North Delta Fish Conservation Bank

Habitat Development Plan

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List of Acronyms

Bank	North Delta Fish Conservation Bank
Bank Sponsor	Liberty Island Holdings II, LLC, an affiliate of Wildlands, Inc.
BDCP	Bay Delta Conservation Plan
BOD	biochemical oxygen demand
CBEI	Conservation Bank Enabling Instrument
CBRT	Conservation Bank Review Team
CDFW	California Department of Fish and Wildlife
CESA	California Endangered Species Act
CPUE	catch per unit effort
CVFPB	Central Valley Flood Protection Board
CVP	Central Valley Project
CNDDB	California Natural Diversity Database
EFH	Essential Fish Habitat
ESA	Federal Endangered Species Act
FAV	floating aquatic vegetation
GPS	global positioning system
HDP	Habitat Development Plan
Land Manager	Liberty Island Holdings II, LLC, an affiliate of Wildlands, Inc.
Liberty Island	5,000-acre island in the southern Yolo Bypass
LICBP	Liberty Island Conservation Bank and Preserve
msl	mean sea level
MUR	Mitigation Use Rights
NMFS	National Marine Fisheries Service
RGL	Regulatory Guidance Letter

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SAV	submersed aquatic vegetation
SRA	shaded riverine aquatic
SWP	State Water Project
SWPPP	Stormwater Pollution Prevention Plan
TPL	Trust for Public Land
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

1.0 INTRODUCTION

Liberty Island Holdings II, LLC (**Bank Sponsor and Land Manager**) proposes to entitle the North Delta Fish Conservation Bank (**Bank**) on approximately 811.08 acres in the southern Yolo Bypass in the Primary Zone of the Legal Delta. The Bank is located along the southern border of Yolo County approximately 10 miles north of Rio Vista (**Figures 1** and **2**). The Bank includes two landowners, Reclamation District 2093 (**RD 2093**) (Assessor Parcel Numbers [**APN**] 033-270-007, 033-280-014, and 033-280-015) and the Trust for Public Land (**TPL**) (APNs 033-280-01, 033-280-05, and 033-280-16) (collectively referred to as **Land Owners**), as depicted in **Figure 3**. Both the Land Owners have agreed to cooperatively enhance and permanently protect the conservation values of the Bank property. The Bank is adjacent to and contiguous with the Liberty Island Conservation Bank and Preserve (**LICBP**) on the northeast. If approved, the Bank will contribute towards the restoration and permanent protection of nearly 1,200 acres of fisheries habitat in the Primary Zone of the Legal Delta sponsored by Wildlands, which includes the Bank, the LICBP, and the proposed Little Hastings Island Conservation Bank (**Figure 4**).

The Bank is located at the northern end of Liberty Island, and includes a portion of the island along the stair-step agricultural levees, tidal slough channels (Shag Slough and Liberty Cut), and a small portion of the land immediately north of the northernmost slough (herein referred to as Shag Slough). Liberty Island is located in southeastern Yolo County at the southern end of the Yolo Bypass. An aerial overview of the Bank site is provided as **Figure 5**. Liberty Island is located near the California Department of Fish and Game's (**CDFW**) Yolo Bypass Wildlife Area and Wildlands' Pope Ranch Giant Garter Snake Conservation Bank. It is also located within the proposed North Delta Wildlife Refuge. The Bank location corresponds to Sections 29, 30, 31, and 32, Township 6 North, Range 3 East of the Liberty Island U.S. Geological Survey (**USGS**) 7.5-minute quadrangle (Figure 2). Liberty Island is centrally located at the lower end of the Yolo Bypass just west of the Port of Sacramento Deepwater Shipping Channel in the tidal primary zone of the Legal Delta.

The Bank is proposed to provide compensatory mitigation that may be required by federal, state and local agencies as compensation for effects of development activities on tidal aquatic habitat that supports state and federally listed fisheries resources. Establishment of the Bank is subject to the review and approval of the Conservation Bank Review Team (**CBRT**) consisting of the National Marine Fisheries Service (**NMFS**), U.S. Fish and Wildlife Service (**USFWS**) and CDFW.

The Bank offers an excellent opportunity to preserve and restore Delta habitat and will benefit the following species which have special protection status under the federal Endangered Species Act (**ESA**) and/or California Endangered Species Act (**CESA**):

- Delta smelt (*Hypomesus transpacificus*) and critical habitat;
- Longfin smelt (*Spirinchus thaleichthys*);
- Chinook salmon, Sacramento River winter-run (*Oncorhynchus tshawytscha*) and critical habitat;
- Chinook salmon, Central Valley spring-run (*O. tshawytscha*) and critical habitat;
- Steelhead, Central Valley Distinct Population Segment (DPS) (*O. mykiss*) and critical habitat;
- Green sturgeon (*Acipenser medirostris*), Southern DPS and critical habitat; and
- Pacific lamprey (*Lampetra tridentata*).

The Bank also will benefit the following non-listed species recognized by federal and state wildlife agencies as declining:

- Chinook salmon, Central Valley fall-late and fall-run (*O. tshawytscha*);
- Sacramento splittail (*Pogonichthys macrolepidotus*);
- White sturgeon (*Acipenser transmontanus*); and
- River lamprey (*Lampetra ayresii*).

Historically, Liberty Island was part of a large-scale agricultural reclamation project that converted tidal marsh to farmed lands. Following several levee failures, with the last in 1997, the majority of the island has reverted back to natural tidal habitats. The northern 1200-acre portion of the island remains in a transition between fallow land and a tidal marsh complex including emergent marsh and open water habitats. The entire island is zoned as Agricultural within the Yolo County General Plan. The entire island is under a flood easement with the Central Valley Flood Protection Board (**CVFPB**, formerly the State Reclamation Board). Surrounding properties have the same General Plan zoning designation.

