ATTACHMENT A

Fish and Wildlife Service Coordination Act Report

C-089152

UNITED STATES DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

DRAFT FISH AND WILDLIFE COORDINATION ACT REPORT

PROSPECT ISLAND RESTORATION PROJECT

PREPARED FOR

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

MARCH 1997

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Ecological Services
Sacramento Field Office
3310 El Camino Avenue, Suite 130
Sacramento, California 95821-6340

IN REPLY REFER TO:
HC-CE

March 24, 1997

Mr. Walter Yep
Chief, Planning Division
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814-2922

Subject: CESAC-Prospect Island Wetland Restoration

Dear Mr. Yep:

The enclosed Draft Fish and Wildlife Coordination Act (FWCA) report is provided pursuant to the Scope of Work for Fiscal Year 1997. This report considers revised designs and other information provided through January 8, 1997. The Habitat Evaluation Procedures analysis has been thoroughly revised based on this latest information.

The Service is generally supportive of a tidal restoration project on Prospect Island. We believe this can be done at reasonable cost, and will have significant benefits to a variety of fish and wildlife species.

Much of this information has been coordinated formally with the California Department of Fish and Game and National Marine Fisheries Service previously as part of the Planning Aid Report we issued in 1995. Because the project has several significant changes, we request by copy of this letter that these agencies review the enclosed report, and provide us with agency concurrence and/or comments by April 7, 1997. Comments by these agencies and any other concerned party will be considered in the final report.

We thank your staff for their cooperation during this planning process. Should you have any questions, please call Dr. Steven Schoenberg of my staff at (916) 979-2107.

Sincerely,

for Joel A. Medlin

Wayne S. White
Field Supervisor

Enclosure

C-089154

C-089154

cc: ARD-ES, Portland, OR
COE, Sacramento (Attn: Leslie Lew/Bob Koenigs)
COE, Sacramento, CA (Attn: Elizabeth Dyer)
FWS, Realty Field Office, Sacramento, CA (Attn: Karen Bierly)
FWS, Stone Lakes NWR, Sacramento (Attn: Tom Harvey)
FWS-ES, Sacramento (Attn: Bob Pine)
FWS-Central Valley Fish and Wildlife Restoration Program, Sacramento (Attn: Joel Miller)
DWR, Sacramento (Attn: Kate Wadsworth)
FRO, Stockton (Attn: Pat Brandes)
CDFG, Bay-Delta Division, Stockton (Attn: Don Stevens)
NMFS, Santa Rosa (Attn: Dante Maragni)
TPL (Trust for Public Land), San Francisco
USBR, Regional Director, Sacramento

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FISH AND WILDLIFE SERVICE

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PROSPECT ISLAND RESTORATION PROJECT

prepared by

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prepared for

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO, CALIFORNIA

March 1997

TABLE OF CONTENTS

LIST OF APPENDICES

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

The Corps of Engineers has conducted a reconnaissance level study to assess the potential for restoring tidal action to a 1,316 acre portion of Prospect Island. The objectives of the restoration project are to reduce levee maintenance costs while providing habitat for fish and wildlife resources, including several listed fish species. This report includes information on baseline site conditions, a general discussion of freshwater tidal restoration design features, qualitative and quantitative (Habitat Evaluation Procedures, or HEP) evaluations of the revised project alternative, discussion of impacts and benefits from a resource perspective (including species of concern), and recommendations for final design refinement.

The current project design includes cost-related reductions in earthwork and plantings, resulting in longer wind fetches than earlier designs. These modifications may result in less protection against erosion and suboptimal habitat quality. However, the Service does support this plan for tidal restoration at Prospect Island. The site has advantages such as low surrounding development, modest subsidence, and availability of fill material on and off site. The site is currently farmed with row crops, a variable portion of which becomes seasonally flooded in the winter, providing habitat to migratory waterfowl and other birds. For a majority of the year, the area is intensively cultivated, providing relatively low values to wildlife, and no aquatic values. Restoration of tidal action would increase the total acreage of several cover-types of high value to a diversity of common fish and wildlife, as well as to some threatened and endangered species.

Using HEP, we estimate that with-project habitat values for high importance cover-types (sum of tidal or non-tidal emergent marsh, riparian, shaded palustrine, and shallow flood cover) would show a net gain of about 161 to 199 Average Annualized Habitat Units (AAHUs), a 4-fold increase over baseline conditions, while habitat values of low importance cover-types (sum of open water, mudflat, upland, and agriculture) would increase by 126 to 215 AAHUs, a 38 to 59% increase over baseline conditions. The restored mix of open waters, mudflat, and tidal marsh cover would provide high quality tidal habitat for delta smelt, and many other delta fishes, in all water years. Inundated riparian islands would serve as spawning habitat for Sacramento splittail during most water years. In above-normal water years, the site could function as a rearing area for winter-run chinook salmon. Many species of birds would profit from the emergent marsh and riparian cover.

The project has other positive attributes not revealed by HEP. The shallow water wetlands would produce large quantities of plankton and detritus, which not only support benthic forage on site, but would be transported by tidal action to the major channels, providing a food base for fishes off site. The high surface-to-volume ratio of these shallow wetlands improves water quality by enhancing oxygen levels, and provides for the sorption of excess nutrients by sediments and emergent plants. The project would eliminate the current unscreened agricultural diversion on the site, and offer a route for adult salmon which stray into the lower end of the ship channel to re-enter the Sacramento River system. We believe the Prospect Island Restoration Project, if successfully implemented, can contribute a significant benefit to fish and wildlife populations of the Delta as a whole.

I. INTRODUCTION

Prospect Island is located in Solano County in the northern portion of the Sacramento-San Joaquin Delta (Delta). The project area includes: (a) a 1,228 acre parcel of Prospect Island recently purchased from the Sakata Brothers, (b) surrounding levees owned by the Port of Sacramento, and (c) overwater shade cover provided by trees growing on the outboard side of the levees. The area is bounded to the east by Miner Slough, the west by the Sacramento River Deep Water Ship Channel (SRDWSC), the south by a levee at about SRDWSC mile 20 and the north by an east-west levee from Arrowhead Harbor (formerly Five Points Marina) to the SRDWSC (Fig. 1). With the exception of limited areas near the levees, the topography of the island is generally flat, varying from 0 feet mean sea level (MSL) in the northern third to -3 feet MSL in southern portions of the site. Mean water level (MWL) in nearby Shag Slough is about 2 feet above MSL, which, if applied to Miner Slough would place most of Prospect Island at -2 to -5 feet MWL. This is considered a relatively modest degree of subsidence (DWR 1993).

Prospect Island is one of six sites identified by the National Marine Fisheries Service (NMFS) and the Corps of Engineers (Corps) in a pilot study to determine the feasibility of a nationwide program of fisheries habitat restoration and creation (NMFS and Corps 1990). The Trust for Public Land has exercised an option to purchase the Sakata property and simultaneously convey fee title to the Bureau of Reclamation. The purchase was accomplished with a combination of Central Valley Project Improvement Act restoration funds and a congressional add to the Fiscal Year 1995 budget. The objective of the restoration is to perform one of several alternative plans of earthwork, levee modification, and planting on the site. Following this work, a breach would be made in each levee to restore tidal action to the island interior, and the SRDWSC levee would not be maintained.

Unlike neighboring islands in the peripheral north Delta, Prospect Island is flooded more frequently because of the relatively low height of the SRDWSC levee, allowing overtopping and/or levee failure. Between 1967 and 1997, Prospect Island was flooded six times (1980, 1982, 1983, 1986, 1995, 1997; DWR 1993 and personal observation). Since completion of the ship channel in 1963, erosion of the levee from passing ships has necessitated relatively frequent and extensive rock bank protection (i.e., riprap) to maintain levee integrity. In recent years, levee failure along Miner Slough has occured both adjacent to and south of the site, resulting in subsequent failure of the south levee. Restoring tidal action to the island would eliminate the need to maintain the ship channel levee and, possibly, other levees surrounding the site.

In 1986, the Fish and Wildlife Service (Service) provided a fish and wildlife mitigation plan for a proposed project to enlarge the SRDWSC; this report included a Habitat Evaluation Procedures (HEP) analysis of restoration to tidal action of the southern end of Prospect Island, located south of the site for the currently proposed project (USFWS 1986). A September 1994 Planning Aid Report (PAR) provided a qualitative analysis of six conceptual alternatives for restoring a major part of Prospect Island to tidal habitat . A revised PAR was prepared in April 1995, providing additional information on baseline conditions, and a HEP analysis of two earthwork plans (USFWS 1995). In January 1997, the Corps prepared a single, refined earthwork plan with significant changes from the original preferred alternative identified previously as alternative 1B (Alt 1B). This report discusses these changes, and includes appropriate revisions to the HEP as well as additional recommendations based on the current design.

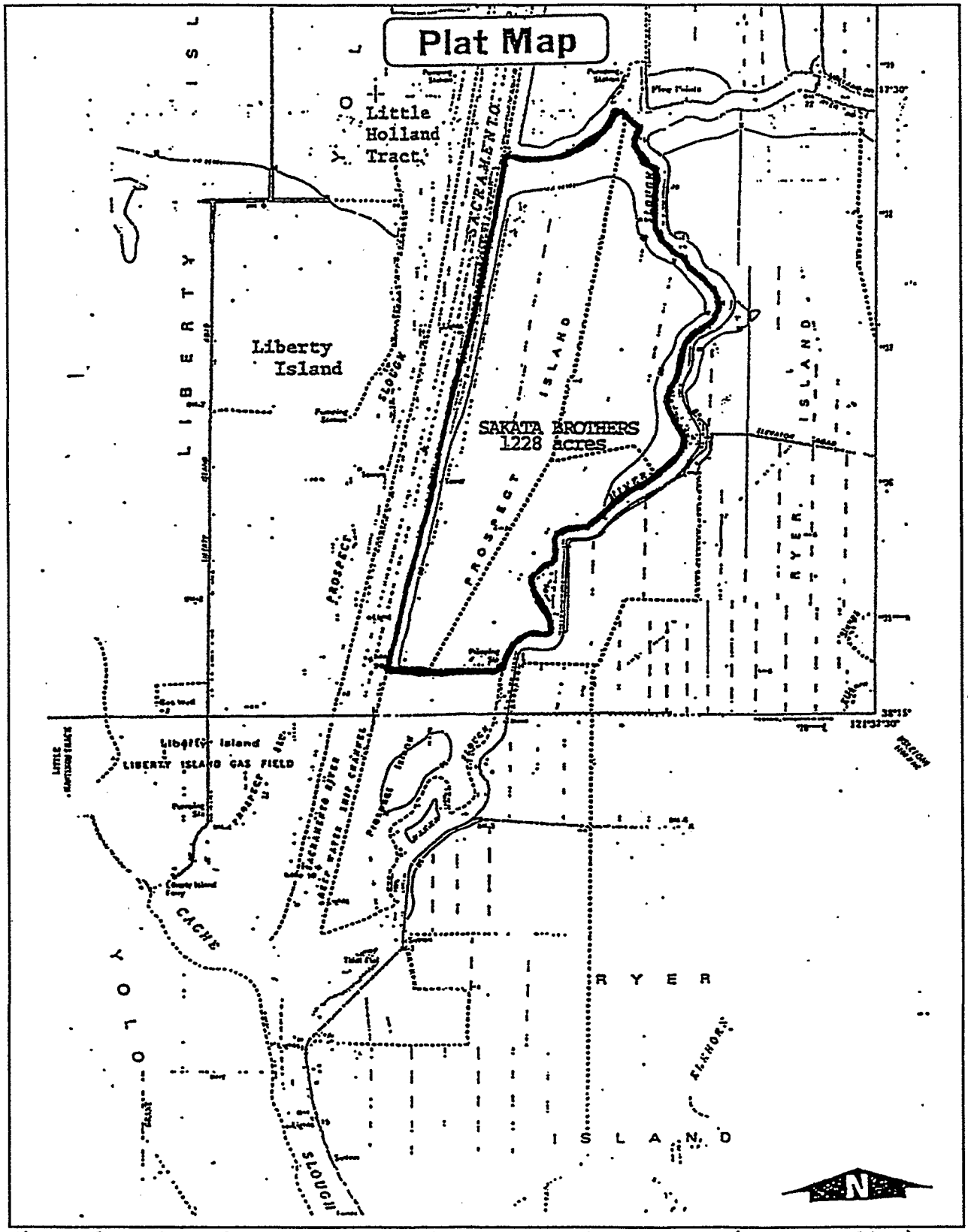

Figure 1. Site of the Prospect Island Restoration Project (heavy outline).

II. EXISTING RESOURCES

A. Vegetation

Through 1994, the interior of Prospect Island had been farmed as a row cropland, and this agricultural cover-type comprises the great majority of the project site. In 1994, about 450 acres each of corn and wheat, and about 250 acres of safflower were planted. Roughly the same proportions of these crops are rotated annually, but may include about 100 acres of sugar beets in some years. A minor portion of the land is bare ground, represented by the perimeter levee road and several machinery access roads within the site. Several irrigation ditches are also present; these are generally free of vegetation, although a few small scattered patches of young willow scrub-shrub and emergent marsh are present. Both the SRDWSC and Miner Slough levees are riprapped. The large rock riprap which has been applied to the southern third of the SRDWSC levee and to levee repairs on the northern two-thirds supports no vegetation of any kind. However, a terrace of up to about 40 feet wide is present outside the levee toe on the northern two-thirds of the SRDWSC; this area contains mature cottonwoods and willows, interrupted by occasional levee repair areas. Small rock riprap has been applied to the entire length of Miner Slough. Smaller trees, primarily willows up to 15 feet high, and shrubs such as blackberry may be observed growing through the riprap along the outer slope of some areas of the Miner Slough levee. Very small, isolated stands of tidal emergent marsh are present outside the SRDWSC levee. Upland/herbaceous vegetation covers the levee slopes, road shoulders, and uncultivated margins of the irrigation ditches and field borders. Water drains towards the southeast corner of the site, where there is a larger, open-water canal, and a 60 horsepower drain pump that empties into Miner Slough. A portion of the agricultural land in this area exhibits shallow flooding in the winter and spring; this cover-type is referred to in this report as "shallow flood cover."

