

**BIOLOGICAL RESOURCES OF THE  
SAN FRANCISCO BAY/  
SACRAMENTO-SAN JOAQUIN  
DELTA ESTUARY**

**STATUS AND TRENDS:  
WILDLIFE AND PLANT RESOURCES  
IN THE SAN FRANCISCO BAY/  
SACRAMENTO -SAN JOAQUIN  
DELTA ESTUARY**

**State of California  
The Resources Agency  
DEPARTMENT OF FISH AND GAME**

**STATUS AND TRENDS:  
WILDLIFE AND PLANT RESOURCES  
IN THE SAN FRANCISCO BAY AND  
SACRAMENTO-SAN JOAQUIN DELTA**

**BAY-DELTA AND SPECIAL WATER PROJECTS DIVISION**

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## FOREWORD

This report is intended to be used as an informational tool by the Bay-Delta Oversight Council (BDOC). It provides a description of status and trends relating to wildlife and plant resources in the San Francisco Bay/Sacramento-San Joaquin Delta Estuary.

The narrative discussion is an assemblage of information from written publications concerned with the Estuary and the decline of its biological resources. This paper discusses the abundance and distribution of wildlife and plant resources in the Estuary, the diversity and interactions among various plant communities which comprise this unique ecosystem, and the importance of the Estuary as a part of the Pacific Flyway.

More detailed information may be gleaned from the San Francisco Estuary Project's "Status and Trends Reports; Wildlife of the San Francisco Estuary" (SFEP 1991a). In addition, the SFEP prepared a similar technical report reviewing the Estuary's wetland habitats, "Status and Trends Report on Wetlands and Related Habitats in the San Francisco Estuary" (SFEP 1991b), which may be of further interest to the BDOC as it demonstrates the diversity and significance of the Estuary's wetlands to its wildlife and aquatic inhabitants.

The majority of the species examined in this report are state or federally listed as endangered or threatened. The California Department of Fish and Game's (DFG) "1991 Annual Report on the Status of California State Listed Threatened and Endangered Animals and Plants" provides a summary of the status of animals and plants listed as rare, threatened or endangered by the California Fish and Game Commission.

## INTRODUCTION

The purpose of this document is to describe the existing status and present trends of some wildlife and plant resources within the San Francisco Bay/Sacramento-San Joaquin Delta Estuary ("Estuary"). While this report reviews and describes wildlife resources within the Estuary, identifies important waterfowl habitat and documents other wildlife species utilizing wetlands and associated habitats which are critical to the perpetuation of the shorebird and waterfowl resources of the Pacific Flyway, it should be noted that the entire Sacramento and San Joaquin basins of the Central Valley are also regions of critical importance to the future of waterfowl, and associated wetland dependent wildlife.

A brief description of the environmental setting and an historical perspective detailing changes in the Estuary has been included to provide additional context for the information presented. Although waterfowl are the most conspicuous, other groups of wildlife common in marsh and riparian areas throughout the Estuary will also be considered; birds, mammals, amphibians, reptiles, insects and other invertebrates, as well as plant resources, some species of which have experienced substantial declines in their historical numbers and distribution.

Plant resources will be addressed during the discussion of wildlife and plant habitats. This will provide a diversity profile of wetland and aquatic habitats which will more clearly describe the interrelationship they have with wildlife communities which are partially or entirely dependent on them for food, shelter, or as the locale of some part of their life cycle.

## ENVIRONMENTAL SETTING

### GEOGRAPHY

The Estuary is the ocean outlet for the Sacramento and San Joaquin rivers, which drain 25 percent of California's land area carrying 40 percent of the state's runoff.

The San Francisco Bay basin is bounded by northwest to southeast oriented coastal ranges, includes San Francisco and San Pablo bays, the Carquinez Straits, Suisun Bay, and the Sacramento River below the confluence of the Sacramento and San Joaquin rivers. The area encompasses a total of 3,464 square miles. The regions within the San Francisco Bay basin include: North Bay -- Suisun Bay from Chippis Island to Benicia-Martinez Bridge and San Pablo Bay from Suisun Bay west through the Carquinez Strait and south to a line between Point San Pedro (San Rafael) and Point San Pablo (Richmond); Central Bay -- between the Golden Gate Bridge to the east, San Pablo Bay to the north, and the Bay Bridge to the south; South Bay -- all waters south of the Bay Bridge.

The Sacramento-San Joaquin Delta is geographically separated from the San Francisco Bay basin, which lies to the west, by the hills of the Coast Range. On the east, it is bounded by the outwash plains of the Sierra Nevada foothills. To the north and south there are no topographical features defining the Delta, although the cities of Sacramento and Tracy coincide with the approximate historic northern and southern limits of the tidal marshes which, together with extensive freshwater marshes and overflow lands, characterized most of the region before its reclamation (SFEP 1991b). This report will use the most common definition of the Delta, i.e., the "legal" definition of the Delta, set forth in the California Water Code at section 12220.

### GENERAL ECOLOGY

In the late 1700s, approximately 27 million acre-feet of freshwater flowed into the Delta annually, mixing with saltwater entering through the Golden Gate to create a 1,300 square mile estuarine ecosystem. Tidal marshes covered over 850 square miles, including freshwater and brackish marshes in the Delta and Suisun Bay, and salt marshes in North and South San Francisco Bay. At the time, the Estuary contained the largest contiguous tidal marsh system on the Pacific Coast of North America (SFEP 1991b).

Beyond the tidal wetlands, there were vast areas of grasslands dotted with seasonal wetlands, oak-woodland savannah and chaparral. Rivers and creeks sustained large growths of riparian vegetation. The coastal ranges west and east of the Bay supported large areas of evergreen forests, oak woodland, and conifer forests. The area provided for a large abundance of waterfowl, deer, elk, antelope, and other wildlife associated with these habitat types.

After 1850, the Estuary's diverse array of marine, estuarine, freshwater, and upland habitats, which supported an abundance of birds, mammals, reptiles and amphibians, began to feel the effects of development within the Estuary through the elimination or alteration of over half the acreage of natural habitat. The wildlife suffering the greatest losses from urban and agricultural encroachment were those species inhabiting wetlands, grasslands, and oak woodlands.

Large populations of fur-bearers, such as otters and beaver, plus several big game mammals and waterfowl supported commercial harvests during the last half of the nineteenth century. However, habitat loss, human disturbance, overharvest, and pollutants have dramatically reduced the population of furbearing and big game mammals, raptors (birds of prey), migratory waterfowl and other waterbirds. (SFEP 1991a).

A significant portion of the Estuary's wetland acreage has disappeared over the last 150 years, falling victim to development and related filling. Although there was some expansion of vegetated tidal marsh over mudflats as a result of hydraulic mining depositing debris in the Estuary during the mid- to late 19th century, the overall trend of gradual expansion has been reversed. The majority of the Estuary's wetland tidal marshes disappeared before 1920, and the present situation is one marked by the continuing diminution of this habitat type. Most notably, there has been a large-scale conversion from tidal to non-tidal wetlands, such as salt ponds and farmed wetlands. Moreover, the loss and degradation of other wetlands, such as riparian woodland and non-tidal freshwater marsh, has been significant as well (SFEP 1991b).

## WILDLIFE RESOURCES

Many wildlife and plant species inhabit the Estuary's channels, smaller rivers, creeks, perennial lakes and ponds, riparian corridors, grasslands, and seasonal wetlands such as vernal pools. (Vernal pools are a particularly important habitat type, which are generally shallow, temporarily shaded wetlands that in the spring support a unique community of plants and animals.) Populations of the following species depend on the Estuary for all or part of their life cycle.

### BIRDS

#### Waterfowl

Hundreds of thousands of acres of tidal and freshwater marshes, overflow lands, and waterways in the Central Valley and San Francisco Bay/Sacramento-San Joaquin Delta Estuary once served as a wintering and migratory haven for tens of millions of shorebirds and waterfowl, constituting nearly two-thirds of the waterfowl in the Pacific Flyway. Not

surprisingly, the Delta is considered a waterfowl wintering area of national and international significance. Today, waterfowl populations in the State are below five million.

Waterfowl present in the Estuary during all or part of the year can be divided into the following categories:

Dabbling ducks; mallard, northern pintail, gadwall, American wigeon, green-winged teal, cinnamon teal, and northern shoveler.

