and Wildlife Service personnel. The total number of sample units used in this study was 328.

Each sample unit is a four-square mile area, two miles on each side. After the units were selected at random within strata and plotted on U.S. Geological Survey topographic maps, aerial photography was obtained. The majority of the early photography was taken in the years 1937 through 1942 (mean of 1939) and consists of 1:20,000 scale black and white prints. The mid-1980's photography was 1:58,000 scale color infrared transparencies taken in 1983 through 1987 (mean of 1985).

The mid-1980's photography was interpreted and annotated in accordance with the classification system described previously and procedures developed by the U. S. Fish and Wildlife Service's National Wetlands Inventory. The results were then transferred to an overlay on a U. S. Geological Survey 1:24,000 scale topographic base map using a zoom transfer scope. The early aerial photography was interpreted using a stereo zoom transfer scope and any changes in classification between the early and recent photography were annotated. Both the recent classification and the classification for the early period were recorded for each change.

Black and white May 1940 1:20,000 scale

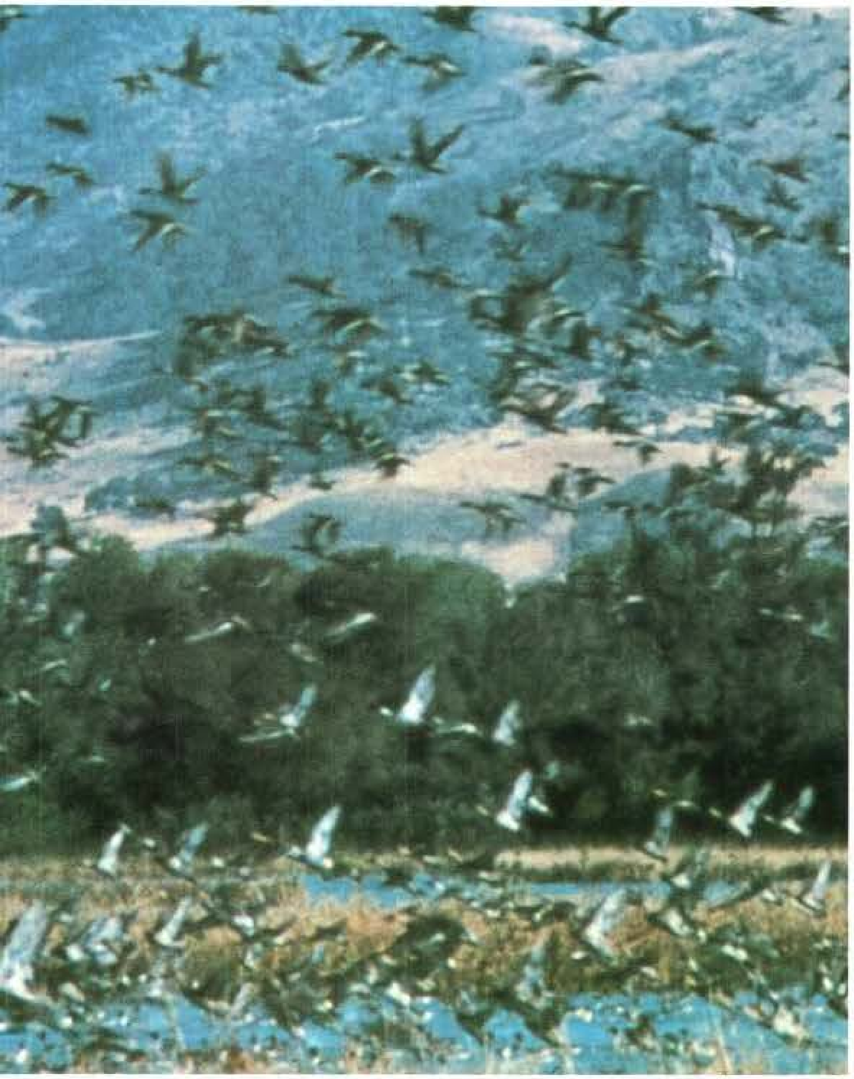
Courtesy of Dan Connelly

Gray Lodge Wildlife Management Area

Color infrared April 1985
1:58,000 scale

CHAPTER SIX

RESULTS



Waterfowl, Butte Sink

The intent of the Central Valley wetland change study was for the period of study to be from approximately 1940 to the mid-1980's. The average years of the photography are 1939 and 1985, with an average interval of 46 years. Thus, the results should be interpreted in terms of a 46-year interval.

Results for the categories discussed in the classification system are given in Table 1 of the appendix. Several of the individual categories in Table 1 were grouped based on physical, chemical and biological similarities and are shown in Table 2 of the appendix. Groupings in Table 2 include the following:

Wetlands and deepwater habitats includes all estuarine, palustrine, riverine, and lacustrine classifications.

