SACRAMENTO-SAN JOAQUIN DELTA INVESTIGATION

FISH AND WILDLIFE COORDINATION ACT REPORT

U.S. FISH AND WILDLIFE SERVICE
SACRAMENTO, CALIFORNIA

AUGUST 1982

DRAFT

C-102904

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PREFACE

This is a detailed report of the impacts on fish and wildlife associated with measures proposed (selected and alternative plans) for the flood protection of numerous islands located in the Sacramento-San Joaquin Delta, California. The Sacramento-San Joaquin Delta Investigation is being conducted by the Corps of Engineers pursuant to (1) a resolution of the Senate Committee of Public Works of June 1, 1948 and January 31, 1961, (2) Section 205 of the Flood Control Act of May 17, 1950, and (3) a resolution of the House Committee of Public Works of January 31, 1961. The investigation, conducted jointly with the California Department of Water Resources, seeks to determine Federal and State interests in providing flood protection and recreation facilities, preserving scenic and environmental values, and improving water quality in the Delta.

The Corps has evaluated five candidate plans in this investigation. As requested, this report provides detailed impact evaluation, compensation and enhancement recommendations only for the selected plan; it provides general analysis and comments on the other construction plans. The islands and tracts included in each plan are identified in Appendix I.

The findings of this report are based on available data, field investigations and surveys. Project impacts have been determined according to methods set forth in the Fish and Wildlife Service's Habitat Evaluation Procedures (HEP). These procedures provide a means to appraise existing and future conditions of the project area with respect to its value in providing the necessary habitat

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requirements for selected species. Results of the HEP are presented in Appendix II. The objective of the HEP is to quantify in nonmonetary terms the impacts of the selected plan and to provide a basis for determining the preservation, compensation and enhancement measures which are needed to maintain and improve the integrity of the ecosystem. Our impact analysis is based on a project life of 100 years for the period 1985 to 2085.

Much of the information presented in this report regarding recreational use levels associated with various fish and wildlife species is based on a recent study conducted for the California Department of Water Resources, Delta Outdoor Recreation Survey, 1980. A summary of existing and future recreational uses is shown in Appendix III.

DESCRIPTION OF PROJECT AREA

The Sacramento-San Joaquin Delta is an area where the Sacramento and San Joaquin Rivers, along with the Mokelumne, Cosumnes, and Calaveras Rivers converge to form an inland 1,150 square mile network of waterways, islands and wetlands (Figure 1). Situated about 50 miles northeast of San Francisco, it is a part of the San Francisco Bay-Delta ecosystem. It drains approximately 61,000 square miles or roughly 37 percent of the State of California.

Historically, the Delta was comprised of approximately 400,000 acres of fresh and brackish water marshes surrounded by nearly 300,000 acres of slightly higher lands and shallow backwaters. Its treasure of natural resources

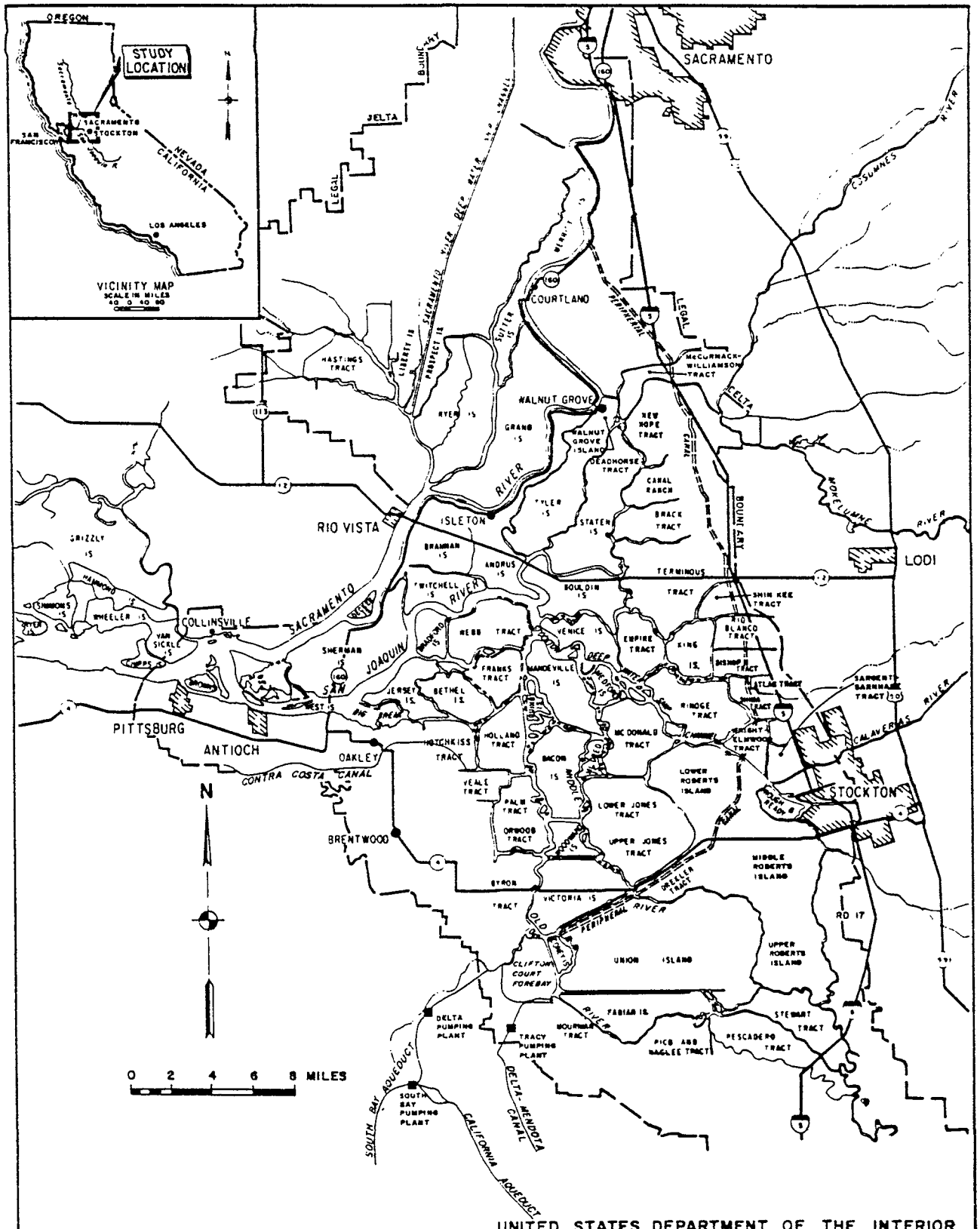

FIGURE 1

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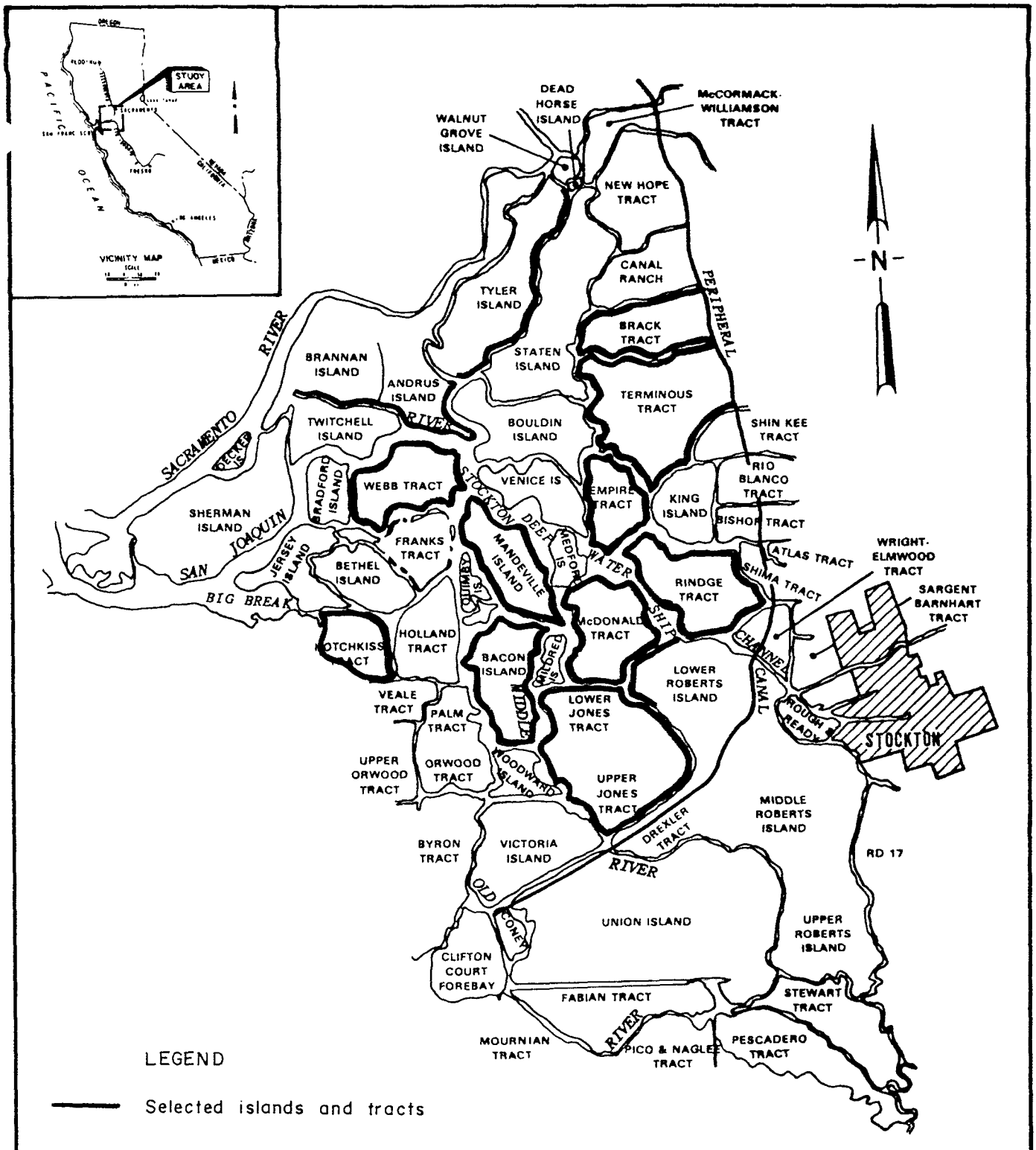
supported a large population of native Americans for thousands of years and later encouraged inland expeditions by European explorers. Reclamation of the Delta wetlands for farming began in the 1850's. By 1880 about 100,000 acres of land had been reclaimed; 50 years later reclamation was essentially complete, with the major leveed islands comprising about 450,000 acres. In spite of the enormous loss of natural habitat resulting from the conversion of wetlands to agriculture, the Delta is still considered one of the most productive and important fish and wildlife resource areas remaining in California.

Today, the Delta consists of approximately 25,000 acres of wetlands interspersed among 500,000 acres of agricultural lands and 50,000 acres of waterways. About sixty major islands, some as much as 20 feet below sea level, are protected by 1,062 miles of levees. Many of the levees, constructed on unstable peat foundations, are in very poor condition.

Although the Delta's legal boundary encompasses about 730,000 acres, this investigation is limited to that portion of the Delta with a history of levee failures, an area of about 270,000 acres.

PROJECT DESCRIPTION

Under the selected plan (Incremental Plan), 333 year flood protection would be provided to 15 islands and tracts (Figure 2). Each island or tract would be analyzed individually to determine the economic feasibility of providing flood protection. In addition, the project would provide recreational areas, fishing access sites, boater destination sites, canoeing areas and miles of bicycle, hiking and equestrian trails.



UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

SACRAMENTO - SAN JOAQUIN DELTA INVESTIGATION

SELECTED PLAN
(Incremental Plan)

JUNE 1982 CALIFORNIA

ADAPTED FROM CORPS OF ENGINEERS MAP

FIGURE 2

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All levees would be improved using a stage construction method, i.e., the improvement of enlarged embankments in stages. This method of construction includes the removal of all vegetation from the existing slopes, initial levee enlargement, and where required and when necessary, additional raising to maintain designed crown elevations. Landside berms would be constructed where the underlying peat depth is 20 feet or greater, or where existing levees exhibit seepage. Although, on the average, the levees would be completely rehabilitated within 50 years from the onset of construction (year 2035), work on levees underlain by the deepest peat beds would not be completed until year 2065.

Most of the rehabilitated levees also would have landside berms to improve stability. A typical levee section would have a 16-foot wide crown, a 2:1 side waterside slope, a 3:1 landside slope, and a landside berm with a 15:1 landward slope. Total levee width would be about 200 feet. Levee segments not requiring landside berms would be about 100 feet in width. To minimize erosion, all waterward slopes would be revetted to within 1 foot of the crown; revetment would consist of a 12 to 18 inch layer of quarrystone.

With the selected plan, levee rehabilitation would require about 12 million cubic yards of fill material. Fill material would be obtained from several sources near the project area. Potential sources include two sites in the Montezuma Hills, the Stockton and Sacramento Deepwater Ship Channels, Delta and Tracy pumping plant intake canals, Los Vaqueros Reservoir at Kellogg Forebay, and the Portero Hills Ditch. There would be no dredging solely for the purpose of obtaining fill material.

Project levees would be maintained to Federal standards presented in Title 33, Part 208.10 of CFR; the Corps would prepare an Operation and Maintenance Manual for the project on that basis. Levee design would allow only low-growing ground covers and grass on land and waterward slopes; the levee crown would be kept clear. Non-Federal interests would be responsible for levee maintenance.

ECOLOGICAL EVALUATION

EXISTING CONDITIONS

DELTA ENVIRONMENT

The Delta supports a vast array of fish and wildlife resources. The abundance and diversity of these resources is made possible by a complex of aquatic and terrestrial habitats. Open water habitat can be divided into the following classifications: mainstem rivers; high flow-through channels; low flow-through channels; deadend sloughs; and special habitat such as the Sacramento and Stockton Deepwater Ship Channels, and Franks Tract (an inundated agricultural tract). The various open water habitats of the Delta support somewhat different assemblages of aquatic organisms. The value of each habitat type to fish is enhanced where dense shoreline vegetation provides cover and a source of invertebrate food and litter fall.

Delta fish populations are supported by a nutrient base which has its origin in the photosynthesis of phytoplankton and of higher forms of aquatic and terrestrial plants. Primary consumers of detritus and phytoplankton are opossum shrimp and other zooplankton, benthic invertebrates and some fish species. Secondary consumers, which include fish, meet their energy requirements by feeding on the primary consumers and smaller fishes. Thus, the fishery of this estuarine system depends on detritus derived from aquatic and terrestrial plants growing in and upstream of the Delta as well as on planktonic organisms produced within the estuary.

The Delta channel bottoms are typically composed of sand and peat. Fine silts and clays carried into the waterways usually do not settle out in large quantities, but remain suspended until they reach the brackish, saline waters of Suisun and San Pablo Bays where flocculation occurs. In the flocculation zone, a great concentration of nutrients supports extremely high biological productivity.

Delta water quality is a function of the quality and quantity of freshwater entering and leaving the estuary. Inflow from the Sacramento River, San Joaquin River and east side streams varies considerably. Sacramento River water is of high quality (100 ppm TDS) and constitutes about 80% of the inflow. Water from the east side tributaries (Calaveras, Cosumnes and Mokelumne Rivers) is comparable in quality to Sacramento River water, but makes up only 5% of the total inflow. Inflow from the San Joaquin River is of poor quality (300-400 ppm TDS) because of surface and subsurface agricultural runoff; this river contributes 15% of the Delta's total inflow.