Diving ducks; redhead, canvasback, ring-necked duck, greater scaup, lesser scaup, common goldeneye, Barrow's goldeneye (a state listed species of Special Concern), bufflehead (status of taxa is of concern), and ruddy duck.

Sea ducks; surf-scoter, white-winged scoter, and the black scoter.

Mergansers; common, hooded, and red-breasted merganser.

Geese; "white geese" -- snow goose and Ross goose, "white-fronted geese" -- tule goose and Pacific greater white-fronted goose, "Canada geese" -- cackling Canada goose, great basin Canada goose, lesser Canada goose, and Aleutian Canada goose.

Swans; tundra swan and trumpeter swan.

Biologists from the DFG and United States Fish and Wildlife Service (USFWS) carry out aerial and ground surveys within California to determine the distribution and relative numbers of waterfowl wintering in the state. This statewide survey, called the Mid-Winter Inventory (MWI), is conducted in January, approximately a month after populations peak, and then melded with censuses taken in other western states to provide total counts for the entire Pacific Flyway. Waterfowl surveys conducted in California assess trends in overall population levels and not necessarily changes in use of certain habitat areas by waterfowl. Generally, migratory waterfowl adjust their wintering distribution based on weather and food resources over a wide area.

The MWI is utilized as a monitoring technique to provide vital information about distribution and relative numbers of waterfowl, which helps to determine populations and trends of the various bird species. It is used in conjunction with banding data, breeding surveys, age ratios of harvested birds (i.e., killed during hunting), and weekly counts. The results of the MWI also affect the promulgation of hunting regulations as the survey provides a good indicator of sustainable hunting yields (USFWS 1993).

In 1993, the annual statewide MWI found 2,020,436 ducks, 565,348 geese and 52,632 swans; for a total waterfowl count of 2,638,416. Though these data are difficult to compare because of inclement weather and variation in survey periods from year to year, the 1992 totals were 2,322,825 ducks, 676,764 geese and 45,120 swans; for a total of 3,044,709. In

1991, the count was 2,717,503 ducks, 686,231 geese and 38,609 swans; for a total of 3,341,343 waterfowl observed (DFG 1993).

During the 1970s, the total numbers of waterfowl in the Estuary averaged approximately 750,000, compared to 250,000 in the 1980s. The 1981-1990 winter waterfowl counts conducted throughout the entire Estuary determined 24 percent of the waterfowl counted were from the Sacramento-San Joaquin Delta. For 1993, the MWI count within the Estuary concluded that 36 percent of the waterfowl were in the Delta, 26 percent in the Grizzly Island Wildlife Area and Suisun Marsh, and 34 percent in the San Francisco Bay region. The breakdown of the 1990-1993 MWI numbers for waterfowl in the Delta reveal total populational distribution averages of 74 percent ducks (87,627), 12 percent swans (15,295), and 7 percent geese (8,705) (1993, DFG Wildlife Management Division).

Waterfowl that use the Estuary as a wintering and resting area during their migration depend on the availability and condition of potential habitat. A 1988-1989 study was conducted to understand the importance of each habitat to waterfowl for proper waterfowl management (USFWS 1989). The population-to-area ratio indicated the region maintains one of the densest wintering duck populations in the United States.

Composition of available waterfowl habitats differ in the Estuary. The northern region of the Sacramento-San Joaquin Delta is comprised mainly of rice, winter wheat, and black dirt (resulting from plowing of cereal grain and row crops). The central and southern Delta has provided a greater diversity of habitat types, with corn, sunflower, and winter wheat the most prevalent (1989, USFWS). In general, flooded croplands provide the largest component of wetland available to waterfowl in the winter. Flooding and drainage is closely related to the opening and closing dates of hunting season. In dry years, drainage significantly reduces wetland acreage that can be used as waterfowl habitat.

Overall, statewide waterfowl populations for many species of dabbling ducks and geese are at the lowest levels since monitoring began in the 1950s. Population decline has primarily been attributed to the combined effects of drought, habitat loss, trace element contaminants, and predation within both wintering and nesting grounds.

### Shorebirds

In April, 1990, the San Francisco-San Pablo Bay ecosystem was recognized as a site of hemispheric importance by the Western Hemisphere Shorebird Reserve Network, a coalition of public and private agencies dedicated to the conservation of shorebirds. Only three other wetlands in the Pacific Flyway have also received this designation, the Reserve Network's highest recognition of an area's importance to shorebirds (SFEP 1991a).

During spring and fall migration, many more shorebirds are found in the Estuary than in any other area of California. Shorebirds of the Estuary are comprised of plovers,

oystercatchers, stilts and avocets, sandpipers (includes willets curlews, small sandpipers, snipe and dowitchers), and phalaropes.

Since 1989, Point Reyes Bird Observatory has organized a broad-based census of shorebirds in many of the most important wetlands in California, Nevada and British Columbia, as well as some wetlands in Utah, Oregon, and Baja California, to identify their relative importance to migrating and wintering shorebirds (Page et. al. 1990). These censuses have shown that many more shorebirds are present in the Estuary during spring and fall migration than may be found in any other wetland in California. As many as 1 million shorebirds have been counted in the San Francisco Bay region in the spring (1989) and as many as 375,000 in the fall (1989). The most abundant species surveyed during the spring count were the western sandpiper, dunlin, dowitchers, and marbled godwit. In the fall survey, the western sandpiper, least/western sandpiper, marbled godwit, and the willet were the most abundant species surveyed.

At least 27 species of shorebirds occur annually in the Delta. During the summer, breeding shorebirds in the Delta include the killdeer, black-necked stilt, American avocet, and, irregularly, the snowy plover and spotted sandpiper. In the fall, the most abundant species are the black-bellied plover, long-billed curlew, western sandpiper, and long-billed dowitcher. In the winter, the most abundant species are the killdeer, long-billed curlew, mountain plover, dunlin, and long-billed dowitcher. In the spring, the most abundant species are the long-billed curlew, western sandpiper, dunlin, long-billed dowitcher, black-bellied plover, least sandpiper, and killdeer.

Although no formal shorebird censuses have been conducted in the Delta, resident shorebird numbers are probably lower than those found in the San Francisco Bay region. To a significant degree, shorebird use of the Delta is dependent on agricultural practices, especially crop patterns and the flooding of fields. Extensive early fall and spring flooding of plowed fields can result in large concentrations of shorebirds. When agricultural fields are flooded, they provide feeding habitat for several species, including black-bellied plover, semipalmated plover, killdeer, greater yellowlegs, long-billed curlew, least sandpiper, dunlin, and common snipe.

### Colonial Waterbirds and Seabirds

Colonial waterbirds and seabirds include several species; cormorants, herons, egrets, ibis, gulls, terns, pelicans, loons, grebes, and alcids. Nesting colonial waterbirds and seabirds occur in a variety of Estuary habitats. Nesting pairs of colonial species generally prefer to nest in close proximity to several other pairs, together forming a "colony."

Population estimates of colonial birds are generally based on counts of active nesting sites during the breeding season (Kelly 1992). Monitoring of nesting colonial waterbirds and seabirds, such as cormorants, herons, gulls, and terns, has been conducted for the last 10-15

years, but not consistently throughout the Estuary. Little information is available comparing current nesting populations to historic levels, which makes it difficult to describe trends. The following describes the status of several species of colonial waterbirds and seabirds.

### Brown Pelican

The brown pelican is common from May through November throughout the open waters of Central San Francisco and San Pablo bays. The brown pelican forages over deep open waters and roosts on sites relatively free from human disturbance, such as breakwaters, pilings, and salt-pond dikes.

A major population decline in breeding brown pelicans during the 1950s, from the Channel Islands to Monterey Bay, contributed to the species being federally listed as endangered in 1970 (Gress and Lewis 1988) and state listed as endangered in 1971. Factors contributing to this decline included pesticides (ingestion caused eggshell thinning), oil spills, human disturbance of breeding colonies, over harvest of its prey, loss of post-breeding roost sites, and fishing gear entanglement (DFG 1989).

Year-to-year variations in the numbers of post-breeding brown pelicans in California and San Francisco Bay may be related to the timing and success of nesting in Gulf of California colonies, the availability of their main prey (the northern anchovy), and sea surface temperatures along the coast (Briggs et al. 1983). Brown pelican numbers in the Bay region may have been higher in the past. However, given natural population fluctuations expected at the northern periphery of its range, and the current limited use of the Bay region as compared to the overall abundance of the brown pelican statewide, the local population was probably never very significant (SFEP 1991a).