Table 1. Existing cover-type distribution at the Prospect Island Restoration Project site.

Cover-type	Acres
Upland	39.8
Non-tidal Open Water	0.7
Riparian Forest	7.4
Riparian Scrub-shrub	7.8
Non-tidal Emergent Marsh	2.7
Shallow Flood Cover	120.0
Shaded Riverine Aquatic Cover	7.4
Agriculture	1116.8
Bare Ground	20.8
Total (includes Sakata and Port perimeter levees, and overwater cover outside these levees)	1323.4

As part of the Habitat Evaluation Procedures analysis of project impacts, it was necessary to determine the existing, or baseline, acreages of the site for nine existing cover-types (*see* Appendix A for details). This was accomplished by inspection of 1993 aerial photographs and visits to the site in the summer and fall of 1994, and spring of 1995 (Table 1; Figures 2 and 3).

B. Fish and Wildlife

At present, the study area provides significant shallow water habitat for fishes only during major flooding. At such times, the island would likely contain fish species of the Sacramento River and other flooded islands. The Cache Slough Mitigation Area, a 30-acre tract located near Prospect Island at the confluence of Cache and Shag Sloughs, was sampled by the Service several times in 1992 and 1993 (M. Fris, U.S. Fish and Wildlife Service, Sacramento Field Office, unpublished data). The most common of the 23 species collected from this site included, in order of decreasing abundance: inland silverside, yellowfin goby, threadfin shad, hitch, Sacramento squawfish, prickly sculpin, delta smelt, bigscale perch, fathead minnow, and mosquitofish. The delta smelt were most abundant in beach seine samples taken near the levee breaches where tidal currents were strongest, and more abundant near the Shag Slough breach compared to the Cache Slough breach. These findings are similar to modified purse seine samples taken later by Lindberg and Marzuola (1993).

One specimen each of Sacramento splittail and chinook salmon were also identified in Cache Slough during the Service's sampling, however, Sacramento splittail have also been captured at the northern end of the SRDWSC at other times (Kathy Hill, California Department of Fish and Game Region II, personal communication). Beach seining conducted in the Cache Slough area in 1976 yielded predominantly delta smelt and Sacramento splittail (Pat Brandes, U.S. Fish and Wildlife Service, Sacramento-San Joaquin Estuary Fisheries Resource Office, personal communication).

The nearest sampling for the Service's monitoring of juvenile chinook salmon is done at the upper end of Steamboat Slough, a deep water habitat where the salmon exhibit similar abundance patterns as the Sacramento River, although at reduced densities (Pat Brandes, personal communication). Adult chinook salmon have been documented in the upper end of the ship channel during Service sampling in 1975-76 and in 1994, even though this channel is not along a direct migration route to spawning tributaries (Doug Weinrich, U.S. Fish and Wildlife Service, Sacramento Field Office, personal communication).

In addition to salmon, other anadromous fish species of the Sacramento River and deeper channels (i.e., deeper than -12 feet MWL) of the Delta include steelhead, striped bass, American shad, white sturgeon and Pacific lamprey. The more common warmwater, resident fishes of these deep water areas are largemouth bass, crappie, white and channel catfish, bluegill, tule perch, Sacramento squawfish, Sacramento sucker, and other sculpins and minnows such as observed in Cache Slough. Striped bass are often taken by anglers in the deep water habitats adjacent to levee breaches, such as those near Cache Slough, Frank's Tract, as wekk as Prospect Island during levee failures.

The riparian areas along the levees support a wide variety of wildlife species, providing forage, cover, and nest sites. Animals which depend on such areas include mammals such as beaver, skunk, and muskrat as well as birds, incuding belted kingfisher, rufous-sided towhee, and some wading birds which nest in riparian trees, like the great blue heron. Remnants of tidal freshwater marsh near the SRDWSC provide some forage and cover for gulls and terns, and also benefit wildlife that reside primarily in the adjacent riparian areas.

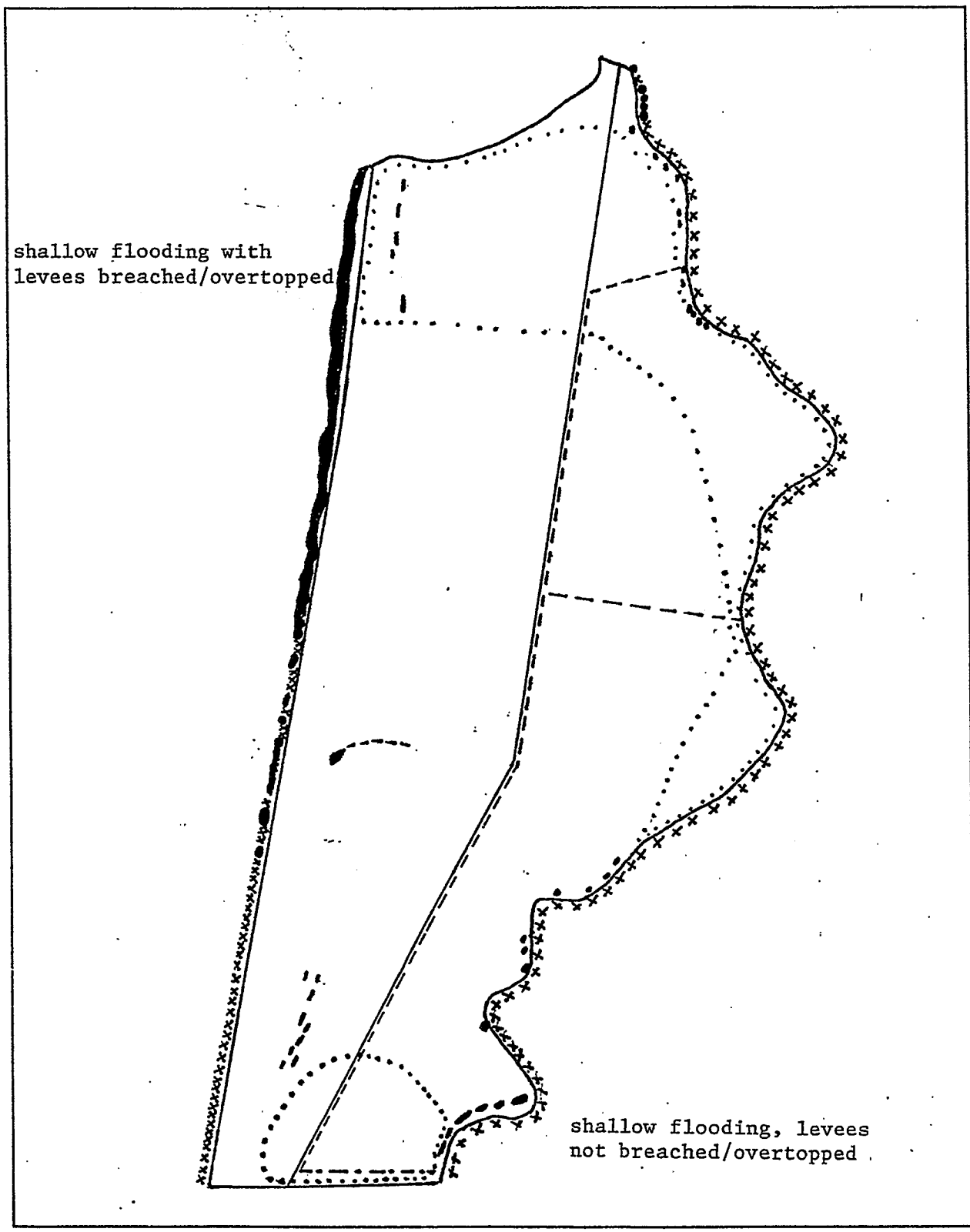

Figure 2. Baseline map showing locations of existing rip-rap (xxx), roads (_____), non-tidal emergent marsh (----), non-tidal open water (—•—•—), riparian forest or shrub-scrub (filled polygons), and shallow flood cover (area within ....) for the Prospect Island Restoration Project.

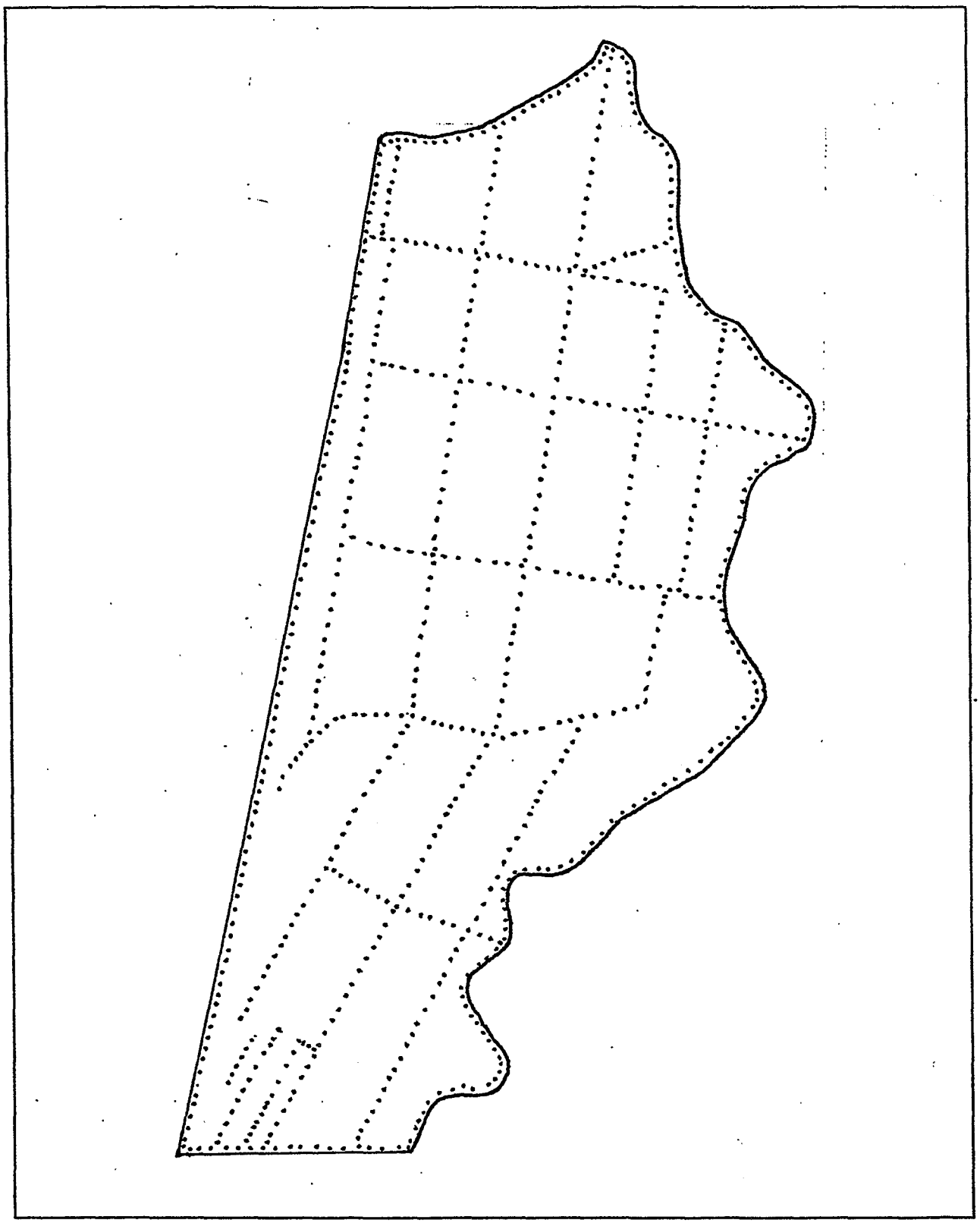

Figure 3. Baseline map showing locations of existing uplands (....) along levee, ditch, field, and road borders at the Prospect Island Restoration Project site. Agriculture constitutes all other areas within the island, except those shown in Figure 2.

Based on the Service's 1987 National Wetland Inventory, the whole project site exclusive of the levees is designated *farmed, palustrine* wetland. Of this, at least 60 acres located in the southern end of the site would be considered *seasonally flooded*, defined as a condition where surface water is present for extended periods, especially early in the growing season (Cowardin et al. 1979). The remainder, about 1,100 acres, would only be flooded as a consequence of levee overtopping or breaching primarily during flood events requiring operation of the Yolo Bypass(i.e., *temporarily flooded*). Farmed wetlands, especially those cultivated with grain, play a significant role in providing winter and spring habitat for migratory birds such as geese, swans, ducks and shorebirds.

Unflooded fields of stubble corn and wheat provide forage for geese, and for resident upland game birds such as ring-necked pheasant, California quail, and mourning dove (Madrone 1980). These agricultural areas, as well as the upland and riparian habitats, likely support a variety of small mammals which provide a forage base for raptors such as the red-tailed and Swainson's hawks. These species were observed during the Service's vegetation mapping for the project.

To further evaluate wildlife use of the site, Service representatives conducted qualitative surveys of bird use and flood cover at the end of the migratory season in 1995 (March 23, March 27, April 10). During this period, a levee bordering the Port of Sacramento's property to the south had been breached, and water was apparently seeping through the cross-levee between the Port and Sakata properties. The pump station was inoperable. As a result, over a thousand acres of the site exhibited shallow, non-tidal flooding. The shallowest, northern third of the project area displayed corn stubble from the previous growing season. Under these conditions, several thousand waterfowl and waterbirds of a variety of species were observed foraging at the site. The most abundant species of waders were dowitchers, sandpipers, with fewer numbers of sandhill crane, egrets, and yellowlegs. Waterfowl included dabbling ducks like shoveler, mallard, widgeon, coot and pintail in the shallower waters, and occasional coots, grebes and scaups in the deeper areas. Cliff swallows, blackbirds, flicker, and goldfinch were also fairly abundant, with fewer numbers of other passerine species. According to a lessee of the property (Tom Slater, Slater Farms), the flooded area and winter bird use is typically restricted to a much smaller area near the drain pump in the southern portion of the site. We suspect that wildlife use is diminished in area in below normal or dry years, but occasionally more significant in wet years such as 1995 and 1997.