The Bank will provide mitigation for approved projects located within the service area as mapped and described in *Exhibit B of the Conservation Bank Enabling Instrument (CBEI).*

This Habitat Development Plan (**HDP**) describes the preliminary design for the development the Bank, including the preservation, enhancement, restoration, and creation of a mosaic of habitats beneficial to Delta fish species, regional flood protection, and the overall ecological health of the Delta. By benefiting the overall ecological health of the Delta, the Bank will contribute towards species recovery. The mosaic of habitats to be preserved, enhanced, and restored/created includes tidal channel (open water), tidal marsh complex (including emergent marsh, seasonal wetland floodplain, and open water), tule and riparian scrub shrub shaded riverine aquatic (**SRA**), tule and riparian scrub shrub shoreline habitat, and upland levee habitats.

2.0 GOALS

The main goal of the Bank is to facilitate the natural development of Delta habitats through the preservation, enhancement, restoration, and creation of habitats beneficial to Delta fish species (including Chinook salmon, Central Valley steelhead, Sacramento splittail, longfin smelt, and delta smelt). The Bank has been designed to develop into a naturally functioning mosaic of tidally influenced habitats that support Delta native fishes, including federally and state listed species as well as other sensitive native fishes that are in decline. Overall, the proposed activities at the Bank will improve conditions for Delta natives fishes and provide compensation for impacts to listed and other sensitive species within the service area of the Bank. Furthermore, proposed activities at the Bank will provide for and permanently protect high quality habitat contributing to recovery goals as specified for federally listed species in approved recovery plans (USFWS 1995). Specific goals include:

1. **Improve tidal circulation and increase connectivity to Yolo Bypass flood flows to restore biogeochemical and fluvial geomorphic functions:** Breaching the levees and directing the natural development of interior channels through the creation of strategically placed channel connections will restore hydrologic connection to the surrounding tidal sloughs and provide tidal influence to northern Liberty Island The strategic breaching and lowering of the existing east-west oriented levees (stair-step levees or restricted height levees) will provide benefits to the Yolo Bypass flood system by reducing pressure on the

western Project levee. As specified in the H.T. Harvey and Associates 2010 "*Northern Liberty Island Fish Restoration Project Assessment*" the benefits of flood flows in the Yolo Bypass for juvenile salmonids, delta smelt, and other native fishes is well documented (Sommer et al. 2004, Nobriga et al. 2005, Feyer et al. 2006). Lowering of the restricted height levees is designed to increase the frequency of the flood flows between the Yolo Bypass and the Bank site.

2. **Contribute towards the recovery of Delta native fishes:** Restoration activities conducted at the Bank will improve and protect delta and longfin smelt spawning habitat, larval and juvenile transport hydrology and habitat, larval and juvenile rearing habitat, and adult migration hydrology and habitat. Bank activities will facilitate the development of permanently protected shallow water habitat important for delta and longfin smelt and other Delta native fishes, as well as improve the amount of suitable substrate for smelt egg attachment including cattails and tules (Federal Register 1994). The breaching and lowering of the east-west oriented levees will improve the ability of delta and longfin smelt and other Delta native fishes species to migrate through the Yolo Bypass by providing slower water areas outside of but directly connected to Liberty Cut and Shag Slough. A greater frequency of inundation by Yolo Bypass flood flows provides for increased inundation of the seasonal wetland area on the north end of the Bank providing high quality foraging habitat for salmon and other native fishes.

3. **Reduce predation on Delta native fishes**: In order to reduce predation on Delta native fishes, Bank habitats will include and facilitate the development of refugia from predators. Increasing the amount and quality of habitat on the Bank will facilitate the development of significant amounts transitional habitats creating a more heterogeneous and natural ecosystem expected to supply significantly more refugia for Delta native fishes. Seasonally flooded and shallow water habitat is thought to benefit native fishes. Additionally, improved circulation and more frequent inundation by Yolo Bypass flood flows, as well as active treatment, will reduce cover by invasive aquatic weeds, including creeping water primrose (*Ludwegia peploides* ssp. *peploides*) and other rooted or non-rooted floating vegetation; thereby reducing favorable habitat for predatory fishes (HT Harvey 2010, see **Appendix A**).

4. **Reduce habitat fragmentation:** Habitat within the Delta has been highly fragmented by channel dredging, marsh reclamation, bank protection, and levee construction. In order to reduce fragmentation, the Bank has been designed to preserve high quality habitat areas, reconnect to known habitat, and enhance and conserve large contiguous habitat areas to benefit Delta native fishes.

5. **Improve understanding of factors influencing target species**: The Bank has incorporated an adaptive management framework with monitoring and research to help determine its effectiveness and to guide future restoration and enhancement projects. The proposed habitat design for the Bank will lead to greater understanding of how Delta native fishes (in particular Chinook salmon, Central Valley steelhead, Sacramento splittail, longfin smelt, and delta smelt) use the various Bank habitats.

3.0 EXISTING CONDITIONS

3.1 Location

The Bank occurs at the northern end of Liberty Island, approximately 10 miles north of the city of Rio Vista in the southern Yolo Bypass (Figure 1). Liberty Island is centrally located at the lower end of the Yolo Bypass just west of the Port of Sacramento Deepwater Shipping Channel in the tidal, primary zone of the legal Delta. The limits of the Bank are more completely described in the legal description and legal parcel map (*Exhibit E-1 of the CBEI*). Specifically, the Bank corresponds to a portion of Sections 29, 30, 31, and 32 Township 6 North, Range 3 East on the Liberty Island USGS 7.5-minute quadrangle (Figure 2).