Colony sites in Southern California and Mexico have been designated as preserves to give the brown pelican protection during its nesting season. In general, numbers of nesting pairs and reproductive success have increased in Southern California since 1978, to the point that the USFWS is currently considering reclassifying the species as threatened instead of endangered (SFEP 1991a).

### California Least Tern

The California least tern historically nested on coastal, sandy beaches. The first verified Bay area nesting occurred on an Alameda sandy bayfill (Ballena Bay) in 1967, probably following displacement from the coast (Anderson 1970). This site was eliminated by residential development, as was a second colony site at Bay Farm Island (Anderson 1970).

California least terns may be found nesting on open, flat, smooth sandy or hardpan surfaces such as bayfill sites, abandoned salt ponds, and aircraft runways.

Currently, the California least tern nests in the San Francisco Bay area at scattered locations. The total number of nesting least terns has fluctuated significantly over the years, with an average of 74 pairs a year during 1973-1989. About 100 to 110 pairs of birds attempted to nest within the Estuary during 1990 (Carter et al. 1990). A 1991 population count of breeding seabirds recorded 317 sightings of California least terns (Carter et al. 1992).

Current trends indicate that there has been a recent increase in the California least tern population. The number of breeding colonies occupied each year have been stable. The California least tern is a state (1971) and federally (1970) listed endangered species.

#### Marbled Murrelet

The marbled murrelet is occasionally reported in winter, rarely in summer, in the waters off Lands End at the entrance to the Golden Gate. It has rarely been recorded within San Francisco Bay (Carter and Erickson 1988). 1992 non-game bird population data for the San Francisco Bay and Suisun Marsh areas recorded 225 breeding pairs of marbled murrelets (DFG 1993). Southern San Mateo and northern Santa Cruz counties provide other breeding areas for the murrelet.

Marbled murrelets may have bred in the vicinity of the Golden Gate on the Oakland Hills in the late 1800s (Carter and Erickson 1988). The loss of old growth forest nesting habitat, and mortality from gill-net fishing and oil spills, may have attributed to large declines in the marbled murrelet population since the 1800s. The decline is especially acute in California, Oregon, and Washington. Although old growth forest is not found in the Estuary, foraging areas, important habitat for successful murrelet reproduction, is currently found there.

The marbled murrelet population probably is continuing to decline, despite management efforts aimed at controlling timber harvest in old-growth, coastal coniferous forests (Burkett 1991). The marbled murrelet is listed as endangered by the state (1991) and threatened by the federal (1992) government. However, changes in the Estuary would probably not significantly affect the murrelet's population status.

#### Other Bird Species

Other bird species of the Estuary that have experienced a decline in population numbers are profiled below. Ongoing threats affecting these populations may be reviewed in our companion report, "Factors Affecting Wildlife and Plant Resources of the San Francisco Bay and Sacramento-San Joaquin Delta".

- The California black rail is believed to have occurred historically in the tidal salt, brackish, and freshwater marshes of the Estuary (DFG 1989).

The current trend for the California black rail indicates some of its populations are declining due to a loss of coastal salt marshes and inland freshwater marshes (Gustafson 1991). The California black rail is currently a state-listed threatened species and is a Category 2 candidate for federal listing. (Category 2 listing is applied to species for which the USFWS has some biological information indicating that an endangered listing may be appropriate but for which further biological research and field study are necessary.)

- The California clapper rail is a non-migratory subspecies of the clapper rail. Tidal salt marsh is the California clapper rail's optimal habitat and supports their highest population densities.

The California clapper rail population was estimated at about 700 in 1988, but only between 300-500 in 1990-1991. The California clapper rail's current population trend indicates it is declining (Gustafson 1991), and it is believed to be on the verge of extinction (DFG unpubl. data in SFEP 1991a). The California clapper rail is listed as endangered by both the federal government (1970) and the state (1971).

- California's population of greater sandhill cranes (a 1983 State-listed species) winter entirely within the Central Valley and the Delta. One of the most significant roosting sites within the Delta for populations of both the greater and lesser sandhill cranes (not a listed species) is in the vicinity of Thornton. High numbers of the greater sandhill crane are also found on Brack Tract and Staten Island (DFG pers. com. in SFEP 1991a).

Optimal roosting sites are characterized by shallow water bodies, from 5 to 20 acres in size, typically interspersed with or surrounded by low herbaceous or emergent vegetation (USFWS 1978). These birds forage within the Delta, usually in harvested cornfields or nearby pastures.

The population of the greater sandhill crane is believed to be relatively stable, however, because greater and lesser sandhill cranes intermix on the wintering grounds it is difficult to characterize overall population trends. One recent count estimated that there are 3,500-6,000 greater sandhill cranes and 25,000 lesser sandhill cranes wintering in California annually. The greatest threat to both species is the potential loss of wintering, breeding, and foraging habitat.

- The western snowy plover is a migratory shorebird that nests on salt pond levees and islands and in abandoned salt ponds in both the south San Francisco Bay and San Pablo Bay. Loss of natural breeding and foraging habitat due to

loss of tidal salt and brackish marshes in the Estuary and other locations in the western United States has resulted in this species being significantly reduced in numbers.

The western snowy plover is a federal threatened species and a state species of Special Concern.

- The western yellow-billed cuckoo is a state listed endangered species that migrates into the Central Valley of California to breed. This species is closely tied to dense, extensive riparian forest particularly along the Sacramento and Feather rivers. The Delta is now only intermittently used by cuckoos migrating northward to these areas.
- Salt marsh yellowthroats, a subspecies of the common yellowthroat, range throughout North America and can be found year round in the Bay region of the Estuary. Loss of tidal salt, brackish and freshwater marshes around the Estuary have severely reduced the salt marsh yellowthroat's breeding and wintering habitats.

The salt marsh yellowthroat is a Category 2 Candidate for federal listing and is a state Species of Special Concern.

- Suisun song sparrows are non-migratory; their distribution is currently concentrated just west of the Delta, primarily in the Suisun Bay region. Members of this subspecies are physiologically and behaviorally adapted to a naturally occurring brackish tidal condition that occurs in Suisun Bay. Prior to habitat alteration by humans, these sparrows were known to exist throughout the entire Suisun Marsh area. The Suisun song sparrow is a state species of Special Concern and federal Category 2 species.
- The Alameda and San Pablo song sparrows are also non-migratory birds whose distribution is limited to South San Francisco Bay and San Pablo Bay respectively. Both subspecies are state Species of Special Concern and federal Category 2 Species.
- Tri-colored blackbirds are permanent residents of California's lowlands and are largely endemic, i.e., native, to the state. Breeding colonies tend to concentrate primarily in the Sacramento and San Joaquin Valleys. Tri-colored blackbirds prefer to nest and roost in marshes or trees near freshwater where emergent vegetation, such as cattails or tules, is present.

The most recent information detailing tri-colored blackbird population trends documents a continuing drastic decline in overall numbers and average colony size. The average total annual population count for the 1980s was estimated at

about 51,600 per year, representing a decline of 72 percent between the 1970s and 1980s, and an overall decline of 89 percent since the 1930s (Beedy et al. 1991). The tri-colored blackbird is currently a Category 2 federal candidate species, and a state Species of Special Concern.

- Bald eagles are winter residents in California, preferring large lakes, reservoirs or rivers near the northern and eastern periphery of the Estuary. Annual variations in numbers of wintering birds are likely influenced by food availability north of California. Frequently, the occurrence of eagles is associated with concentrations of American coots, a regular prey species whose habitat includes ponds, lakes, marshes, salt bays and fields (Detrich 1986).

There was a steady decline in the number of eagles during the first half of the 20th century. Additionally, there was a pesticide induced elimination of about 70 percent of their breeding population between 1945-1972, which led to the bald eagle being listed as an endangered species by the federal government (1967) and by California (1971).

The current trend of the bald eagle population, as described in the 1991 Annual Report on the Status of California Listed Threatened and Endangered Animals and Plants, indicates the breeding population is increasing and the winter population appears to be stable, varying from year to year and exceeding 1,000 birds some winters (Jurek 1991). As of April, 1993, the bald eagle remains a state and federally listed endangered species.