Wetlands includes estuarine and palustrine wetlands.

Estuarine wetlands is listed singly as in Table 1.

Palustrine wetlands includes palustrine forested and scrub/shrub, palustrine emergent and other palustrine wetlands.

Deepwater habitats includes riverine and lacustrine deepwater habitats.

Agriculture includes rice and other crops.

Other categories, listed singly as in Table 1, include **urban** and **other lands.**

Status and trend results presented in the remainder of this chapter are based on information found in Tables 1 and 2.

Courtesy of John B. Cowan

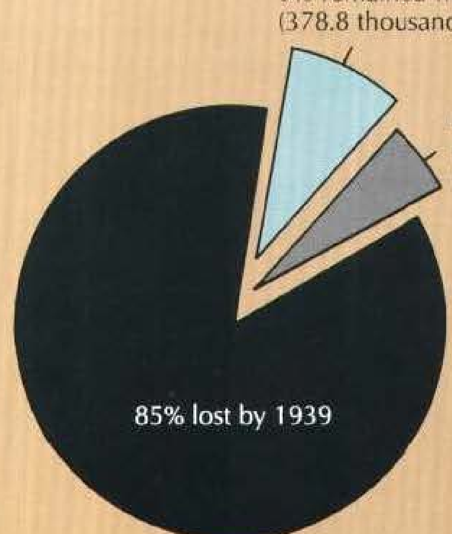
Dragline at work, Butte County ca. 1962

TRENDS IN WETLANDS AND DEEPWATER HABITATS

The 1939 estimate of wetlands and deepwater habitats is 794.8 thousand acres (6% of the Valley area). The mid-1980's estimate is 544.6 thousand acres (4% of the Valley area), a net loss of 250.2 thousand acres. This is an average annual net loss of 5.4 thousand acres of wetlands and deepwater habitats during the study period. Virtually all of the net loss is attributable to conversion to agriculture.

TRENDS IN WETLANDS

The 1939 and mid-1980's estimates of wetlands are 619.4 thousand acres and 378.8 thousand acres, respectively. This is a net loss of 240.6 thousand acres, or an average annual net loss of 5.2 thousand acres. The vast majority of loss was to agriculture.



Original (four million acres) and remaining acreages of wetlands, California Central Valley

RESULTS

Estuarine Wetlands

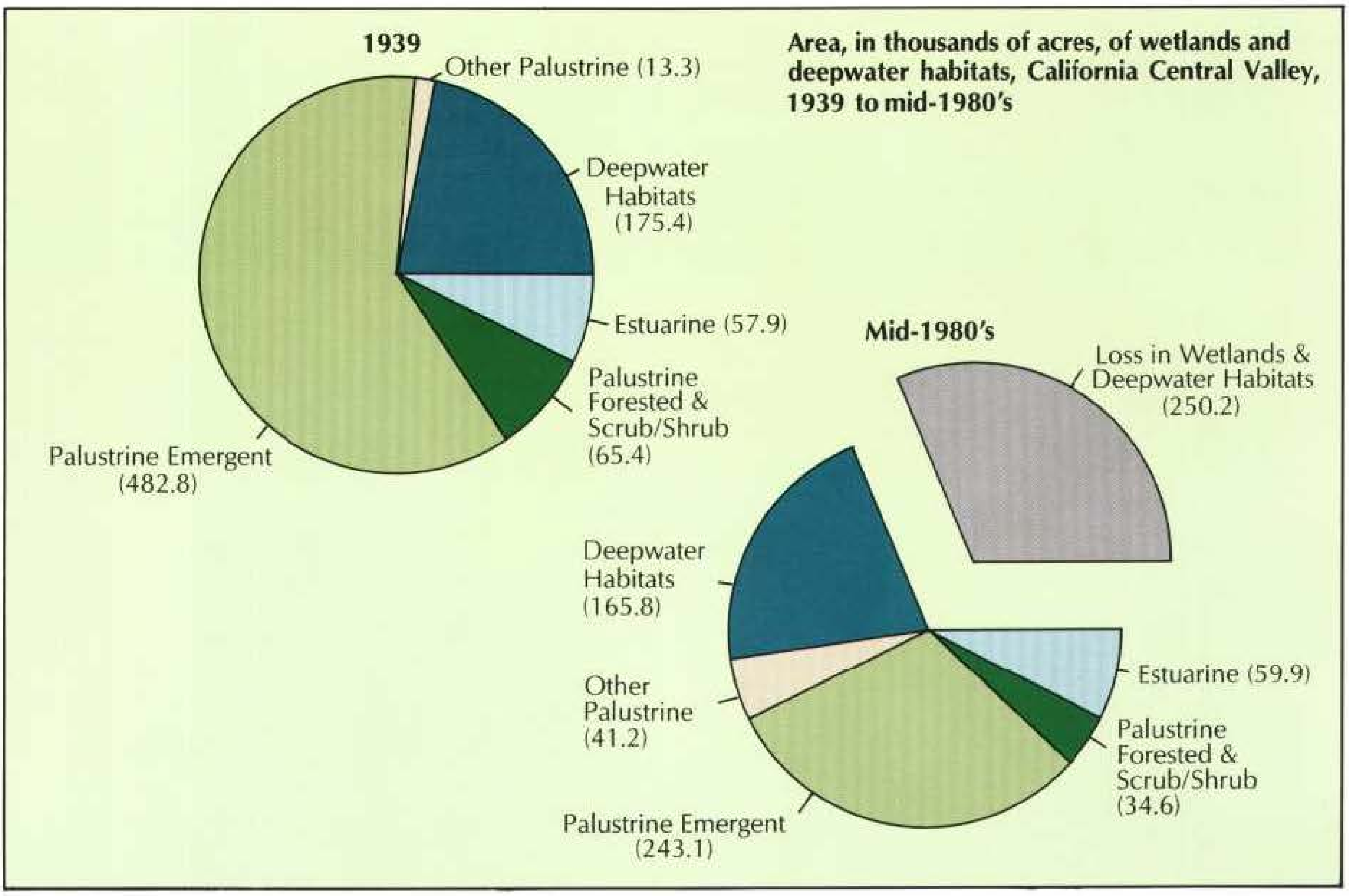
The total amounts and changes in estuarine wetlands in the Central Valley study area were relatively small, with individual estimated changes not having a high degree of reliability.