3.2 Topography

Liberty Island is typical of land within the Yolo Bypass, which is characterized by a low gradient, wide floodplain confined by federal project levees to the east and west that range from above tidal to subtidal elevations. Remnant historic levees dominate the topography on the northern, eastern, and western perimeters of the Bank, reaching elevations up to 18 feet. Levees located in the interior of the island are severely degraded with many breaches. Elevations on the Bank site range from below mean sea level (msl) in marsh areas to approximately 18 feet above msl on the levees. Topography generally slopes from northwest to southeast. However, there is a drainage divide that functions essentially as a watershed break in the lower third of the Bank (**Figure 8**). Water depths reach 8 to 10 feet in the southern end of the Bank.

3.3 Present and Historical Land Use

Historically, the floodplain of the Sacramento River occupied vast expanses of the lower Sacramento Valley. The enormous agricultural potential of the Sacramento Valley and Delta region began to be realized in the late 1800s. The fertile land attracted farmers and investors, but the annual floodwaters had to be controlled for the farmland to realize its full potential. A number of reclamation efforts in the Delta were conducted between 1860 and 1930. Based on the cultural resources research work conducted for the Bank (*Exhibit J in the CBEI*), Liberty Island was reclaimed between 1910 and 1930.

Farming operations on Liberty Island included potatoes, asparagus, beans, zucchini, onions, peas, and tomatoes. At its development peak, the island had paved roads, power and telephone lines, homes, farm buildings, and a school. Between 1918 and 1973, Liberty Island flooded 27 times and each time reclamation activities continued, until 1997 when the levees breached and the island was never reclaimed. The portion of the Bank property owned by TPL was purchased using CALFED funding for the purposes of habitat preservation.

With the exception of the northern portion, the majority of Liberty Island has reverted back to natural tidal habitats following levee failures in 1997. The northern 1200-acre portion of the island remains in a transition between fallow agriculture and tidal marsh. While most of the levees remain intact and functional in the north, a portion of the levee system in the south has degraded and washed away. Patches of riparian habitat grow on the water and land sides of the levees, but the levee tops primarily support ruderal, nonnative upland habitat. Over half of the interior of the 5,000-acre Liberty Island is now intertidal and has reverted to seasonal and perennial marsh. Some of the higher areas on the island are in various stages of reverting to supratidal seasonal wetlands.

The entire Bank is zoned as Agricultural with the Delta Protection Overlay in the Yolo County General Plan. The Delta Protection Overlay mandates that land use be consistent with the Delta Protection Commission's Land Use and Resource Management Plan. The entire island is under a flood easement with the CVFPB. Surrounding properties within Yolo County have the same General Plan zoning designation. Properties to the south and west of the Bank are located within Solano County, and are designated Agriculture with a Resource Conservation Overlay. The Resource Conservation Overlay designation recognizes important natural resources.

The Bank is bordered on the northeast by the LICBP. Together, the Bank and the LICBP make up the northernmost approximately 1000 acres of Liberty Island, including the majority of the remaining land that has not reverted to open tidal water. The Bank is surrounded on three sides by tidal sloughs. These sloughs function as buffers and protect conservation values at the Bank. The south edge of the Bank is connected to the remainder of Liberty Island, some of which has reverted back to tidal marsh, and the majority of which has reverted to tidal open water. The land north of the Bank is currently being used as pasturelands. The land to the east is former agricultural land that has begun reverting back to wetland. Some of the adjacent land is being evaluated for restoration potential. There are no adjacent land uses that conflict with the conservation values at the Bank.

3.4 Buffers

The Bank contains several features that act as buffers for the conservation values on the site. The primary features are the tidal sloughs (Shag Slough and Liberty Cut) along the east and west boundaries. Just north of the Bank boundary is the Westlands property that is currently being investigated for habitat restoration. Once the Westlands restoration project is completed, it will constitute a permanently protected buffer on the north. The property to the south is permanently inundated and provides existing fisheries habitat. All of Liberty Island occurs within the Yolo Bypass and is under a flood easement, which severely restricts the activities allowed on the island. All of the features mentioned above result in the hydrological isolation of the Bank from neighboring properties which serves to protect the conservation values of the site.

3.5 Hydrology

The hydrology on Liberty Island is dominated by tidal freshwater flows of the southern Yolo Bypass, agricultural drainage with Bypass canals, and winter-spring flood flows of the Yolo Bypass.

Due to the levees surrounding the Bank, water only flows over the entire site once every three years, on average. As the water recedes, some standing water remains on the site and water pools behind the existing levees. There are three levee breaches along the northern portions of the Bank that allow water to enter the site during high tides. Additionally, the existing external and internal levees in the southern portion of the site have failed, allowing large amounts of tidal water to enter the Bank from the south, resulting in the development of tidal open water habitat. The water on the Bank generally drains from north to south.

3.6 Soils

The Soil Survey of Yolo County, California (SCS 1972) maps two soil mapping units on the Bank (**Figure 6**):

- Sycamore complex, flooded

- Sacramento Soils

Sycamore complex, flooded consists of about 60 percent Sycamore silty clay loam and about 25 percent Sycamore silt loam. The remaining 15 percent is made up of Maria silt loam, Merritt silty clay loam, deep, and Sacramento soils, flooded. These soils are underlain by silty clay at a depth of 40 to 60 inches. These soils are subject to flooding 1 year out of 3 because of flowage easements. Elevation is between 0 and 60 feet and the frost free period is 275 to 300 days. Typically the soil is used for sugar beets, grain sorghum, and rice. Other uses include dryfarmed safflower, wildlife habitat, and recreation.

Sycamore silty clay loam is formed on alluvial fans. Slopes are less than 1 percent. Typically the soil ranges in color from gray to grayish brown and in texture from silty clay loam to heavy clay loam or light clay to a depth of 14 inches. At a depth of 14 to 44 inches the soil is olive gray, light yellowish brown, dark gray, or brownish yellow, textures range from silty clay loam to heavy clay loam. At a depth of 44 to 60 inches the soil is light yellowish brown to pale olive, texture ranges from strata of sandy loam to silty clay. Drainage has not been improved and water table ranges from 36 to 60 inches. The soil is used mainly for sugar beets, tomatoes and alfalfa. Other uses include prunes, dryfarmed barley, dryfarmed safflower, wildlife habitat, and recreation.