C. Endangered and Threatened Species

Included below are preliminary discussions of most federally-listed threatened, endangered and candidate species which may be found within the project area. This should be regarded as preliminary information, which we are providing here only to assist the Corps in preparation of a Biological Assessment, should one be deemed necessary. Appendix B is a summary of a Federal agency's responsibilities under Section 7(a) and (c) of the Endangered Species Act of 1973, as amended (Act). We recommend that the Corps also review its requirements, published in 50 CFR 402, for compliance with the Act. The National Marine Fisheries Service has consultation responsibility for anadromous fishes, including the winter-run chinook salmon and Central Valley steelhead, and should be contacted regarding further consultation requirements. The Service has consultation responsibility for the other federally-listed species that may be affected by the project, and this office should be contacted regarding further consultation requirements. The California Department of Fish and Game (CDFG) should be contacted regarding any species which is listed under the California Endangered Species Act. To our knowledge, no surveys for listed species have been conducted on Prospect Island.

The Corps should request in writing from the Service a list for the project area of all federally-listed and proposed threatened and endangered species, or an updated list if an earlier list is more than 90 days old at the time preparation of any Biological Assessment for this project is undertaken. The most recent list was transmitted on December 4, 1996 (Appendix C).

Several listed fishes may be present around the margins of Miner Slough and the SRDWSC. Any of these species could potentially be entrained into the irrigation and drainage ditches of the site by the water supply siphon at the northern end of Miner Slough. These fishes would be subject to loss during irrigation, or while exiting the drain pump at the southern end of the island. These include:

Delta smelt, *Hypomesus transpacificus* (Threatened)

The delta smelt is a slender-bodied planktivorous fish known to occur in the Sacramento-San Joaquin Delta. The delta smelt typically has a 1-year life span. Adults enter dead-end sloughs and channel edge-waters of the Delta to spawn between about February and June. Spawning occurs in fresh to slightly brackish open waters, and the adhesive, demersal eggs attach to hard substrates such as rocks, tree roots, gravel, and submerged branches and vegetation. Fecundity is low, usually ranging between 1,400 and 2,800 eggs per female. Adults typically die after spawning. Eggs hatch in 10 to 14 days, and the planktonic larvae and juveniles are transported downstream to the estuarine mixing zone that, depending on outflow, may be located from Suisun Bay to the confluence of the Sacramento and San Joaquin Rivers. Juveniles also feed on zooplankton.

Although the delta smelt was one of the most common fish in the Delta as recently as the 1970s, the species has undergone roughly a ten-fold decline in the past 10 years (from several million to several hundred thousand). In 1993, delta smelt was listed as threatened under the Federal Endangered Species Act. Factors believed to have contributed to the decline in its population are: (a) low Delta outflow, that relocates the mixing zone upstream, within the "zone of influence" of the Central Valley Project/State Water Project pumps, and reduces the geographic distribution of the smelt, (b) acute toxicity caused by influences of irrigation drain water, and (c) competition for food sources with recently introduced species such as the inland silverside and the Asiatic clam.

Prospect Island is in close proximity to a known spawning area for delta smelt; the Cache Slough Mitigation Area. Given this species' preference for shallow waters with good tidal action, the proposed project would likely confer a significant benefit to delta smelt by providing habitat for spawning and rearing of early life stages. We anticipate that smelt would benefit from habitat which is much better in water quality, food, and cover, than is currently provided by either the ship channel or Miner Slough. Some construction activities (e.g., levee breaching) could, depending on timing, have a one-time adverse effect on this species.

Sacramento splittail, *Pogonichthys macrolepidotus* (Proposed Threatened)

The Sacramento splittail is a large (up to 40 cm) minnow endemic to the California Central Valley. The species is now restricted to a small portion of its former range and is found primarily in the Sacramento River and Sacramento-San Joaquin Delta, Suisun Bay, Suisun Marsh, and Napa Marsh. The Sacramento splittail is easily distinguished from other minnow species by the enlarged upper lobe of its caudal fin. It is tolerant of brackish water conditions, and can be found in Suisun Bay, San Pablo Bay, and the Carquinez Straits following winter high-flow periods, when waters in these areas are relatively diluted. Sacramento splittail feed primarily upon benthic invertebrates. Spawning habitat requirements resemble those of delta smelt,

in that both species congregate for spawning in the dead end sloughs of the Delta. However, Sacramento splittail are known to spawn on flooded streambank vegetation or on beds of aquatic plants, exhibiting a preference for recently flooded terrestrial habitat. Spawning season seems to be associated with increasing water temperature and day length and occurs in late April and May in marsh habitats. In tidal freshwater habitats, spawning occurs by late January to early February and continues through July. Larvae remain in the shallow, weedy areas inshore in close proximity to the spawning sites and move into the deeper offshore habitat later in the summer. Sacramento splittail have disappeared from much of their native range because dams, diversions and agricultural development have eliminated or drastically altered much of the lowland habitat these fish once occupied.

The decline in Sacramento splittail abundance coincided with hydrologic changes to the Sacramento-San Joaquin Estuary. These changes include increases in water diversions during the spawning period of January through July, and dams that limit upstream migration. Diversions, entrainment due to Central Valley Project/State Water Project pumping, dams, and reduced outflow, coupled with years of severe drought, introduced aquatic species, and loss of wetlands and shallow-water habitat, appear to have reduced the capacity of the species to reverse its decline.

It is anticipated that any low-elevation riparian areas created by the restoration project would benefit this species by providing preferred spawning habitat. This species would also benefit from the general increase in area of productive shallow-water rearing habitat. Splittail year class strength is currently believed to be strongly related to the extent and duration of flooding of the Yolo Bypass, located primarily upstream of the project area. No adverse impacts to this species are anticipated from the proposed action.

Winter-run chinook salmon, ***Oncorhynchus tshawytscha*** **(Endangered)**

The winter-run chinook salmon is a unique race of chinook salmon that spawns in the Sacramento River, and is distinguishable from other chinook salmon runs based on the timing of its upstream migration and spawning season. Modification and loss of spawning and rearing habitat are thought to be major factors contributing to the decline of its population. The proportion of young fish which rear in the Delta versus the rivers has not been definitively established. However, the north Delta is believed to be an important rearing area in wetter years, as there is a positive correlation between juvenile abundance and flow into the Delta (USFWS 1987). Winter-run juveniles arrive in the Delta from September to May, with a peak between January and April. In contrast, fall-run salmon juveniles begin to arrive later, around January through March, with a February to March peak. For either race, high Sacramento River stages which necessitate use of the Yolo Bypass could transport juvenile salmon into the Prospect Island restoration site.

Only general observations are available regarding habitat quality for this species. In general, young salmon are found feeding in schools in salt marsh, mudflats and other intertidal areas. There is some evidence from studies of deeper channels that the juvenile salmon seek out riparian shaded areas as protection from predators or temperature stress; similar preferences may also apply to shallow-water areas. Cannon (1982) reviewed studies which showed higher juvenile growth rates in estuaries; this faster growth is considered beneficial because the salmon reach smolt size before the water temperature becomes too warm for survival.

The proposed project would increase the overall area of productive shallow water habitat in the Delta in association with palustrine shade cover which would moderate temperatures; we believe this habitat would benefit this species. The extent to which salmon would utilize the site for rearing would likely be limited by its indirect connection to the Sacramento River through

Miner Slough and the Yolo Bypass; during wetter years, there may be sufficient flows to carry significant numbers of young salmon into the project area. However, there is little specific information on the mixture of cover-types which would optimize habitat conditions.

Central Valley steelhead, *Oncorhynchus mykiss*, (Proposed Endangered)

Steelhead are an anadromous form of rainbow trout. Adults in the Central Valley populations exhibit what is known as the winter-run pattern, migrating during the rain and snowmelt season from December to June. They spawn in cool, small-graveled rivers, after which the adults may return to the ocean. The young rear for at least 1 year in freshwater (usually two years), before migrating to the ocean as smolts, where they mature after another 1 to 3 years.

In general, the effects of the proposed project on this species would be similar to those described above for winter-run salmon. Unlike winter-run salmon, which move towards the Delta as fry and juveniles, we suspect that most steelhead would not migrate until reaching smolt size, although some may be carried into the area by flood waters. The duration of smolt residence in the restoration site, and exposure to benefits (or adverse impacts), would be short relative to the overall rearing period.

The following terrestrial species may potentially occur on Prospect Island:

Valley elderberry longhorn beetle, *Desmocerus californicus dimorphus* (Threatened)

The valley elderberry longhorn beetle (VELB) is found only in association with its host plant, elderberry (*Sambucus* spp.), which the beetles requires to complete their life cycle. Larvae live in hollowed stems, and adults feed on elderberry foliage. Adults feed on the foliage and perhaps flowers, and are present from March through early June. The beetles mate in the spring, and the females lay eggs on living elderberry plants. After transforming into an adult within the plant, the beetle chews an exit hole and emerges from the elderberry. Elderberry shrubs/trees with VELB populations occur in a variety of habitats and plant communities, but most often in riparian or savannah areas. VELB or its habitat would likely be restricted to the thin band of riparian forest and scrub-shrub bordering the northern portion of the SRDWSC. Because no construction is planned for this area, and since there will be an overall gain in riparian habitats adjacent to existing areas, there would likely be no adverse impact of the proposed project on this species.

Giant garter snake, *Thamnophis gigas* (Threatened)

The giant garter snake inhabits sloughs, ponds, small lakes, low gradient streams and other waterways, such as irrigation and drainage canals. It feeds primarily on small fishes and frogs. Some of the habitat requisites for this snake consist of adequate water during the snake's active season (early spring through mid-fall) to provide food and cover, and emergent, herbaceous wetland vegetation such as cattails and bulrushes, for escape cover and foraging habitat during the active season. The giant garter snake inhabits small mammal burrows throughout its winter dormancy period (November to mid-March). The breeding season extends through March and April, and females give birth to live young from late July through early September. Clutch size is variable, ranging from 10 to 46 young. Urban expansion, flood control projects, and other human activities currently threaten the survival of this snake throughout its range. Because of cultivation practices, very little suitable habitat for this species currently exists in the project area. The uplands remaining after restoration would be a much smaller area than the agricultural or levee "uplands" that exist now, but would be of greater value to any giant garter snakes owing to a much lower level of disturbance.

Other federally-listed animal species on the Service's December 4, 1996 species list are not likely to occur in the project including: three vernal pool crustacian species, the delta green ground beetle, the California red-legged frog, and three birds (peregrine falcon, Aleutian Canada goose, and bald eagle). Of the special status plants, listed species are not present to our knowledge, however, Mason's lilaeopsis (*Lileaeopsis masonii*, formerly Category 2 status, or C2) has been reported along islands just to the south of Prospect Island (USFWS 1986).

Implementation of the restoration would restore tidal action only to those cover-types within the cultivated interior of the island. Moreover, additional area of interface between tidal marsh and riparian would be created with the project providing some potential habitat for these candidate plant species.

III. ALTERNATIVES

The Corps has developed a single, refined earthwork design for the project (Figure 4). This refined design was developed in response to the need to maintain a $5,000,000 total project cost. This design assumes that the levee breaches which occurred in early 1997 would be repaired and the site drained prior to construction. Elements include:

-Two *levee breaches*; one on the SRDWSC at the southern end of the project site and another on the Miner Slough levee, also at the southern end of the project site. The width of each breach would be about 100 feet, and set at -2 MWL.

-A 100-foot-wide *central channel*, to be excavated to an elevation of -7 feet MWL, connecting the planned breach in the SRDWSC to the northeast portion of Miner Slough. No breach is planned at the terminus of the central channel at this time, but may be added in the future.

-Several *secondary sloughs* would also be excavated; two through the "potential" emergent marsh west of the main channel as indicated in Fig. 4, and a third east of the main channel through the open water. The overall design balances cut and fill within the site.

-About 50 acres of earthwork additions (benches, islands) to the interior of the levees would be constructed, of which about 37 acres would be at riparian elevation (above +1 MWL).

-*islands* would have standard dimensions of 20 feet in width (at the +1 MWL contour), 5:1 sideslopes, and 30 feet sideslope width (of which 20 feet would be within the emergent marsh zone of -2.5 to +1 MWL). One peninsula would be built connecting with the north levee. Islands would be sited in a north-south orientation and positioned to minimize wind fetch build up.

-*benches* would be constructed on a portion of the interior side of the levees where none or insufficient such areas exist presently. These created benches would have standard dimensions, depending on location, of either 10 feet in width (at the +1 MWL contour) with 10:1 sideslopes, or 60 feet wide and 5:1 sideslopes.

-several *demonstration areas* of limited extent may be constructed on the windward sides of island and benches with non-standard, wider dimensions for bench and island width, and shallower sideslopes.