- Swainson's hawks nest in the Central Valley and the Great Basin region of California. The Central Valley and the Delta support an estimated 78 percent and 9 percent respectively, of the total statewide population of 550 pairs (SFEP 1991a).

Current population trends show the Swainson's hawk is declining statewide (Schlorff 1991). Following recognition of an approximate 91 percent decline in the breeding population, California listed it as threatened in 1983. The Swainson's hawk is a federal Category 3C species. The National Audubon Society has Blue-Listed the Swainson's hawk and considers it of Special Concern (Tate 1986). This Audubon designation is of note as CEQA gives weight to it when project impacts are evaluated.

## MAMMALS

Historical accounts of wildlife present in the Bay-Delta region attest to large and diverse populations of mammals. Grizzly bears, sea otters, pronghorns, and tule elk were

numerous. Changes occurring after the arrival of early explorers, gold miners, and trappers contributed to the elimination of some of these species.

The once abundant mammalian fauna in the Estuary is now dominated by species which can tolerate proximity to human populations, such as skunks, raccoons, opossums, and ground squirrels, and aquatic species such as beavers, muskrats, minks and river otters. The red fox, an introduced species, has expanded its population in the Bay area considerably to the detriment of native species, particularly ground nesting birds such as clapper rail and least tern.

Furbearing mammals within the Estuary which may be harvested include the badger, beaver, bobcat, coyote, grey fox, mink, muskrat, opossum, raccoon, spotted skunk, striped skunk, and long-tailed weasel. In 1980, the total number of furbearers taken was 20,554. In 1988, that number dropped to 2,259. Probable causes for this decline include urban encroachment and resulting destruction of habitat, fewer trappers, and market effects on fur prices. The historical changes have caused many animal populations to decline. Following is a discussion of special status species and their decline.

Salt marsh harvest mice are found in suitable tidal and non-tidal marshes around San Francisco Bay, Suisun Bay, and in Suisun Marsh. Dense salt marshes of pickleweed, gumplant, and fat hen are characteristic of the principal habitat of the mice and cover appears to be a major factor affecting habitat use. During high water outflows, high tides in tidal areas, and when managed duck clubs are flooded for hunting or other management purposes, mice seek refuge in more upland areas on adjacent levees and, for short periods of time, on emergent vegetation. These areas are generally densely vegetated and provide excellent escape cover. However, in the South Bay this species only has a narrow strip of vegetation on the levee slope of tidal areas remaining as refugial habitat. These mice require a varied diet, including green and dry plant stems and leaves and plant seeds, provided in areas supporting diverse habitat types.

The salt marsh harvest mouse is a California endangered species (1971) and a federal endangered species (1970). Current population trends for the salt marsh harvest mouse show it to be declining due to loss of habitat (primarily wetlands) through residential, commercial and industrial development, flood control, mosquito abatement activities, and freshwater encroachment caused by increased sewage treatment plant discharge (Gustafson 1991).

The Suisun ornate shrew occupies a smaller area and requires more specialized habitat than the salt marsh harvest mouse. It is a state species of Special Concern and a Category 1 Candidate for federal endangered listing. (Category 1 Candidates are species for which the USFWS has sufficient biological evidence to support a proposal to list as endangered or threatened.) At one time, San Pablo and Suisun bays were lined with salt and brackish water marshes. Today, however, marshes are broken into several small, isolated units. This deterioration has eliminated many of the Suisun shrew's habitat areas, as there are only a few

remaining suitable tidal marshes in the Estuary which have adjacent upland areas accessible to shrews when seeking shelter during extreme high tides.

The salt marsh wandering shrew has also experienced a decline in population. Its preferred habitat, salt marsh, has been virtually eliminated in the San Francisco Bay region as a consequence of human development. Because the wandering shrew relies on a more limited area in the salt marsh than the harvest mouse, it is presented with even less usable habitat and could be under a greater threat of extinction than the already listed harvest mouse. A recent survey (Ford, 1986) found only 16 live salt marsh wandering shrews in the marshes of San Francisco Bay. Presently, the wandering shrew is a state listed species of Special Concern and a Category 1 Candidate for federal listing.

The San Pablo vole (a small rodent) is found in the seasonal marshes of western Contra Costa County particularly in the Richmond area. Losses of suitable habitat have resulted in continuing population declines. This subspecies is a federal Category 2 Candidate and a State Species of Special Concern.

The riparian brush rabbit is a state candidate for listing as an endangered species. Its habitat is the dense riparian forest found in the south portion of the Delta. The population of this subspecies has undergone severe long-term decline since historical times due to continuing habitat losses.

## AMPHIBIANS

Amphibians found in the Delta generally occur in marsh or riparian habitats, except for the California slender salamander and the arboreal salamander, which occur in upland habitats. Bullfrogs, an introduced species, are now abundant and widely distributed.

Currently, there are several amphibian species whose population trends are of concern, however, their official status is not yet endangered or threatened. One species, the California tiger salamander, requires large vernal pools for breeding (Feaver 1971). Farm ponds can also be used for breeding. Access to rodent burrows by way of unobstructed migration routes are required for juveniles and adults (Twitty 1941). The California tiger salamander is designated as a California state listed Species of Special Concern and a Category 2 Candidate for federal listing. (The USFWS is considering a petition to list the California tiger salamander.)

California red-legged frogs were historically abundant in marshlands of the Central Valley and in fresh and brackish water marshes and riparian habitats surrounding San Francisco Bay. They inhabit quiet pools in streams, marshes and, occasionally, ponds. They historically occurred west of the Sierra-Cascade crest and along the length of California's Coastal Ranges. From Marin County south, red-legged frogs are no longer present from the Sierras, the Central Valley, and Southern California. Red-legged frogs are rare in the San

Francisco Bay area. The remaining populations are at risk from proposed projects which would affect the Coast Range slope of the Central Valley. The red-legged frog is presently designated as a California state listed Species of Special Concern and a Category 2 Candidate for federal listing. (The USFWS is considering a petition to list this species.)

Similar to California red-legged frogs, foothill yellow-legged frogs have also experienced adverse effects caused by watershed management practices that have resulted in listing as a California Species of Special Concern and a Category 2 Candidate for federal listing. At one time, these frogs could be found in the Estuary at the edge of the Delta in Putah Creek, the lowlands of the Mokelumne River, and possibly small creeks near Pittsburgh and Brentwood. Today, they are probably no longer present in the Delta, but they are still found in the Mount Diablo Range and the hills east of Petaluma.

### REPTILES

Most reptiles of the Estuary are restricted to upland or agricultural habitats. The only common, aquatic reptiles are the western pond turtle, the western aquatic garter snake, and the giant garter snake. Reptiles are the only animal group in the Delta with no successfully introduced species, although an occasional non-native red-eared slider (a common pet turtle) is found as a result of being released into the Delta.

The giant garter snake is currently listed as a threatened species by California and is a federally proposed endangered species. The current population trend of the giant garter snake is considered to be declining (Brode 1991).

Western pond turtles may occur in a variety of aquatic environments within the Estuary, including brackish water habitats. Historically, western pond turtles were exploited for food. The southwestern pond turtle, a subspecies of the western turtle, is designated as a Category 1 Candidate for federal listing, and a state species of Special Concern. The northwestern subspecies is a Category 2 Candidate for federal listing.

### INVERTEBRATES

Valley elderberry longhorn beetles are unique to most valley oak woodlands along rivers and streams in the lower Sacramento and San Joaquin Valleys, where elderberry bushes, its primary food source, grow. These beetles are found in the Delta portion of the Estuary (SFEP 1991a). Due to limited riparian habitat within the Central Valley, the beetle is listed as a federal Threatened Species.

The USFWS has proposed five vernal pool invertebrates for listing under the Federal Endangered Species Act. They are the conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, California linderiella, and vernal pool tadpole shrimp. All are

species that have declined in abundance due to significant losses of vernal pool habitats throughout California, including the Estuary.

## PLANTS

The Estuary's diverse assemblage of wildlife habitats and plant communities are comprised of an equally diverse assemblage of plant species. Botanists recognize that the abundance, distribution and health of these plant species are indicative of the health of the Estuary's ecosystem. Plant species diversity, number of exotics, and favorable reproductive conditions also help define the Estuary's condition. The large number of listed and candidate species indicates that the Estuary is in a declining condition. The interaction of plant species and other species in the Estuary has been noted in the previous wildlife sections, where the disruption of wildlife habitat and the plant species in those habitats have experienced similar declines. Further information regarding specific wetland and upland plant communities are discussed in the "Wildlife Habitat and Plant Communities" section of this report.