Sycamore silt loam is similar to Sycamore silty clay loam, except that it has a silt loam texture throughout the profile. Included in mapping are small areas of Maria silt loam, Merritt silty clay loam, Tyndall very fine sandy loam, and Yolo silt loam. Permeability of this Sycamore soil is moderate. The available water holding capacity is 10.0 to 12.0 inches in areas that have been drained. The effective rooting depth is 36 to 60 inches and is restricted by the water table. This soil is used principally for irrigated sugar beets, corn, alfalfa, asparagus, and prunes. Other uses include dryfarmed barley, wildlife habitat, and recreation.

Sacramento soils, flooded consist of poorly to very poorly drained soils with slow to very slow runoff and slow permeability. Altered drainage occurs in reclamation districts and areas protected by levees, resulting in improved drainage. The water table fluctuates between a depth of 34 inches to below 60 inches. Sacramento soils are subject to frequent overflow where not protected by levees or located within flood control systems. Located in nearly level basins with slopes of 0 to 1 percent at elevations of 0 to 60 feet above msl, Sacramento soils formed in fine textured alluvium of mixed origin. The depth to restrictive feature is more than 80 inches, and a typical soil profile consists of silty clay loam from 0 to 16 inches, and clay from 16 to 60 inches. The climate is dry subhumid, mesothermal with hot dry summers and cool moist winters. Mean annual precipitation is 15 to 19 inches. Average January temperature is 45 degrees F., average July temperature is 75 degrees F., and mean annual temperature is 60 degrees F. Average frost-free season is over 275 days.

3.7 Vegetation and Habitat Types

There are five habitats that occur within the Bank: tidal marsh complex, seasonal wetland, riparian scrub shrub, tidal channel (open water), and levee upland (**Figure 7**). Each habitat type is described below.

3.7.1 Tidal Marsh Complex

Tidal marsh complex comprises 591.55 acres of the Bank. This habitat is located throughout the Bank and has developed as a result of levee breaches that occurred in early 1997. This habitat is tidally influenced via hydrological connectivity to the adjacent Shag Slough and the predominantly tidal open water areas of the southern end of Liberty Island. Tidal marsh complex includes a mosaic of emergent marsh, riparian scrub shrub, and open water habitat. Vegetated areas within the complex are dominated by common tule (*Scirpus acutus*), American tule (*Scirpus americanus*), saltmarsh tule (*Scirpus robustus*), and broad-leaf cattail (*Typha latifolia*).

3.7.2 Tidal Emergent Marsh

Patches of tidal emergent marsh are located along the shoreline of Shag Slough across from the stair-step levees. The total extent of this habitat type is 0.97 acres. Tidal emergent marsh is generally dominated by large emergent vegetation including those listed above for Tidal Marsh Complex.

3.7.3 Seasonal Wetland

Seasonal wetland habitat occurs on 79.63 acres of the Bank. This habitat is located in a corner of the Bank adjacent to marsh habitat and along the northern bank of the portion of Shag Slough bisecting the Bank. This habitat is only seasonally flooded and consists of a mix of upland and wetland associated species. The seasonal wetlands are dominated by Bermuda grass (*Cynodon dactylon*), Fitch's tarplant (*Hemizonia fitchii*), Italian ryegrass (*Lolium multiflorum*), bird's-foot trefoil (*Lotus corniculatus*), rabbits foot grass (*Polypogon monspeliensis*), curly dock (*Rumex crispus*), and saltmarsh bulrush.

3.7.4 Riparian Scrub Shrub

The riparian scrub shrub habitat occurs on 36.24 acres of the Bank. This habitat is located around the perimeter of the Bank between the restricted height levees and the tidal channels/open water (Shag Slough and Liberty Cut). This habitat is dominated by black willow sandbar willow (*Salix exigua*), (*Salix gooddingii*), box elder (*Acer negundo* ssp. *californicum*), white alder (*Alnus glutinosa*), Santa Barbara sedge (*Carex barbarae*), Oregon ash (*Fraxinus latifolia*), creeping wildrye (*Leymus triticoides*), wild rose (*Rosa californica*), Himalayan blackberry (*Rubus discolor*), American tule, saltmarsh tule, and broad-leaf cattail.

3.7.5 Tidal Channel (Open Water)

The tidal channel open water habitat at the Bank includes Shag Slough and Liberty Cut. Other open water habitat occurs within the tidal marsh complex in permanently inundated areas. Tidal channel habitat comprises approximately 71.64 acres of the Bank. This habitat is tidally influenced and is mostly unvegetated.

3.7.6 Levee Upland

The 28.73 acres of levee upland habitat occurs around the east, west, and north edges of the Bank. This habitat has moderately convex topography and was historically used as a barrier to tidal flow and winter flood events. This habitat is dominated by nonnative annual grasses and forbs.

3.8 Jurisdictional Habitats

A summary of the Bank's jurisdictional habitats including wetlands is provided as **Table 1.**

Table 1. Jurisdictional Habitat Summary

Wetlands	
Tidal Emergent Marsh	502.257 acres
Seasonal Wetland	79.629 acres
Riparian Wetland	32.934 acres
Wetland Total	**614.82 acres**
Other Waters of the U.S.	
Open Water	**162.202 acres**
Total Jurisdictional Habitat	**777.022 acres**

Three separate delineations were conducted over the Bank property: two on property owned by TPL (TPL 440-acre Property, November 2009 and West Property 274-acre Property, March 2010) and one on property owned by RD 2093.(Reclamation District 2093 120-acre Property, November 2009) The TPL 440-acre Property and the Reclamation District 2093 Property delineations were verified in January 2010 (USACE File No. SPK-2008-00115). The West Property 274-acre Property was verified in September 2010 (and June 2010 (USACE File No. SPK 2010-00755). For details on jurisdictional habitats and maps, see *Exhibit I of the CBEI*.