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Delta water quality is usually good throughout the year except in some dead-end sloughs, in the southern Delta where water circulation is poor during the summer, and in the Stockton Deepwater Channel near Stockton where there are large inputs of cannery effluent and municipal wastewater in the late summer.

Emergent vegetation (freshwater marsh) occurs at the land/water interface along the periphery of many of the leveed islands, and on unleveed channel islands and sand bars (Figure 3). It grows in shallow water and varies in composition according to successional stage. Common species include southern tule, hardstem bulrush, spike rush, and broad-leafed cattail. The emergent stands adjacent to levees rarely exceed 30 feet in width and usually are dominated by bulrush. Their presence is considered beneficial as they reduce the erosive power of waves and currents. Emergent wetland is extremely productive, providing a nutrient/energy base for the aquatic ecosystem and essential habitat for scores of invertebrates, fish, bird and mammal species.

In addition to numerous aquatic habitats, the project area supports several terrestrial plant communities. Of these, riparian forest is of greatest value to wildlife. Historically, riparian forest occurred in large stands on the natural levees of alluvial soil adjacent to the major waterways along the periphery of the Delta. Presently, where land management practices allow, riparian vegetation also occurs on flood control levees. Riparian forest is characterized by trees greater than 18 feet in height such as willow, white alder, cottonwood, box elder, Oregon ash, sycamore, and interior live oak (Figure 4). Understory species include blackberry, wild rose, wild grape, elderberry, and grasses and forbs. The diversity of canopy and understory species is dependent on land management.

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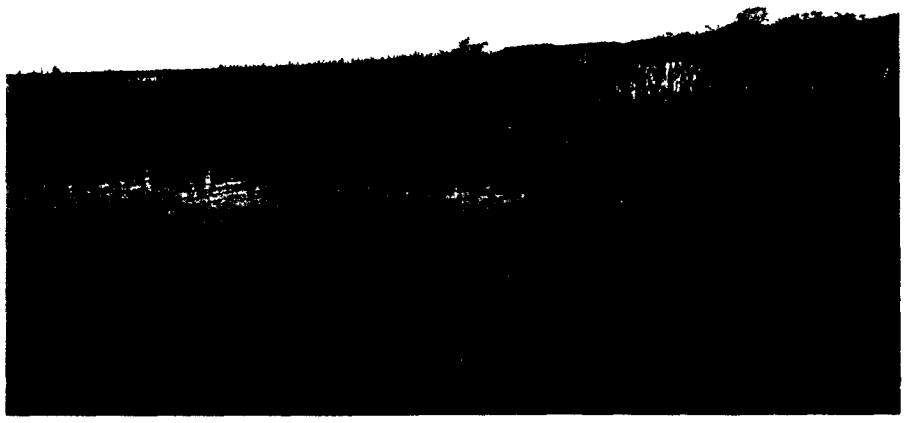

Figure 3. Emergent Marsh, Mokelumne River

Figure 4. Riparian Forest adjacent to the San Joaquin River

In the project area, levees have been degraded through levee maintenance. Although few Delta levees support quality riparian forests, there are excellent stands on many of the unleveed channel islands.

Riparian forest provides many benefits to fish and wildlife. Mature stands, with their towering trees, dead snags, shrubby understory and varied ground cover support numerous ecological niches. Of all types of habitat in California, this vegetation provides the highest diversity of bird life. The value of this vegetation also is reflected by the diversity of mammals and other species of wildlife which it supports. Riparian forest also provides many benefits to adjacent aquatic ecosystems: the overhanging canopy shades the waterways and moderates water temperatures; leaves, twigs and insect fall provide energy and nutrients; exposed root systems supply resting and cover habitat for fish and invertebrates, and irregular banks provide den sites for aquatic mammals. Riparian trees continue to enhance the aquatic ecosystem even after they die by providing escape cover for fish.

Scrub-shrub vegetation is characterized by broadleafed woody growth less than 18 feet in height. Predominant species include willow, young alder, wild rose, blackberry, elderberry, and forbs such as mugwort and stinging nettle (Figure 5). This community occurs on the waterside of unrevetted levees and also on the margins of unleveed channel islands. Revetted levees also support this vegetation; however, habitat value is generally lower than on the unprotected levees. If left undisturbed, most scrub-shrub vegetation would develop into a mature riparian forest. Because existing maintenance practices discourage this process of succession on most levees, scrub-shrub vegetation is very common in the Delta.

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Although scrub-shrub vegetation is of less value to fish and wildlife than mature riparian forest, many birds and small mammals use it for forage and cover. Continuous strips of growth provide a protected travel corridor for daily and migratory movements of birds. Many mammals, reptiles and amphibians that frequent riparian woodland also use riparian scrub-shrub areas, particularly if the two types are adjacent. However, the diversity of cover types and denning and nesting opportunities are low. Benefits to the aquatic ecosystem are similar to those of riparian forest; however, the value is commensurate with the extent and maturity of scrub-shrub vegetation on the waterside of levees.

Upland vegetation -- including grasses and forbs such as wild oat, riparian biome, Bermuda grass, mugwort, fennel, mustard, milk thistle and hemlock -- grows on landward and waterward levee slopes wherever levee maintenance prohibits woody species (Figure 6). This vegetation is the predominant levee cover; however, it is the least desirable for wildlife. It provides little reproduction habitat and is suitable cover for only a few species of birds or mammals. Although the habitat value is low in comparison to other kinds of vegetation, it does provide important food and cover during the winter and early spring when adjacent agricultural fields are bare.

Agriculture is the major land use in the Delta. More than 90 percent of all land on project area islands and tracts is under agricultural production. Major crops include corn (33%), wheat and barley (20%), alfalfa (12%), asparagus (8%), tomatoes (6%), safflower (5%), and others. Most of the crops are sown in the spring and harvested during late summer or fall months. During the growing

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Figure 5. Scrub-Shrub vegetation adjacent to Disappointment Slough

Figure 6. Upland vegetation, McDonald Tract

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season, fields provide food and cover for many species of birds and small mammals. Corn stubble, fallow land, and bare plowed fields are important habitat for migratory shorebirds and waterfowl during the fall and winter months (Figure 7).

Unleveed channel islands provide extremely valuable fish and wildlife habitat. Separated from larger islands by dredging during the process of major upland reclamation, these smaller islands are remnants of the historic Delta wetlands. They are the main areas where biological processes continue relatively undisturbed and are used extensively by wildlife, especially during the spring and summer months (Figure 8).

The vegetative composition of channel islands varies markedly depending on topography and soil compositon. Some islands, particularly in the Stockton Deepwater Ship Channel, have been used as dredge spoil disposal sites and as a result have relatively high surface elevations and well drained and sandy soil. They often support dense stands of riparian shrubs and trees and are frequently ringed with emergent vegetation. Most islands, however, have surface elevations only slightly above the mean high water mark and support emergent species.

Unleveed channel islands provide Delta wildlife with important nesting, feeding and cover habitat that is sorely lacking on the surrounding agricultural tracts and islands. Hence, these small, natural islands are not only of enormous biological value in and of themselves, but also greatly enhance the habitat value of the adjacent cultivated areas.

Figure 7. Agricultural Field, Central Delta

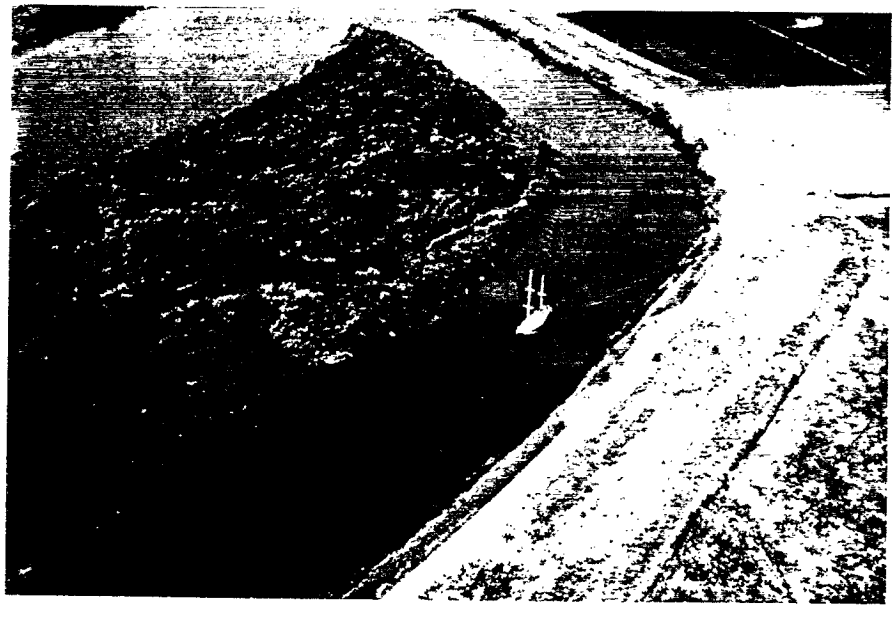

Figure 8. Unleveed Channel Island, Central Delta

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FISH

The Delta supports a diverse and abundant assemblage of anadromous and resident fishes. The area's exceptional fishery values are a product of the diversity of its aquatic habitats and the productive nature of the ecosystem.

The project area is used by anadromous species such as chinook salmon, striped bass, American shad, steelhead, and white and green sturgeon. The important commercial and sport salmon fishery that exist off the California coast is dependent on adequate habitat in the Delta. Resident species in the project area of significant sport value include white and channel catfish, brown bullhead, and many species of sunfish including largemouth bass, black crappie and bluegill. A variety of other species including threadfin shad, delta and long-fin smelts, golden shiner, splittail, tule perch, carp, blackfish, sculpin, and Mississippi silverside utilize the Delta.

Chinook salmon pass through the project area on their annual migration to and from spawning grounds in the Sacramento and San Joaquin River systems. Most proceed up the Sacramento River to spawn in the upper reaches of the river and its tributaries. It is estimated that more than 150,000 adults entered the system in 1981. The San Joaquin system run, seriously depleted by water development projects and degraded water quality, numbers about 10,000 fish. On their seaward migration, young salmon enter the project area and undergo physiological changes before entering the salt water environment of Suisun and San Francisco Bays.

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Chinook salmon support important commercial and sport fisheries with most of the harvest occurring in the ocean. Since 1971, the average annual commercial catch landed at San Francisco has been about 1.8 million pounds (dressed weight), with a value of 4.6 million dollars (1982 dollars). Since 1976, the ocean sport catch has averaged about 70,000 fish annually; together with the inland sport catch, it is valued at 1.9 million dollars. An average annual angler-use of 100,000 days occurs in the Delta for this species.

Striped bass spend a significant portion of their life cycle in the project area. Adults spawn primarily in the Sacramento River above the city of Sacramento and in a segment of the San Joaquin River in the Central Delta. The newly hatched larvae drift downstream until they reach an area where suitable food supply exists. The main nursery area for striped bass usually extends from the western Delta to Suisun Bay. The adult striped bass population, estimated at 1.4 million fish in 1978, is now less than 1 million adults; recent surveys indicate that the population may be significantly lower. It is estimated that the average annual angler-use of this resource is 980,000 days (California Department of Water Resources, 1980).

American shad also spends considerable time in the project area. The adults pass through the Delta during the spring upstream migration to spawn primarily in the tributaries of the Sacramento River. Newly hatched larval shad are carried downstream to the Delta and subsequently pass through the project area as juveniles in late summer. The project area serves as a nursery ground. This species

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supports an intensive sport fishery from about April through July in the Delta and the Sacramento River and its tributaries. The average annual angler-use of this resource in the Delta is estimated at 71,000 days.

Steelhead pass through the project area on their way to and from spawning grounds in the Sacramento River drainage. Unlike chinook salmon, young steelhead spend at least a year in freshwater prior to migrating to the sea. Steelhead provide considerable recreation for inland anglers; about 20,000 fish are caught each year in the Sacramento River system. The estimated average annual angler-use effort in the Delta for steelhead is 89,000 days.

White and green sturgeon pass through the project area on their annual spawning migration up the Sacramento River. White sturgeon spawn in the Sacramento River below Red Bluff. Young sturgeon drift downstream using the western Delta and Suisun Bay as a nursery area. It is not known if they spawn in the San Joaquin system. Spawning habits of green sturgeon in the Sacramento-San Joaquin system are not well known; however, recent collections suggest that they also may spawn far upstream. The estimated average annual angler-use for sturgeon in the Delta is 328,000 days.

More than 30 species of resident fishes are found in the project area and other parts of the Delta. Many of these species, particularly catfish, largemouth bass, crappie and bluegill attract boat and shore anglers. It is estimated that the average annual angler-use for these species is 1.5 million days.

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WILDLIFE

The project area supports more than 250 species of wildlife. These species are an important part of the biological fabric of the Delta and encourage many consumptive and nonconsumptive uses. All four of the vertebrate classes - birds, mammals, reptiles and amphibians - are well represented.

About 25 species of waterfowl utilize the project area. It is estimated that as many as one million birds winter in the area in some years. The more common species include whistling swan, Canada goose,white-fronted goose, snow goose, mallard, gadwall, pintail, green-winged teal, blue-winged teal, cinammon teal, American widgeon, northern shoveler, wood duck and ruddy duck. Open waters are used by dabbling ducks for resting and for feeding by diving ducks. Emergent wetland and flooded agricultural lands provide an important source of food (waste grains and corn) for dabbling ducks. Agricultural tract and islands with high wintering waterfowl values include Staten Island, Canal Ranch Tract, Brack Tract, Bouldin Island, Venice Island, Webb Tract, Mandeville Island, Empire Tract, King Island, Ringe Tract, McDonald Tract, Quimby Island, Mildred Island and Medford Island. Waterfowl hunting occurs throughout the Delta on private lands, and on state owned hunting areas on Lower Sherman and Grizzly Islands. Average annual hunter-use at these State areas is about 19,000 days; average annual Delta waterfowl hunter-use is 88,000 days.

Wading birds such as the great blue heron, green heron, great egret, snowy egret, black-crowned night heron and American bittern are frequently seen foraging in agricultural fields, irrigation ditches, and emergent wetlands and they are among the most majestic of the Delta species.

Shorebirds use the area extensively, especially during the non-breeding winter season. Common species include killdeer, plover, common snipe, long-billed curlew, spotted sandpiper, willet, greater yellow-legs, pectoral sandpiper, least sandpiper, dunlin, long-billed dowitcher, western sandpiper, American avocet and black-necked stilt. These species frequent cultivated lands and emergent wetlands.

Raptors such as the white-tailed kite, red-tailed hawk, Coopers hawk, marsh hawk and American kestral are common. In addition, perching birds such as belted kingfisher, acorn woodpecker, western flycatcher, cliff swallow, marsh wren, red-winged blackbird, American goldfinch, savannah sparrow, and white-crowned sparrow are numerous. These species occur in all Delta habitats and support many nonconsumptive uses. Many species which have great aesthetic value are associated with riparian and aquatic habitats. Others, such as the hawks, kite and kestral are commonly seen over agricultural fields. All of these species have important functions in either the aquatic or terrestrial ecosystems of the project area, and can continue to provide aesthetic, recreational and economic benefits only if there is suitable habitat.

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Upland game such as ring-necked pheasant, California quail and mourning dove are abundant in the project area where there is favorable habitat afforded by the interspersion of field crops, fallow land and riparian cover bordering channels and irrigation ditches. The pheasant is the most popular upland game species. Late fall migrations of mourning dove also provide excellent hunting. Other common upland game species include desert cottontail, black-tailed jackrabbit and California ground squirrel. Delta upland game species support an average annual hunter use of about 150,000 use-days.