Palustrine Forested and Scrub/Shrub Wetlands

The 1939 estimate of palustrine forested and scrub/shrub wetlands is 65.4 thousand acres. The corresponding estimate for the mid-1980's is 34.6 thousand acres, indicating that almost half of the acreage was lost during the period. Because of the small acreages involved in terms of the total size of the Valley, the estimates of change for this category are not highly reliable. Most of the change is attributed to conversion to agricultural crops other than rice.

Courtesy of Gary Zahm

Loss of duck club, North Grasslands



Courtesy of Bureau of Reclamation

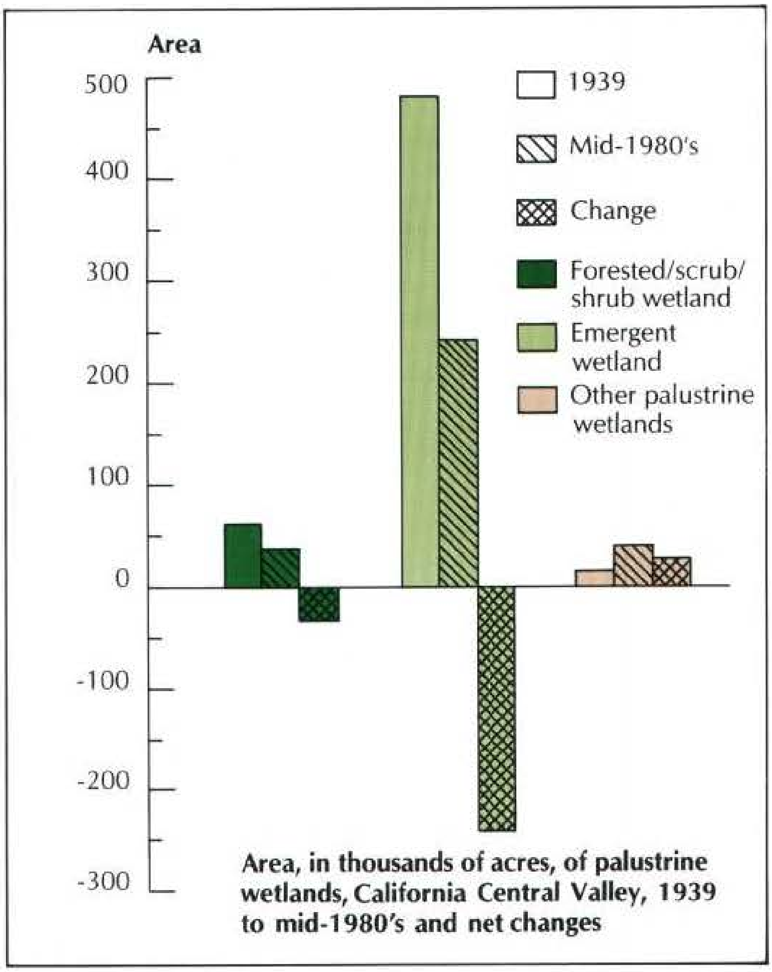
Urban expansion

Palustrine Emergent Wetlands

The 1939 and mid-1980's estimates are 482.8 thousand acres and 243.1 thousand acres, respectively. This is a net loss of 239.7 thousand acres, about half the 1939 amount. Losses include: 30.0 thousand acres to rice, 229.6 thousand acres to other agriculture, and 58.1 thousand acres to lands other than wetlands, deepwater habitats, or agriculture. The losses were to a small degree offset by gains, the largest of which was 41.4 thousand acres from rice.

Changes in Other Palustrine Wetlands

The 1939 estimate of surface area in this category is 13.3 thousand acres, with a mid-1980's estimate of 41.2 thousand acres, a gain of 27.9 thousand acres. The largest gain (15.5 thousand acres) came from land not originally wetlands, deepwater habitats, or agriculture. Other gains came from other wetland categories and agricultural land.



Area, in thousands of acres, of palustrine wetlands, California Central Valley, 1939 to mid-1980's and net changes

RESULTS

DEEPWATER HABITATS

All changes in deepwater habitats were small in terms of total acreage in the Valley. There are indications of several gains and losses, especially in lacustrine deepwater habitats. However, the reliability of the estimates is not sufficient to provide definitive comparisons.

AGRICULTURAL LANDS

Changes in Rice Acreage

The acreage in rice in 1939 was 434.5 thousand acres. The rice acreage in the mid-1980's is 658.6 thousand acres, a net increase of 224.1 thousand acres. However, there were several losses as well as increases contributing to the net change. Significant increases in rice acreage include: 31.2 thousand acres from wetlands and deepwater habitats (primarily from palustrine emergent wetlands), 384.2 thousand acres from other agricultural crops, and 63.6 thousand acres from lands not originally classed as wetlands, deepwater habitats, or agriculture. Significant losses were: 42.3 thousand acres to wetlands and deepwater habitats (primarily to palustrine emergent wetlands), 184.4 thousand acres to other agricultural crops, and 22.6 thousand acres to urbanization.

Changes in Acreage for Agricultural Crops other than Rice

The 1939 and mid-1980's estimates for this category are about 6.9 million acres and 7.9 million acres, respectively, for a net increase of 973.0 thousand acres. Major net increases were 258.0 thousand acres (315.1 - 57.1) from wetlands and deepwater habitats, the vast majority of which came from palustrine emergent wetlands; and 1561.8 thousand acres (1923.7 - 361.9) from lands not originally classed as wetlands, deepwater habitats, agriculture or urban. Major net decreases were 199.8 thousand acres (384.2 - 184.4) converted to rice; and 647.0 thousand acres (647.1 - 0.1) converted from agricultural uses by urbanization.