3.9 Wildlife

A search of the U.S. Fish and Wildlife Service (USFWS) database of federally endangered and threatened species occurring in or potentially affected by projects within the Liberty Island U.S. Geological Survey 7.5-minute quadrangle map, the California Natural Diversity Database (CNDDB) records within a 5-mile radius around the Bank, the National Marine Fisheries Service (NMFS) species information, and the CDFW 20mm fish survey results identified occurrences or critical habitat of the following wildlife species of conservation interest:

- **green sturgeon** (*Acipenser medirostris*)
- **western pond turtle** (*Actinemys marmorata*)
- **western burrowing owl** (*Athene cunucularia*)
- **Swainson's hawk** (*Buteo swainsoni*)
- **valley elderberry** l**onghorn beetle** (*Desmocerus californicus dimorphus*)
- **delta smelt** (*Hypomesus transpacificus*)
- **Central Valley steelhead** (*Oncorhynchus mykiss*)
- **Chinook salmon** (*Oncorhyncus tshawytscha*)
- **Sacramento splittail** (*Pogonichthys macrolepidotus*)
- **longfin smelt** (*Spirinchus thaleichthys*)
- **giant garter snake** (*Thamnophis gigas*)

Delta smelt, longfin smelt, Chinook salmon, green sturgeon, steelhead, and splittail are sensitive fish species covered by the Sacramento-San Joaquin Delta Native Fishes Recovery Plan (USFWS 1996). The Bank is within designated critical habitat for Chinook salmon, steelhead, and delta smelt. Studies by Sommer et al. (2001), Nobriga et al. (2005), and Mager et al. (2006) have shown that delta smelt, longfin smelt, splittail, sturgeon, Chinook salmon, and steelhead all occur within the southern Yolo Bypass within or near Liberty Island. The CDFW 20mm surveys identified larval and adult delta smelt within the sloughs surrounding Liberty Island as recently as March of 2010. The CDFW 20mm surveys identified splittail within the sloughs surrounding Liberty Island as late as 2005 and 2006. They have not been caught during CDFW 20mm surveys in the delta since. The CDFW 20mm surveys identified longfin smelt within the sloughs surrounding Liberty Island in 2009. The results of various fish surveys and an aquatic habitat assessment of Liberty Island is provided in an appendix of the Biological Resources Report (*Exhibit H of the CBEI)*. Other biological resources are also discussed in Exhibit H.

Delta smelt, longfin smelt, Chinook salmon, Central Valley steelhead, giant garter snake, and other native fishes expected to occur on or adjacent to the Bank are discussed below.

3.9.1 Delta Smelt

Delta smelt is a federally and state listed as threatened that is a member of the *Osmeridae* family. The delta smelt is a small, slender-bodied fish with a typical adult size of two to three inches that is found only in the Sacramento-San Joaquin Estuary. Historically, it was one of the most common species in the estuary; however, the population declined dramatically in the early 1980s. Delta smelt are considered environmentally sensitive because they usually live only one year (they rarely live two years), have a limited diet, have a low fecundity for a fish with planktonic larvae, are poor swimmers, are easily stressed, and reside primarily in the interface between salt and freshwater.

Mature adult and larval delta smelt have been found during spring in channels adjacent to Liberty Island and channels of the adjacent Cache Slough system; therefore, it is generally inferred that the Cache-Liberty Slough area of the North Delta is a spawning ground for delta smelt. According to Moyle (2002):

- Delta smelt begin moving into spawning areas as early as the fall and spawn from February to July with a peak in late April and early May during periods when water temperatures are the lowest of the year (7-15ºC).

- They spawn in sloughs and shallow edges of channels.

- Spawning likely occurs over sand, gravel, or other hard substrate material in slow currents near main channels.

- Hatching and early feeding occur in the second or third week after spawning.

Intertidal and subtidal habitats with hard substrate (sand, gravel, clay rock, woody material, and emergent plant stems and roots) in the Liberty Island area likely serve as spawning substrate for delta smelt. Tidal and flood-flow currents act to flush freshwater continuously over deposited eggs. After hatching, young smelt likely feed on abundant plankton in the tidal sloughs and embayments in the Liberty Island area. Cache, Shag, and Liberty sloughs likely have high concentrations of planktonic invertebrates that are important forage of early rearing delta smelt.

The Liberty Island area is likely most important to delta smelt between February to May. Smelt likely leave the Liberty area when they reach the juvenile stage 30-45 days after spawning, which would be early May in dry non-flood years or early June in wetter years. Positive flow through the lower Bypass likely helps the smelt move the 20-plus miles to the brackish waters of the western Delta and eastern Suisun Bay.

Based on the general life history of delta smelt and the study by Grimaldo et al. (2004), the newly hatched larvae are likely found primarily in pelagic habitats of the tidal channels and not within the marsh or marsh edge habitats. After the pelagic larval period, juveniles need refuge from river currents and predators provided by logs, root wads, marsh plants, overhanging vegetation, and shallow water, although still requiring some tidal circulation (Mager et al. 2004).

Delta smelt benefit from off-channel and shallow water habitats that stay cool from shade especially from late spring through early fall. They also benefit from continuous corridors of connected tidal habitat for migration that provide shade, cover, food, and cool clean water, and refuge from stronger currents. The CDFW 20mm surveys identified larval and adult delta smelt within the sloughs surrounding Liberty Island as recently as March of 2010.