The following provides a profile of the plant species which have experienced a decline in population numbers resulting in a State or Federal endangered or threatened listing status. Also included are several plant species which are listed as "rare", (Section 1901, Fish and Game Code), and four additional candidate species of importance, Suisun aster, Delta tule pea, Suisun Slough thistle, California hibiscus and hispid bird's-beak.

- The Palmate-bracted bird's beak is listed as endangered by both the USFWS and DFG. The California Natural Plant Society (CNPS) includes the palmate-bracted bird's beak on their list of Plants of Concern. These plants are located in alkali grasslands and iodine bush scrub vegetation types. Historically, occurrences were scattered throughout the San Joaquin Valley, Livermore Valley in Alameda County and the Sacramento Valley in Colusa and Yolo counties. Five populations of palmate-bracted bird's beak are currently known, four in the Central Valley, the fifth population occurs in the Springtown wetlands, located north of Livermore in Alameda County. The Springtown population is the largest of the remaining five, and has been subject to protection efforts. Although plans to restore and enhance the Springtown populations are underway, the long-term trend for palmate-bracted bird's beak continues to be one of decline (DFG 1991).
- Solano grass, a federal and State endangered plant species, is very localized and is known from only two large vernal pools in central Solano County (CNPS 1988, NDDDB 1992). The Solano grass occur in very specific habitats which are not widespread and populations continue to be adversely affected and are declining.

- The San Joaquin Valley orcutt grass is a State endangered species and a proposed federal endangered species. This grass was once common in vernal pools in Stanislaus, Merced, Fresno, Madera, and Tulare counties. Many species associated with the San Joaquin Valley orcutt grass such as the Colusa grass, Boggs Lake hedge-hyssop and succulent owl's clover are all state-listed endangered. The general trend for San Joaquin Valley orcutt grass is one of decline.
- Slender orcutt grass is a State endangered and a proposed federal threatened species. This grass occurs in the bottom of vernal pools associated with valley grassland and blue oak woodland communities. Associated species that are also State listed included Boggs Lake hedge-hyssop and Greene's tuctoria. Much of the vernal pool habitat supporting this plant has been damaged or lost. Although discoveries of additional populations in recent years have extended the known range of this species, the overall trend for slender orcutt grass is one of decline as a result of habitat alteration and loss.
- The Sacramento orcutt grass or sticky orcutt grass, is a State endangered species and a proposed federally endangered plant species. This grass is restricted to several vernal pool complexes in Sacramento County and is the rarest and most narrowly distributed member of the genus Orcuttia. Fewer than 10 occurrences of Sacramento orcutt grass have been reported. Most occurrences are on private land and remain unprotected. The trend for Sacramento orcutt grass is one of rapid decline.
- Colusa grass is a State endangered and federal Candidate 1 species. The general habitat type of Colusa grass is vernal pools. This grass occurs only on the adobe muds of large or deep vernal pools in Merced, Stanislaus and Solano counties. Colusa grass has been extirpated at its type locality in Colusa County. Associated species in some locations include hairy orcutt grass and San Joaquin Valley orcutt grass, both also State listed as endangered.
- Burke's goldfields is listed as a State and federal endangered species. The general habitat type is vernal pools however, they are also located in meadows and seeps. This sunflower relative grows in the vernal pools and moist depressions in the vicinity of Santa Rosa in Sonoma County and to a lesser extent at sites in Lake County. The trend in the population numbers of Burke's goldfields is one of drastic decline. The Burke's goldfield often occurs with two other State and Federally listed endangered plants, the Sebastopol meadowfoam and Sonoma sunshine.
- The Sebastopol meadowfoam grows in seasonally wet meadows, pasture and vernal pools primarily in the drainage of the Laguna de Santa Rosa in Sonoma County. Most occurrences are on private land within five miles of the City of

Santa Rosa. Sebastopol meadowfoam often occurs with the two other listed specie, Burkes's goldfields and Sonoma sunshine. The trend for Sebastopol meadowfoam is one of decline.

- Sonoma sunshine is a State and federal endangered species that is a narrowly occurring California endemic, restricted to vernal pools, shallow depressions, and intermittent swales in the Santa Rosa Plains and the adjacent Sonoma Valley of Sonoma County. Approximately 30 percent of the historic occurrences of Sonoma sunshine have been eliminated or seriously damaged, and most of the remaining sites are threatened with urbanization, wastewater effluent irrigation, and conversion of habitat to agricultural lands. Similarly, the trend for Sonoma sunshine population is one of decline.
- White sedge is restricted to moist sites adjacent to freshwater marshes and creeks in Sonoma County. Only five occurrences have been reported and only one of these, Lower Pitkin Marsh, has been confirmed in the last 10 years (DFG 1991). White sedge grows with two other State-listed endangered plants: Pitkin Marsh lily and Pitkin Marsh Indian paintbrush. The present trend for the white sedge population is one of continued decline.
- The soft-haired birds's beak is a State listed "rare" and Federal candidate species. This species is an annual herb endemic to higher elevations of tidal marshes fringing the shorelines of San Pablo and Suisun bays. The soft bird's beak is found in tidal marshes at the north end of the San Francisco Bay and in the Suisun Marsh (CNPS, 1977). There are approximately a dozen historic occurrences of soft bird's beak, but a 1986 survey confirmed that only three remain. Recent, known locations are limited to several areas in Napa Marsh, South Hampton Bay, the confluence of Cutoff Slough and Montezuma Slough (west of Beldons Landing) in Suisun Marsh and several locations along the northern Contra Costa County shoreline (DFG 1991a). The overall trend for soft bird's beak is one of decline.
- California hibiscus occurs along the Sacramento River and adjoining sloughs from Butte County to the Delta. The California hibiscus is restricted to freshwater marsh habitats in riverine backwaters, irrigation canal banks, and Delta islands. It is associated with tules, willows, buttonwillow and other marsh and riparian species on heavy silt, clay, or peat soils. The California hibiscus is classified as a Category 2 candidate for federal listing.
- Mason's lilaeopsis is classified as a Category 2 Federal candidate plant species and listed as "rare" by DFG. Mason's lilaeopsis is known from a minimum of 39 sites according to information from the California Natural Diversity Data Base (CNDDDB). The overall distribution of the plant includes Contra Cost, Napa, Solano, Sacramento, and San Joaquin counties. The plant is restricted to

the tidal zone and grows in disturbed muddy banks and flats and occasionally on rotting wood. The formation of habitat is primarily due to natural disturbance of riparian or marsh vegetation as a result of bank failure and erosion. The plants appear to colonize new habitat both vegetatively and by seed deposition. Entire plants of Mason's lilaopsis were observed floating in sloughs suggesting that vegetative reproduction and the formation of clonal populations may be important in colonization. The habitat of Mason's lilaopsis is generally considered transient. The rate of habitat formation, colonization, and eventual loss varies as a function of bank stability. Steep levee banks are unstable and the viability of a population of Mason's lilaopsis may be as short as one year after colonization. More stable situations, such as those on riparian islands, may support a population for over 20 years based on historical information obtained from topographic maps of islands in the sloughs (DFG 1991a). In summer, habitat viability is directly related to the level of human development with levied banks having low viability. The future trend for this small perennial herb is one of imminent decline due to numerous modifications planned for its habitat.

- The Napa bluegrass is a State endangered and federal Candidate 1 species, known from just two sites near Calistoga in Napa County. It grows in moist alkaline meadows that are fed by runoff from nearby hot springs. Population numbers are declining, and preservation efforts through acquisition of habitat by DFG or by conservation easements are essential to this species' survival.
- The fountain thistle is a state endangered and federal Candidate 1 species. General habitat of the fountain thistle are the valley and foothill grasslands. This member of the sunflower family occurs in the extremely restricted serpentine seeps of the Crystal Springs region, San Mateo County. It sometimes grows with other rare plants like fragrant fritillaria and San Francisco wallflower. The overall trend for fountain thistle has been one of decline, with a sharp decline when Highway 280 was built resulting in destruction of habitat and alteration of drainage patterns, and a slower rate following that initial disturbance. The recent trend for fountain thistle is one of stability.
- The Delta button celery is listed as a State endangered and federal Candidate 2 species. The Delta button celery's generally occur on the clay soils in lowland areas of riparian (riparian scrub) and floodplain habitat. Delta button celery occurrences are under private ownership, on USFWS property, and on DFG's Los Banos and North Grasslands Wildlife Areas. There are no specific protection measures being implemented for this species. The trend for the Delta button celery population is one of decline.