Furbearers such as oppossum, muskrat, river otter, spotted and striped skunks, mink, beaver, fox, coyote, ring-tail cat, raccoon, long-tailed weasel, and badger are found in the project area. Although habitat destruction has greatly reduced trapping efforts in the project area, populations still support substantial trapping activity. The annual harvest of muskrat, raccoon and beaver is about 6,000, 5,000, and 100 pelts, respectively, valued at approximately $130,000. Most furbearers are almost entirely dependent on the riparian and emergent vegetation interface for their existence.

More than 40 species of other small mammals occur in the project area. Although the more secretive species are rarely seen by the casual observer, many of the larger and less wary species are observed on Delta levees, unleveed islands and even in the more natural waterways. The more common species include ornate shrew, broad-footed mole, big brown bat, Botta's pocket gopher, Heermann's kangaroo rat, western harvest mouse, deer mouse, dusky-footed woodrat, California vole, Norway rat, house mouse, and feral dogs and cats. Most of the terrestrial mammals utilize the various levee habitats, while the more aquatic species prefer emergent vegetation adjacent to levees and on unleveed channel islands.

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ENDANGERED SPECIES

Federally listed endangered and threatened species found in the Delta include Lange's metalmark butterfly (Apodemia mormo langei), San Joaquin kit fox (Vulpes macrotis mutica), salt marsh harvest mouse (Reithrodontomys raviventris), Contra Costa wallflower (Erysimum capitatum var. angustatum), Antioch Dunes evening-primrose (Oenothera deltoides var. howellii), and Solano grass (Orcuttia mucronata). The American peregrine falcon (Falco peregrinus anatum) and Aleutian Canada goose (Branta canadensis leucopareia) are occasional visitors. Critical habitat has been established near Antioch for the wallflower and evening-primrose, pursuant to the Endangered Species Act of 1973. Solano grass occurs only at a vernal pool near Dozier in Solano County.

FUTURE WITHOUT PROJECT

FISH

Future conditions for the project area's fishery resources will be determined by physical, biological, social and economic factors. Because the Delta has hydrological ties to much of the State, its future must reflect the interactions of these factors on a State-wide basis. Given the complexity with which these factors interact, and the myriad possible future scenarios, it is impossible to predict the Delta's future with a high degree of certainty.

Under without project conditions, the quantity and quality of Delta inflow and outflow, a major determinant of habitat conditions for fish, will undoubtedly be altered by future State, Federal and private water developments. The projected reductions in average annual Delta outflow of two million acre-feet, due to increased State water project exports alone, would increase losses of most anadromous species, particularly striped bass. Although the exact cause of the striped bass population decline is not known, we believe Delta outflow is one of many controlling factors contributing to the demise of the population. It could decline even with improved fish screens at State and Federal export facilities if water exports are increased. Chinook salmon, shad, steelhead and sturgeon also could be adversely affected by increased Delta diversions. Populations could decline regardless of attempts to improve adult escapement.

Although resident fish species would not be affected as seriously as anadromous fishes by reduced Delta outflow, their habitat would be degraded by increased salinity intrusion, reduced nutrient input and total productivity, and degradation of overall water quality. These impacts, a result of increased industry and agricultural wastewater and reduced outflow, would be worst in the southern Delta. In addition, fish habitat would be degraded by private bank protection projects and increased recreational activities such as high speed boating and water skiing.

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Under without project conditions, the intensity of recreational use is expected to increase as recreational travel costs rise for San Francisco Bay area and Delta residents. Increased unemployment and a shortened work week would elevate consumptive use of the Delta fish resources. To the benefit of fish, a tight economy would reduce construction of water-dependent structures such as boat docks, piers and swim floats. It also would discourage energy-intensive forms of recreation. It is estimated that without the project, average annual angler-use for salmon, steelhead, striped bass, sturgeon, shad, and resident species is expected to increase. The number of angler-days and their relative values are included in Appendix III.

WILDLIFE

Under without project conditions, impacts on wildlife would be determined by changes in land-use and agricultural cropping patterns, and by levee maintenance practices. Although habitat conditions are not expected to change significantly, some species would be adversely affected.

Although it is assumed that all islands and tracts would be reclaimed in the event of levee failure, the Service does not believe that this would occur because the islands are underlain by deep layers of peat. It is probable that within 50 years such islands could be 35-40 feet below sea level, thereby requiring enormous berms for levee stabilization.

Since it could be prohibitively expensive for a private landowner to rehabilitate an entire levee system adequately, such an island, if inundated, probably would not be reclaimed. Some small islands, irrespective of peat depth, probably would not be reclaimed due to economic considerations. Island inundation would result in a total loss of all wildlife habitat except on the remaining levees.

The availability and condition of wildlife habitat on intact islands would be determined primarily by land maintenance practices and cropping patterns. Present maintenance practices greatly limit the wildlife value of levee vegetation. Since landside slopes are disced annually and riparian vegetation on the waterward slope is generally disturbed, conditions are far from optimal. We believe these conditions would continue due to flood control and economic considerations. In addition, the placement of rock revetment on segments of presently unprotected levees would permanently reduce habitat for raptors, upland game and furbearers such as beaver and muskrat. Intensive cultivation would continue to minimize available habitat for small mammals and perching birds. Improvement of harvesting techniques would further reduce the amount of waste grains available for migratory waterfowl.

A shift in cropping patterns would adversely affect wildlife, especially waterfowl. Although the increase in corn acreage from 90,000 acres in 1969 to 174,000 acres in 1978 has favored grain feeding ducks (pintail and mallard), and geese, changes in cropping patterns could adversely affect habitat conditions for wintering waterfowl through a reduction in waste grains.

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Although wildlife values of the unleveed channel islands will remain unchanged, provided State and Federal policies and regulations continue to prohibit unnecessary habitat losses, there will be a slight reduction of island acreage. A comparison of aerial photographs taken by the U.S. Bureau of Reclamation in 1949 and photographs taken in 1979 by the Corps indicates a loss of narrow peninsulas on some islands as a result of natural erosion and possibly increased boating activities. We expect further losses of these narrow peninsulas, most of which are vegetated by hardstem bulrush.

Although we expect additional losses of wildlife habitat, future conditions without the project would be only slightly less favorable than they are at present. Therefore, we believe consumptive and non-consumptive recreational uses of wildlife will increase. Estimated average annual hunter-day use for waterfowl and upland game, and general recreation use and their values are included in Appendix III. A shift from grain production or changes in farming practice, however, could quickly degrade existing waterfowl habitat and subsequently result in the decrease of hunter-day use for waterfowl. Fur harvest is expected to remain at existing levels.

ENDANGERED SPECIES

Future without project conditions in the Delta for Federally listed endangered and threatened species would depend on the degree existing habitats can be protected and improved. Habitat for Lange's metalmark butterfly, Contra Costa wallflower and the Antioch Dunes evening-primrose is secure at the Service's refuge near Antioch; however, opportunities exist for expanding the distribution of these species to other dune areas in the Delta, including some dredge disposal sites.

Although without the project, urbanization, conversion of natural vegetation to agriculture, and loss of wetlands would adversely affect species such as the San Joaquin kit fox, salt marsh harvest mouse, American peregrine falcon and Aleutian Canada goose, conditions should not change significantly.

FUTURE WITH PROJECT

Implementation of the selected plan would result in adverse impacts to fish and wildlife resources. These impacts would stem primarily from changes in the composition of project area vegetation. An overall reduction in habitat value would depress fish and wildlife values accordingly. Acreages of the various habitats indicated below were estimated through use of the Corps' Delta Environmental Atlas, 1979.

FISH

Adverse impacts on fish resources would be relatively minor with the project. A loss of 343 acres of scrub-shrub and 45 acres of riparian vegetation would slightly decrease the amount of insect and litter fall entering the aquatic ecosystem. This could reduce aquatic productivity. The initial removal of 165 acres of emergent vegetation at the edge of existing levees would reduce escape, feeding and resting habitat for juvenile fishes; however, because 80 percent of the original acreage of this vegetation would reestablish naturally by year 2015, the ultimate loss of emergent vegetation would be 65 acres. With the project, average annual angler-use of the fish resources in the Delta is expected to increase. The estimated average annual angler-day use for chinook salmon, steelhead, striped bass, sturgeon, shad, and resident species and their relative values are included in Appendix III.

WILDLIFE

The impacts of project construction on wildlife resources would be substantial. The conversion of 343 acres of scrub-shrub vegetation to upland vegetation resulting from levee enlargement would destroy reproductive, foraging and cover habitats for many small mammals and resident and migratory birds. Also, the loss of 65 acres of riparian forest would reduce the availability of raptor perch sites and nesting habitat already in short supply in the project area. The initial loss of 165 acres of emergent vegetation, mainly hardstem bulrush, would adversely affect many species of songbirds and furbearers. This vegetation is utilized by marsh wren and red-winged blackbird as nesting habitat; beaver

and muskrat use bulrush as nesting material and also as a food source. The loss of emergent vegetation would decrease habitat for amphibians. In addition, conversion of 1,126 acres of agricultural land to upland vegetation would reduce the availability of waste grain for many species of graniverous birds such as pheasant and dove; however, this would be offset through the availability of natural food items and improved cover. Overall, the conversion of agricultural lands to upland would be beneficial.

The placement of rock revetment from below the mean low water level would result in the loss of potential bank burrow sites for beaver. It also would lower the foraging value of the waterward slope for terrestrial mammals and birds. The replacement of dirt roads with gravel roads on the levee crowns would reduce the value of this open space as a foraging area for graniverous birds. Similarly, this would lower habitat quality for raptors such as marsh hawk and American kestral which forage extensively on levee crowns.

In addition to a traditional analysis of project impacts on fish and wildlife, the Service conducted a modified version of its 1980 HEP. Results of the HEP indicate that implementation of the Selected Plan would reduce existing wildlife habitat values on an average annual basis by about 13 percent (Appendix II).

With the project, hunter-day use for waterfowl and upland game and general recreational use is expected to increase. Estimated number of average annual use days and their values are included in Appendix III.

ENDANGERED SPECIES

No adverse impact on endangered or threatened species would occur.

PRESERVATION, COMPENSATION AND ENHANCEMENT PLAN

PRESERVATION

There are many measures that can be incorporated into the selected plan to minimize impacts to existing wildlife habitat on and adjacent to the levees and borrow sites. Because much of the existing valuable wildlife habitat in the project area occurs on the waterside of the levees, it is important to minimize disturbance in this zone. Accordingly, the regrading and replacement of revetment on waterward slopes should be restricted to sections which presently do not meet project specifications. We believe many of the existing levees have waterward slopes that meet or nearly meet the project specification of 2:1. The deletion of work on levee sections that meet waterward slope specifications and also have adequate revetment would reduce impacts on wildlife habitat. The avoidance of unnecessary resloping would benefit the emergent marsh areas as well as the uplands.

The development and implementation of biologically sound project standards for revegetation of levee slopes would significantly decrease adverse project impacts on fish and wildlife. We do not believe that levee slopes, especially landside berms, should be totally devoid of shrubs and trees. The Department of Water Resource's Bulletin No. 167, Pilot Levee Maintenance Study of June 1967, and the State Reclamation Board's recently adopted Guide for Vegetation on Project Levees, December 18, 1981, indicate that some vegetation on levee slopes is acceptable from an engineering standpoint. Vegetation standards should be developed in coordination with the California Department of Fish and Game and the Fish and Wildlife Service.

Locating borrow sites on uplands would minimize adverse impacts on the most important terrestrial wildlife habitats - emergent marsh and riparian forest. Although the direct impacts associated with borrow activities would be minimal at upland sites, excavation may affect subsurface runoff patterns or divert small watercourses. Since this could result in adverse impacts to wetland vegetation, surface and subsurface hydrology should be studied by the Corps prior to evaluating potential borrow sites. Also, if temporary storage of fill material obtained from upland sources is necessary, areas of low wildlife value should be used.

Timing of construction activities may influence the nesting success of perching birds and raptors. Removal of nesting habitat, i.e., shrubs and trees, before or after the nesting season would reduce nestling loss.

Generally, nesting occurs from April through early June; therefore, removal of nesting habitat before or after this period would eliminate futile nesting attempts.

The establishment of staging areas and construction camps near zones of existing high disturbance would be preferable to locating facilities in remote, relatively undisturbed portions of the project area. This would minimize adverse impacts associated with human activities including movement of heavy equipment, equipment maintenance, and transportation of workers.

COMPENSATION

To compensate the loss of 1,579 acres of wildlife habitat, the development and management of existing agricultural lands behind levees, and/or leveed and unleveed channel islands for wildlife would be required. In addition, rehabilitated levee slopes should be revegetated with plant species of value to wildlife.

Compensation Plan I

Under this plan, lands adjacent to rehabilitated levees would be converted from agricultural use to natural vegetation. This would be accomplished either through the natural establishment of vegetation or by more intensive methods. With a natural management plan, agricultural production would cease on selected parcels throughout the project area. The use of fire

and herbicides for vegetation control, and intrusions by off-road vehicles would be prohibited. The natural establishment and succession of plant species would convert the site from agriculture to riparian forest, with intermediate stages of annual grassland and scrub-shrub vegetation. Maximum habitat values would be attained by year 2025 when mature and decadent riparian trees including cottonwood and willow would predominate. This management plan would require the conversion of 650 acres of agricultural lands to fully compensate project impacts. Acquisition costs have not been determined. No development and maintenance costs are required.

Alternatively, management could be intensified. Under the intensified management plan, 609 acres would be required to compensate project losses. Similar to the natural establishment management plan, agricultural production would cease on selected parcels throughout the project area; however, management would be intensified. Willow, cottonwood, elderberry and oak slips or seedlings, would be placed to greatly increase flora and faunal diversity; fertilizer and additional water would be provided to establish and enhance growth. Intensified management would reduce to twenty years the period necessary to attain maximum habitat values. Estimated planting and early maintenance costs would be about $1000 per acre; however, these costs could change due to higher transportation costs and possible access problems. Acquisition costs have not been determined at this time.