3.9.2 Longfin Smelt

The longfin smelt is an anadromous smelt (family Osmeridae) found in California's bay, estuary, and nearshore coastal environments from San Francisco Bay north to the Oregon border. The San Francisco Estuary and the Sacramento-San Joaquin Delta support the largest longfin smelt population in California. The longfin smelt is listed as a threatened species under the California Endangered Species Act. Its status remains unresolved at the federal level.

Longfin smelt have a short lifespan living only two to three years. They spend their adult life in bays, estuaries, and nearshore coastal areas, and migrate into freshwater rivers to spawn. Spawning occurs primarily from January through March in upstream freshwater areas of the tidal estuary. Longfin smelt habitat includes the Bay-Delta from the Cache Slough region of the North Delta, the San Joaquin region from Medford Island, downstream through Suisun Bay and Marsh, and northern San Francisco Bay. Adult longfin smelt migrate from low-salinity (brackish) estuary waters upstream into freshwater reaches of the estuary to spawn. Newly hatched larvae are buoyant and are transported downstream from freshwater spawning areas to brackish water nursery areas of the western Delta and Suisun Bay and Marsh. Few young longfin smelt remain in the Delta during the summer as the Delta is too warm (>22ºC) and fresh, as compared to the low-salinity, cooler waters of the western Delta and Suisun Bay/Marsh, which the longfin smelt appear to prefer.

Survival is apparently enhanced in the cooler (<23ºC), brackish water for several reasons:

- Critical thermal maximum temperatures are exceeded in the Delta, but not Suisun Bay.
- Food abundance is greater in brackish waters
- Less energy is needed to sustain young smelt if they reside in slightly brackish water that is similar in salt concentration as their body fluids.

The spawning distribution of longfin smelt extends upstream into the freshwater Delta. In drier years, the distribution is slightly upstream with the focus being the west and north Delta. In wetter years, the focus extends further downstream into Suisun Bay/Marsh. In very wet years, the focus is much further downstream in San Francisco Bay.

After hatching, the larvae drift downstream into brackish waters of the western Delta and Suisun Bay/Marsh. In some years, small numbers of larvae remain in the upstream spawning areas including the Lower Yolo Bypass/Cache Slough region.

It appears based on survey data (see Aquatic Resources Report in *Exhibit H of the CBEI*) that the Liberty Island area is a minor but significant spawning area for longfin smelt. Though some rearing occurs in the Liberty area, most rearing occurs downstream in the western Delta and Suisun Bay/Marsh.

The distribution of later rearing larvae and early juveniles exemplified in the April-May sampling data would indicate that yearclass production occurs from rearing in the brackish waters of the estuary in the western Delta (drier years), Suisun Bay (dry to moderate years), and San Pablo Bay (very wet years). However, even in wet years like 2010, larval and early juvenile longfin rearing extends upstream from the brackish waters throughout the freshwater estuary in the West and North Delta, as well as into the Central Delta. Water temperatures remained adequate (16-20ºC) throughout the Delta through May in 2010. In 2009, a drier warmer year, water temperatures in the Delta were higher by mid-May (20-23ºC). Length-frequency data from the 2010 CDFW 20-mm survey indicate that the vast majority of young longfin smelt have reached the early juvenile stage (12-25 mm) by early May and were found in brackish water (300-6000 EC) of Suisun Bay (Figure 5). A similar pattern occurred in 2009.

The Bank along with other northern Delta habitat improvement projects will contribute directly and indirectly to the longfin smelt's food supply in the West Delta and Suisun Bay. Many of the nutrients needed to drive the lower estuary food web are derived from upstream sources with the Yolo Bypass being a major contributor. Habitat improvements in the Lower Yolo Bypass, Cache Slough, and other areas of the upper estuary are generally considered essential to support the food web, habitats, and native fishes of the lower estuary. In this way the Liberty Island Preserve both directly and indirectly supports longfin smelt production that comes predominately from the lower estuary.

3.9.3 Chinook Salmon

All runs of Chinook salmon are known to occur in the Yolo Bypass. Winter-run and spring-run Chinook salmon are state and federal listed. Designated critical habitat for winter-run and spring-run Chinook salmon includes the entire Yolo Bypass, including Liberty Island with a portion of the Bank lying within the boundaries of the Evolutionary Significant Units for Sacramento River winter-run and Central Valley spring-run Chinook salmon. In high flow years the floodplain in the Yolo Bypass has been demonstrated to be important foraging habitat for juvenile Chinook salmon in the Sacramento River basin (Sommer et al. 2001). Juvenile Chinook salmon rearing on the floodplain have higher growth rates, and perhaps higher survival rates, than fish that migrate down the Sacramento River channel (JSA 2002). The Bank will provide permanent protection of over 800 acres of beneficial habitat and include expansion of tidal marsh habitat and increased inundation of floodplain habitat within and adjacent to the spring/winter-run Chinook salmon Evolutionary Significant Units.

Chinook salmon enter the Yolo Bypass from spawning tributaries as fry (30-50 mm). Most enter the Bypass in flood years when the Sacramento River spills into the head of the Yolo Bypass. Young Chinook salmon likely benefit most from the inundated winter habitats including flooded uplands, intertidal marsh, and subtidal channels. They may also be found in backwater marshes and open embayments. A major limiting factor for juvenile Chinook salmon is temperature, which strongly affects growth and survival. Warmer winter water temperatures (up to 19ºC) and greater invertebrate food production in the Bypass may improve salmon production. However, high spring water temperatures in excess of 20ºC may be detrimental to young salmon and shorten the potential rearing period in the Bypass.

During wetter years, adult winter-run and spring-run Chinook salmon are known to migrate upstream through the lower Bypass channels. Their young pass downstream through the Bypass and may spend some time rearing in the sloughs and flooded areas during the winter and early spring.