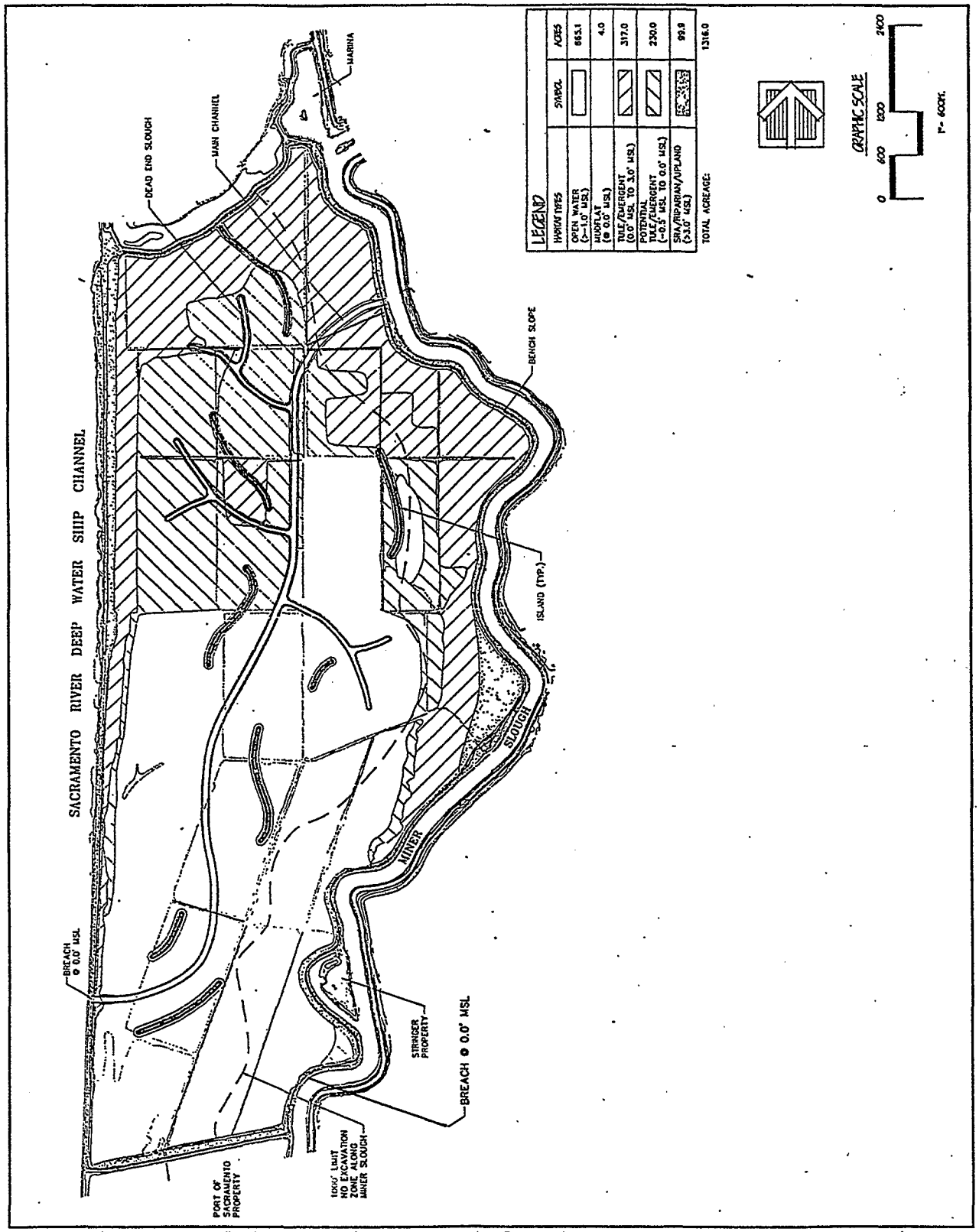

Figure 4. General layout of earthwork for the Prospect Island Restoration Project. Levee benches (not shown) will be 10 to 40 feet wide. Island positions and dimensions are subject to minor revisions.

-*plantings*, which would be done shortly after breaching, would be at the interface of the riparian/emergent marsh zone (-1 to +1 MWL), and consist of a row of emergent marsh species (e.g., *Carex*, *Scirpus*) and/or hydrophytic woody species like willow and cottonwood cuttings. Roughly 20,000 of 45,000 linear feet of combined bench, levee and island interfaces would be planted, focussing primarily on wind-exposed levee benches and island slopes.

-*hydroseeding* with native herbaceous species to minimize establishment by non-native weeds would be done on all created riparian areas and disturbed upland areas that are not planted.

This refined design represents a significant reduction in the project elements since our analysis of the previous selected design (USFWS 1995). The current design has 60% less riparian, and 40% less emergent marsh than in the Alt 1B (Table 2). The former dimensions of the islands and benches were at least several hundred feet in width, with elevations up to +4 feet MWL on some islands, compared to 20 feet in the current design. Maximum fetches in Alt 1B were about 1,200 feet, compared to about 2,500 feet with the current design. Alt 1B also had a different breach location on Miner Slough, near the northern end of the site.

Table 2. Approximate distribution of area within elevation ranges by target cover-type for the previous design (Alt 1B) and the current design for the Prospect Island Restoration Project.

Elevation (feet MWL)	Cover-type	Acres	
		Alt 1B	Current
Below -3	Open Water	479	665
-3 to -2	Mudflat	246	234
-2 to +1	Tidal Emerg Marsh	332	230
above +1	Riparian/Upland	259	100

IV. ANALYSIS OF THE REFINED DESIGN

A. Comparison with Recommended Design Criteria

A number of elements need to be considered in designing a successful habitat restoration project. The prior restorations of Donlan and Venice Cut Island using dredged material (Corps and USFWS 1990) provide a good starting point for developing such a project. However, the much larger size of Prospect Island, somewhat different location and tidal cycle, and experiences at the Corps' Cache Slough Mitigation Area, also need to be considered. In this section, we identify specific features which can be varied to optimize habitat values for fish and wildlife and provide the greatest stability (e.g., resistance from wave erosion), and compare these desired features with the latest alternative. Particular attention is given towards providing spawning and/or rearing habitat for federally-listed aquatic species. Preferred habitat features gleaned from the literature, including the Service's rulings on these species, are presented in Table 3.

The relation of these features to the life history of these species was discussed in the endangered species section of this report. It should be emphasized that there is considerable overlap in desired habitat features, both among these species, as well as among other desired fish and wildlife species. Thus, the general goal of the final project plan should be to

achieve a hydrologically and physically stable design which would restore habitat values for a maximum diversity and productivity of all fish and wildlife, rather than focus only on the listed species.

Table 3. Habitat features favored by fishes currently protected or proposed for protection by the Endangered Species Act.

Habitat Characteristic	Species
-shallow, productive tidal areas	delta smelt, splittail, winter-run salmon
-overhanging riparian cover	winter-run salmon
-subtidal spawning substrate (submerged vegetation, roots, tules)	delta smelt
-maximum tidal flushing	delta smelt, splittail
-absence of riprap	delta smelt, splittail, winter-run salmon
-seasonally flooded terrestrial areas	splittail
-shoal areas	delta smelt, splittail
-dead-end sloughs	delta smelt, splittail
-deeper waters	splittail (mature form)
-connection to Sacramento River	winter-run salmon

1. Levee Breaches

Previously, we reviewed factors that should be considered in siting and sizing the levee breaches (USFWS 1995), including differences between historic and created tidal areas. Since that time, the breach configuration of the preferred design has been altered. Here, we report the potential benefits and adverse impacts of the original and revised breach configurations. The original design had two breaches, one on the southern end of the SRDWSC side, and a second on the northern end of the Miner Slough side. The revised design has the same SRDWSC breach, but with a second breach on the southern end of the Miner Slough border.

Historically, natural Delta islands may have had less tidal influence as the riparian perimeter thickened, restricting outlet channels. Such natural islands probably did not support large expanses of open water (i.e., deeper than -3 feet MWL) in the interior, and probably had limited tidal action in much of the tule regions. However, greater tidal exchange has the advantages of: (a) increasing planktonic productivity of shallow waters, thus increasing forage for juvenile fishes and wildlife, (b) providing preferred habitat of delta smelt, (i.e., they are attracted to marginal vegetated shallow waters with a strong tidal influence), (c) augmenting tidal flows which are needed to move young juvenile salmon into the island, and young delta smelt and Sacramento splittail out of the island, and (d) eliminating "dead water" zones where water quality may deteriorate and/or predators may accumulate.

Salmon juveniles do not necessarily require strong tidal action to stimulate outmigration; this occurs naturally in association with the physiological changes during smolting. Therefore, muted tidal action for part of the area, rather than maximum tidal action, may be of benefit in that it might retain the salmon in an area of relatively high productivity, and provide habitat for other fish species which depend on deeper, less tidally-influenced areas.

In response to our September 1994 draft PAR (USFWS 1994), the National Marine Fisheries Service recommended an additional breach at the southern end of Miner Slough to provide further migration opportunity for fish passage and

forage in the area. Presently, the south central portion of the island has lower elevations (equivalent to -5 to -7 feet MWL) than the rest of the island which, if inundated, may experience less tidal circulation than shallower areas. While providing additional access to the site, a third breach (two on Miner Slough) could also potentially improve tidal exchange in this deeper water area. This breach would also direct some of the sediment load back into Miner Slough, where it could nourish the mudflats at the confluence area. If erosion were significant, there is the potential that sediments from the project area would resettle in the ship channel.

NMFS concurred with the downstream location of a single breach on the SRDWSC because water quality is assumed to be better at the southern end. We have not yet reviewed water quality data for this site which would demonstrate this aspect, although it seems intuitively correct. Another advantage of the southern location is that it would occur in a stretch of ship channel which has been extensively armored by large riprap and has no vegetation or habitat value of any kind. Such a breach would have no adverse habitat impact.

As stated above, the original design (Alt 1B) had one breach situated in the northern (upstream) end of Miner Slough. This location is desireable in that it should promote use of the site by juvenile salmon. Their entry into the site depends in part on potential tidal and riverine flow velocities between Miner Slough and the project site, which juvenile salmon would presumably follow during outmigration. Previously (USFWS 1995) we recommended that the Corps provide us with detailed information on differences in water levels in Miner Slough and the SRDWSC over the full range of tidal cycles to be experienced at the project (i.e., including different year-types). The Corps (1995) did make one measurement of a 0.9 foot difference in water level between the northern end of Miner Slough and three other potential breach locations at an unreported Sacramento River stage. If this elevation difference is typical, a positive riverine flow would occur between the breaches which in turn would direct outmigrating juveniles from Miner Slough into the restoration site. This breach configuration provides a route by which salmon which stray into the lower end of the SRDWSC could return to the Sacramento River. In addition, the close proximity of the breach to the emergent marsh area would provide the best circulation and access to that area by native species. Our preliminary studies at Cache Slough Mitigation Area had suggested that Delta smelt, for example, appear to congregate in marsh areas nearest such breaches.

Our review of Corps (1995) also revealed several actual and potential disadvantages of this north Miner Slough breach. First, it involved a substantial bridge construction (and maintenance) cost which would be done at the expense of earthwork features, and appeared to be necessary for non-interference with access to the Stringer property (Fig. 4). Additional earthwork cannot be done after breaching because depths would be insufficient for barges. Second, some of the Corps' (1995) hydraulic studies of alternatives similar but not identical to Alt 1B, suggest that the stage difference of Miner Slough would create a predominant riverine condition; with a bulk of the water entering through the upstream breach, and exiting downstream breaches. If this occurred, fish entering the site would also exit through the SRDWSC, and residence time could be lowered to the point that important tidal benefits (improved productivity, sediment trapping, etc.) might be impaired. Finally, it is possible that the depth and distance of the southeast portion of the site from the SRDWSC breach would have lower tidal velocities and, possibly, predator concentration within the site.

In consideration of these disadvantages, the refined design has the Miner Slough breach moved to the southern end of the site. This site maximizes tidal influence, while retaining some potential access to downstream-migrating salmonids which may be present in Miner Slough. Improved circulation is provided in the deepest waters of the site, and the tidal regime should induce

fish to exit both breaches. The breach location coincides with a natural breach which occurred in early 1997, that indicated this section of the levee may be prone to failure. A bridge element is unnecessary for this location and the cost savings can be used to improve earthwork and planting elements. Finally, the channel design is not changed, permitting subsequent addition of a third breach, if deemed necessary.

We recognize that there are tradeoffs involved with this design change. Most importantly, lower water velocities will occur in the shallow, emergent marsh region, which will produce lower (although not necessarily undesireable) localized tidal and riverine exchange than in the original design. The exchange which is expected to occur is between the shallow marsh and the deep open water, and may take several tidal cycles to exchange with new water from outside the site. The lower tidal velocities in the major marsh area may result in suboptimal use of the site by some fish species, although higher velocities near marsh habitat would be present in limited areas on islands and benches in the southern portion of the site.

2. Levee Maintenance

In the refined design, the constructed islands are as much as 2,500 feet from the edge of the levee. Based on a recent elevation survey conducted by the Corps, the northern two-thirds of the interior Miner Slough levee has sufficient elevation to eventually become established with emergent marsh, which would then provide protection of the Miner Slough levee from wave erosion. However, prior to establishment of vegetation, this levee may be subject to wind fetch erosion. While winds are especially strong and sustained during the summer, damage to the levees may also occur during the winter when water levels are high, as suggested by damage to this levee in 1997.

The Corps has proposed to raise elevations along the interior of the wind-exposed portions of Miner the Slough levee in the southern portion of the island in 10- or 60-foot-wide bands for some of the interface. Once the riparian vegetation becomes established, the trees would function as an adequate windbreak, and there would be no need to sustain the levee at its present elevation of +14 feet MWL. We previously recommended a more gradual, biotechnically-stabilized slope on the inboard side of the levee of no steeper than 20H(horizontal):1V(vertical), beginning at about +4.0 to +5.0 feet MWL, and extending 120-140 feet into the island. Due to cost limitations, the proposed slopes (5-10:1) and widths (10-60 feet) are somewhat less than that recommended.

It would be desireable to relax maintenance of the Miner Slough levee because the current height is above the preferred height of tidal riparian cover (about +0.5 to +3.0 MWL). The ideal plan would take about 20-25 years to realize full habitat potential. After grading, the lower slope would be planted in its entirety and irrigated with appropriate tidal riparian species such as willow and cottonwood. The trees would then be permitted to establish for 3 to 5 years prior to breaching of the levee. After breaching, the trees would be allowed to grow for a period of 10 to 15 years to create an adequate wind buffer, after which the Miner Slough levee would be reduced to about +4.0 feet MWL, the excavated material used to extend the bench, and the outboard side of the levee replaced by another biotechnical slope. The proposed plan has no pre-breach establishment period, plantings on limited portions of the wind-exposed interface, and no plans for alteration of the levee. However, this plan does preclude the possibility for future modification.

By letter of March 23, 1995 to the Service, the Corps stated that road access along the Miner Slough levee "...must be maintained." Because of the potential for enhancing riparian and SRA cover, to minimize disturbance of wildlife, and to minimize long-term maintenance costs the Service recommends

that this levee eventually be abandoned as an access route. This levee has experienced failure during 1997, which must be repaired prior to restoration of the site, at an estimated additional cost of $1,000,000. Over the long term, breaching of this levee is inevitable. While we do not believe this would compromise integrity of the Ryer Island levee through wind fetch, the cost to maintain it as a road may be prohibitive to the Service. Prior to transfer of the site to Service ownership and responsibility, options to levee repair and maintenance, such as acquisition or alternative means of access to private properties (i.e., by boat) should be negotiated with affected landowner(s).