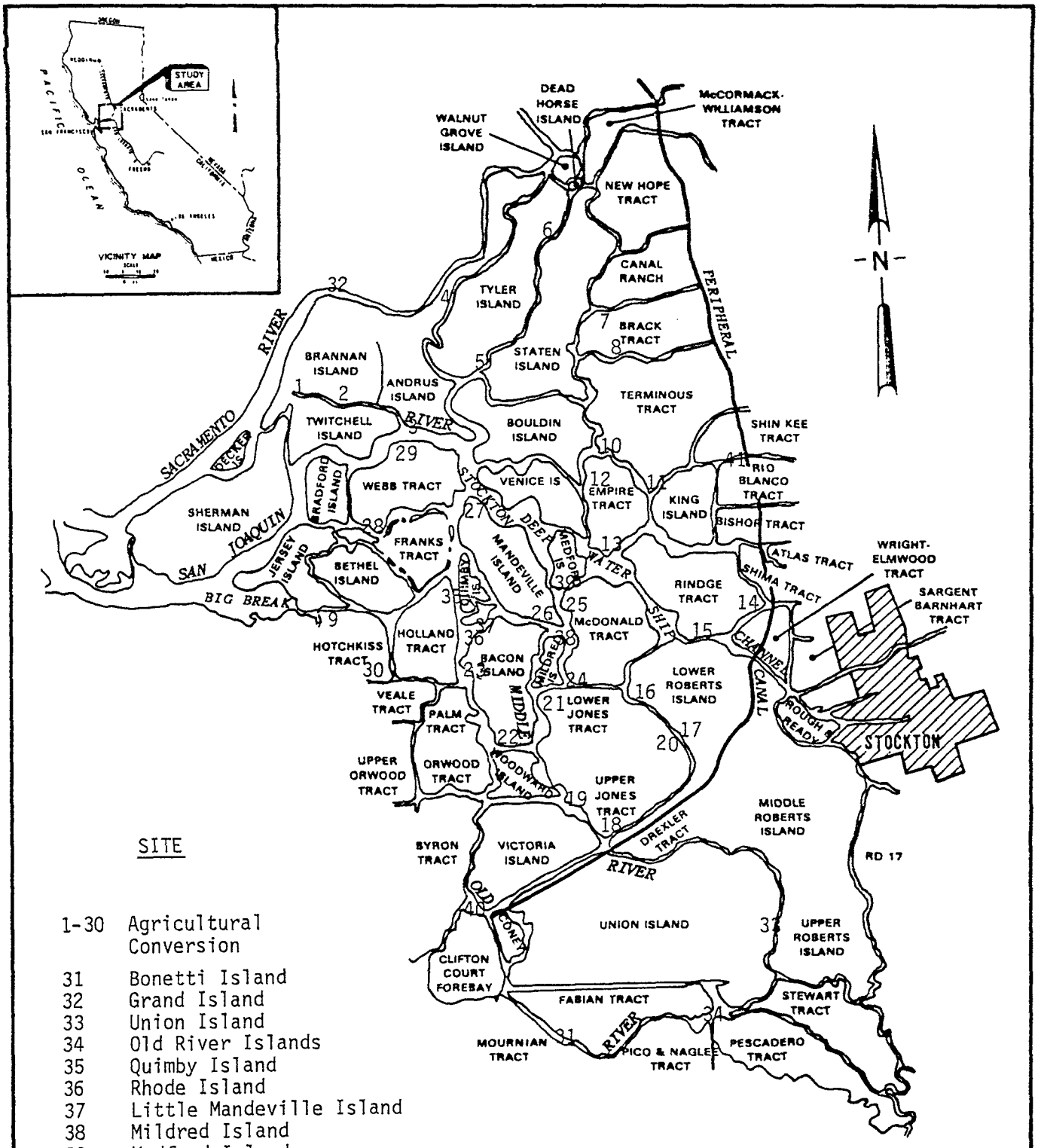
Regardless of management intensity, the attainment of full compensation can occur only if the management sites are of appropriate size and shape, and are adequately distributed throughout the project area. Each

C-102939

site should be circular in shape, if possible, and 15 to 20 acres in size. This would provide adequate reproductive habitat and cover for most mammals and perching birds that occur in the area, and also minimize predation and nest parasitism associated with thin strips of habitat.

Several factors determine the optimal distribution of management sites. For maximum benefit, sites should be evenly distributed throughout the project area. Even distribution of management sites would require the recipients of project flood control benefits to share equally the loss of agricultural production associated with compensation of project impacts on wildlife. Where feasible, management sites should be located on small peninsulas or other similar topographical irregularities in order to minimize impacts on farming operations. In addition, sites should be located away from private or commercial developments. Thirty potential management sites have been identified in the project area (Figure 9). Final site selection should be coordinated with the California Department of Fish and Game, Fish and Wildlife Service and landowners.

We believe that improvements to wildlife resources through acquisition of an easement would equal those attained under fee title acquisition, provided that stipulations designed to preserve the habitat in perpetuity are included in contractual agreements with the landowners and are enforced. Although the details of the conservation easement have not been developed at this time, they should include an easement and right-of-use for the maintenance of land and water in perpetuity. This



SITE

1-30 Agricultural Conversion
31 Bonetti Island
32 Grand Island
33 Union Island
34 Old River Islands
35 Quimby Island
36 Rhode Island
37 Little Mandeville Island
38 Mildred Island
39 Medford Island
40 Widdows Island
41 Shin Kee Tract

FIGURE 9

COMPENSATION SITES

C-102941

would be subject to existing easements, rights-of-way of record, outstanding mineral rights, etc. Owners would reserve the right to develop retained oil, gas, and mineral rights using methods that would not reduce the wildlife habitat value of the management parcel. The easement would not preclude transfer of fee title. We believe enforcement of easement conditions should be the responsibility of the State Department of Fish and Game or the State Reclamation Board.

Compensation Plan II

In lieu of managing only existing agricultural lands for wildlife, acquisiton and development of other areas would be acceptable provided that at least one-half of all compensation occurs on the islands receiving levee improvements. Because of the importance and scarcity of riparian forest in the project area, we believe that at least two-thirds of all benefits attributed to compensation should result from an increase of riparian vegetation. Other vegetation types that could be improved for compensation purposes are oak-woodland and emergent marsh; however, because riparian forest, emergent marsh and oak-woodland have different relative values for wildlife, the acquisition and management of emergent marsh or oak-woodland would not reduce the compensation requirement for riparian forest development on an acre-for-acre basis. For the purpose of meeting compensation requirements, we believe the relative value of one acre of riparian forest would equal two acres of emergent wetland or four acres of oak-woodland.

The following areas identified in Appendix IV and indicated on Figure 9 could be acquired in fee title and managed for compensation purposes.

Bonetti Island (30 acres) - This island in Old River presently supports annual grasses and a few valley oaks; it appears to be grazed regularly. The elimination of grazing and the establishment of additional oaks throughout the island would greatly improve wildlife values. Ultimately, the island would support a mature oak woodland. This type of woodland, which once surrounded much of the Delta wetlands, provides habitat for many species of birds and mammals. Bonetti Island's isolation from human disturbance would allow the establishment of high habitat values.

Grand Island (100 acres) - The west tip of Grand Island at the confluence of Steamboat Slough and Sacramento River is a dredge disposal site for the Sacramento River Deepwater Ship Channel. Because no spoil has been placed at the site since 1977, numerous native species have colonized the spoil material; a mosaic of sand dunes, upland and scrub-shrub areas now provide a diverse environment for many wildlife species. The placement of additional spoil material would adversely affect these values. Accordingly, the elimination of this area as a designated spoil disposal site, and subsequent protection from off-road vehicle use would benefit wildlife.

Union Island (45 acres) - There is an area on the east side of Union Island, adjacent to Middle River and just east of Wing Levee Road, that is suitable for expansion of oak-woodland and the improvement of riparian forest vegetation. According to the Corps, 25 acres of the site support remnant riparian vegetation; 20 acres are in fallow agriculture. Protection and improvement of the site would benefit wildlife species associated with both habitat types.

Old River Islands (220 acres) - Several islands near the confluence of Tom Paine Slough are similar in character to Bonetti Island, but support more riparian vegetation. Most of the largest island is cultivated. The elimination of agriculture and conversion of the upland portion of these islands to oak-woodland would provide similar benefits as on Bonetti Island. The elimination of grazing would encourage expansion and increased quality of riparian vegetation.

Quimby Island (769 acres), Rhode Island (92 acres), Little Mandeville Island (376 acres), Mildred Island (998 acres), Medford Island (1,219 acres) and Widdows Island (60 acres) - The selected plan does not include improvement of the levee systems on any of these islands. It is assumed that without levee improvement, Quimby, Little Mandeville, Mildred and Medford Islands would be inundated during the life of the project. With the probabilities of levee failure of 0.12, 0.04, and 0.03 for Medford, Mildred, and Quimby, respectively, it is reasonable to expect that all of these islands would be flooded within 35 years. Although flood probabilities are not available for Little Mandeville or Widdows Islands, we believe that they also could experience flooding during this

period; Rhode Island is already flooded. Because most of the island interiors are 10 to 20 feet below mean sea level, inundation would eliminate important habitat for small mammals, song birds, raptors and wintering waterfowl; about 2.3 million waterfowl use-days would be lost. Inundation would concentrate wintering waterfowl on adjacent lands, thereby increasing stress and density-dependent diseases. It also would increase crop depredation in the vicinity. To avoid the loss of valuable waterfowl habitat, management of these areas would consist of raising the island interiors with dredge spoil material and establishing natural marsh vegetation. Fill material could be obtained from maintenance of the Stockton Deepwater Ship Channel or from upland borrow sites. Use of the islands as temporary storage sites for imported project fill would provide an additional opportunity to obtain sufficient fill for subsequent wildlife habitat improvement. As a partial compensation measure, we believe it would be feasible to raise the bottom elevation on about 100 acres of one or more of the islands and allow subsequent establishment of emergent marsh and some riparian vegetation.

Shin Kee Tract (50 acres) - A remnant of emergent marsh and riparian forest vegetation remains on the south side of the tract. Protection of the area from agricultural development would ensure habitat for species associated with this vegetation.

Using the aforementioned relative values of riparian forest, emergent marsh and oak-woodland, the acquisition and management of the above areas would reduce the acreage required for conversion from agricultural

to riparian forest. The amount attributed to each site would be: Bonetti Island - 8 acres, Grand Island - 100 acres, Union Island - 45 acres, Old River Island - 55 acres, Quimby Island and others - 50 acres, Shin Kee Tract - 25 acres. With a combined acreage of 3,939 acres, these areas would account for 283 acres of compensation. The acquisition and management of these areas could reduce the compensation requirement for agricultural land conversion to 367 acres under a natural management plan, or 326 acres under an intensified management plan; however, this would be contingent on the avoidance of reduced habitat value at the sites resulting from the construction and operation of project recreation facilities. The development of a final compensation plan that is acceptable to local interests, the Corps and the Service will require additional impact analysis and further coordination. Acquisition and management costs will not be determined until a compensation plan is developed.

The Service's Regional Director has indicated that these areas, if selected for compensation purposes, could be included in the National Refuge System; however, this would be contingent upon prior completion of all necessary habitat improvements, negligible annual operation and maintenance costs, and final approval by the Director. Alternatively, the areas could be managed by local interests.

Other Compensation Measures

Additional measures to compensate project related adverse impacts to wildlife should include the revegetation of project levees and other

disturbed areas with plant species of value to wildlife. Plant species that control dust and erosion on well drained soils include blando brome (Bromus mollis), lana vetch (Vicia dasycarpia) and rose clover (Trifolium hirtum). For poorly drained soils, reed canary grass (Phalaris tuberosa) should be used. Two additional grasses which can be used are pubescent wheatgrass (Agropyron trichophorum) and perla grass (Phalaris tuberosa var. hirtiglumis). Where practical, seeds should be mixed. Where project features allow, native coyote bush (Baccharis pilularis) should be planted to provide additional and more diverse wildlife cover. The greatest variety of plants possible is desirable because of the need to provide for a diverse group of wildlife.

ENHANCEMENT

The project offers many possibilities to enhance wildlife values over the life of the project, thereby preserving and improving habitat which otherwise would be lost because of flooding or inappropriate commercial and private recreational developments. Enhancement would consist of the acquisition of leveed and unleveed islands, and some habitat improvement thereon.

Enhancement Plan I

As discussed in the previous section, we believe that many of the smaller leveed islands including Quimby, Little Mandeville, Rhode, Medford, Mildred and Widdows Islands would be inundated as a result of levee failure early in the life of the project. We assume economic considerations would prevent subsequent reclamation of these islands. The resulting loss of extremely valuable wildlife habitat could be avoided through the acquisition and subsequent raising of island interiors to allow the development of emergent marsh and riparian vegetation. Construction of interior dikes would enable incremental filling and breaching. Eventually, an island would consist of many cells of emergent marsh subject to tidal flows and surrounded by riparian vegetation. This diversity of vegetation would provide numerous benefits to nearly all fish and wildlife found in the Delta. Aquatic organisms including fishes and benthic invertebrates would benefit through increased spawning, rearing and feeding habitat; terrestrial species including waterfowl, shorebirds, songbirds, and semi-aquatic mammals would gain reproductive, feeding and cover habitat. In addition, these marshes would improve Delta water quality and enhance esthetic values. The total area of the created wetlands would be 3,514 acres. Acquisition, development and maintenance costs have not been determined.

Although most of the benefits attributable to wetland development are difficult to measure from a strictly economic standpoint, we estimate the placement of spoil material on these six islands would increase

migratory waterfowl use of the area by at least two million bird use-days annually. Hunting and non-consumptive use-days, valued at $16.30 and $4.10, respectively, each would be increased by an average of 10,000 annually. These recreational uses, in combination with reduced crop depredation that would result from wetland development, would produce an annual economic benefit in excess of $260,000.

Enhancement Plan II

As an alternative to Enhancement Plan I, the levee systems on the same islands would be rehabilitated to allow the continuation of farming. The production of crops attractive to waterfowl would greatly increase bird use. This alternative would require regular levee maintenance and water management. Although the production of cultivated crops for waterfowl would be relatively expensive, such management would be extremely productive. The six islands could support at least six million bird use-days annually; hunting and non-consumptive uses would each average about 12,000 use-days annually. These recreational uses, in combination with reduced crop depredation, would produce an annual economic benefit of about $322,000. Acquisition, development and maintenance costs have not been determined at this time.

Enhancement Plan III

This enhancement feature would be implemented together with Enhancement Plans I or II. It would consist of acquisition in fee title of many project area unleveed channel islands. Although existing State and

Federal policies and regulations protect these valuable resource areas from most developments, future economic and political considerations could greatly reduce protection. The resulting degradation of these areas, many of which represent the last vestiges of historic Delta conditions, would impact fish and wildlife severely. Considering their development potential and high natural values, we believe unleveed islands should receive maximum protection through acquisition. Islands that should be acquired include: an unnamed island in Old River adjacent to Coney Island; the Disappointment Slough channel islands; Eucalyptus Island; Headreach, Fern, Lost Lake and Tule Islands; Middle River and Latham Slough channel islands; Potato Slough channel islands; an unnamed island in Sevenmile Slough; Spud and Hog Islands; and an unnamed island in the South Fork of the Mokelumne River near Sycamore Slough. In total, we recommend the acquisition of 1,525 acres of unleveed islands as a project enhancement feature. Management of the unleveed islands would consist of the immediate removal of all unpermitted structures and the eventual removal of all structures. Acquisition and management costs have not been determined. Subsequent to structure removal, annual operation and maintenance costs would be negligible; the islands merely would be protected from any developments except those authorized as part of the project.

As discussed previously, unleveed Delta islands represent remnants of pristine Delta conditions, and as such have high aesthetic, historical and biological values. Acquisition of 1,525 acres of these islands would benefit many species of Delta fish and wildlife by protecting valuable reproductive, feeding and resting habitat. These islands

are especially important for species dependent on emergent and riparian forest vegetation; when adjacent agricultural fields are burned or flooded, the islands also provide refuge for more widely adapted species.

The establishment of enhancement areas on leveed and unleveed Delta islands would be consistent with the purpose of the National Migratory Bird Management Program, administered by the Fish and Wildlife Service. The areas would be located in an area traditionally important for wintering waterfowl and other water-dependent migratory birds of the Pacific Flyway. The Service, in its concept plan for Waterfowl Wintering Habitat Preservation-Central Valley, California, May 1978, identified the Delta as the second most important waterfowl area in the Central Valley, and indicated the importance of improving migratory bird habitat there. Establishment of the enhancement areas would provide much needed additional habitat and help alleviate waterfowl diseases and crop depredation problems.