The Bank would improve rearing habitat for juvenile salmon through increased shading and cover habitat, providing access to created shallow water habitat within the Bank, and increased productivity from the natural development and expansion of intertidal habitats. Additionally, actions that would minimize increases in water temperature in spring past their thermal threshold should benefit salmon. Salmon would likely benefit from protecting existing seasonally flooded grasslands and improved access to (and from) flooded portions of northern Liberty Island.

3.9.4 Central Valley Steelhead

Central Valley steelhead was listed as threatened in 1999. The southern Yolo Bypass (including the Bank) falls within the designated critical habitat for this species with a portion of the Bank falls within the Distinct Population Segment for Central Valley steelhead. Delta native fishes including steelhead have been documented to utilize the floodplain habitat for foraging (Sommer 2001). A greater frequency of inundation by Yolo Bypass flood flows provides for increased inundation of the seasonal wetland area on the north end of the Bank providing high quality foraging habitat for steelhead and other native fishes. The Bank will provide permanent protection of over 800 acres of beneficial habitat and include expansion of tidal marsh habitat and increased inundation of floodplain habitat within and adjacent to the Central Valley steelhead Distinct Population Segment. Adult steelhead migrate upstream through the lower Sacramento River from late fall through spring when waters are cool and flows are generally high, and then spawn in tributaries in winter and spring. Juvenile steelhead generally migrate as yearlings from the tributaries to the ocean during these same cool high-water seasons. During their migration they may be found feeding along river shorelines or in backwater habitats of Central Valley rivers and the Delta including the Yolo Bypass from late fall through spring.

The Bank would improve rearing habitat for juvenile steelhead through increased shading and cover habitat, providing access to created shallow water habitat and increased productivity resulting from the natural development and expansion of intertidal habitats. Steelhead would likely benefit from protecting existing seasonally flooded grasslands and improved access to (and from) flooded portions of northern Liberty Island.

3.9.5 Other Native Fishes

In addition to delta smelt, longfin smelt, Chinook salmon, and Central Valley steelhead, other fishes identified in the Delta Native Fishes Recovery Plan include Sacramento splittail, green sturgeon, and Sacramento perch. Sacramento splittail is expected to use the Bank and benefit from restoration activities within the Bank. The CDFW 20mm surveys identified splittail within the sloughs surrounding Liberty Island as late as 2005 and 2006. The other two species are not expected to make significant use of the habitat developed on Liberty Island. Green sturgeon spawn in the upper Sacramento River and would only pass through the area moving upstream or downstream between the river spawning areas and Bay rearing areas. Young or adult sturgeon may reside in main channels of the Bypass for short periods in wetter years when the Bypass floods. Sacramento perch are extinct from the Delta. Wildlands has stocked Sacramento perch in the lower Bypass at the Pope Ranch Giant Garter Snake Conservation Bank; however, there has been no success documented from the effort. It is unlikely that perch will re-establish at Liberty Island given the predominance of non-native fish throughout the Delta.

3.9.6 Giant Garter Snake

The giant garter snake is listed as threatened by the federal government and the state of California. This species is protected under both the federal and California Endangered Species Acts (ESA and CESA) as administered by the USFWS and CDFW, respectively.

The giant garter snake is one of the larger species of garter snakes, with adult females commonly reaching four feet in length, and males being somewhat shorter in length. The basic color is dull brown with a checkered pattern of well-separated black spots on the dorsal side. There is a dull yellow, mid-dorsal stripe, but lateral stripes are often not present. The head is elongated with a pointed snout.

Historically, the range of this snake was the San Joaquin Valley from the Butte County southward to Buena Vista and the Tulare Lake Basin. The current distribution extends from near Chico, Butte County, to the vicinity of Burrel, Fresno County. This species is one of the most aquatic garter snakes and is usually found in areas of freshwater marsh and low-gradient streams. Additionally, it has adapted to human-made habitats, such as drainage canals and irrigation ditches, especially those associated with rice farming.

As a result of human activities, the giant garter snake and its supporting natural habitat are depleted throughout its range. In addition, much of the remaining habitat is degraded or threatened in those areas that still support this species. Urbanization, including housing, business, industrial, and recreational developments, often leads to the destruction of wetlands and channelization of streams. Other impacts of urbanization include pollution, destruction of food sources, predation by native and introduced species, and removal by collectors (CDFW 1999).

Two occurrences of GGS have been documented within a 5-mile radius of the Bank (CNDDB 2009).

4.0 PROPOSED DESIGN

The proposed design for restoration and enhancement of the Bank will result in a hydrologically connected complex of tidal marsh habitat including open water, emergent marsh, tule SRA, riparian SRA, seasonal wetland floodplain, and upland habitats to benefit Delta native fishes. The proposed project was also designed to provide improvements to the flood system and Project levee stability. Overall, improved connectivity with the Yolo Bypass flood events is anticipated to support higher densities of native fishes and limit access of non-native fishes. Improved connectivity is also expected to enhance primary production and food transport to open water habitats for smelt and other pelagic fishes over time (HT Harvey 2010, see Appendix A).

The proposed project consists of the following restoration and enhancement actions (Figure 8):

1. Lowering two east-west levees along the northern edge of the Bank to allow complete flooding of the site at an increased frequency;

2. Creating three sub-tidal breaches and channels and widening a previously existing breach to improve circulation and tidal connectivity;

3. Removing a water control structure along the northern edge of the Bank;

4. Installation of a plug in one of the north-south ditches to better direct flows to and from the Liberty Island Conservation Bank created channels;

5. Controlling invasive aquatic weeds that harbor predatory fishes; and

6. Lowering an approximate 20-acre floodplain along the northern boundary of the Bank to create a tidal emergent marsh.

7. Protection and enhancement of existing of existing tule marsh and riparian scrub shrub habitat along the shoreline.

At completion, the proposed project would result in the following:

- restoration/creation of 11.6 acres of tidal emergent marsh associated with rock removal (levee lowering),
- restoration/creation of 20.75 acres of tidal emergent marsh associated with lowering of floodplain habitat.
- enhancement of 657.2 acres of tidal marsh complex,
- preservation of 25.3acres of riparian scrub shrub shoreline habitat,
- enhancement of 68.4 acres of tidal channel/open water,
- preservation of 19.2 acres of levee upland,
- restoration/creation of 10,297 linear feet of tule SRA (levee lowering and rock removal, floodplain lowering),
- preservation of 18,598 linear feet of riparian scrub shrub SRA, and

A breakdown of the extent of post-project habitat types by Property Owner (i.e., TPL vs. RD 2093) is provided in *Exhibit F-1 of the CBEI*.