URBAN AREA

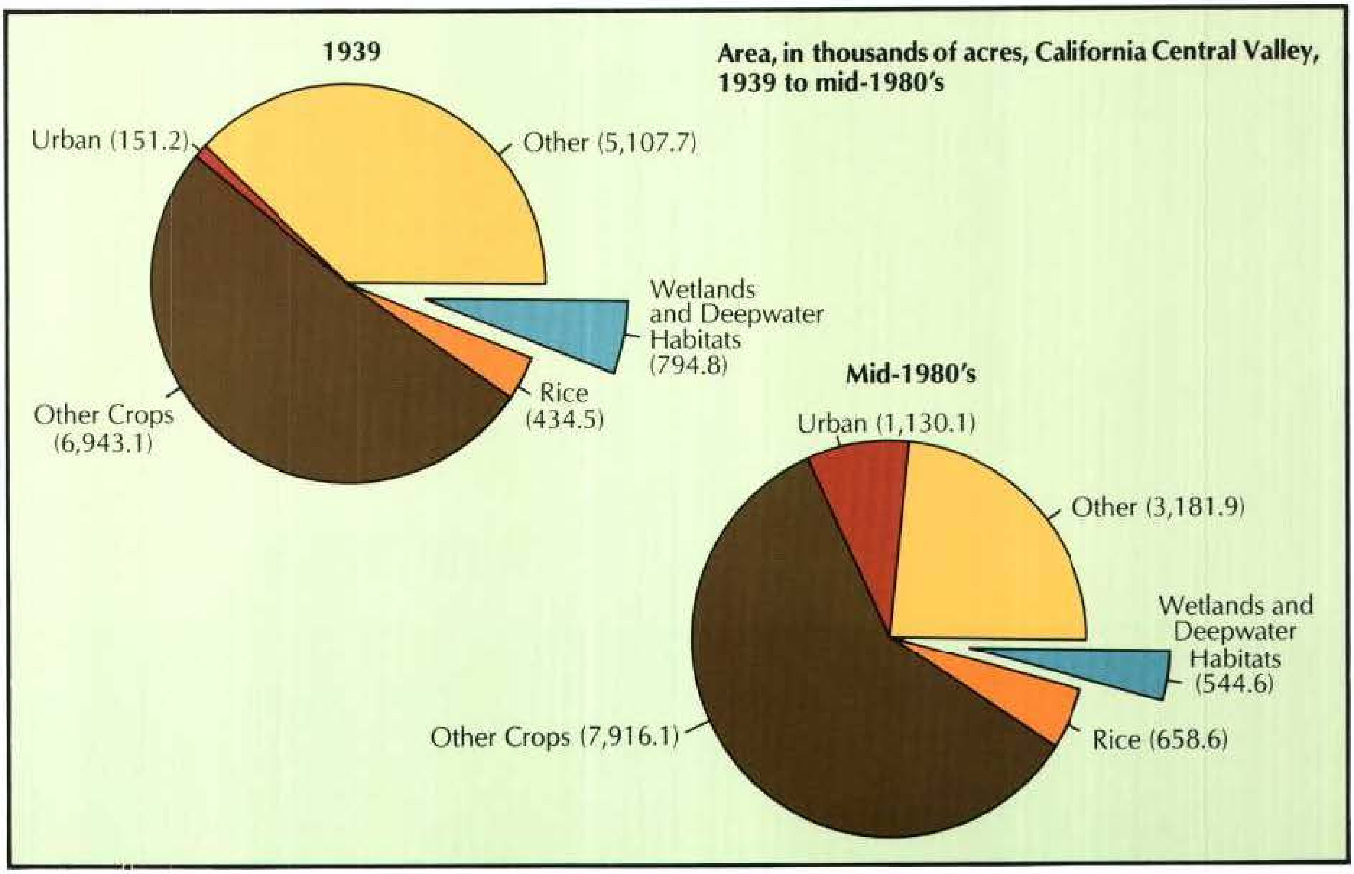
The 1939 estimate for urban acreage is 151.2 thousand acres. The mid-1980's estimate is 1.1 million acres. This net increase of 978.9 thousand acres is accounted for by losses of 669.6 thousand acres originally in agriculture; 301.1 thousand acres originally not classed as wetlands, deepwater habitats, or agriculture; and 8.2 thousand acres of wetlands and deepwater habitats.

Rice fields

Courtesy of Fish and Wildlife Service

Courtesy of Gary Zahm

Conversion to agriculture



CHAPTER SEVEN

IN CONCLUSION

Significant wetland losses beyond the wetland conversions of the early 1900's have continued to occur in the California Central Valley. These represent losses of valuable natural resources and not simply reclamation of wasteland as once thought.

The Central Valley of California has long been recognized as an important wintering area for Pacific flyway waterfowl. About 60% of the ducks, geese, and swans of this flyway use the Valley wetlands during the winter. These wetlands, deepwater habitats, and adjacent uplands also provide habitats for many species of birds other than waterfowl. These include, in part, greater sandhill cranes, white-faced ibis, black-crowned night-herons, great and snowy egrets, tricolored blackbirds, long-billed curlews, and willow flycatchers.

Wildlife habitat, particularly for waterfowl, is often the major focus for wetland values. However, the Central Valley wetlands offer a myriad of other important functions. These include aesthetic, scientific, and educational interests; primary productivity in the food chain; fish habitat; endangered and threatened wildlife species habitat; shoreline and bank stabilization and protection; flood protection; groundwater recharge; and recreation opportunities.

The majority of the remaining 378.8 thousand acres of wetlands in the Central Valley are managed areas, created and maintained by seasonal or controlled application of water. Today the extent and quality of Federal and state wildlife areas and private wetlands reflect the availability and quality of water rather than historic natural distribution of wetlands in the Valley.

Within the Central Valley, 270.5 thousand acres of palustrine vegetated wetlands were lost between 1939 and the mid-1980's. Conversion to agriculture was responsible for about 95% of the net loss of these wetlands.

There have been increases in ponds and palustrine unvegetated wetland acreages of 27.9 thousand acres (from 13.3 thousand acres to 41.2 thousand acres). The importance of this gain to fish and wildlife species has not been assessed but the limited acreage involved does little to offset losses of other wetlands. The extensive acreages of emergent, forested, and scrub/shrub wetlands lost are negative impacts to known valuable fish and wildlife habitats and other environmental quality values.