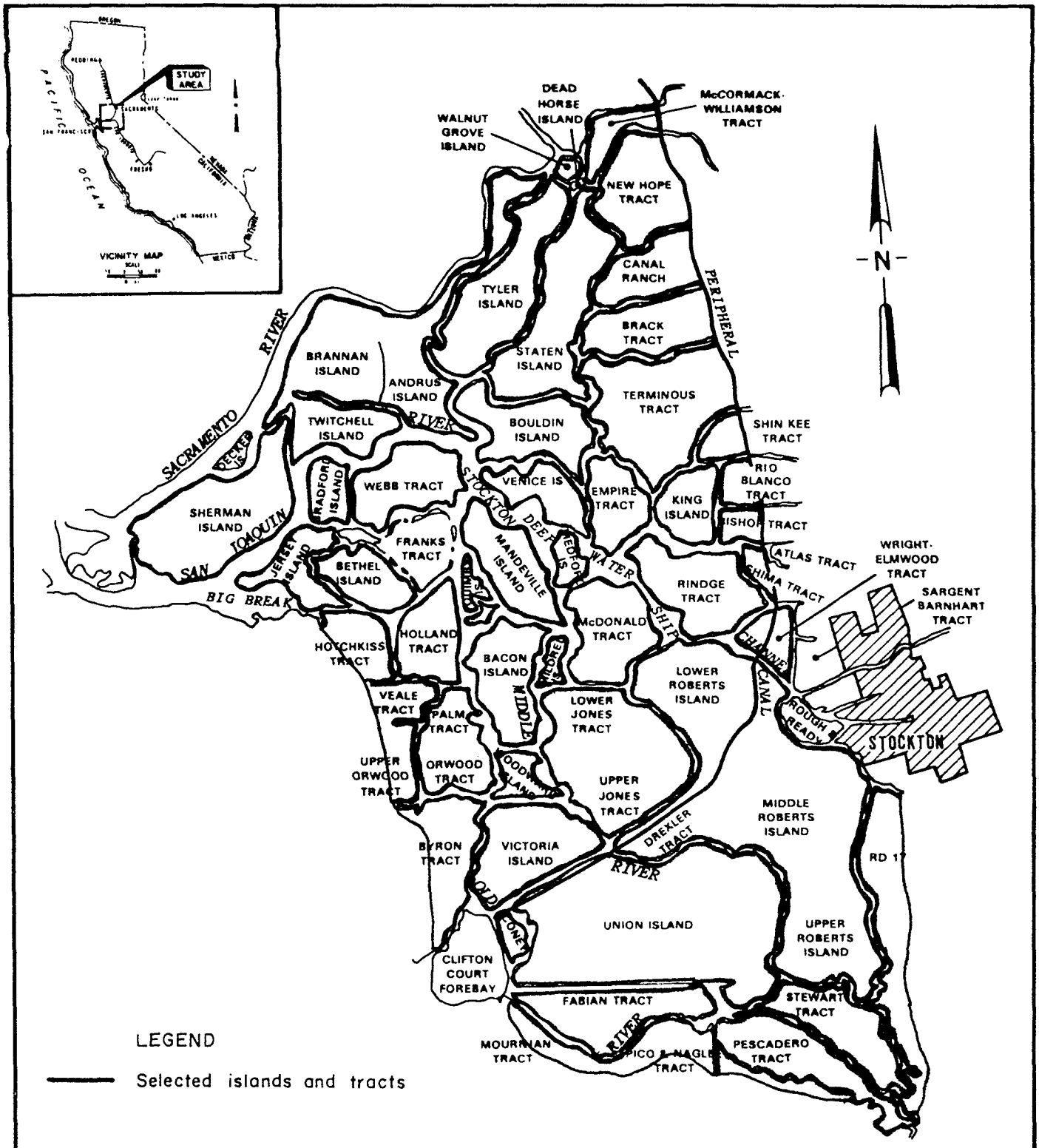
The Service's Regional Director has indicated that the enhancement areas could be included in the National Refuge System, contingent upon prior completion of all necessary habitat improvements and negligible annual operation and maintenance costs. Because we believe there will be high operation and maintenance costs associated with the enhancement alternative involving levee rehabilitation and farming of the six leveed islands, the Service would be unwilling to assume responsibility for these islands under this alternative. If it is feasible to acquire the islands only under this alternative, it may be possible for the Califronia Department of Fish and Game to assume management responsibility. Informal response

by CDFG staff regarding this proposal has been favorable. Final approval by the Service's Director would be necessary for any enhancement feature that would be included in the National Refuge System. At this early planning stage, we believe the Corps should pursue all enhancement possibilities.

EVALUATION OF ALTERNATIVES

System Flood Control Plan

The System Plan consists of levee rehabilitation on all islands in the Delta regardless of economic feasibility of individual islands as long as the entire project retains a positive benefit:cost ratio. Features of this plan include: (1) Flood Control - Project flood protection (333 year) would be provided to 57 islands and tracts (Figure 10); (2) Recreation - Recreation facilities would consist of 14 recreation areas, 23 fishing access sites, 8 boater destination sites, and 145 miles of bicycling, hiking, equestrian, and canoe trails; (3) Environmental Quality - The EQ portion of this plan includes the acquisition through public purchase or easement of about 6,000 acres of lands within the project area. Potential sites are listed in Appendix IV; (4) Nonstructural - Land use regulations would be developed by the non-Federal sponsor to limit or prohibit development on the project islands.



UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

SACRAMENTO - SAN JOAQUIN DELTA
INVESTIGATION

SYSTEM PLAN

JUNE 1982 CALIFORNIA

ADAPTED FROM CORPS OF ENGINEERS MAP

FIGURE 10

C-102953

C-102953

Under this alternative, the levee systems of 57 islands and tracts would be rehabilitated. Wildlife habitat in the project area would include 2,821 acres of agriculture; 2,823 acres of upland; 1,630 acres of scrub-shrub; 260 acres of riparian forest, and 1,440 acres of emergent marsh. Project construction would result in the conversion of all agriculture, scrub-shrub and riparian forest vegetation to upland. Initially, one-half of the emergent vegetation would be destroyed; the ultimate loss would be 20 percent of the original amount, or 288 acres.

Implementation of this plan would result in adverse impacts to species associated with scrub-shrub, riparian forest and emergent vegetation. Species dependent on upland vegetation would not be adversely affected. Project impacts on fishery resources would be negligible.

Modified System Plan

The modified system flood control plan concentrates on the flood prone areas of the Delta. Islands with existing flood protection greater than 50 years would be eliminated from consideration. Features of this plan include the provision of project flood protection to 35 islands and tracts (Figure 11). Other components of the project would be similar to those described above.

This alternative would impact 35 islands and tracts. Wildlife habitat in the project area would include 1,845 acres of agriculture; 2,113 acres of upland; 975 acres of scrub-shrub; 180 acres of riparian forest, and 730 acres of emergent marsh. There would be a conversion of all

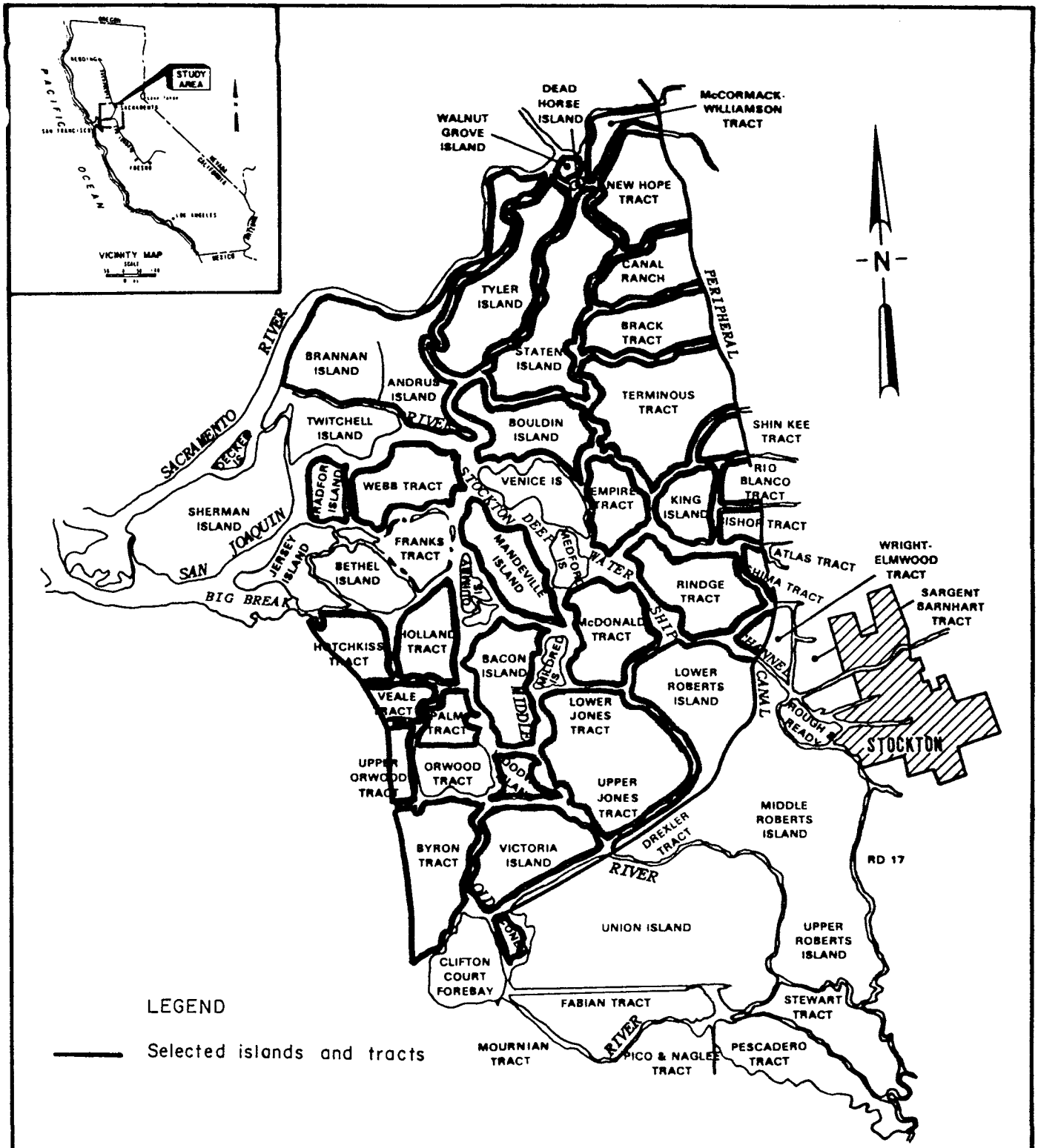


FIGURE 11

C-102955

agriculture, scrub-shrub and riparian forest to upland and an ultimate loss of 146 acres of emergent marsh. Impacts on the fish resources would be negligible.

Polder Plan

This plan would consist of the construction of master levees enclosing groups of islands or tracts; the levee systems on individual islands also would be improved. Project configuration would maximize net National Economic Development benefits. This plan would provide project flood protection to two polders and ten individual islands (Figure 12). Other components of the project would be similar to those previously described.

Implementation of this plan would result in levee rehabilitation on 14 islands and tracts. Wildlife habitats affected would include 981 acres of agriculture; 997 acres of upland; 343 acres of scrub-shrub; 45 acres of riparian forest, and 305 acres of emergent marsh. As with the other alternatives, all agriculture, scrub-shrub and riparian forest would be converted to upland; there would be an ultimate loss of 61 acres of emergent marsh. The creation of two polders would modify fish and wildlife habitat conditions in Connection Slough and Empire Cut. Reduced flow quantities and velocities, and increased residence time would result in elevated water temperatures and lowered dissolved oxygen levels. These changes would improve conditions for juvenile and adult warmwater fishes at the expense of anadromous species.

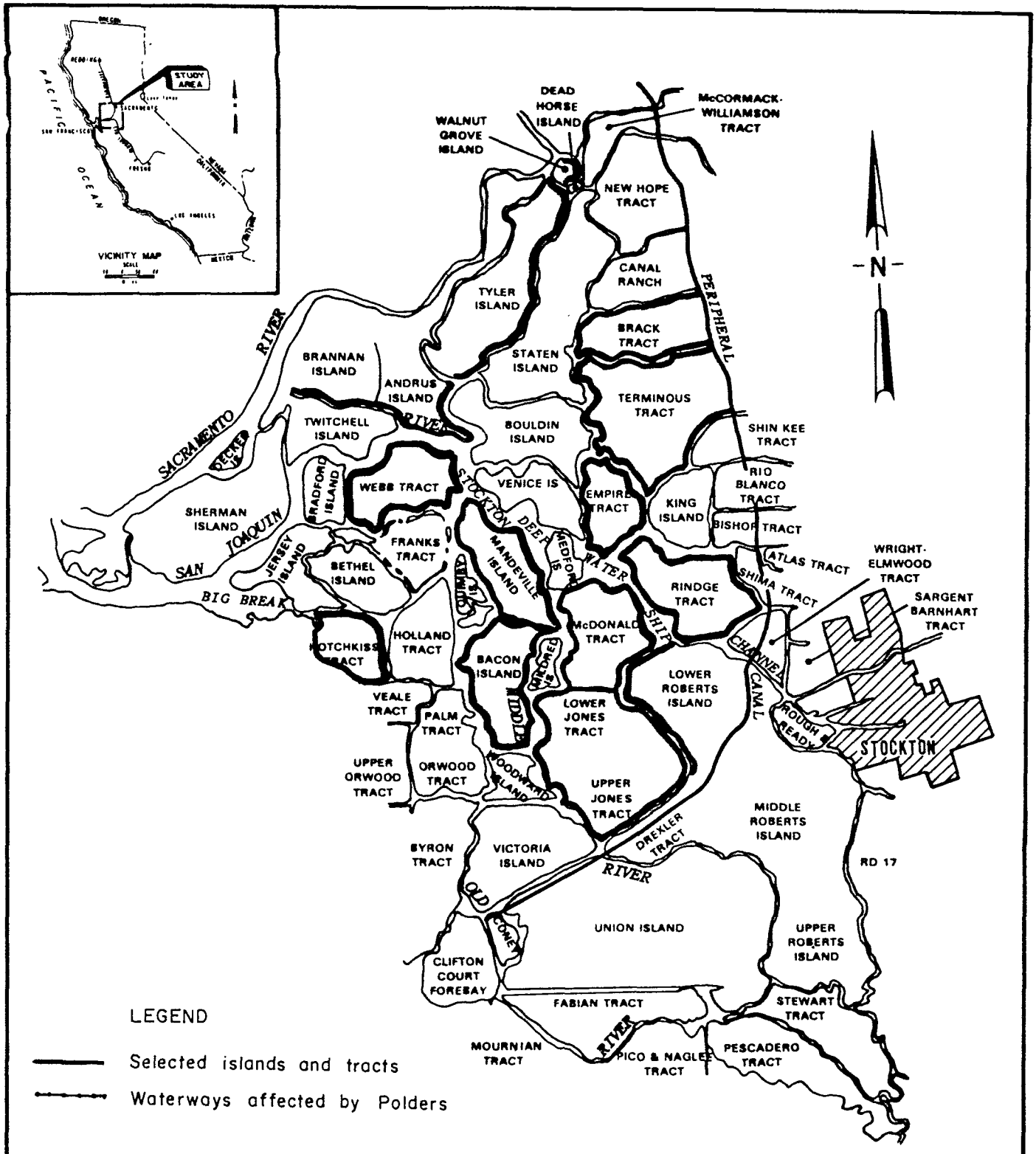


FIGURE 12

C-102957

C-102957

Migratory patterns of anadromous species would be affected. In addition, rock fill structures at the distal ends of the waterways would act as predator traps and increase the mortality rates of juvenile fishes. Other impacts associated with the polder plan would include changes in erosion rates in poldered and non-poldered waterways, alterations in terrestrial and wetland vegetation along the poldered waterways, and reduced access for sport fishing and recreational navigation.

No Action Plan

This plan would include no Federal participation in improving Delta Flood control or enhancing recreation, fish and wildlife, and environmental quality opportunities. All non-project levees would be ineligible for P.L. 84-99 emergency assistance.