3. Channel Depth

Major channels should be sized so that they will accommodate a reasonable degree of sedimentation and submerged vegetation and still sustain adequate tidal action. The ideal depth should be slightly deeper than any open water in the system. Open water areas would likely begin to occur at an elevation of about -3.0 feet MWL (Corps and USFWS 1990), so a channel depth of -4 feet MWL would be a minimum to account for filling due to sedimentation.

Nevertheless, deeper channels with a maximum depth of -6 to -8 feet MWL (or more) may be needed to allow for drainage, supply fill for islands, and/or achieve the desired tidal action. Minor channels, if included in the design, should be slightly shallower than the major channels to facilitate drainage, and provide depth diversity of channel waters. The depth of the major channels (-7 feet MWL) is consistent with these criteria.

4. Cover-type Elevations

In comparing the monitoring of vegetation on Venice Island (Corps and USFWS 1990) and several other planning reports by the Service and Corps regarding deepening of the SRDWSC, some variation in the recommended water depth for different cover-types may be noted, especially for the lowest (open water) and highest (riparian) elevation cover-types. If the mean water level of +2 feet MSL, high tide (+3.9 feet MSL) and low tide (+0.1 feet MSL) at Shag Slough are assumed to approximate conditions at Miner Slough and the SRDWSC, the following general criteria would be recommended for determining the target distribution of area with the 5 cover-types, including uplands:

	MWL (feet)	Criterion
Open Water	below -3.0	Below Mean Lower Low Water (MLLW)
Mudflat	-3.0 to -2.0	Between MLLW and Mean Low Water (MLW)
Tule	-2.0 to +1.0	Between MLW and slightly above MWL
Riparian	+1.0 to +4.0	Above tules, to Mean High Water (MHW)
Upland	above +4.0	Above MHW

It is important for the Corps to estimate, as accurately as possible, any consolidation of sediments which may diminish the initial elevations of the islands, as well as estimate any accretion or scouring of sediments which could occur in channels or mudflats. We also recommend that the elevations of existing stable cover-types be surveyed as near as possible to the project area in order to confirm these recommended elevations. Based on aerial photography provided by the Corps, potential areas for this groundtruthing exist to the south of Prospect Island at the confluence of Miner Slough and the SRDWSC, and to the north of Prospect Island at the southern end of Little Holland Tract. Remnant tidal emergent marsh along the SRDWSC could also be surveyed adjacent to Prospect Island.

The variation in habitat complexity is not only important in providing for a higher diversity of wildlife, but also takes into account uncertainties regarding the extent of sediment compaction, erosion, or deposition which could affect the elevations of the planned restoration, and hence the target

cover-types. Therefore, the distribution of elevations should include the full range of elevations from the deepest (i.e., -8 to -10 feet MWL) channels which can maintain good tidal action to slightly above the upper limit of tidal riparian islands (i.e., about +4.0 feet MWL). These higher elevations exist presently on the interior levee slopes.

The maximum and minimum depths should be viewed as flexible. To optimize habitat for delta smelt, a water depth of -3 to -9 feet MWL is considered best. Excessive depths may result in areas of inadequate tidal action and/or a lack of submerged vegetation. However, deeper open waters may be more desireable near the levee breaches than within the interior of the site. Elevations slightly higher than the +4.0 MWL upper limit of tidal action may be managed to sustain riparian growth, for example, by using pole cuttings and/or irrigation methods to promote deeper root growth. Riparian areas with slightly higher initial design elevations may be needed in certain areas to allow for any decrease in earthwork elevation after flooding due to sediment consolidation. If maintenance were relaxed, the higher elevations of levees could also possibly support riparian vegetation, using pole cuttings.

5. Cover-type Composition

The cover-type mixture ideal to native fish and wildlife would provide all of the four major cover-types, but with an emphasis on providing habitat which would benefit listed aquatic species. In its pristine condition, the Delta was a hydrologically contiguous tidal marshland of about 400,000 acres, surrounded by 200,000 to 300,000 acres of slightly higher lands and shallow backswamps behind natural alluvial levees (SFEP 1991). Flooding of the backswamps, as was Prospect Island, occurred annually due to a combination of tides and spring runoff from the Sacramento and San Joaquin rivers.

Natural Delta islands, including those in the vicinity of Prospect Island, were almost certainly dominated by tule marsh, with lesser but significant proportions of scrub-shrub and riparian vegetation on the island borders and dead-end sloughs. Open water was likely limited to the deeper portions of major sloughs and waterways, comprising a very small proportion of the island interiors in the form of dead-end sloughs.

These historic wetland islands were completely diked by the turn of the century, leaving no natural "model" system on which to develop a cover-type mixture. In nearby Prospect Slough, island and border riparian cover comprises a small proportion, perhaps 20 percent, of the total area. Schematics of a mitigation plan using the southern tip of Prospect Island were developed in planning for deepening the SRDWSC, illustrating a target mixture of about 20% open water and 10% mudflat, 30% tule marsh, 35% riparian, and no upland (USFWS 1986). The remnant tidal area at the confluence, owned by CDFG, has about 50% open water, 10% mudflat, 15% riparian, and no uplands. Specific to the restoration of tidal action to Prospect Island, we recommend a target mixture about 30% open water, 15% mudflat, 30% emergent marsh, 25% riparian and no upland. While providing a good mixture of aquatic habitat types needed for fishes, this composition would also provide high habitat values to a large diversity of wildlife species. These proportions are based on our knowledge of the historical condition of the site, the existing conditions on nearby sloughs, and discussion with Corps planners, CDFG, and Service refuge staff.

Based on our assumed cover-type elevation ranges, the calculated distribution of cover-types for the Corps' previous and current alternative are:

	Percent of area		
	Recommended	Alt 1B	Current*
Open Water	30	37	50
Mudflat	15	19	18
Emergent Marsh	30	24	24
Riparian	25	16	5
Upland	0	4	3

(*-assumes "conservative" scenario; see Appendix A for details)

This comparison shows a progression towards increasingly less riparian vegetation and more open water than we would consider ideal. We estimate that about 95% of the riparian for the current alternative is associated with the perimeter levee, with the remainder as relatively thin strips distributed among the narrow islands.

The current design retains a small component of upland on the levee slopes, a cover-type recognized for several habitat functions. Some species of snakes and turtles require an upland component, either for nesting or for burrowing during their winter dormancy period. Uplands could provide so-called "loafing" habitat; generally considered any unvegetated dry ground adjacent to waters where birds preen, sleep, escape wind/wave action, conserve energy, or absorb radiant energy. Such areas are often included as small islands within managed wetlands (Mensik 1993). To retain their function, these loafing islands typically require special construction and orientation to the wind, and regular maintenance using burning. Loafing habitat can also be provided by mowing short stretches along roadways, although these areas are less likely to be free of disturbance.

For several reasons, the Service had earlier (USFWS 1995) recommended against upland creation except where needed for maintaining structural stability of the perimeter levee. First, upland creation or compensation is secondary to the goal of restoring natural, relatively maintenance free tidal wetland. Secondly, upland creation requires at least 2.5 feet of additional fill needed above the minimum riparian elevation, and 5.5 more feet of fill above the minimum emergent marsh elevation. This adds cost to the project which would result in a reduction in area of riparian and/or emergent marsh creation. Third, the uplands would not retain a loafing function without regular maintenanance. In the absence of maintenance, the uplands would probably convert to low shrubs. Such areas would be of low value as loafing areas, and provide less of a windbreak owing to the lower height of shrubs. Finally, the existing perimeter levee, and contiguous lands to the north, currently provide adequate upland area for the aforementioned habitat functions. The current design is consistent with our recommendations.

Placement of cover will have some influence over wildlife use. Although riparian perimeter provides a good windbreak, more use would be expected in areas farthest from any disturbance (i.e., center of the site). A riparian border should be designed to surround as much of the project area as possible. Such a feature would provide additional wind protection to the levee structures and takes advantage of the slope provided by the existing levees. Also, a riparian border provides "sanctuary value" to some wildlife species, by limiting access and disturbance from human activity.

6. Interspersion

Interspersion refers generally to the degree of homogeneity of vegetation types with respect to the overall layout. Islands should generally have at least two cover-types, with relatively large unit sizes (we recommend a minimum dimension not less than 300 feet of any one cover-type) to allow for

gradual slope transitions, and immediate access of wildlife to several cover-types on one island. The current design has reduced interspersion compared to Alt 1B due to the reduction of island dimensions and overall riparian area, and elimination of island embayments. It is understood that this was a result of cost beyond the limits of the Corps' Section 1135 program.

7. Complexity

In addition to interspersion, the complexity of project can be modified in a number of ways to enhance aquatic and/or terrestrial habitat values. The boundary between cover-types, or "edge" habitat, provides both shelter and forage for some species of juvenile fish. The amount of this "edge" can be increased by varying the sinuosity of channels, providing a number of small islands, convoluting the borders of planned islands, and excavating smaller, shallower channels into the interior of marsh or riparian areas. Smaller channels could be constructed to function as mudflat at low tide. These smaller channels need not necessarily be constructed initially. It may be better to add smaller channels after initial revegetation has established, so as to minimize siltation, and improve circulation. Alt 1B did not include side channels.

Island shape and depth could be altered to take into account any established limits in the amount of fill available, such as by creating (a) "donut" or "horseshoe" shapes, with central ponds or bays, (b) ribbon-shaped islands (oriented approximately parallel to the Miner Slough levee to maximize windbreak), or (c) "submerged" islands, below the vegetation zone, but shallow enough to promote full tidal action. Ponds within the islands would experience muted tidal action, but could provide some habitat values similar to mudflats and seasonal wetlands. Again, cost limitations on earthwork have virtually eliminated any such features from the design.

Dead-end sloughs (i.e., blind, open-water channels which penetrated the interior of Delta islands) are known to be utilized by Delta smelt and other fishes as a preferred spawning habitat. We note that six such sloughs are included in the current design, as branches of the main channel, and that the main channel also acts as a slough since the east breach has been relocated to the south end of the levee.

8. Planting

Planting should be considered as one way to stabilize island borders, which would otherwise be subject to erosion by wind or tidal action. Such erosion could be a significant problem with either alternative because of long fetches between the islands and the Miner Slough levee. The Corps intends to conduct planting following breaching, and to perform planting on less than half of the interface areas, focussing on select areas most prone to wind fetch erosion.

While we appreciate the need to minimize costs, we advise against this plan. Based on our observations at the Cache Slough Mitigation Area, we believe it creates an elevated risk of erosion of the interior of the Miner Slough and south Port-owned levees, and loss of initial plantings. Fetches at Cache Slough Mitigation Area were no more than 2,000 feet, yet extensive erosion of the interior of the Shag Slough levee occurred. Rather, we recommend a phased restoration consisting of earthwork, planting, and a period of vegetation establishment prior to levee breaching. Following earthwork, limited plantings of willow cuttings or other appropriate species in a 5- to 10-foot-wide band should be done at the emergent marsh-riparian interface of the levee and island perimeters. At a minimum, all wind-exposed interfaces should be planted. For one or two years prior to breaching the levees, the existing irrigation system could be used to permit shallow, stable flooding of the island. This would promote establishment of the cuttings, consolidate the island borders, and allow for initial establishment of the emergent plants.

Finally, the levees would be breached. Planting of riparian areas, prior to deep flooding, would also have the added benefit of minimizing invasion by unwanted species, such as giant reed.

9. Access

Habitat values, particularly for wildlife, could potentially be diminished if there is significant human disturbance. Human-related activities may include hunting, water-skiing, fishing, camping, and birdwatching. At this point, the Service has not formulated a position on the extent of human use which would be compatible with the restoration purpose of the site. Some activities, such as the use of high-speed powerboats during water-skiing, would certainly create a greater disturbance than would be compatible with wildlife use and could result in erosion of levee and island borders. Other use of motorcraft for fishing or transit would impart a lower, but still significant disturbance to wildlife in the area. The current plan does not address the access issue.

Alternatives described in our September 1994 PAR included various features to limit access of powerboats, through the use of poles or tree stumps in the inlets, or through the use of culverts. The Service does not object to restricted access, however, with relaxed maintenance of the SRDWSC levee and the formation of additional natural breaches, it may become increasingly more difficult to design such restrictions. Also, physical restrictions may be a site of debris accumulation which, in turn, could limit tidal action. Some physical restrictions, including culverts, are likely to be avoided by fishes. One potentially compatible physical restriction would be to connect a series of logs or floats with cables and anchors to span the breach. This would enable some debris to pass under the restriction, but prevent vessel access. Debris accumulations would be managed by manually uncoupling the strucure when necessary.

To discourage powerboat use by water skiers, we had recommended that long stretches of straight, deep, channel be avoided in the design. We note that the relocation of the east breach in the current design brings the breach to an area farther from Arrowhead Harbor at the north, but raises the spector of boats taking a shortcut between SRDWSC and Miner Slough since the breaches are about across from each other. Some minor re-orientation of the islands may be possible to provide a visual obstruction to this route. Physical restrictions, if necessary, should be of a type which is not an impediment to tidal action or fish access.

The method proposed by the Corps (1995) would be to post underwater hazard signs, as has been attempted at the Cache Slough Mitigation Area. In view of the close proximity of Prospect Island to Arrowhead Harbor, and the large size of the project site, a physical barrier is recommended, preferably at both breaches, but at least at the Miner Slough breach.

10. Fill

The Corps had indicated in revised design information dated January 6, 1997 that no fill would be required from outside the project area for construction. A potential source of fill material, if additional monies for earthwork become available, is part of the 304-acre portion Prospect Island immediately south of the project area, owned by the Port of Sacramento ("potential borrow site" or PBS). Of this, 241 acres is a designated dredge disposal area ("S-12"), with a capacity of about 1.4 million cubic yards. Various plans for using the site as a mitigation area for the deepening of the SRDWSC have been developed and analyzed, ranging from 63 to 304 acres, of which at least 182 acres is currently committed to mitigation pursuant to the Corps' modified plan (Corps 1988).