- The Pitkin marsh lily is a State endangered and federal Candidate 1 species. There are three recorded occurrences of Pitkin Marsh lily, only two of which have been seen recently (DFG 1991). These occurrences are confined to a small portion of Sonoma County, near freshwater marshes in the vicinity of Sebastopol and Cunningham. Although the overall trend for Pitkin Marsh lily has been one of decline, recent focused attention has helped to create greater stability.
- The Kenwood marsh checkerbloom is a State endangered and federal Candidate 1 species. Only two occurrences of this unique California plant are known, one in Kenwood Marsh and the other in Knights Valley, both in Sonoma County (DFG 1991). The overall trend for Kenwood Marsh checkerbloom is one of decline due to development and habitat destruction.
- The Delta Tule Pea is a Federal candidate species. Historically this plant species was distributed throughout the Bay area marshlands, with additional populations known from San Benito, Fresno and Tulare counties. Due to widespread habitat losses, its current distribution is largely restricted to fresh and brackish tidal wetlands bordering San Pablo and Suisun bays and tidal wetlands in the Delta.
- The Suisun Slough thistle is a Federal candidate species. This species is known only from one site-- 0.75 miles SSW of Suisun City. Last observed in 1974, the plant is still presumed to be present at this site. The habitat of this thistle consists of salt to brackish wetlands periodically inundated during high tides.
- Suisun aster typically occurs along tidal sloughs in salt to brackish marshes and is a Federal candidate species. Populations visited by DWR botanists included Suisun Slough, Hill Slough and other western Suisun Marsh waterways. Populations were often dense, but highly restricted to the narrow band of Scirpus alongside the streams (DFG 1991a).
- The Hispid bird's-beak is classified as a Category 2 candidate species for federal listing. This species is found in alkaline grasslands and brackish seasonal marshes. The plants are associated with saltgrass, iodine bush, alkali barley, and alkali heath. Known from only a few populations, the subspecies extends from the Sacramento-San Joaquin Delta and southern Sacramento Valley south through the San Joaquin Valley to Kern County.

## WILDLIFE HABITATS AND PLANT COMMUNITIES

"Habitat" refers to the physical place where an organism lives. A "community" is all the plants and animals of an area which interact and form an interdependent network.

Surveys in the 1850s described the Estuary as supporting a vast complex of tidal salt, brackish and freshwater marshes and riparian woodlands. About 313 square miles of tidal marshes were believed to have bordered San Francisco, San Pablo and Suisun bays (Nichols and Wright 1971), with the Delta supporting an additional 540 square miles of tidally influenced, freshwater emergent marsh (Atwater et al. 1979), characterized by erect, rooted wetland plants that grow only in water or saturated soil.

### WETLANDS

The Estuary is a region where salt and freshwater mix. The wetlands within the historical range of tidal marshes (Nichols and Wright 1971) are influenced by saline conditions at sometime during the year. Tidal influence extends from the Bay up most reaches of Delta waterways, which are generally considered tidal freshwater habitat. Saltwater intrudes into the Delta to a varying extent during the dry season, when outflows of the Sacramento and San Joaquin rivers are at their lowest level. Freshwater flows into the Bay and Pacific Ocean during winter and spring months (SFEP 1991b).

Wetland and related communities within the Estuary can be divided into the following categories (SFEP 1991b):

- Intertidal mudflats and rocky shore (estuarine)
- Tidal salt and brackish marsh, tidal channels/pond connections (estuarine)
- Seasonal and permanent marshes (palustrine)
- Tidal freshwater marshes
- Riparian forest (palustrine)
- Salt ponds (lacustrine)
- Lakes and Ponds (lacustrine/palustrine)
- Perennial and intermittent streams (riverine)
- Adjacent upland habitat (and transition area)
- Farmed wetlands
- Open water "wetlands"

Mudflats and salt ponds are the predominant wetlands presently found within the Estuary in the vicinity of South San Francisco Bay, other than open water "wetlands" (which are technically not wetlands but include deepwater areas and, through mixing, exhibit some basic wetland characteristics). San Pablo Bay has an abundance of intertidal mudflats and farmed wetlands, and the Suisun Bay/Marsh area of the North Bay is governed by diked salt and brackish marshes. In the Delta, farmed wetlands are predominant. These are areas that

exhibit wetland characteristics (e.g., hydric soils, wetland hydrology, hydrophytic vegetation), but are used for agricultural production. They are generally diked and/or drained, but annually pond water or have saturated soils for variable periods.

Current wetland acreage assessments indicate farmed wetlands total 385,755 acres (156,176 hectares). The majority of these farmed wetlands are in the Delta and North Bay. The next most abundant wetland type is open water, 266,158 acres (107,756 hectares). In addition to farmed wetlands, there are 85,134 acres (34,467 hectares) of seasonal wetlands, which are comprised of diked marshes, vernal pools, abandoned salt ponds, and other freshwater habitats. The Suisun Marsh contains the largest diked seasonal wetland in the Estuary, extending over 57,310 acres.

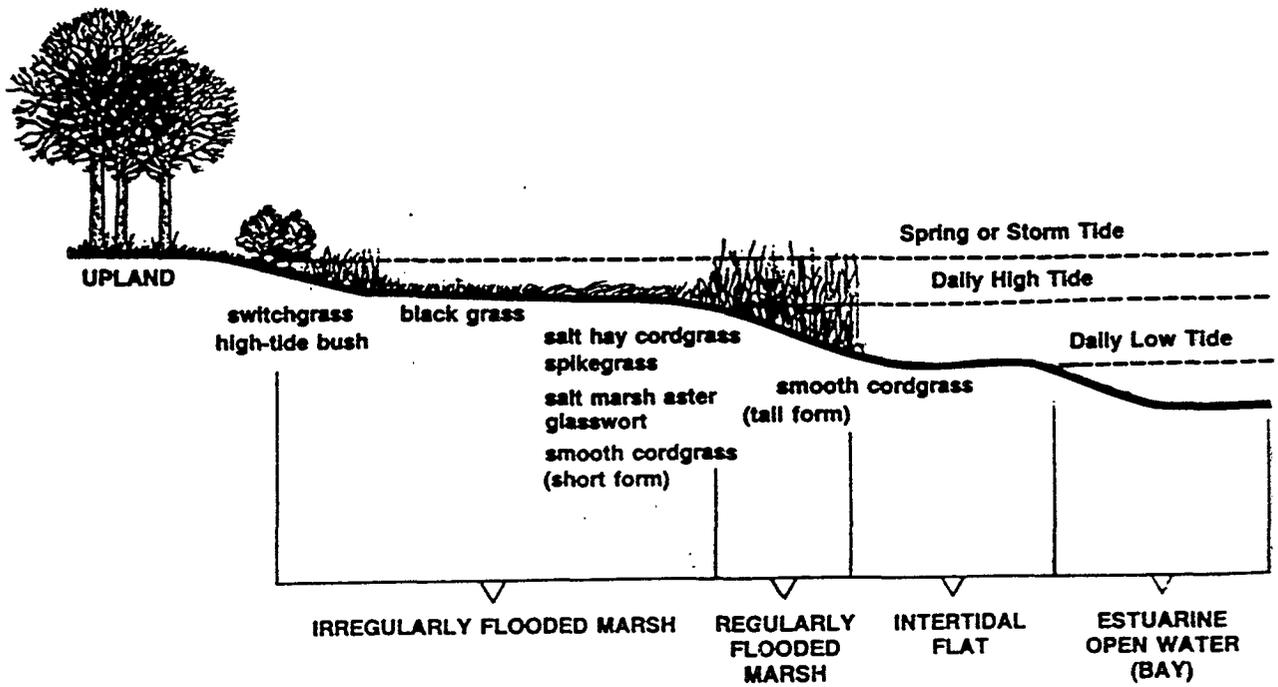
### Tidal Marshes

Currently, tidal marshes comprise 44,370 acres of the Estuary's wetlands. Tidal marshes can be salt, brackish, or freshwater marshes depending upon water and soil salinities. At least 82 percent of San Francisco Bay tidal and salt marshes have been filled or converted to other wetland types (Dedrick 1989).