SUMMARY OF IMPACTS

With the exception of the polder plan, project impacts on fish and wildlife resources would be qualitatively similar for all construction alternatives. Implementation of any of the alternatives would result in the conversion of agriculture, scrub-shrub and riparian forest to upland vegetation; all would result in loss of emergent marsh vegetation. The degree of impact, however, would vary markedly between the various alternatives. For example, the total acreage affected under the system plan would be more than three times that affected under the polder plan.

The polder plan is the only alternative whose implementation would result in significant adverse impacts to the aquatic ecosystem. Of the four construction alternatives considered, implementation of the incremental plan would seem to have the lowest overall adverse impacts on fish and wildlife resources. This alternative affects a relatively small acreage and would not result in unacceptable changes to the aquatic ecosystem. As a benefit, improved flood protection would assure against loss of valuable wildlife habitat on agricultural lands.

A summary of the impacts associated with the various construction plans is presented in Table 2.

AGENCY VIEWS ON FISH AND WILDLIFE SERVICE RECOMMENDATIONS.

This section will be completed in the final report.

COMPLIANCE WITH ENVIRONMENTAL LAW AND EXECUTIVE ORDERS

There are several Federal laws and Executive Orders with which this project must comply; the most important include the National Environmental Policy Act, Federal Water Pollution Control Act, Fish and Wildlife Coordination Act, Estuary Act, Executive Order 11988 (Floodplain Management and Executive Order 11990 (Protection of Wetlands). Compliance with many of these laws and orders is contingent upon the development and implementation of measures to avoid unnecessary losses and to compensate for unavoidable adverse impacts on fish and wildlife and their habitats. Compliance also is contingent on the prevention of urbanization within the project area floodplain.

TABLE 1

Summary of Impacts
(without compensation or enhancement)

IMPACT	ALTERNATIVE			
TERRESTRIAL:	System Plan	Modified System Plan	Incremental Plan Selected	Polder Plan
Miles of levee impacted	608	483	163	157
Total acreage impacted	8974	5843	3096	2671
Ultimate net change in acreage of wildlife habitat				
Agriculture	- 2821	- 1845	- 1126	- 981
Upland	+ 4711	+ 3000	+ 1514	+ 1369
Scrub-Shrub	- 1630	- 975	- 343	- 343
Riparian Forest	- 260	- 180	- 45	- 45
Emergent Marsh	- 288	- 146	- 65	- 61
Adverse impacts of construction on most valuable wildlife habitats	Very High	High	Moderate	Moderate
Benefits resulting from reduced inundation	Very High	High	Moderate	Moderate
Adverse impacts on land-dependent recreational uses	low	low	low	low
AQUATIC:				
Change in water quality?	minimal	minimal	minimal	moderate
Change in channel velocities?	no	no	no	yes
Change in fish mortality rates?	no	no	no	yes
Change in fish migration patterns?	no	no	no	yes
Change in habitat diversity?	no	no	no	yes
adverse impacts on water-dependent recreational uses	low	low	low	moderate

The Service believes that the implementation of all loss prevention and compensation measures presented in this report would assist in compliance with all laws and orders except Executive Order 11988. Compliance with this order would require acquisition from local interests of binding assurances preventing urbanization of the project area. On several occasions the Service has indicated a concern regarding this project's potential to increase urban development in the Delta, with concomitant losses of wildlife habitat. Accordingly, unless assurances are provided at the state or county level, we believe the project would not be in conformance with the Floodplain Executive Order, and we would recommend that the project not be constructed.

We have recommended the implementation of a major wetland enhancement program that requires full consideration by the planning process and the Corps of Engineers; however, compliance with environmental laws and Executive Orders does not depend upon eventual implementation of the recommended enhancement program.

APPENDICES

C-102962

APPENDIX I

SYSTEM PLAN
ISLAND OR TRACT

1. Andrus
2. Atlas
3. Bacon
4. Bethel
5. Bishop
6. Bouldin
7. Brack
8. Bradford
9. Brannan
10. Byron
11. Canal Ranch
12. Coney
13. Dead Horse
14. Drexler
15. Empire
16. Fabian*
17. Holland
18. Hotchkiss
19. Jersey
20. Jones
21. King
22. Mandeville
23. McCormack-Williamson
24. McDonald
25. Medford
26. Mildred
27. Mourian*
28. New Hope
29. Orwood
30. Orwood, Upper
31. Palm
32. Pescadero*
33. Pico-Neglee*
34. Quimby
35. RD-17*
36. Rindge
37. Rio Blanco
38. Roberts, Lower
39. Roberts, Middle
40. Roberts, Upper
41. Sargent-Barnhart
42. Sherman
43. Shima
44. Shin Kee
45. Stewart*
46. Staten*
47. Terminous
48. Twitchell
49. Tyler
50. Union
51. Veale*
52. Venice
53. Victoria
54. Walnut Grove
55. Webb
56. Woodward
57. Wright-Elmwood

* No levee improvements would be required

MODIFIED SYSTEM PLAN
ISLAND OR TRACT

1. Andrus
2. Bacon
3. Bishop
4. Bouldin
5. Brack
6. Bradford
7. Brannan
8. Byron
9. Canal Ranch
10. Coney
11. Dead Horse
12. Empire
13. Holland
14. Hotchkiss
15. Jones
16. King
17. Mandeville
18. McCormack-Williamson
19. McDonald
20. New Hope
21. Orwood, Upper
22. Palm
23. Rindge
24. Rio Blanco
25. Roberts, Lower
26. Shima
27. Shin Kee
28. Staten
29. Terminous
30. Tyler
31. Veale
32. Victoria
33. Webb
34. Woodward
35. Wright-Elmwood

INCREMENTAL PLAN
ISLAND OR TRACT

1. Andrus
2. Bacon
3. Brack
4. Brannan
5. Empire
6. Hotchkiss
7. Jones
8. Mandeville
9. McDonald
10. Rindge
11. Roberts, Lower
12. Terminous
13. Tyler
14. Webb

POLDER PLAN

1. Andrus
2. Bacon
3. Brack
4. Brannan
5. Empire
6. Hotchkiss
7. Jones
8. Mandeville
9. McDonald
10. Rindge
11. Roberts, Lower
12. Terminous
13. Tyler
14. Webb

APPENDIX II

Habitat Evaluation Procedures

Introduction

The Corps of Engineers' selected plan for the Sacramento-San Joaquin Delta Investigation involves the rehabilitation of levee systems on fourteen individual islands or tracts. The project would consist of the enlargement of levee cross-sections and, for some areas, the addition of landside berms. The project would be constructed in stages. All vegetation would be removed from levee slopes prior to initial construction and also in areas where additional fill material would be placed during subsequent stage construction.

Nearly all of the fill material for levee rehabilitation would be imported. Because the exact locations of all fill sources have not yet been determined, this analysis of project impacts does not include impacts on fish and wildlife resources resulting from borrow activities.

Methodology

The 1980 Habitat Evaluation Procedures (HEP) were used in the field analysis conducted on March 24, and April 8, 9 and 16, 1982. Participants in the field analysis were Bob Mapes, California Department of Fish and Game; Cay Goude, U.S. Army Corps of Engineers; and Mike Monroe, U.S. Fish and Wildlife Service. A modified version of the 1980 HEP was used to inventory baseline habitat conditions and project future habitat conditions with and without the project.

Five vegetative types encompassed by the study area were: (1) Emergent Marsh, dominated by hardstem bulrush; (2) Scrub-Shrub riparian vegetation, characterized by woody vegetation less than 6 meters in height, such as willow and blackberry; (3) Riparian Forest, characterized by woody vegetation more than 6 meters in height including cottonwood, white alder, and interior live oak; (4) Upland, characterized by forbs such as thistle and wild mustard, and annual grasses such as wild oat; and (5) Agriculture. Though the study area's vegetation could have been classified in greater detail, use of these five habitat types allowed acreage determinations using the Corps' Delta Environmental Atlas. Three sample sites within each habitat type were rated to determine their capacity to support a number of evaluation species known to occur commonly in that habitat type. Figure 1 indicates sample site locations; Table 1 identifies the acreage of each habitat type.

The preliminary selection of wildlife evalution species was based on team knowledge of species occurrences in the study area and also on the availability of habitat suitability index evaluation models. The final selection of evaluation species was agreed upon by team members and was based primarily on feeding guilds. Table 2 identifies the selected species and habitat types for which value ratings were calculated.

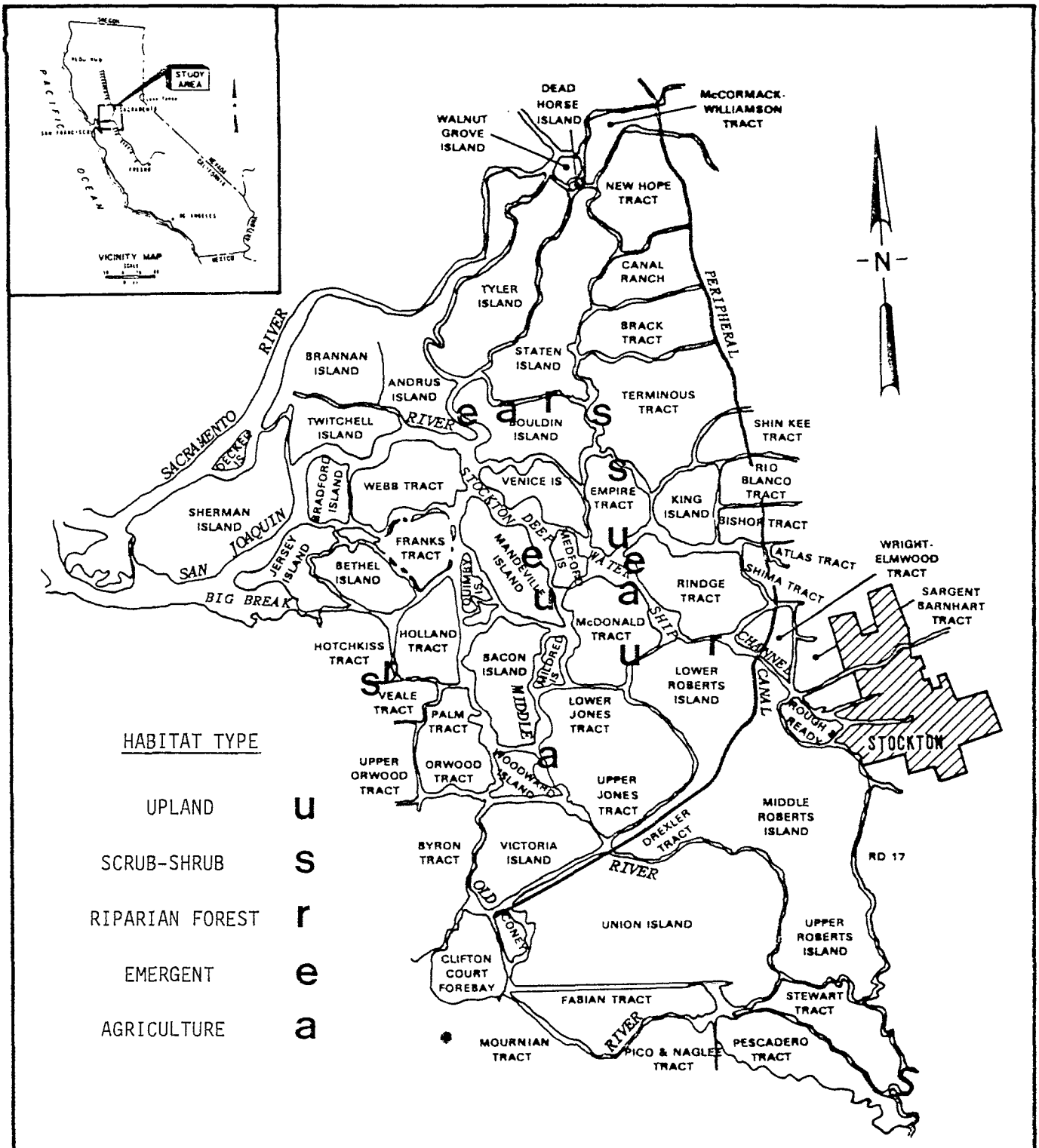


Figure 1

HEP EVALUATION SITES

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Table 1

PROJECT AREA HABITAT ACREAGES
(With and Without Project Scenarios)

Island	Target Year	Habitat (Acres)				
		AGRI	UPLAND	SCRUB-SHRUB	RIPARIAN FOREST	EMERGENT
Andrus	0[1]	127	102	5	0	0
	2[2]	0	234	0	0	0
	50 + 100[3]	127	234	5	0	0
Bacon		82	98	32	0	13
		0	212	0	0	6
		82	98	32	0	10
Brack		34	112	10	0	15
		0	156	0	0	7
		34	112	10	0	12
Brannan		49	17	35	0	0
		0	101	0	0	0
		49	17	35	0	0
Empire		33	70	20	5	5
		0	128	0	0	2
		33	70	25	0	4
Hotchkiss		33	53	20	5	0
		0	111	0	0	2
		33	53	25	0	0
Jones, Upper and Lower		118	78	81	5	34
		0	282	0	0	17
		118	78	86	0	27
Mandeville		69	88	40	0	56
		0	197	0	0	28
		69	88	40	0	45
McDonald		119	115	0	5	35
		0	239	0	0	17
		119	115	5	0	28
Rindge		126	130	10	0	20
		0	266	0	0	10
		126	130	10	0	16
Roberts, Lower		28	37	5	10	0
		0	80	0	0	0
		28	37	15	0	0
Terminous		142	122	20	0	56
		0	284	0	0	28
		142	122	20	0	45
Tyler		84	181	25	0	15
		0	290	0	0	7
		84	181	5	0	12
Webb		82	54	40	15	76
		0	191	0	0	38
		82	54	55	0	61
Totals:						
Baseline condition[1]		1,126	1,257	343	45	325
After initial construction[2]		0	2,771	0	0	160
Years 50 + 100[3]		1,126	1,257	388	0	260

1/ Baseline condition - same for both scenarios
2/ After initial construction - project scenario only
3/ For no-project scenario only

Table 2. Species Evaluated Within Sacramento-San Joaquin Delta Study Area

Evaluation Species	Habitat Type 1/				
	Ag. (1126 ac.)	Upland (1257 ac.)	Scrub-Shrub (343 ac.)	Riparian Forest (45 ac.)	Emergent (325 ac.)
1. Beaver			X	X	X
2. Bewick's wren			X	X	
3. Mourning dove	X	X	X	X	
4. Meadow vole	X	X	X	X	
5. Belted kingfisher			X	X	X
6. Ring-necked pheasant	X	X	X		X
7. Red-winged blackbird	X	X			X
8. Striped skunk	X	X	X	X	
9. Western fence lizard		X	X	X	
10. White-tailed kite	X	X		X	X

1/ Acreages are for all 14 islands combined

Ratings for evaluation species within each habitat type were averaged to produce a habitat suitability index (HSI) for each evaluation species. The HSI, a number between 0 and 1.0, is a measure of the capacity of the study area to meet the life requisites of the species evaluated. The HSI, when multiplied by the acreage of each habitat type utilized by the evaluation species, yields the total number of habitat units (HU), a measure of the quality and quantity of habitat, available to each evaluation species.

For the ten selected species, the HEP team evaluated baseline habitat conditions and also conditions of three future scenarios: Future without the project; Future with the project/no management (no wildlife habitat management); Future with the project/with management (with wildlife habitat management). Using HSI values produced in the baseline habitat evaluation, the team predicted future HSI values for these scenarios. Wildlife impacts associated with each future scenario were evaluated for a number of target years.