A Service representative visited the PBS in November, 1994. At that time, the filled area is dominated by grasses and forbs, much of which appears to be at or above MWL. Thickets of willows are evident along both sides of the Miner Slough levee where it borders the PBS, and on the southern levee; woody vegetation was absent on the SRDWSC side. Woody vegetation is also very sparse in the filled portion of the interior, consisting of not more than a few dozen young willows and cottonwood saplings. A few acres of permanent wetlands are associated with seepage water around several short ditches at the southern end of the site. Considerations in the use of fill in tidal restoration are: (a) habitat value losses at the source site, (b) contaminant levels in the dredged material, (c) suitability of soils for emergent or submerged vegetation, and (d) how moving the fill affects the potential for restoring the PBS to tidal action, and its use as a mitigation site for the SRDWSC deepening project.

Because the project design balances cut and fill within the site, detailed information has not been developed for this site. Recent failure of the south levee, however, raises a possibility that the PBS might be restored concurrent with the planned 1316 acres of the restoration site, in advance of deepening of the SRDWSC. If this were the case, some excavation may be desireable to maximize habitat benefits, and this fill could be used to further improve earthwork at the adjacent Prospect Island restoration site.

B. Acreage and Habitat Value

A comparison of acreage and habitat impacts of the project is provided below for two potential future scenarios: "conservative" - represented by fut-A, and "optimistic" - represented by fut-B (Table 4; *see* Appendix A for detailed assumptions and calculations). With the exception of the riparian cover-types (riparian forest, riparian scrub-shrub, and SRA cover), the HEP assumptions resulted in Habitat Suitability Indices (HSIs) which were optimized early in the period of analysis after restoration of the island. As a consequence, the habitat value changes greatly reflect changes in cover-type area. For the riparian cover-type, which would constitute between 48.4 and 84.6 of the 1,316 acres beyond target year 6, our analysis predicts a net gain of in-kind acreage and habitat value with the project. All acreage and habitat value of the agricultural cover-type (1,116.8 of 1,316 acres), and the less abundant non-tidal wetland cover-types (shallow flood cover, non-tidal emergent marsh, and non-tidal open water) would be replaced out-of-kind, by the target cover-type mixture of tidal open water, tidal emergent marsh, mudflat, and additional riparian cover-types.

Primarily due to baseline management assumptions, the HSIs are generally lower for the agriculture and non-tidal wetland cover-types than for the tidal wetland cover-types which would replace them under either with-project alternative (*see* Appendix A for details). To simplify the representation of benefits, we aggregated cover-types into "low" and "high" importance groups based on overall diversity and productivity of plant and animal species expected for the cover-types, then performed comparisons with- and without-project for both future scenarios. For each scenario, the maximum possible losses for a cover-type (where more than one species was applied), was compared with the minimum expected gains due to restoration (Table 5).

Relative to the baseline condition, these changes are highly significant. Existing high-value cover-types produce about 45 AAHUs, most of which is shallow flood cover (*see* Appendix A, "Form D" results). The future scenarios predict about a 4-fold increase in high importance cover-type values over the baseline (net gain of 161 to 199 AAHUs), all derived from high importance cover-types such as riparian and tidal emergent marsh cover (Table 5). The 126 to 215 AAHU increase in low importance cover-type value represents a 38 to 59% increase over the baseline condition.

Table 4. Summary of changes in habitat area (acres) and value (Average Annualized Habitat Units, or AAHUs) by cover-type for the Prospect Island Restoration Project (*see* Appendix A for definitions of fut-A and -B scenarios.

Cover-type	Model	Acres no project	Acres, net change for:		AAHUs, net change for:	
			fut-A	fut-B	fut-A	fut-B
agriculture	redwinged blackbird	1116.8	-1116.8	-1116.8	0	0
	ring-necked pheasant				-335.04	-335.04
	red-tailed hawk				-44.67	-44.67
	striped skunk				-199.05	-199.05
upland	western meadowlark	39.8	-15.1	-27.1	-8.30	-15.89
	California vole				-12.34	-18.23
	ring-necked pheasant				-2.05	-8.13
all riparian	rufous-sided towhee	15.2	+33.5	+69.8	+23.59	+48.26
	striped skunk				+30.03	+99.38
all SRA cover	SRA cover-type	7.4	0.0	0.0	0.0	0.0
SPA cover	SRA cover-type	0.0	+16.4	+16.4	+10.45	+11.27
shallow flood cover	wintering mallard	120.0	-120.0	-120.0	-30.89	-30.89
non-tidal emergent marsh	egret guild	2.7	-2.7	-2.7	-0.24	-0.24
non-tidal open water	egret guild	0.7	-0.7	-0.7	-0.001	-0.001
tidal open water	inland silverside	0	+665.0	+665.0	+368.03	+434.86
tidal emergent marsh (deep + shallow)	marsh wren	0	+300.6	+300.6	+157.96	+170.59
	egret guild	0			+173.64	+275.15
mudflat	wintering shorebird guild	0	+234.0	+54.0	+194.53	+44.89
bare ground	--------	20.8	-10.0	-17.8	--------	--------

Table 5. Aggregate comparisons of (a) low importance cover-types with (tidal open water-TOW, mudflat-MF, upland-UP) and without restoration (agriculture-AG, upland, non-tidal open water-NTOW) and (b) high importance cover-types with (riparian-RIP, tidal emergent marsh-TEM, shaded palustrine aquatic-SPA) and without restoration (riparian, shallow flood cover-SFC, non-tidal emergent marsh-NTEM) of Prospect Island.

Sum of net changes in importance group:	max loss, scenario:		min gain, scenario:	
	fut-A	fut-B	fut-A	fut-B
"low": AG, UP, MF, NTOW, TOW	-348.47	-354.27	+562.56	+479.75
"high": RIP, NTEM, TEM, SFC, SPA	-31.13	-31.13	+192.00	+230.12

These comparisons show that the net gain in AAHUs for high-importance cover-types is about 20% greater for fut-B compared to fut-A, while the net gain in AAHUs for low-importance cover-types is about 20% greater for fut-A compared to fut-B (Table 4). This increase in high-importance cover-type value in fut-A is almost completely due to the doubling to tripling of riparian cover-type values with this scenario (*see* Appendix A, "Form D" results). On the other hand, the increase in low-importance value in fut-B is due to relatively high future HSIs for mudflat, which has a greater area for this scenario.

We emphasize that this HEP analysis only gives an approximate indication of the general magnitude of benefits of the restoration, and should not be used exclusively for comparison of the alternatives. The models selected were developed for general application and as such, do not include parameters which account for important differences in complexity, island form and distribution, the secondary channels and embayments, and cover-type distribution. Moreover, HEP does not take into account the regional distribution of cover-types, nor the relation of the restored cover-types to the historic condition.

C. Future Without the Project

We assumed for both quantitative and qualitative descriptions of without-project conditions that the project site would continue to be farmed, with a moderate frequency of levee overtopping and/or breaching during wetter years that necessitate operation of the Yolo Bypass. The continued intensive agriculture would provide wildlife values to waterfowl and wading birds during the fallow winter season when shallow flooding occurs. Continued maintenance of the levees will limit SRA values to no more than is present currently. It is possible that reinforcement of the levees through reconstruction, additional riprap, and/or more frequent maintenance, could reduce SRA values below current levels. Availability of tidal marsh habitat to both fish and wildlife would remain at present levels, with the best developed habitat immediately to the south of the restoration site. Fish using the temporary shallow water habitat created by levee failure/overtopping would be subject to loss during levee repair and through unscreened pumps used to drain the site.

D. Future With the Project

Immediately following construction of the project, a significant area of mudflat will form in about a third of the site (designated in Figure 4 as "tule/emergent"). During this initial period, use by waterfowl will be lower per unit area of available shallow habitat, due to the absence of residual grain forage, but wading birds should be abundant. Over a period of 20 years, this marsh plain will become gradually covered by emergent species, and the islands vegetated by hydrophytic riparian species. Use by wading birds, songbirds, and to a lesser extent, waterfowl, should increase as the vegetation becomes denser. Suitably dense emergent marsh will be used as

foraging and nesting by birds like rails and marsh wrens, and by mammals like muskrat and beaver. This tidal marsh habitat will remain constant, being largely unaffected by use of the Yolo Bypass or Sacramento River stage.

The deeper portion or the site will receive a lower degree of use by wildlife, and probably will harbor different species. Coots and diving ducks may seasonally use this area, which should have a resident population of forage fish likely dominated by the non-native inland silverside.

Fish abundance and use of the site should begin immediately after construction, and be enhanced as the vegetation develops. Species will be similar to those observed at the Cache Slough Mitigation Area, with silversides, gobies, shad, hitch, squawfish, sculpin, delta smelt, tule perch and others. Striper will probably congregate near the levee breaches, and fishing activity is likely to increase.

The presence of special-status species will vary seasonally and between years. During operation of the Yolo Bypass, we expect delta smelt to use the site for spawning and early life stage rearing. The positive relationship of splittail year-class strength to flooding of this bypass (Ted Sommer, DWR, 1997 Interagency Ecological Program Conference) suggests that splittail spawn predominantly on newly flooded lands within the bypass, upstream of the restoration site. As bypass floodwaters recede, larval splittail should seek out shallow emergent marsh areas such as provided by the proposed restoration project, where they would experience better growth and survival. Some juvenile salmonids (salmon and steelhead) could also be present in the site during wet years; during dry years, they would probably be absent not only due to absence of conveyence through the floodway, but also because most rearing would occur in the rivers rather than the Delta region.

V. DISCUSSION

A. Mitigation Policy

The recommendations herein for mitigation and the protection of fish and wildlife resources conform with the Service's Mitigation Policy as published in the Federal Register (46:15 January 23, 1981). The Mitigation Policy provides Service personnel with guidance in making recommendations to protect, conserve, and enhance fish and wildlife resources. The policy helps ensure consistent and effective Service recommendations, while allowing agencies and developers to anticipate Service actions and plan early for mitigation needs.

Under the Mitigation Policy, resources are assigned to one of four distinct Resource Categories, each having a mitigation planning goal which is consistent with the fish and wildlife habitat values involved. The Resource Categories cover a range of habitat values from those considered to be unique and irreplaceable to those believed to be much more common and of relatively lesser value to fish and wildlife.

In applying the Mitigation Policy during a habitat impact assessment, each specific habitat or cover-type which may be impacted by the project is identified. Evaluation species which utilize each habitat or cover-type are then selected for Resource Category determination. Selection of evaluation species can be based on several rationales, including: (a) species known to be sensitive to specific land and water use actions, (b) species that play a key role in nutrient cycling or energy flow, (c) species that utilize a common environmental resource, or (d) species that are associated with important resource problems, such as anadromous fish and migratory birds, as designated by the Director or Regional Directors of the Service. Evaluation species used for Resource Category determinations may or may not be the same evaluation elements used in an application of the Service's HEP, if one is conducted.

Finally, based on the relative importance of each specific habitat to its selected evaluation species, and the habitat's relative abundance, the appropriate Resource Category and associated mitigation planning goal are determined.

Mitigation goals range from "no loss of existing habitat value" (Resource Category 1) to "minimize loss of habitat value" (Resource Category 4). The goal for Resource Category 2 is "no net loss of in-kind habitat value"; to achieve this goal, any unavoidable losses of habitat value would need to be replaced in-kind. As defined in the Mitigation Policy, "in-kind replacement" means providing or managing substitute resources to replace the habitat value of the resources lost, where such substitute resources are physically and biologically the same as, or closely approximate, those lost.

In addition to mitigation goals based on habitat values, as defined according to Resource Categories in the Mitigation Policy, Region 1 of the Service has a goal of "no net loss of wetlands *acreage* or habitat *values*, whichever is greater." The Service applies this goal for all proposed Federal and non-Federal water development or flood control activities in California that may affect wetlands habitats.

In recommending mitigation for adverse impacts to any of these habitats, the Service uses the same sequential mitigation steps recommended in the Council on Environmental Quality's regulations. These mitigation steps (in order of preference) are: avoidance, minimizing, rectification measures, measures to reduce or eliminate impacts over time, and compensation measures.

Exclusions to the Mitigation Policy are that it does not apply to: (a) threatened and endangered species, (b) projects permitted or licensed prior to Service authorities, or (c) Service recommendations related to enhancement of fish and wildlife resources. The Policy also allows some latitude in Service guidelines for meeting the goal of in-kind replacement of habitat value as prescribed by the Resource Category 2 determination. Specifically, *exceptions* to this goal may be recommended when either (a) different habitats and species available for replacement are determined to be of greater value than those lost, or (b) in-kind replacement is not physically or biologically attainable in the ecoregion.

B. Cover-types and Mitigation Goals

The project area has nine existing cover types: riparian forest; riparian Scrub-shrub; upland/herbaceous; non-tidal freshwater emergent marsh; non-tidal open-water (ditches, drains, and canals); Shaded Riverine Aquatic cover (SRA cover); agriculture; shallow flood cover and bare ground (Table 1). Additional cover-types which would be created by the restoration, but are not present currently within the site are tidal freshwater emergent marsh; tidal open water; Shaded Palustrine Aquatic cover (SPA cover); and mudflat.

Riparian Forest consists of woody vegetation predominantly of trees greater than 20 feet tall, and is present along the northern third of the site border with the SRDWSC. Typical species of this cover-type are cottonwood, various willow species, Oregon ash, black walnut, box elder, and alder. Understory species include shrubs such as poison oak, young willows, buttonbush, elderberry, blackberry, and others. The once widely-distributed riparian forests in the Delta have been reduced to remnants, comprising only about 9,788 of 744,586 acres (SFEP 1991). Riparian forests provide nesting, resting, and/or foraging values for numerous passerine birds, raptors, and small mammals, a number of which could serve as suitable evaluation species. By virtue of its regional scarcity and importance to wildlife, we have designated riparian forest as Resource Category 2 (i.e., no net loss of in-kind habitat value).