Tidal salt, brackish, and freshwater marshes in the Estuary are dominated by sparse to dense stands of emergent vegetation. Salt and brackish marshes are usually interspersed with unvegetated tidal channels and salt pans (generally flat, unvegetated areas in the high marsh) that are exposed at low tide. The vegetation in this area is usually comprised of grasses, sedges, rushes, and succulents.

The exact distribution of plant species is dependent on the period of submergence, sediment salinity, and competition. Although elevation with respect to tides appears to be the primary determinant of species distribution, many species can be found in discrete patches at elevations in which they are not expected. Vegetated salt and brackish marshes generally exhibit cordgrass (grasses) between mean tide level (MTL) to mean high water (MHW) and pickleweed (succulents) above MHW. Rushes and sedges are usually found in saturated soils with comparatively low salinity levels.

A typical tidal salt marsh is characterized by a band of cordgrass stretching from approximately mean sea level to the mean high water level. In addition, there are several other vegetation subdivisions stratified by elevation (Figure 1). At the mean high water level, pickleweed begins to intermix with cordgrass, and, together with the low cordgrass band, forms a "low marsh". In the middle marsh, the ecotone is comprised almost exclusively of pickleweed stands, which persist to high tide elevations. At higher elevations, the high marsh is made up of combinations of pickleweed and peripheral halophytes (plants that can grow in salty or alkaline soil), such as salt grass, salt bush and alkali heath. Above the high marsh, adjacent upland



Status and Trends Report of Wildlife Resources in the San Francisco Bay and Sacramento-San Joaquin Delta. Graph of Tidal Wetlands Vegetation.

Figure 1

habitat forms a transition zone supporting plants from the high marsh and upland plant communities. Depending on their slope, tidal marshes may vary from a few feet to over a thousand feet in width, and may contain all, one, or just a few of the marsh zones described above.

Tidal brackish marshes occur where the tidal salt water of the Bay has been diluted by freshwater runoff. The dominant plant species in these marshes vary with elevation: The low marsh is dominated by the California bulrush; the middle marsh is primarily a mixture of cattails and bulrushes; and the high marsh supports a varied group of halophytes such as saltgrass, brass buttons and baltic rush. Tidal brackish marshes are common in Suisun Bay, San Francisco Bay and generally in areas of local freshwater influence; for example, the Petaluma and Napa rivers, and the several South San Francisco Bay rivers, creeks, or sloughs that receive treated sewage effluent.

Brackish tidal marshes are predominant in areas experiencing freshwater influences of the Delta, local rivers, creeks, and sloughs (e.g., Suisun Bay, San Pablo Bay, South San Francisco Bay). In the Napa Marsh, on the north shore of San Pablo Bay, about 94 square miles of tidal marsh extends several miles northward, up the Sonoma and Napa valleys (Dedrick 1989). Tidal wetlands also extend about 13 miles upstream along the Petaluma River. The brackish tidal marshes of Suisun Marsh encompass about 111 square miles, from Benicia eastward to Collinsville (Dedrick 1989).

The Bay's tidal brackish marshes support several rare or endangered species: among plant species, the soft bird's-beak and hispid bird's-beak; among wildlife species, the California black rail, California clapper rail, salt marsh yellowthroat, three races (Alameda, San Pablo, Suisun) of salt marsh song sparrows, and the salt marsh harvest mouse, which are found in tidal and non-tidal wetlands. The salt marsh vagrant shrew and the Suisun ornate shrew are found only in tidal marshes (SFEP 1991b).

### Freshwater Marshes

Freshwater marsh can primarily be found in the western and southern Delta. Natural alluvial levees, which are lower and allow more regular flooding (Atwater et al. 1979), account for the more extensive and regularly inundated tidal marsh areas in the southern Delta. The northern Delta is characterized by higher, man-made levees that preclude frequent flooding.

Freshwater marshes comprise less than one percent of the Bay's area. Freshwater marshes in the Delta include a successional progression of community types that range from tules and reed grasses (newly established on recently deposited

sediment) to more complex tule and shrub communities on higher elevation, older islands or river bank sediment deposits (Madrone Assoc. 1980).

Surveys conducted in freshwater marshes of the Delta from January 1979 to February 1980 revealed 57 wildlife species associated with this habitat type (Madrone Assoc. 1980). Of these, 19 were found to depend upon some feature of freshwater for breeding, migration, resting or roosting. Residents of the freshwater marshes include; American bittern, pied-billed grebe, marsh wren, tri-colored blackbird, western pond turtle, giant garter snake and beaver (SFEP 1991b).

#### Intertidal Mudflats

Where tidal marshes still exist, incoming tides flood into the upper marsh areas. As these tidal waters recede, organic materials are transported down slope to mudflats and become a food source for millions of detritus feeding invertebrates. The mudflats are a living system of diatoms, microalgae, protozoans and a multitude of arthropod, annelid worms, and mollusks. During low tides, exposed mudflats are exploited as a food source by millions of shorebirds, which are probably the most prominent wildlife group associated with intertidal mudflats (SFEP 1991b).

The South Bay mudflats have the greatest diversity and abundance of invertebrates, followed by San Pablo Bay, then Suisun Bay, and last the Delta (Nichols and Pamatmat 1988). The abundance of shorebirds in tidal mudflats also follows this same pattern (SFEP 1991a).

Table 1

WILDLIFE HABITAT AND APPROXIMATE ACREAGE WITHIN THE ESTUARY

<u>Habitat Type</u>	<u>Acres</u>
Wetland and Deepwater Communities	
1) Open Water	266,158
2) Intertidal Mudflat and Rocky Shores	64,093
3) Tidal Salt, Brackish and Freshwater Marshes	44,371
4) Seasonal Wetlands	
Farmed Wetlands	385,755
All Others	
Diked Marsh (Salt and Brackish), Vernal Pools and Other Freshwater Habitat, and Abandoned Salt Ponds	85,134
5) Riparian Woodland	12,513
6) Salt Ponds	36,684
7) Lakes and Ponds	29,369
Upland Communities	
8) Grassland	213,100
Annual Grassland, Perennial Grassland, and Irrigated Pasture	
9) Coastal Scrub	31,500
10) Mixed Chaparral	32,965
11) Oak Woodland	287,784
Valley Oak Woodland/Savannah and Blue Oak Woodland	
12) Broad-leaved Evergreen Forest	553,133
Coast Live Oak/Canyon Live Oak Forest, California Bay Forest, and Mixed Evergreen Forest	
13) Agriculture (upland only)	234,786
Croplands, Orchards, and Vineyards	
14) Urban	1,775,277
<b>TOTAL AREA</b>	<hr/> 4,081,611

(from SFEP 1991a)

Intertidal mudflats typically border open water and subtidal areas. This substrate, and the smaller adjacent rocky shores, now cover 64,093 acres. The extensive intertidal mudflats of San Francisco Bay provide feeding habitat for wintering shorebirds of the Pacific Flyway and are a key migratory staging and refuging area (SFEP 1991b).

The most abundant shorebird species using the tidal mudflats in San Francisco Bay include; western sandpipers, dunlins, dowitchers, marbled godwits, and least sandpiper. Little information is available on common shorebirds using intertidal mudflats of Suisun Bay and the Delta. However, large numbers of western sandpipers, dunlins, and long-billed dowitchers have been sighted in Suisun Marsh (DFG 1975). Also, a study of intertidal mudflats associated with islands constructed of dredged material concluded it was common for western and least sandpipers, dunlins, and semipalmated plovers to forage and roost on them.

### Vernal Pools

Two groups of vernal pools occur on the western edge of the Delta. The Jepson Prairie, also known as the Dozier vernal pools or Dixon vernal pools, lies at the western end of Lindsey Slough, roughly between Barker and Calhoun Cuts. The pools are surrounded by remnant perennial grasslands and are of great botanical significance. Also, in the southwestern portion of the Delta, there is a second group of vernal pools along the railroad tracks south of Byron. They are slightly alkaline, and the plant community composition is correspondingly different than those of the Jepson Prairie and elsewhere.