Because the team initially assumed that riparian vegetation would be allowed on levee berms, the HSI values for upland habitat at years 7, 16 and following stage construction were not calculated in the field. A change in this assumption necessitated a desktop estimation of the with project upland HSI values. Assuming complete revetment of all waterward slopes, construction of gravel roads on levee crowns, and an increase in the average landside cross section, the with project upland HSI value was only 11 percent lower than the baseline upland HSI value, or 0.43. The calculation of this figure is shown in Table 3.

Table 3

Calculation of Year 7 Adjusted HSI for Upland Habitat

BASELINE:

baseline HSI = .48
levee width = 75 feet

	Width (feet)		Relative Value	
waterward slope	25	x	.5 =	12.5
crown	10	x	.2 =	2.0
landward slope	40	x	.5 =	20.0
	75			34.5

$\frac{34.5}{75} = .46$ .46 x .48 (baseline HSI) = .2208

Therefore, baseline relative index = .2208

FUTURE WITH PROJECT (year 7):

levee without berm: width = 100 feet
length is 70% of total project length

	Width (feet)		Relative Value	
waterward slope	36	x	.2 =	7.2
crown	16	x	.1 =	1.6
landward slope	48	x	.6 =	28.8
	100			37.6

$\frac{37.6}{100} = .38$

levee with berm:
length is 30% of total project length
width = 200 feet

	Width (feet)		Relative Value	
waterward slope	36	x	.2 =	7.2
crown	16	x	.1 =	1.6
landward slope	148	x	.6 =	88.8
	200			97.6

$\frac{97.6}{200} = .49$

combining bermed + unbermed levees:

.70 x .38 = .266
.30 x .49 = .147
1.0 .413

$\frac{.413}{1.0} = .41$ .41 x .48 (HSI) = .1968

Therefore, year 7 relative index = .1968

$\frac{.1968}{.2208} = .89$

.89 x .48 (HSI) = .43

Therefore, the adjusted year 7 HSI for upland is .43

A unique characteristic of this project was the variation for each island or tract in the interval between the end of the initial construction and the onset of stage construction, the duration of the total stage construction period, the duration between stage construction efforts, and the length of levee reworked during each effort. To facilitate the calculation of project impacts, the HEP team melded the data and analyzed impacts for all islands and tracts combined. The various construction intervals and durations were weighted and combined to give a single weighted interval between the end of initial construction and the onset of stage construction, a single weighted project construction period, and a weighted duration between stage construction efforts. The calculation of the average weighted interval between stage construction efforts for one tract (Empire Tract) is shown on Table 4. For this tract, a figure of 24.1 years indicates that habitat values for all levee sections where stage construction occurs at any time would be affected, on the average, every 24.1 years.

Data and calculations in Table 5 indicate that for all islands and tracts combined, stage construction would begin 8 years after completion of initial construction, that the total stage construction period would be 40 years, and that stage construction efforts would occur at intervals of 20 years, or two times during the project life. Thus, for purpose of analysis, stage construction would be completed by year 50; the project life would extend to year 150. These figures were derived only to facilitate impact analysis; in reality, all initial construction would take about ten years to complete; the duration of stage construction would be between 8 and 70 years. For each island, the life of the project would be 100 years following the last stage construction.

Table 4. Calculation of Average Weighted Intervals between Stage Construction for Empire Tract

Station	A Length	B Intervals Between Stages (years)	C Average Interval $\bar{x}$ of B	D Weighted Interval A x C
0	10	4,12,13,(25)**	13.5	135
20	81	16,(38)	27	2,187
162	190	29,(25)	27	5,130
400	172	16,(38)	27	4,664
505	70	4,4,8,13,(29)	10.8	756
540	20	8,21,(25)	18	360
545	8*	4,4,12,13,(29)	10.8	87
	551			13,299

The average interval during stage construction that the entire stage construction portion of the levee would be affected is:

$$13,299 \div 551 = 24.1 \text{ years}$$

* Last figure in column adjusted column so sum equals total length of levee affected by stage construction.

** Numbers in ( ) = interval between last construction year and total construction period.

TABLE 5

Initial and Stage Construction Data;

Calculation of Total Project Intervals and Durations

ISLAND	A. Length of Initial Construction (000's of feet)	B. Area Impacted by Initial Construction (Acres) 1/	C. Length of Stage Construction (000's of feet)	D. Area Impacted by Stage Construction (Acres) 1/	E. Time Between Initial and Stage Construction (Years)	F. Duration of Stage Construction (Years)	G. 2/ Weighted Interval Between Stage Construction Efforts	H. (CXF) Weighted Duration of Stage Construction Period	I. (CXE) Weighted Interval Between Initial and Stage Construction Period
AMORUS	34.4	234	34.4	88	4	60	23.2	2064	138
BACON	73.8	212	73.8	176	6	60	25.5	4428	443
BRACK	71.0	156	28.0	26	8	8	8.0	224	224
BRANNAN	17.2	101	14.4	50	1	60	17.8	864	14
EMPIRE	55.1	128	55.1	53	4	54	24.1	2975	220
HOTCHKISS	45.6	111	20.0	21	30	30	30.0	600	600
JONES (U + L)	95.4	282	63.5	254	18	18	18.0	1143	1143
KANDEVILLE	74.1	197	74.1	133	10	45	18.5	3335	741
MCDONALD	70.0	239	60.0	179	4	38	14.6	2280	240
RIDGE	81.1	266	52.7	157	8	42	18.4	2213	422
ROBERTS,LOWER	30.0	80	0	0	NA *	NA *	NA *	NA *	NA *
TERMINOUS	95.0	286	70.0	209	4	70	24.5	4900	280
TYLER	52.0	290	38.0	39	20	20	20.0	760	760
WEBB	67.7	191	67.7	173	4	46	14.5	3047	271
	862.4 (163.3 miles)	2,771	651.7 (123.4 miles)	1,558		550	257.3	28,833	5,495

*, Not Applicable

1/ Excluding Emergent Vegetation

2/ See Table 5 for example of calculation

For all islands together: Weighted Interval between end of Initial Construction and start of Stage Construction: 5,495 ÷ 651.7 = 8.4 years, say 8 years

Weighted Duration of Stage Construction: 28,833 ÷ 651.7 = 44.2 years, say 40 years

Weighted Interval between each Stage Construction work effort: 257.3 ÷ 13 (islands) = 19.8 years, say 20 years

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From this aggregated project information, the team listed habitat condition assumptions for each scenario (Table 6), and predicted habitat changes for various target years (Table 7). Given the assumptions, long-term losses and gains in HU's could be estimated for each future scenario over the life of the project and expressed as average annual habitat unit (AAHU) gains or losses.

To predict future habitat conditions for the scenario - future with project with management - the evaluation team developed two sets of management acitivities. Because no management would be possible on levee slopes, the management activities were limited to existing agricultural lands contiguous with the levees. The first management plan, Natural Management, would consist of the elimination of cultivation and the natural establishment of riparian species on 20 acre plots throughout the project area. Management plots would be located at the base of rehabilitated levee slopes, preferably on small peninsulas. Habitat values would reach maximum value at year 40.

The second management plan, Intensified Management, would be more intensive. Slips and seedlings of cottonwood, willow, elderberry and oak would be planted at each plot and nurtured by watering, weeding,etc. for several years. Under this plan, habitat values would peak at year 20 instead of year 40. Assuming that the management activities listed in Table 8 would be carried out over the life of the project, the evaluation team then determined the future HSI values for each evaluation species and the required size of the management areas.

Table 6. Assumptions Adopted by the Evaluation Team for Predicting Future Scenarios

Scenario	Assumptions
Future Without Project	1. Levee maintenance practices will not change. 2. Riparian trees will die out and be replaced by scrub-shrub vegetation. 3. The proportion of scrub-shrub and upland vegetation will remain about constant. 4. All unprotected levee slopes will be riprapped. 5. Agricultural practices will not change, e.g., use of herbicides and clearing of ditches will continue. 6. Most unleveed channel islands will remain undeveloped. 7. The water regime will not change. 8. The acreage of emergent vegetation adjacent to levees will be reduced by 20%. 9. Islands and tracts will be inundated for one year once every 25 years.

Table 6 (continued)

Scenario	Assumptions
Future with Project/no Management	1. All vegetation within the levee construction area will be removed during construction. 2. Following construction, all bare earth will be seeded with grasses. 3. Only grasses and forbs will be allowed on the rehabilitated levees. 4. Levee habitat values will peak five years after completion of a construction stage. 5. Most unleveed channel islands will remain undeveloped. 6. The water regime will not change. 7. Agricultural practices will not change. 8. 50% of the emergent vegetation will be removed during construction. 9. 80% of the initial emergent vegetation acreage will reestablish following construction.

Table 6 (Continued)

Scenario	Assumptions
Future with Project/with Management	In addition to the assumptions for the Future with Project/ no Management scenario, we assume for each management site:
Natural Management	1. Exclusion of cultivation. 2. Natural succession of grasses, scrub-shrub and riparian forest species; no plantings; no fertilizer; no additional water.
Intensified Management	1. Exclusion of cultivation. 2. Planting of willow, elderberry and cottonwood slips; oak seedlings; application of fertilizer and additional water.

Table 7. Predicted Habitat Changes for Future Scenario Target Years

Scenario/Target Year		Predicted Habitat Change
Future Without Project:		
Target Year	0	Baseline Habitat Conditions
	50	Riparian forest vegetation converted to scrub-shrub; all waterside slopes revetted; scrub-shrub/upland vegetation in same proportion as baseline; unleveed channel islands intact; some loss of emergent vegetation.
	100	No riparian forest vegetation; only minimal growth of scrub-shrub on revetted slopes; no change in emergent vegetation acreage.
	150	End analysis.
Future with Project/No Management:		
Target year	0	Baseline habitat condition
	1	Initial construction occurs - all levee slopes bare earth on landside, revetted on waterside; some loss of emergent vegetation.
	7	Levee slopes totally revegetated with grasses and forbs.
	10	Stage construction occurs - total loss of vegetation above riprap on waterside slope, and on entire landside slope.
	16	Same as year 7.
	30	Same as year 10.
	36	Same as year 7.
	50	End construction.
	150	End analysis.

Table 7 (continued)

Scenario/Target Year		Predicted Habitat Change
Future with Project/with Management		In addition to predicted habitat changes for levees and berms, each management site would exhibit the following:
Natural Management	0	Baseline habitat conditions-site in agricultural use.
	5	Agriculture converted to grassland; some willows present.
	15	Scrub-shrub vegetation; a few cottonwoods present; no oaks.
	40	Scrub-shrub and riparian forest mix; moderate species diversity; no oaks.
	150	Riparian forest with scrub-shrub understory; no oaks.
Intensified Management	0	Baseline habitat conditions - site in agricultural use.
	5	Agriculture converted to grassland; many young willows, elderberry and oaks present.
	10	Scrub-shrub vegetation; many cottonwoods and young oaks present.
	20	Scrub-shrub and riparian forest mix; high species diversity; many oaks.
	150	Riparian forest with scrub-shrub understory; many mature oaks.

Table 8. Management Activities for Future with Project/with Management Scenario

Natural Management	Management sites protected from agricultural cultivation; natural establishment of shrubs and trees; prohibition of ORV use.
Intensified Management	Artificial establishment of willow, elderberry and cottonwood slips and valley oak seedlings; application of fertilizer and additional water for first three years; removal of volunteer shrubs and grasses competing with slips and seedlings; prohibition of ORV use. Density of plantings/acre: willow - 15 elderberry - 10 cottonwood - 10 oak - 5 Oaks would be planted along the landward boundary of each site; other species would be planted closer to the levee toe.

Results

Results of the field evaluation of baseline conditions indicate that there are 10,689 Habitat Units in the project area (Table 9). The acreage of habitat used to calculate HU's for each species was dependent upon individual species habitat requirements. Species able to utilize more than one habitat type within the project area to meet life requisites have relatively large numbers of habitat units. Habitat suitability index (HSI) values for baseline conditions varied from .40 to .69. For all species combined, the average HSI value is .55, indicating that the total available wildlife habitat within the project area is slightly above average in its capability to support the evaluation species compared to the Delta as a whole.

Changes in average annual habitat units (AAHU's) are compared in Table 10 for the scenarios: future without the project, and the future with the project/no management. The total change in AAHU's of 1,282 indicates that the adoption of the project/no management scenario would result in a net loss in habitat value for all evaluation species combined.

To offset project induced habitat losses, the HEP team developed two management plans based on the concept of relative replacement. Under this concept, a gain of HU's for one species is used to offset the loss of HU's for another species at a differential rate depending on the species involved. Trade-off rates are defined by Relative Value Index (RVI) values for each species. Table 11 indicates the criteria

Table 9

FORM B

STUDY NAME : SAC-SJ DELTA INVESTIGATION
PROPOSED ACTION : PA01 FUTURE WITHOUT CONDITION
TARGET YEAR : BASELINE

ID	SPECIES NAME	AREA	HSI	HU
1	BEAVER	713.00	.61	434.93
2	WREN	388.00	.60	232.80
3	DOVE	2771.00	.69	1911.99
4	VOLE	2771.00	.60	1662.60
5	KINGFISHER	713.00	.64	456.32
6	PHEASANT	3051.00	.45	1372.95
7	BLACKBIRD	2708.00	.52	1408.16
8	SKUNK	2771.00	.47	1302.37
9	LIZARD	1645.00	.49	806.05
10	KITE	2753.00	.40	1101.20
			TOTAL =	10689.37

Table 10

FORM D

STUDY NAME : SAC-SJ DELTA INVESTIGATION
PROPOSED ACTION (WITH) : PA02 FUTURE WITH PROJECT
PROPOSED ACTION (WITHOUT) : PA01 FUTURE WITHOUT CONDITION

ID	SPECIES NAME	AAHU WITH	AAHU WITHOUT	AAHU CHANGE
1	BEAVER	74.33	331.27	-256.94
2	WREN	.52	200.34	-199.82
3	DOVE	1725.78	1885.52	-159.74
4	VOLE	1348.09	1638.93	-290.84
5	KINGFISHER	123.22	345.60	-222.38
6	PHEASANT	1107.55	1272.88	-165.33
7	BLACKBIRD	1249.69	1293.52	-43.83
8	SKUNK	976.59	1170.05	-193.46
9	LIZARD	965.69	764.76	200.93
10	KITE	1077.32	1028.15	49.17
			TOTAL	-1282.24

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and relative weights used to derive RVI's for the evaluation species. The derivations of RVI's are shown in Table 12. The relative baseline HU's and future with project relative AAHU's are shown in Tables 13 and 14 respectively. Table 14 indicates that 603 relative AAHU's would be lost as a result of the project.

The data in Table 14 indicate that an acceptable project compensation plan must develop at least 603 relative or weighted HU's annually. Implementation of either the natural or intensified management plan could fulfill this requirement; however, the less intensive plan would require greater management acreage.

Use of the HEP software to determine the compensation requirement under a particular management plan requires the input of a dummy acreage figure; a figure of 300 acres was input for this purpose. Table 15 indicates that the management of 300 acres of agricultural land under the natural management plan would increase relative AAHU's by 278 units; Table 16 indicates that the management of 300 acres under the intensified plan would increase relative AAHU's by 297 units. In either case, compensation would not be achieved through management of only 300 acres.

Table 17 indicates that full compensation could be attained through natural management of 650 acres. Table 18 indicates that intensified management of 609 acres also would meet the compensation requirement.

TABLE 11

Form E. Pairwise comparison matrix for determining relative weights for each ranking criterion.