The Central Valley wetlands and their values not only compete for space with agriculture but also for water. There is a continuing thrust to develop the finite supply of water for irrigated agriculture and urban-industrial uses without an adequate, guaranteed, clean water supply for public and private wetland areas.

Courtesy of Dan Connelly

Courtesy of Mike Miller

Central Valley agricultural land

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APPENDIX

Estimates produced include proportions of area and their standard errors, acreages with standard errors, and coefficients of variation. Many estimates are not considered reliable enough to recommend their use for making decisions. An indication is given of the reliability of each estimated acreage in the summary tables included in this appendix. The standard error of each entry expressed as a percentage of the entry (SE%) is given in parentheses. Reliability can be stated generally as "we are 68 percent confident that the true value is within the interval constructed by adding to and subtracting from the entry the SE%/100 times the entry." For example, if an entry is one million acres and the SE% is 20, then we are 68 percent confident that the true value is between eight hundred thousand and 1.2 million acres. An equivalent statement for 95 percent confidence can be made by adding and subtracting twice the amount to and from the entry.

It is easy to see that a large SE% indicates low reliability, if any, in the estimate. In fact, if the SE% is 100 or greater, we cannot even say that we are 68 percent confident that the true value is not zero.

This discussion on reliability is meant to aid in interpretation of the study results. It was expected that only certain estimates would be precise enough to be meaningful. However, all entries are included in the summary tables for additivity and ease of comparison.

Estimates for 1939, the mid-1980's and change during the period were produced for categories described in Chapter Four. These estimates are summarized in Table 1 of the Appendix. Totals for columns are estimates of total acreage by category for the mid- 1980's. Row totals (the extreme right column) are estimates of total acreage by category for 1939. Entries are interpreted as in the following examples (all from the third row or column of Table 1):

**137.2 thousand acres classified as palustrine emergent in 1939 were again classified palustrine emergent in the mid-1980's.

**229.6 thousand acres classified as palustrine emergent in 1939 had changed to agriculture (other than rice) by the mid-1980's.

**41.4 thousand acres classified as rice in 1939 had changed to palustrine emergent by the mid-1980's.

**The estimate of palustrine emergent area in 1939 is 482.8 thousand acres.

**The estimate of palustrine emergent area in the mid-1980's is 243.1 thousand acres.

**The estimate of net change in palustrine emergent area between 1939 and the mid-1980's is -239.7 thousand acres.

CURRENT CLASSIFICATIONS

ORIGINAL CLASSIFICATIONS		ESTUARINE	PALUSTRINE FORESTED & SCRUB/SHRUB	PALUSTRINE EMERGENT	OTHER PALUSTRINE	RIVERINE	LACUSTRINE	RICE	OTHER CROPS	URBAN	OTHER	TOTAL SURFACE AREA
		ALL WETLANDS				DEEPWATER HABITATS		AGRICULTURE				
ALL WETLANDS	ESTUARINE	56.7 (36.4)	<0.1	0.1 (83.6)	0.1 (90.0)	0	0.6 (88.9)	0	<0.1	0.4 (88.9)	0	57.9 (36.4)
	PALUSTRINE FORESTED & SCRUB/SHRUB	0	16.6 (19.5)	5.0 (28.1)	1.2 (63.6)	2.5 (34.8)	0.6 (47.2)	0.7 (25.9)	33.9 (54.5)	0.2 (30.5)	4.7 (45.0)	65.4 (32.8)
	PALUSTRINE EMERGENT	<0.1	6.9 (20.6)	137.2 (15.6)	9.4 (47.9)	4.1 (18.7)	7.5 (56.5)	30.0 (26.2)	229.6 (18.3)	6.4 (21.1)	51.7 (24.6)	482.8 (14.5)
	OTHER PALUSTRINE	0	0.2 (39.1)	0.9 (23.5)	5.0 (34.9)	0.4 (51.5)	<0.1	0.2 (50.3)	2.2 (22.1)	1.0 (60.1)	3.4 (48.4)	13.3 (25.5)
DEEPWATER HABITATS	RIVERINE	0	3.8 (31.6)	3.4 (42.5)	1.0 (60.8)	94.6 (13.8	0.1 (51.8)	0.3 (51.8)	4.5 (40.0)	0.3 (47.5)	8.6 (55.0)	116.6 (13.6)
	LACUSTRINE	0	<0.1	0.7 (33.9)	0.1 (75.9)	0	12.2 (35.2)	0	44.9 (95.3)	0	0.9 (93.1)	58.8 (73.3)
AGRICULTURE	RICE	0	0.5 (59.7)	41.4 (62.8)	0.2 (38.0)	0.1 (56.4)	0.1 (69.0)	179.6 (16.6)	184.4 (23.5)	22.6 (66.5)	5.6 (35.4)	434.5 (16.8)
	OTHER CROPS	3.1 (73.6)	1.8 (26.7)	18.2 (28.3)	8.7 (18.4)	8.0 (33.1)	17.3 (41.1)	384.2 (23.4)	5492.8 (7.3)	647.1 (27.4)	361.9 (31.5)	6943.1 (6.1)
URBAN		0	0	0.1 (39.7)	<0.1	0	0	0	0.1 (87.7)	151.0 (44.2)	0	151.2 (44.2)
OTHER		0.1 (76.9)	4.8 (38.8)	36.1 (41.6)	15.5 (17.0)	10.1 (28.9)	7.6 (47.2)	63.6 (65.3)	1923.7 (13.9)	301.1 (40.0)	2745.1 (13.8)	5107.7 (8.5)
TOTAL SURFACE AREA		59.9 (36.3)	34.6 (17.4)	243.1 (18.9)	41.2 (19.1)	119.8 (12.5)	46.0 (23.0)	658.6 (16.7)	7916.1 (5.2)	1130.1 (22.8)	3181.9 (12.2)	13431.3 (0)
CHANGE IN PERIOD		2.0 *	-30.8 (61.3)	-239.7 (20.8)	27.9 (21.2)	3.2 *	-12.8 *	224.1 (50.9)	973.0 (41.2)	978.9 (22.7)	-1925.8 (17.0)	0