More than 200 plant species are found in vernal pool habitats - 91 percent of them are considered California natives (Holland 1988). Water grasses are typically found in vernal pools (Stebbins 1976), and some species have received special listing, including; the federal and state-listed endangered Solano grass, and the state-listed endangered Colusa grass. Reclamation for agriculture, mineral extraction, and urban/suburban sprawl have fragmented or totally destroyed formerly extensive areas of vernal pools (Holland 1976).

As compared to other wetland types, vernal pools contain the greatest number of special status plant species (six listed species and six candidates). Because of the limited distribution of this community and its susceptibility to agricultural conversion and urban expansion, vernal pools are considered by many agencies a threatened community throughout California (SFEP 1991b).

Eight additional vernal pool plants were recently proposed for federal listing in August 1993. Proposed federally endangered plant species included the San Joaquin Valley orcutt grass, hairy orcutt grass, Sacramento orcutt grass, and Green's tuctoria. The proposed federally threatened plant species were the fleshy owls-clover, Colusa grass, Hoover's spurge, and slender orcutt grass.

### Diked wetlands

Approximately 46 percent of the Estuary's diked salt and brackish marshes occur in Suisun Bay, 14 percent in the North Bay and 8 percent in the South Bay. These wetlands, former tidal areas now behind dikes and partially or totally excluded from tidal action, usually support salt and brackish wetland vegetation.

The Suisun Marsh supports over 25 percent of the Central California waterfowl population in dry years (USFWS 1978); over 3.3 million and 5.6 million of the state's total migratory waterfowl population (DFG 1987). The Suisun Marsh is also important to shorebirds as a migration stop-over area. Due to its size and location, along with abundant prey, the Suisun Marsh is an important area for raptors as well. In recognition of the importance of the Suisun Marsh to wildlife, State legislation was enacted to protect the Marsh's values. Furthermore, the California Department of Water Resources and the U.S. Bureau of Reclamation in cooperation with DFG, and the Suisun Resources Conservation District and its landowners and other regional, State and Federal agencies have begun implementation of a plan to protect the Marsh's existing brackish marsh values. A key aspect of that plan was a salinity control structure in Montezuma Slough designed to reduce the eastward movement of high saline water into the Marsh's channels and managed wetlands. That facility and additional phases of the plan have proven effective at accomplishing protection of the Marsh.

### Farmed wetlands

Currently, habitat studies within the San Francisco Bay and Sacramento-San Joaquin Delta indicate the Estuary's most abundant wetland type is farmed wetlands, totaling 385,755 acres (156,176 hectares). This is 61 percent of the Estuary's total wetland acreage. The majority of these farmed wetlands are in the Delta and North Bay. Most are converted tidal brackish and freshwater marshes. The interiors of most islands in the Delta support farmed wetlands. Vegetation cover is usually low and uniform, and forage crops such as hay and alfalfa are periodically cut or plowed under. Corn and sorghum are planted commercially by gun clubs and by private farmers to provide wildlife food and cover (SFEP 1991b).

### Riparian Woodland

An estimated 1,200 to 1,500 square miles of riparian woodland was believed to have existed in the Estuary region before reclamation occurred. The forest was most extensive on the higher, alluvial mineral soils of the Sacramento, Cosumnes, Mokelumne, and San Joaquin rivers' historic floodplains, situated around the Delta's periphery (Madrone Associates et al. 1980). Along channels of the western and central Delta, the monotypic tules were occasionally interrupted by channel or pond surfaces and intermittent strips of higher alluvial

soil supporting sycamores, white alders, and willows. These trees usually took hold upstream of upper Brannan Island in the north and upper Union and Roberts Islands towards Stockton in the south (Thompson 1957).

Riparian woodland covers 12,513 acres of wetlands in the Estuary. Ironically, riparian woodland is the rarest wetland community in the Estuary, and is thought to be the most valuable of critical habitats for wildlife because it supports a large and diverse group of species (SFEP 1991b).

Riparian communities adjacent to grasslands or agricultural lands provide many unique habitat components. Nesting sites for raptors and cover for upland species are provided by trees and shrubs while adjacent open lands provide necessary foraging areas. Riparian vegetation overhanging sloughs and streams drop leaves and insects. Water temperatures are lowered by shading from adjacent riparian vegetation. Lower water temperature is beneficial in providing food and protection to invertebrates, which in turn provide food for birds and fish. Also, roots and overhanging limbs improve the diversity to aquatic habitats for a variety of fish and aquatic insect species. Of all the wildlife habitat types surveyed in the Sacramento-San Joaquin Delta, riparian woodland supports the greatest diversity of bird species, including both nesting and wintering species (Madrone Assoc 1980).

#### Uplands

The historic extent of upland communities in the Estuary is not well documented. Uplands immediately adjacent to the tidal marshes of San Francisco, San Pablo, and Suisun bays at one time probably consisted of perennial bunchgrass prairies, coastal scrub, and valley oak woodland/savannah (SFEP 1991b). In the Delta, at about the 100-year flood line, riparian forest graded into valley oak savannah and broad reaches of perennial grasslands interspersed with vernal pools (Warner and Hendrix 1985).

The San Francisco Bay watershed historically supported a mixture of coastal scrub, chaparral, oak woodland, and broad-leaved forest. In the hills east of Central San Francisco Bay, a seven-square mile coastal redwood forest supported a thriving timber harvest from about 1840 to 1860 (SFEP 1991b, Monteagle 1976).

Currently, broad-leaved evergreen forest is the most common native upland community, totalling 553,133 acres (223,940 hectares). This is followed in geographic scope by oak woodland, 287,784 acres (116,512 hectares); and grassland, 213,100 acres (86,275 hectares). The most common non-native upland community is urban, with acreage totalling 1,775,277 acres (718,736 hectares).

In the South Bay area, uplands are predominantly urbanized. Broad-leaved evergreen forests (occurring along the Peninsula, in the Berkeley Hills, and in the Mount Hamilton area), and oak/woodlands/savannahs (which occur on the southeastern edge of the Estuary adjacent to the Diablo Range) are of lesser extents. North Bay uplands are comprised of

urban zones and a mixture of oak woodland, coastal scrub, and chaparral in the Coast Ranges. In the Suisun Bay/Marsh area, grassland and urban are the most common upland community types. Grassland is the most widespread of the Delta uplands.

## CONCLUSION

The status of the wildlife and plant resources of the Estuary are a product of both historical and ongoing natural processes and of the relatively recent influences of human developments and activities. While the largest conversions of habitat occurred over 50 years ago, agricultural encroachment into riparian woodland and other processes that fragment natural communities continue and are of particular concern because so little remains of certain habitat types. Agricultural land use within the Estuary also has proven to be a significant benefactor to wildlife. Flooded agricultural fields provide an important substitute for seasonal wetlands as an essential feeding area for waterfowl and shorebirds. A major current threat to existing biological resources is urbanization, primarily of existing agricultural lands in the Delta and of diked wetlands in the San Francisco Bay area.

In general, raptor populations in the Estuary are continuing to experience declines or, at best, limited recovery. For example, the Swainson's hawk continues to be threatened due to the loss of riparian woodland, a primary nesting habitat.

The loss of vernal pools, freshwater marshes, riparian woodlands, and grasslands have contributed to the depletion of several species of amphibians and reptiles within the Estuary, some of which may be verging on extinction. Examples of these are the California tiger salamander, red-legged frog, giant garter snake, and western pond turtle.

At least seven insects, one reptile, three birds, and five mammals have either become extinct or no longer inhabit the Estuary. Ninety taxa of insects, amphibians, reptiles, birds (15% of the total), and mammals (26%) found within the Estuary are currently designated by the federal and/or state government as meriting special protection or monitoring. Sixty-one percent of these designated taxa have been depleted through loss of wetland and riparian habitat. The Estuary's plant resources have also declined in numbers, especially those species associated with habitats of listed wildlife species.

The Estuary provides valuable habitat for significant populations of wintering or nesting species and needs to be protected and improved. Moreover, there are several species identified in this report which are unique to the Estuary and which are threatened with extinction.

The factors influencing the relationship of wildlife and plants to the environment are complex. There are many gaps in the knowledge of how specific relationships function. A discussion of some of the factors that have influenced wildlife and plants as well as wildlife and plant communities in the Estuary is presented in the companion paper to this report.

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