1. Study

SACRAMENTO-SAN JOAQUIN DELTA INVESTIGATION

2. Ranking criteria	3. Ranking criteria (1)	(2)	(3)	(4)	(5)	(6)	Dummy	4. Sum	6. Relative weight
(1) Scarcity	XXXXX	1	1	1	1		1.0	5.0	.33
(2) Vulnerability	0	XXXXX	.5	1	1		1.0	3.5	.23
(3) Replaceability	0	.5	XXXXX	.5	1		1.0	3.0	.20
(4) Importance to humans	0	0	.5	XXXXX	1		1.0	2.5	.17
(5) Management efforts	0	0	0	0	XXXXX		1.0	1.0	.07
(6)						XXXXX	1.0		
Dummy criterion	0	0	0	0	0	0	XXXXX	0.0	0.00
								5. Total 15.0	7. Total weight 1.00

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TABLE 12

Form F. Determination of Relative Value Indices for each Evaluation Species.

1. Study SACRAMENTO-SAN JOAQUIN DELTA INVESTIGATION

2. Evaluation species	3. Relative weight of ranking criteria						5. Relative value	6. Relative Value Index
	1	2	3	4	5	6		
	.23	.23	.20	.17	.07			
	4. Relative importance of each ranking criterion to each evaluation species.							
BEAVER	.7	.9	.2	.8	.4			
Product	.23	.21	.04	.14	.03		.65	.65
WREN	.5	.8	.3	.2	.2			
Product	.17	.18	.06	.03	.01		.45	.45
DOVE	.3	.2	.2	.7	.4			
Product	.10	.05	.04	.12	.03		.34	.34
VOLE	.4	.3	.3	.1	.1			
Product	.13	.07	.06	.02	.01		.29	.29
KINGFISHER	.5	.8	.4	.8	.2			
Product	.17	.18	.08	.14	.01		.58	.58
PHEASANT	.5	.3	.2	.9	.8			
Product	.17	.07	.04	.15	.06		.48	.48
BLACKBIRD	.2	.1	.4	.5	.1			
Product	.07	.02	.08	.09	.01		.27	.27
SKUNK	.4	.4	.8	.2	.1			
Product	.13	.09	.16	.03	.01		.42	.42
LIZARD	.4	.3	.4	.1	.1			
Product	.13	.07	.08	.02	.01		.31	.31
KITE	.7	.3	.8	.8	.5			
Product	.23	.07	.16	.14	.04		.64	.64

Table 13

FORM G2

STUDY NAME :SAC-SJ DELTA INVESTIGATION
PROPOSED ACTION :PA01 FUTURE WITHOUT CONDITION
FORM F :FF01 RESCALING FACTOR : 1.00

ID	SPECIES NAME	RVI	HABITAT UNITS	RELATIVE HU'S
1	BEAVER	.65	434.93	282.70
2	WREN	.45	232.80	104.76
3	DOVE	.34	1911.99	650.08
4	VOLE	.29	1662.60	482.15
5	KINGFISHER	.58	456.32	264.67
6	PHEASANT	.48	1372.95	659.02
7	BLACKBIRD	.27	1408.16	380.20
8	SKUNK	.42	1302.37	547.00
9	LIZARD	.31	806.05	249.88
10	KITE	.64	1101.20	704.77
			TOTAL =	4325.22

Table 14

FORM G1

STUDY NAME :SAC-SJ DELTA INVESTIGATION

PROPOSED ACTION :PA02 FUTURE WITH PROJECT
(WITH)
PROPOSED ACTION :PA01 FUTURE WITHOUT CONDITION
(WITHOUT)
FORM F :FF01 RESCALING FACTOR : 1.00

ID	SPECIES NAME	RVI	CHANGE IN AAHU	CHANGE IN REL. AAHU
1	BEAVER	.65	-256.94	-167.01
2	WREN	.45	-199.82	-89.92
3	DOVE	.34	-159.74	-54.31
4	VOLE	.29	-290.84	-84.34
5	KINGFISHER	.58	-222.38	-128.98
6	PHEASANT	.48	-165.33	-79.36
7	BLACKBIRD	.27	-43.83	-11.83
8	SKUNK	.42	-193.46	-81.25
9	LIZARD	.31	200.93	62.29
10	KITE	.64	49.17	31.47
			TOTAL =	-603.25

Table 15

STUDY NAME :SAC-SJ DELTA INVESTIGATION

MANAGEMENT PLAN (WITH) :MP02 FUTURE WITH NAT'L MGMT AREA : 300.00

MANAGEMENT PLAN (WITHOUT) :MP01 FUTURE WITHOUT MANAGEMENT AREA : 300.00

FORM F :FF01 RESCALING FACTOR : 1.00

ID	SPECIES NAME		RVI	CHANGE IN AAHU	CHANGE IN REL. AAHU
1	BEAVER		.65	0.00	0.00
2	WREN	FORM G1	.45	190.75	85.84
3	DOVE		.34	27.60	9.38
4	VOLE		.29	5.88	1.71
5	KINGFISHER		.58	68.25	39.59
6	PHEASANT		.48	32.78	15.73
7	BLACKBIRD		.27	-91.49	-24.70
8	SKUNK		.42	82.18	34.52
9	LIZARD		.31	198.10	61.41
10	KITE		.64	85.82	54.92
				TOTAL =	278.40

Table 16

STUDY NAME :SAC-SJ DELTA INVESTIGATION

MANAGEMENT PLAN (WITH) :MP03 FUTURE WITH INTENSIFIED MGMT AREA : 300.00

MANAGEMENT PLAN (WITHOUT) :MP01 FUTURE WITHOUT MANAGEMENT AREA : 300.00

FORM F :FF01 RESCALING FACTOR : 1.00

ID	SPECIES NAME		RVI	CHANGE IN AAHU	CHANGE IN REL. AAHU
1	BEAVER		.65	0.00	0.00
2	WREN	FORM G1	.45	196.50	88.43
3	DOVE		.34	29.10	9.89
4	VOLE		.29	5.88	1.71
5	KINGFISHER		.58	70.50	40.89
6	PHEASANT		.48	33.03	15.85
7	BLACKBIRD		.27	-93.84	-25.34
8	SKUNK		.42	86.43	36.30
9	LIZARD		.31	200.65	62.26
10	KITE		.64	104.82	67.08
				TOTAL =	297.08

Table 17

FORM H

STUDY NAME : SAC-SJ DELTA INVESTIGATION
GOAL NUMBER : 3 - RELATIVE REPLACEMENT

PROPOSED ACTIONS : PA01 FUTURE WITHOUT CONDITION
USED (FORM D) : PA02 FUTURE WITH PROJECT

MANAGEMENT PLANS : MP01 FUTURE WITHOUT MANAGEMENT
USED (FORM D) : MP02 FUTURE WITH NAT'L MGMT

MANAGEMENT
AREA SIZE : 333.6.

FORM F : FF01 RESCALING FACTOR : 1.00

ID	SPECIES NAME	PROPOSED ACTION	CHANGE IN REL. AAHU MANAGEMENT PLAN
1	BEAVER	-167.01	0.00
2	WREN	-89.92	85.84
3	DOVE	-54.31	9.38
4	VOLE	-84.34	1.71
5	KINGFISHER	-128.98	39.59
6	PHEASANT	-79.36	15.73
7	BLACKBIRD	-11.83	-24.70
8	SKUNK	-81.25	34.52
9	LIZARD	62.29	61.41
10	KITE	31.47	54.92
	TOTAL	-603.25	278.40

COMPENSATION REQUIREMENTS : 650.07

Table 18

FORM H

STUDY NAME : SAC-SJ DELTA INVESTIGATION
GOAL NUMBER : 3 - RELATIVE REPLACEMENT

PROPOSED ACTIONS: PA01 FUTURE WITHOUT CONDITION
USED (FORM D) : PA03 FUTURE WITH PROJECT

MANAGEMENT PLANS: MP01 FUTURE WITHOUT MANAGEMENT
USED (FORM D) : MP03 FUTURE WITH INTENSIFIED MGMT

MANAGEMENT
AREA SIZE : 300.00

FORM F : FF01 RESCALING FACTOR : 1.00

ID	SPECIES NAME	PROPOSED ACTION	CHANGE IN REL. AAHU	MANAGEMENT PLAN
1	BEAVER	-167.01		0.00
2	WREN	-89.92		88.43
3	DOVE	-54.31		9.89
4	VOLE	-64.34		1.71
5	KINGFISHER	-128.98		40.89
6	PHEASANT	-79.36		15.85
7	BLACKBIRD	-11.83		-25.34
8	SKUNK	-81.25		36.30
9	LIZARD	62.29		62.26
10	KITE	31.47		67.08
	TOTAL	-603.25		297.08

COMPENSATION REQUIREMENTS : 609.18

Compensation could be effected through the development of management plots, each about 20 acres in size, throughout the project area. Other compensation possibilities, including acquisition and management of other lands within the project area, will be presented in the Service's Coordination Act Report for this proposed project.

APPENDIX III

The Delta supports many recreational activities. Such activities include fishing, hunting and many forms of non-consumptive recreation. Non-consumptive recreation is defined as recreational activity that does not directly consume fish and wildlife resources.

The Water Resources Council's (WRC) Principles and Standards for water resource planning requires the use of a Travel Cost Method (TCM) or a Contingent Valuation Method (CVM) to evaluate recreation if there are more than 500,000 user-days or specialized recreation involved in a project. This project qualifies on both accounts, having more than 500,000 user-days and specialized recreation. Until the TCM or CVM can be performed for this project, a unit day value will be assigned to recreation activities. Unit day values are published by the WRC in the Principles and Standards for a variety of recreation activities. The following tables provide user-day estimates of existing recreational activities in the Delta, and a 100-year future projection with and without the project. The project would support 2.4 million user-days more than the future without project condition.

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APPENDIX III

RECREATIONAL VALUES ATTRIBUTABLE TO FISH AND WILDLIFE RESOURCES IN THE DELTA

-EXISTING CONDITIONS-

ACTIVITY	TOTAL ANNUAL USE-DAYS (Millions)[1]	FISH AND WILDLIFE USE-DAYS (Millions)[2]	FISH AND WILDLIFE[3] UNIT DAY VALUE ($)	TOTAL FISH AND WILDLIFE ANNUAL VALUE (Million of $)
FISHING				
Catfish	1.069		4.10	4.38
Striped Bass	0.980		16.30	15.97
Sturgeon	0.328		4.10	1.34
Black Bass	0.271		4.10	1.11
Salmon	0.100		16.30	1.63
Steelhead	0.089		16.30	1.45
Shad	0.071		16.30	1.16
Other[4]	0.122		4.10	0.50
Total	3.030	3.030		27.54
HUNTING				
Upland[5]	0.128		16.30	2.09
Waterfowl[6]	0.088		16.30	1.43
Total	0.216	.216		3.52
NON-CONSUMPTIVE				
Specialized[7]	2.329	--	--	--
General[8]	6.725	(1.345)	4.10	5.51
TOTAL	12.300	4.591		36.57

1/ Includes visitor and resident recreation days for all recreational uses. (Source: Derived from data in Delta Outdoor Recreation Survey, DWR, 1980).

2/ Includes visitor and resident recreation days only for those recreational uses dependent on fish and wildlife.

3/ Unit day values are from the U.S. Water Resource Council's Principles and Standards reference handbook (FY 81) for general recreation and specialized recreation.

4/ Other fishing includes frogs and any fishing activity not listed.

5/ Upland species include quail, dove and pheasant.

6/ Waterfowl includes user-days for ducks and geese.

7/ Specialized recreation includes motorboating, waterskiing, sailing, and flying. No economic value assigned.

8/ General recreation includes relaxing, driving for pleasure, swimming, sightseeing, picknicking, bicycling, overnight camping, photography, canoe-kayak-rowing, dirt bike and snorkling or scuba diving. The figure in paraenthesis is that portion (20%) of total general recreation which we believe is supported by fish and wildlife.

APPENDIX III

RECREATIONAL VALUES ATTRIBUTABLE TO FISH AND WILDLIFE RESOURCES IN THE DELTA

-FUTURE WITHOUT PROJECT, YEAR 2085-

ACTIVITY	TOTAL ANNUAL USE-DAYS (Millions)[1/]	FISH AND WILDLIFE USE-DAYS (Millions)[2/]	FISH AND WILDLIFE[3/] UNIT DAY VALUE ($)	TOTAL FISH AND WILDLIFE ANNUAL VALUE (Million of $)
FISHING				
Catfish	2.052		4.10	8.41
Striped Bass	1.882		16.30	30.68
Sturgeon	0.630		4.10	2.58
Black Bass	0.520		4.10	2.13
Salmon	0.192		16.30	3.13
Steelhead	0.170		16.30	2.77
Shad[4/]	0.136		16.30	2.22
Other[4/]	0.234		4.10	0.96
Total	5.816	5.816		52.88
HUNTING				
Upland[5/]	.246		16.30	4.01
Waterfowl[6/]	.169		16.30	2.75
Total	.415	.415		6.76
NON-CONSUMPTIVE				
Specialized[7/]	4.472	--	--	--
General[8/]	12.912	(2.582)	4.10	10.59
TOTAL	23.615	8.813		70.23

1/ A mathematical (linear) projection is used to estimate future recreation use based on available data (Delta Outdoor Recreation Survey, DWR, 1980, Sac-San Joaquin Delta Investigation, COE, 1982).

2/-8/ See footnotes, Existing Conditions

APPENDIX III

RECREATIONAL VALUES ATTRIBUTABLE TO FISH AND WILDLIFE RESOURCES IN THE DELTA

-FUTURE WITH PROJECT, YEAR 2085-

ACTIVITY	TOTAL ANNUAL USE-DAYS (Millions)[1/]	FISH AND WILDLIFE USE-DAYS (Millions)[2/]	FISH AND WILDLIFE[3/] UNIT DAY VALUE ($)	TOTAL FISH AND WILDLIFE ANNUAL VALUE (Million of $)
FISHING				
Catfish	2.263		4.10	9.28
Striped Bass	2.076		16.30	33.84
Sturgeon	0.696		4.10	2.85
Black Bass	0.573		4.10	2.35
Salmon	0.211		16.30	3.44
Steelhead	0.187		16.30	3.05
Shad	0.151		16.30	2.46
Other[4/]	0.258		4.10	1.06
Total	6.415	6.415		58.33
HUNTING				
Upland[5/]	0.273		16.30	4.45
Waterfowl[6/]	0.186		16.30	3.03
Total	0.459	0.459		7.48
NON-CONSUMPTIVE				
Specialized[7/]	4.92	--	--	--
General[8/]	14.221	(2.851)	4.10	11.69
TOTAL	26.015	9.725		77.50

1/ Future user-days without the project plus 2.43 million additional user-days. Additional user-days are proportionately distributed over all recreational activities. This assumes that the proportion of recreational activities will not change over time.

2/-8/ See footnotes, Existing Conditions.

APPENDIX IV

EQ MEASURES

		Acreage
.	Bonetti Island	33
2.	Unnamed island in Old River adjacent to Coney Island	50
3.	Disappointment Slough Channel Islands	300
4.	Eucalyptus and Widdows Islands	120
5.	Grand Island	100
6.	Headreach, Fern, Lost Lake, Tule Islands	300
7.	Middle River (Union Island)	45
8.	Middle River and Latham Slough Channel	290
9.	Old River Islands	220
10.	Potato Slough Channel Islands	200
11.	Unnamed Island, Sevenmile Slough	20
12.	Spud and Hog Islands	295
13.	Unnamed island, South Fork Mokelumne River	10
14.	Quimby, Little Mandeville, Rhode, Medford, Mildred Islands	3,454
15.	Webb Tract	230
16.	Shin Kee Tract	50
17.	Beaver Slough	50
18.	Hog Slough	100
19.	Mokelumne River	125
20.	Trapper Slough	100
		6,092