Table 1. Area, in thousands of acres, by selected surface area groups. Sampling error, in percent, is given in parentheses below estimate.

*Standard error of estimate is equal to or larger than estimate.

CURRENT CLASSIFICATIONS

ORIGINAL CLASSIFICATIONS		WETLANDS: ESTUARINE	WETLANDS: PALUSTRINE	WETLANDS: TOTAL	DEEPWATER HABITATS	WETLANDS AND DEEPWATER HABITATS	AGRICULTURE: RICE	AGRICULTURE: OTHER CROPS	AGRICULTURE: TOTAL	URBAN	OTHER	TOTAL SURFACE AREA
WETLANDS	ESTUARINE	56.7 (36.4)	0.2 (74.8)	56.9 (36.4)	0.6 (88.9)	57.5 (36.4)	0	<0.1	<0.1	0.4 (98.9)	0	57.9 (36.4)
	PALUSTRINE	<0.1	182.4 (14.1)	182.4 (14.1)	15.1 (29.2)	197.5 (14.2)	30.9 (25.7)	265.7 (17.7)	296.6 (16.9)	7.6 (20.8)	59.8 (22.6)	561.5 (13.5)
	ALL WETLANDS	56.7 (36.3)	182.6 (14.0)	239.3 (13.5)	15.7 (28.3)	255.0 (13.5)	30.9 (25.7)	265.7 (17.7)	296.6 (16.9)	8.0 (20.9)	59.8 (22.6)	619.4 (12.5)
DEEPWATER HABITATS		0	9.0 (22.7)	9.0 (22.7)	106.9 (13.1)	115.9 (12.4)	0.3 (51.0)	49.4 (86.6)	49.7 (86.1)	0.3 (47.5)	9.5 (50.4)	175.4 (25.9)
WETLANDS AND DEEPWATER HABITATS		56.7 (36.3)	191.6 (13.5)	248.3 (13.1)	122.6 (12.5)	370.9 (10.4)	31.2 (25.0)	315.1 (22.8)	346.3 (21.3)	8.3 (20.7)	69.3 (20.7)	794.8 (12.1)
AGRICULTURE	RICE	0	42.1 (61.6)	42.1 (61.8)	0.2 (58.2)	42.3 (61.5)	179.6 (16.6)	184.4 (23.5)	364.0 (15.2)	22.6 (99.5)	5.6 (35.4)	434.5 (16.8)
	OTHER CROPS	3.1 (73.6)	28.7 (7.9)	31.8 (19.0)	25.3 (31.9)	57.1 (19.0)	384.2 (23.4)	5492.8 (7.3)	5877.0 (7.0)	647.1 (27.4)	361.9 (31.5)	6943.1 (6.1)
	TOTAL	3.1 (73.6)	70.8 (38.5)	73.9 (37.1)	25.5 (31.6)	99.4 (28.9)	563.8 (17.4)	5677.2 (7.2)	6241.0 (6.7)	669.7 (27.0)	367.5 (31.1)	7377.6 (5.8)
URBAN		0	0.1 (41.9)	0.1 (41.9)	0	0.1 (41.9)	0	0.1 (87.7)	0.1 (87.7)	151.0 (44.2)	0	151.2 (44.2)
OTHER		0.1 (76.9)	56.4 (27.6)	56.5 (27.6)	17.7 (28.9)	74.2 (25.2)	63.6 (69.3)	1923.7 (13.9)	1987.3 (13.7)	301.1 (40.0)	2745.1 (13.8)	5107.7 (8.5)
TOTAL SURFACE AREA		59.9 (36.3)	318.9 (15.2)	378.8 (13.9)	165.8 (11.5)	544.6 (10.7)	658.6 (16.7)	7916.1 (5.2)	8574.7 (4.9)	1130.1 (22.8)	3181.9 (12.2)	13431.3 (0)
CHANGE IN PERIOD		2.0 *	-242.6 (21.2)	-240.6 (21.4)	-9.6 *	-250.2 (30.0)	224.1 (50.9)	973.0 (41.2)	1197.1 (32.6)	978.9 (22.7)	-1925.8 (17.0)	0