The extent of riparian scrub-shrub cover-type has also been severely reduced due to reclamation and agricultural practices. This cover-type consists of woody vegetation less than 20 feet tall. Within the project area, this cover-type exists in limited patches along parts of the SRDWSC and Miner Slough levees, and in very limited sections of the irrigation ditches which have not been recently subjected to periodic maintenance. Migratory songbirds were selected to represent the values of this cover-type, because of the importance of such habitat as a source of food, water, and cover for songbirds, and the abundant occurrence of songbirds where scrub-shrub is present. Because of the scarcity of scrub-shrub habitat in the project area, we have designated it as Resource Category 2 (i.e., no net loss of in-kind habitat value).

Shaded Riverine Aquatic (SRA) cover is the unique, nearshore aquatic zone which occurs along the edge of streams or river channels, including tidal channels, where the adjacent riverbank is composed of natural substrate, and supports riparian vegetation which overhangs or protrudes into the water. Such areas are very important as a source of cover and forage for many of the Delta's fish and wildlife species. SRA cover has three primary habitat characteristics (Fris and Dehaven 1992): overhanging vegetation, in-water cover, and natural, often eroding banks. Vegetated areas both outboard of the Miner Slough levee and along the SRDWSC exhibit these features. These attributes provide refuge from predators, moderation of water temperature stress, food, rearing areas and/or spawning substrates for a variety of fishes (including the listed winter-run salmon), as well as perches, resting, and nesting areas for many bird species. Appropriate evaluation species could include juvenile salmonids, and waterbirds such as herons and kingfishers. Reclamation of the Delta islands, as well as numerous flood control structures within the Sacramento River system, have involved the placement of riprap to reinforce levees, greatly limiting the extent and value of existing SRA cover. We place SRA cover in the project area in Resource Category 1, with goals of no loss of existing habitat value, acreage, and riverside length.

Shaded Palustrine Aquatic (SPA) is a nearshore aquatic zone which occurs along the interfaces of riparian areas with water bodies that are not streams or river channels, including such zones inboard of the levees of the proposed project site. Such areas retain some but not all of the attributes of SRA cover. Both in-water and over-water cover occur in SPA, however, eroding bank cover with attendant exposed roots and undercuts are unlikely to be present by virtue of the lower water velocity that typifies such areas and the gradual slopes engineered in restoration projects to minimize such erosion. These slopes also mute some benefits, such as temperature moderation, and become exposed at low tide. Palustrine areas are not along the primary migration route of salmonid fishes, but do offer highly significant benefits to waterfowl and shorebirds, and to resident native fishes. Evaluation species would include birds like herons and egrets, and native fishes such as tule perch. SPA cover is appropriately placed in Resource Category 2 (i.e., no net loss of in-kind habitat value). The Service's regional goal regarding wetlands mitigation (i.e., no net loss of acreage or habitat value, whichever is greater) applies to all riparian cover-types, including SRA, SPA, forest, and scrub-shrub components.

Non-tidal Open Water (ditches, drains, and canals) generally lack both emergent and submerged aquatic vegetation in the project area, however, it may still be used by waterfowl during the migration period, and to a small extent by wading birds at other times of the year. Waterfowl are selected as an evaluation species for this habitat. At the project site, disturbances through vegetation removal, farm machinery operation, and variations in water supply reduce the value of this habitat. This cover-type does not provide significant fishery values. Though not extensive in terms of acreage, such waters are a common and typical feature throughout the farmed areas of the Delta. Because of its modest value to wildlife, non-tidal open water in the project area is designated as Resource Category 3 (i.e., no loss of habitat

value while minimizing loss of in-kind habitat value). Nevertheless, the Service's regional goal regarding wetlands mitigation (i.e., no net loss of acreage or habitat value, whichever is greater) applies to this cover-type.

Non-tidal Freshwater Emergent Marsh in the project area is confined to very limited areas near the pump station and intake siphon, and along irrigation channels which receive the most consistent water supply. The same maintenance activities, disturbance regime, and evaluation species just described for non-tidal open water would also apply to non-tidal freshwater emergent marsh. However, the presence of vegetation is likely to increase its value as forage and cover for waterbirds. Because of this greater value to wildlife, non-tidal freshwater emergent marsh is designated as Resource Category 2 (i.e., no net loss of in-kind habitat value). The Service's regional goal regarding wetlands mitigation (i.e., no net loss of acreage or habitat value, whichever is greater) also applies to this cover-type.

Upland/herbaceous cover is typified by plants such as grasses, sedges, forbs, and other weeds. It is present on the levee slopes, road shoulders, and uncultivated strips next to the many irrigation ditches throughout the project area. Appropriate evaluation species would be upland gamebirds such as pheasant and quail. Although less common than agriculture, upland vegetation is widely distributed throughout the Delta and Central Valley as a whole, and regenerates within one to three years following disturbance. Thus, the upland/herbaceous cover-type is designated as Resource Category 4 ("minimize loss of habitat value").

Agriculture dominates the landscape of much of the Delta, including Prospect Island, and is characterized by intensive row cropping practices. Such areas are utilized by upland game birds, songbirds, blackbirds, and raptors during the growing season, but are common and of low to medium habitat value to evaluation species such as blackbirds. This cover-type is appropriately designated as Resource Category 3 ("no net loss of habitat value while minimizing loss of in-kind habitat value").

The part of the cultivated area, which becomes inundated during the winter and spring rains, forms the **shallow flood cover**. Such areas provide temporary, but relatively high value wetland-like habitat for wintering waterfowl such as geese and dabbling ducks, which were selected as evaluation species. With increased upstream storage and improved drainage operations, such areas have progressively been reduced within the Central Valley. Because of the seasonal importance of this cover-type, we designate it as Resource Category 2 (i.e., no net loss of in-kind habitat value). The Service's regional goal regarding wetlands mitigation (i.e., no net loss of acreage or habitat value, whichever is greater) also applies to this cover-type.

Mudflat cover is characterized as an area having occasional tules or other emergents totalling not more than 30 percent cover. Epipelic algae are the principal source of mudflat productivity. Although some mudflats are present to just south of Prospect Island, such areas are not common in the project vicinity, and are primarily located in the western Delta. Under a tidal regime, mudflat usually occurs when the low tide falls below the zone for emergent vegetation. Mudflat can also be created in non-tidal areas, such as along the margins of ponds or rivers subject to a seasonal cycle of flooding and drawdown. Resident and migratory water birds which forage on mudflat, such as gulls and terns, would be appropriate evaluation species. Because of its regional scarcity and importance to fish and wildlife, mudflat is designated as Resource Category 2 (i.e., no net loss of in-kind habitat value). The Service's regional goal regarding wetlands mitigation (i.e., no net loss of acreage or habitat value, whichever is greater) also applies to this cover-type.

Tidal Freshwater Marsh occurs in the shallow areas between -2.0 feet MWL to about MHW. This cover-type dominated the pristine landscape of the Delta, especially island interiors, but has been dramatically reduced through reclamation and agriculture to a mere 8,223 acres (SFEP 1991). Comprised of plants such as California tule and common reed grass, tidal freshwater marsh persists on dredge spoil islands near ship channels (including the SRDWSC), within natural meander deposits, and along the margins of larger islands and the base of levees where sufficient silt has accumulated. Such areas are especially productive, and are important forage areas for smaller native fishes, and juvenile gamefish such as striped bass and chinook salmon. Evaluation species selected for tidal freshwater marsh would include those which favor this habitat, such as egrets, herons, rails and marsh wren. Because of its regional scarcity and importance to fish and wildlife, tidal freshwater marsh is designated as Resource Category 2 (i.e., no net loss of in-kind habitat value). The Service's regional goal regarding wetlands mitigation (i.e., no net loss of acreage or habitat value, whichever is greater) also applies to this cover-type.

Tidal Open Water is considered relatively shallow (3 to 10 feet deep), waters which lack emergent vegetation, and are strongly influenced by the tidal cycle. Submerged vegetation such as water milfoil and yellow water weed may be present in eddies, coves, and other slow-moving channels. Planktonic and invertebrate productivity is high in these areas, providing a food base for a wide array of native and introduced fishes. Regionally, this cover-type is a prime spawning and rearing habitat for the threatened delta smelt and is also used for rearing by juvenile winter-run chinook salmon. The extent of such tidal channels has been markedly reduced as a result of reclamation activities, and ongoing channel maintenance. Native fishes would be appropriate evaluation species for tidal open water. Because of its regional scarcity and value to the evaluation species, tidal open water is designated as Resource Category 2 (i.e., no net loss of in-kind habitat value). The Service's regional goal regarding wetlands mitigation (i.e., no net loss of acreage or habitat value, whichever is greater) also applies to this cover-type.

Bare Ground is represented by the roadways on top of the levees and within the site, and by the exposed riprap. Such areas have virtually no habitat value and were not evaluated further. A summary of these cover-types, resource categories, and mitigation goals is provided in Table 6.

C. Mitigation Needs

The Corps has requested the Service to provide recommendations for any mitigation that the Service would propose for this project. The following decisions regarding such needs follow a thorough evaluation of the existing conditions of the site, a HEP analysis of acreage and habitat value changes based on the Corps' alternatives, and visits to the site to observe wildlife use.

Both mitigation policy and regional mitigation goals for riparian forest, riparian scrub-shrub, SPA cover, non-tidal open water, and uplands, and agriculture, would be fulfilled under with-project conditions. Accordingly, no additional mitigation measures are recommended for these cover-types at this time.

Virtually all of agricultural cover-type on Prospect Island infrequently forms temporarily-flooded wetland acreage during the wettest water years, exclusively as a result of breaching or overtopping of the levees. A majority of these temporarily-flooded wetlands are deeper waters that are partially tidal in nature, and inaccessible as forage for wildlife. Therefore, it is our determination that the acreage and habitat value losses of temporarily-flooded areas of agricultural cover-type would be fully compensated by the

with-project design, which involves a permanent breaching of the levees, and would not require additional mitigation.

Table 6. Summary of the cover-types, resource categories, and mitigation goals for the Prospect Island Restoration Project. * denotes wetland cover-types for which the Service's Regional goal regarding wetlands mitigation (i.e., no net loss of acreage or habitat value, whichever is greater) would also apply.

Cover-type	Resource Category	Mitigation Goal
Riparian Forest*	2	no net loss of in-kind habitat value
Riparian Scrub-shrub*	2	no net loss of in-kind habitat value
SRA Cover*	1	no loss of existing habitat value, acreage, or riverside length
SPA Cover*	2	no net loss of in-kind habitat value
Tidal Freshwater Marsh*	2	no net loss of in-kind habitat value
Non-tidal Open Water*	3	no net loss of habitat value while minimizing loss of in-kind habitat value
Non-tidal Emergent* Marsh	2	no net loss of in-kind habitat value
Upland/herbaceaous Cover	4	minimize loss of habitat value
Agriculture	3	no net loss of habitat value while minimizing loss of in-kind habitat value
Shallow Flood Cover*	2	no net loss of in-kind habitat value
Mudflat*	2	no net loss of in-kind habitat value
Tidal Open Water*	2	no net loss of in-kind habitat value
Bare Ground	-	no mitigation goal

Further, the habitat values provided by tidal emergent marsh created under with-project conditions are considered to benefit many of the same species of wildlife as those which utilize the non-tidal emergent marsh currently existing at the site. Restoration of tidal action is not considered to substantially alter the vegetation composition, or type of wildlife which would utilize the emergent marsh, and is appropriately considered "in-kind". Because the acreage and habitat value with the project for tidal emergent

marsh far exceeds those for non-tidal emergent marsh without the project, no additional mitigation is recommended.

Conversely, the mitigation and regional goals would not be fully met for the estimated 120 acres of shallow flood cover (a form of seasonal wetland) and 2.8 acres of non-tidal emergent marsh (a permanent wetland type). The 1,000-plus acres of seasonal wetland acreage which formed in 1995 provided a much larger area than would normally occur under without-project conditions; this resulted in concentrations of large numbers of migratory birds on the project site. The broad extent, long duration, and shallow depth of flooding in 1995 can be attributed to an unusual combination of conditions: failure of the drainage pumps, heavy precipitation, and failure of the southern most levee bordering the Port's property together with seepage through (but not a breach of) the south cross-levee bordering the restoration site. Levee failure along the ship channel or over-topping of the levees, such as occurred in 1997 undoubtedly created a predominantly open water condition, during which bird use would likely have been concentrated in the northern third or less of the site (*see* Figure 2).

Restoration of Prospect Island to tidal action would result in a loss of some in-kind values, because tidal systems tend to favor a different wildlife species assemblage. Specifically, the cropping practices and shallower inundation of the south central portion of Prospect Island permits foraging by species such as geese and dabbling species like pintail. Forage in the form of waste grain and corn stubble, is significantly different from the invertebrate and fish forage of tidal freshwater wetlands. And, while palustrine farmed wetlands are far more abundant in the Delta (350,347 acres; data from SFEP 1991) than are all tidal marsh types (8,223 acres), shallow flood cover is a less abundant subset of the palustrine farmed wetlands that is inundated on an annual basis. Studies which distinguish shallow flood cover from other farmed wetlands are not available as of this writing, but we believe it to be substantially more abundant than tidal emergent marsh, the cover-type which would replace it.

Mitigation for shallow flood cover is, however, technically feasible and could be done in several ways. One approach could be to isolate 120 acres of the site from tidal action by an additional cross-levee, and conduct appropriate vegetation and water-level management practices that would provide forage for waterfowl during the migration season and for upland species, like the state-listed Swainson's hawk, at other times of the year. A second approach is to create islands with central depressions which would fill at the highest tides. Both of these options would require additional fill material, would involve higher costs for construction and annual operations and maintenance than the proposed alternatives, and could entrain or strand delta smelt or splittail. More important, we believe that the long-term benefits to other fish and wildlife resources, as well as reduced construction and management costs, justify a single-purpose tidal restoration for this particular site.