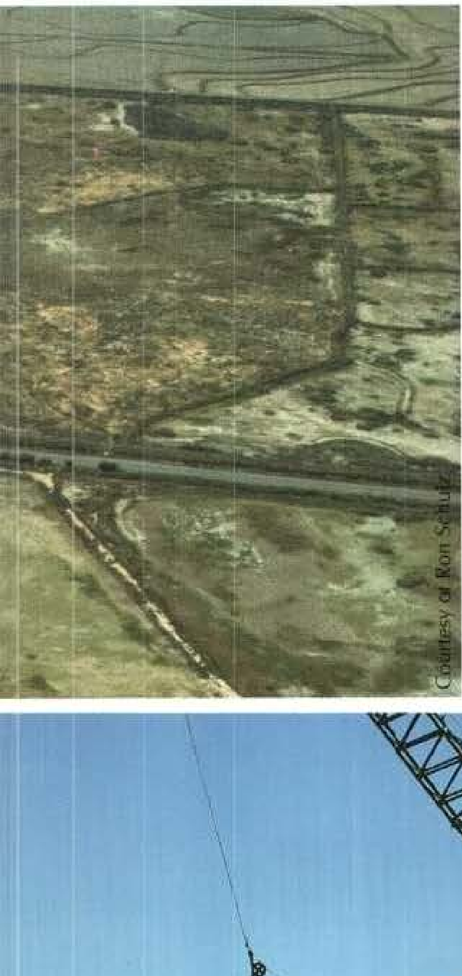
Table 2. Area, in thousands of acres, by selected combinations of surface area groups. Sampling error, in percent, is given in parentheses below estimate.

*Standard error of estimate is equal to or larger than estimate.

Courtesy of Gary Zahm


Courtesy of Ian McKie


Courtesy of Gary Zahm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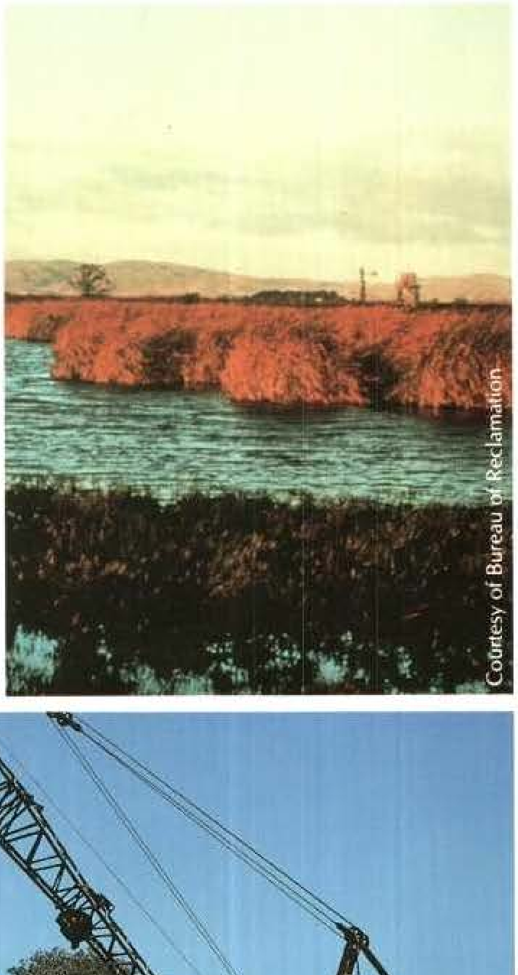
Courtesy of Bureau of Reclamation


Courtesy of Bureau of Reclamation


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