HEP analysis shows that the value of the restored cover-types (a mosaic of riparian, tidal open water, mudflat, and emergent marsh), would yield greater habitat values than would the shallow flood cover, and to a wider array of both terrestrial and aquatic species. The shallow flood cover area is subject to dessication during below normal and dry years, has low suitability due to relatively "clean" agricultural practices, and provides limited aquatic values. Although seasonal wetland values would be lost with the proposed project, the restored complex of tidal wetlands and riparian islands would provide permanent, highly productive foraging areas for duck species like mallard and shoveler, and protective habitat for their broods. Unlike the agricultural lands, the restored habitat would be relatively free of disturbance throughout the year. Moreover, the restored habitat is expected to provide additional aquatic benefits for the threatened delta smelt and

endangered winter-run chinook salmon. Accordingly, no mitigation is prescribed for the lack of in-kind replacement of shallow flood cover.

The designed breach of the Miner Slough levee is sited for an area which is currently breached and will be repaired prior to earthwork. Though this area would probably support some SRA values if the project were not constructed, it is of very limited extent (100 feet) and of modest value (it is not evaluated in the HEP). Despite technical inconsistency with the Resource Category 1 mitigation goal, mitigation is not requested for such SRA loss for this project only.

D. Other Potential Impacts

1. Proximity to Diversions

One potential concern about the project is its location in the general vicinity of the Barker Slough Pumping Plant (BSPP). BSPP is a diversion located on Barker Slough, about 8 miles from the confluence of Cache, Lindsey, and Miner Sloughs with the SRDWSC. The issue is the extent to which the benefit in terms of increased fish production might be offset by increased entrainment into this diversion. A related concern, expressed by the Department of Water Resources, is that such an increase in loss of listed fishes at BSPP could result in pumping curtailment, under the current Biological Opinion.

Consistent with our letter of June 20, 1995 (Clarification to Biological Opinion on the Effects of Long-term Operation of Federal and State Water Projects on Delta Smelt, File Reference 1-1-94-F-70), the Service's intent is that increased larval delta smelt production associated with a restoration at Prospect Island not cause additional pumping restrictions when risk to the overall population of delta smelt is low. Wider distribution and higher numbers of rearing juveniles of delta smelt have been shown to lower risks to this species. If these conditions exist, no additional BSPP pumping restrictions will occur due to increased larval production at the restoration site.

It is possible but unlikely, in our opinion, that a large proportion of the Delta smelt population from throughout the Delta would migrate to Prospect Island to spawn as a consequence of the restoration. Rather, we expect that the local adult population to be the same, and simply attracted to a more favorable shallow water environment conducive to early life history stages. In addition, the restoration would remove the present unscreened diversion on Prospect Island, which currently withdraws on the order of several thousand acre-feet to support crops. Thus, no net adverse impact on listed species is anticipated at this time.

2. Upland Losses

Another concern, expressed in early comments by the CDFG, concerns the impact that losses of uplands and agricultural forage areas due to restoration would have on Swainson's hawk. Swainson's hawk, a state-listed species, have indeed been observed foraging in and around Prospect Island. Although conversion of agricultural lands is one factor contributing to the decline of this species, loss of nesting trees is considered more limiting. Appropriate nesting trees (30 feet or more in height) are present on the SRDWSC border which, under with-project conditions, would be separated from alternative foraging habitat by about 0.5 mile. However, "easy" flying distance to suitable foraging habitat is considered about 5 miles (Koford 1993). Crop types with similar maintenance practices to what is now present on Prospect Island will remain within a 5 mile radius to the east (on Ryer Island), and north (on Reclamation District 999), providing adequate foraging areas. At maturity, the riparian trees on the island and interior levee perimeter will provide additional nesting habitat, which would be relatively free of disturbance.

As mentioned earlier for mitigation of shallow flood cover loss, mitigation for upland loss on-site would also involve modifying the proposed designs with additional island fill, or additional cross-levees and pumping operations. Understanding the limitations in availability of fill and overall funding for this restoration project, the Service is not recommending in-kind mitigation for either uplands or shallow flood cover. Conversion of Prospect Island to tidal action is consistent with the Central Valley Habitat Joint Venture's (CVHJV's) strategy to concentrate this kind of restoration effort to the periphery of the Delta where subsidence and levee maintenance is less. Other, more central areas of the Delta would be the focus of the CVHJV's efforts at enhancement of wetlands associated with agriculture; the levees of such areas is maintained by water interests because the integrity of the levees is needed to pump water south.

E. Design Acceptability

Prospect Island is situated in a key geographic province of the Delta, one that provides spawning habitat for many species of native fish, wintering forage for waterbirds and waterfowl, and riparian nesting habitat for hawks and other wildlife. Moreover, it is still relatively free of the human disturbance so typical of urban areas in other peripheral Delta lands. Finally, the modest level of subsidence make this site a prime candidate for restoration, requiring minimal earthwork to establish appropriate elevations for riparian and marsh cover-types. There are at least three key reasons why efforts should be made to optimize the restoration work at the outset: (a) opportunity - earthwork can only be done before the site is restored to tidal action; after it is flooded, the waters will be too shallow for floating barges for dredging or material transport, (b) wind fetch erosion - the site is subject to sustained winds and very long fetches; these fetches must be adequately reduced through initial earthwork and vegetation establishment in order to protect the Miner Slough levee from erosion, (c) unit size - habitat quality is diminished at very small unit sizes due to inadequate protection from predators, wind, and insufficient local forage.

In our previous report (USFWS 1995), we expressed a concern that the design was becoming too streamlined. The CDFG (by letter dated December 20, 1996) echoed this concern, endorsing our original recommendation to conduct pre-breach vegetative establishment to maximize wind fetch protection and habitat benefits. Unfortunately, the design has since undergone a major revision which greatly reduced the island width (from several hundred feet to 20 feet), reduced the bench widths from several hundred feet to 10 feet standard widths and no more than 60 feet in limited demonstration areas, and diminished the riparian earthwork area (from about 170 acres to about 40 acres created). As a consequence, fetches were doubled to over 2,000 feet. Although we have not been provided a revised budget for the project, many of the other costs (real estate, utility relocation, mobilization, breaching, project modification report) are more or less fixed and not subject to reduction. The total investment in the project will be at least $10 million (including $2 million to fix the existing damaged levees and $3 million already spent to purchase the site, in addition to $5 million targeted for restoration). The amount spent in actual earthwork and planting (i.e, 40 acres) is roughly $2 million (20%) of this. We recommend the Corps investigate all possible means for additional funding and budgetary revision to achieve the best possible design. To assist the Corps in any subsequent design refinements, we recommend a one-third split of any additional funds to improve island earthwork, levee bench earthwork, and vegetative plantings to the target dimensions and priority areas listed in the recommendation #2 (below).

Although mindful of the reduction in earthwork features, the Service would maintain its support of the project as currently designed. First, we believe the redesigned project will still result in a large net benefit to aquatic species relative to an unrestored condition. If maintained for farming, we expect the levees will experience repeated and expensive failures, necessitating drainage operations which could harm native species entrapped in

the site. Second, we believe the minimal earthwork, while prone to some failure, will provide a significant increment of protection to wind fetch. We do not believe that a modest failure of the Miner Slough levee post project would endanger Ryer Island, because the Federal flood control levee which protects it is larger, taller, and constructed and maintained to a higher standard than most private levees. Third, the topography of the site is conducive to development of vegetation on as much as a third of the area without any earthwork. While not optimal, the current design would institute a very significant increase in shallow water habitat in the region. Fourth, existing data on fish distribution in channels and flooded islands in the immediate vicinity of the project indicate that a restoration at Prospect Island will have some positive and immediate benefits without major earthwork.

F. Demonstration Benefits

The design and location of the project create numerous opportunities for evaluating engineered features and habitat development, which could be applied to similar potential tidal restorations elsewhere in the north Delta. This would involve a combination of systematic monitoring, as well as appropriately timed special studies. Several examples are provided below:

1. Relationship of fish distribution within the island to cover-type, water depth, and tidal velocity.

2. Fish growth and condition in the restoration site compared to adjacent ship channel and slough habitats.

3. Predation losses in the restoration site compared to adjacent ship channel and slough habitats.

4. Fish composition and utilization of the project site (especially spawning and rearing by native fishes) as related to operation of the Yolo Bypass.

5. Comparison of erosion and plant establishment on wind-exposed slopes of different sideslope.

6. Vegetation establishment as affected by initial planting density and or method (e.g., live plants vs. supplementation of seedbank).

7. Adult salmonid straying into the ship channel before and after construction of the project.

8. Wildlife versus fish utilization in relation to vegetation establishment.

9. Large-scale manipulation: changes in fish, wildlife, and water quality could be assessed if a breach in the north end of Miner Slough were tried to add more riverine influence.

10. Wildlife and fishery patterns can be compared between Prospect Island (an example restored site), with Holland Tract (not restored but breached since 1991), and Liberty Island (not restored or breached, presently cultivated, and floods only during Yolo Bypass operation).

11. Effect of striper congregation near breach openings of the restored site, and assessment of its impact as a predator on native and other prey fishes.

VI. RECOMMENDATIONS

We recommend the Corps:

1. Fulfill key data and engineering needs identified in this report, as follows:

   (a) Accurate, local tidal ranges should be established, and elevations of existing stable mudflats, tule marsh, and riparian areas should be measured, to serve as a basis for establishing target cover-type elevations in the project area;

   (b) A grading plan for the project needs to be developed, including breach widths, channel depths and widths, island sideslopes, any reinforcement to the interior levees, and any features to limit access of the site by motorcraft. The earthwork should be overlain with a map indicating the target cover-types anticipated for the selected design. Quantities of cut and fill derived from within the site should be specified and totalled.

   (c) A description of any planting design and schedule, and the anticipated rate of revegetation of woody, submerged aquatic, and emergent marsh components to the target cover-type design, need to be provided.

   (d) Precise data are needed on the range of differences in water elevation between Miner Slough and the SRDWSC. The Corps should provide an analysis of anticipated impacts or lack thereof on conditions at the terminus of Prospect Island, and a basis of design for the breach locations and widths so as to avoid any such impacts.

   (e) Maintenance procedures for levees with and without the project need to be specified, in order to evaluate habitat benefits and the acceptability of the selected alternative.

   (f) An analysis of the long-term stability of the selected design is needed, with special emphasis on wind fetch erosion, taking into account the ideal design criteria recommended in this report, and desire to maintain the general form of islands and channels.

   (g) The sources, quantities, contaminant levels, and physical/chemical suitability for wetland revegetation will need to be established if any fill derived from outside of the project site is used.

   (h) Estimates of any consolidation of sediments which may diminish the initial elevations of the islands should be provided, as well as estimations of any accretion or scouring of sediments in channels and mudflats.

2. Investigate all possible means to improve earthwork and plantings, to achieve the recommended dimensions overall and, minimially, for priority areas as follows:

   (a) Islands:

   - 60 foot minimum riparian width for wind fetch protection
   - 100 foot minimum width for habitat quality
   - increase island area overall to reduce the maximum wind fetch to not more than 1,500 feet

   Priority areas: southern third of the project area

(b) Levee Benches:

- 20 foot minimum berms of which at least 10 feet is at the riparian elevation, for wind fetch protection
- 200 foot minimum berms of which at least 100 feet is at the riparian elevation, for habitat quality

Priority areas: (1) any part of the southern third of the east (Miner Slough) levee which does not have the minimum, (2) east levee, from about 1,000 feet north of Elevator Road to Arrowhead Marina.

(c) Plantings:

- 100% of all emergent marsh/riparian interface length should be planted with willow cuttings and desired emergent species

Priority areas: Same as for Levee Benches, above.

3. Delay breaching of the levees after earthwork is completed by two seasons, to allow for initial, irrigated, establishment of vegetation along the riparian-marsh interfaces of islands and levee perimeter.

4. Discontinue maintenance of the Miner Slough and SRDWSC levees and levee roads, and reduce the height of these levees, where necessary, so as to allow maximum establishment of riparian vegetation, and reduce potential maintenance costs in the event of a levee breach. Prior to transfer of the site to Service ownership and responsibility, options to levee repair and maintenance, such as acquisition or alternative means of access to private properties (i.e., by boat) should be negotiated with affected landowner(s).

5. Develop a physical barrier for earthwork along the breaches to limit motorcraft access to the site.

6. Coordinate restoration of the Prospect Island site, with restoration of the Port of Sacramento property immediately south of the site. If coordinated, the south levee need not be repaired (with a cost savings of about $700,000, and any fill excavated from the Port property to enhance tidal action there should be used for more island earthwork for the Prospect Island site.

7. Complete appropriate Section 7 consultations and conferences, as described in Appendix B, and implement any additional measures determined by the Service's Endangered Species staff to minimize impacts to listed species.

VII. CONCLUSION

The restoration of the Prospect Island site, as represented by the Corps' plans, would increase the total acreage of several cover-types of high value to a diversity of common fish and wildlife, as well as to threatened and endangered species. Using HEP, we estimate that habitat values for high importance cover-types with the project would exceed without-project conditions by about 4-fold. An appropriately designed mix of open waters, mudflat, and tidal marsh cover would provide high quality tidal habitat for delta smelt, and many other delta fishes, in all water years. Inundated riparian islands would also provide spawning habitat for Sacramento splittail during most water years. In above-normal water years, the site is likely to function as a rearing area for winter-run chinook salmon. Many species of birds would profit from the emergent marsh and riparian cover.

The project has numerous other positive attributes not revealed by HEP. The shallow water wetlands would produce large quantities of plankton and

detritus, which not only support benthic forage on site, but would be transported by tidal action to the major channels, providing a food base for fishes off site. The high surface-to-volume ratio of these shallow wetlands improves water quality by enhancing oxygen levels, and providing for the sorption of excess nutrients by sediments and emergent plants. The project would eliminate the current unscreened diversion on the Sakata Brothers property, provide a means for downstream juvenile salmon to avoid several other unscreened diversions along Miner Slough, and offer a route for adult salmon which stray into the lower end of the ship channel to re-enter the Sacramento River system. The modest level of subsidence allows earthwork to be done at a reasonable cost, and the location of the site makes possible the beneficial use of clean dredged material for establishing additional islands or widen interior levee berms, should the opportunity arise. In sum, we believe the Prospect Island Restoration Project, if successfully implemented, can result in a significant benefit to fish and wildlife populations of the Delta as a whole.

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