In order to restore natural tidal influence to the Bank, 4,464 linear feet (11.6 acres) of two east-west levees along Shag slough will be lowered. In addition approximately 20.75 acres of the existing floodplain north of Shag slough will be lowered. These areas will be brought down below the mean higher high water mark (i.e., sea level) to allow tidal influence to the site and the development of tidal emergent marsh habitat. Emergent marsh that is created by the removal of levee spoils and rock is expected to colonize naturally with intertidal tule marsh vegetation. Some strategic planting of tule will occur along the new shoreline of the lowered levee. These activities will restore/create 32.35 acres of tidal emergent marsh habitat and 10,297 linear feet of tule SRA habitat. The removal of rock along levees within the Delta, and the Yolo Bypass was specifically identified as a priority in the draft Bay Delta Conservation Plan (**BDCP**). Studies indicate native fishes including salmon heavily use the un-rocked vegetation shoreline habitats in the Delta. By removing the levees that were fortified with large rocks, the project will re-establish important un-rocked shoreline habitat.

The enhancement of tidal marsh complex, including tidal open water, will be supported by two sub-tidal breaches along the east-west levees, widening an existing breach along the east-west levees, removing a water control structure, excavating tidal channels, and plugging an existing ditch. These actions will re-connect an existing seasonal wetland area in the western portion of the Bank to more frequent flooding and increase the area of shallow water floodplain habitat for native fishes. Tidal channels have been extended from the breaches to facilitate hydrologic connectivity with open water habitats located in the interior of the site.

- Breaches and channels will be excavated to a depth that is subtidal and supports open water habitat. These breaches will improve tidal circulation, enhance habitat connectivity.
- Levee lowering will also improve tidal circulation and habitat connectivity, and improve flood flow frequency.
- A ditch plug will be installed to inhibit flow through an existing north-south ditch for improved scour and water flow through the tidal marsh complex.

SRA habitat along Shag Slough levee, including the stair-step levees, will be enhanced by strategic planting of tule where it has been removed and impacted as a result of scouring floods and erosion from channelized, unnaturally high water velocities.

Controlling invasive aquatic weeds, in particular the water primrose, is anticipated to benefit native fishes by excluding habitat for predatory non-native fishes. Improved circulation as well as active treatment will reduce water primrose biomass. Other SAV/FAV identified as impacting the conservation values of the Bank, may also be controlled as needed.

In order to provide the maximum benefit to smelt, the Bank design focuses on facilitating the natural development of tidal channels with cool currents, and hard substrate. Reconnecting northern Liberty Island to flood and tidal flows would benefit smelt by providing increased transport potential for moving larval smelt downstream to brackish waters after hatching. An increase of marsh and shallow water habitats on the island may also contribute to higher productivity of the adjacent tidal channels, which would benefit smelt production.

Several technical studies were conducted to verify the condition and viability of the Bank site for establishing a habitat conservation area. Phase I Environmental Site Assessments and Cultural Resources Inventory and Evaluation reports were produced documenting existing site conditions. No constraints to habitat development were identified on the Bank property based upon the results of these assessments.

4.1 Construction

All habitat development and management activities will comply with applicable local, state, and federal regulations. Construction will be managed by the Bank Sponsor to ensure that the mitigation habitats are constructed as designed, and that any existing wetland or water features in the surrounding area are not impacted by construction activities.

Construction of the habitat will require the use of scrapers, graders, excavators, dump trucks, and/or other heavy equipment. The heavy equipment will be used to excavate the open water channels.. Post-construction restoration will include the removal of construction debris and establishing pre-construction conditions in temporarily disturbed areas. Excavated spoils materials will be removed from the Bank site. To provide soil stabilization post-construction, an erosion control seed mix will be applied to all disturbed upland areas.

In general, the following protection measures will be implemented:

- The Bank Sponsor will set construction limits that do not encroach on preserved wetlands or other water features.
- The limits of the construction area will be delineated using high visibility construction fencing.
- A Storm Water Pollution Prevention Plan (SWPPP) will be prepared and best management practices will be implemented to control sediment and erosion during construction.
- The Bank Sponsor will attend pre-construction meetings and conduct environmental trainings regarding the location of wetland or other water features as well as other sensitive resources.
- The Bank Sponsor will conduct a post-construction inspection to determine if any post-construction remediation is needed. If remediation actions are necessary, the Bank Sponsor will ensure that those actions are performed by the construction personnel.

Due to the location of the Bank and its' marginal GGS habitat, it is unlikely that GGS will be utilizing the site during the construction period. However, the following standard avoidance measures recommended by USFWS (1997) will be used to minimize any potential disturbance to GGS.

- Conduct construction activities only during GGS active period (May 1–October 1).
- Implement a workers' awareness program wherein construction personnel are provided instruction on recognition of GGS and their habitats, and the legal protection afforded GGS by the Endangered Species Act.
- Conduct a GGS survey 24 hours prior to commencement of habitat maintenance activities.
- Have a biological monitor on site during construction activities to monitor, observe, and detect any GGS that may be in the immediate area and, if necessary, relocate the GGS to another area of the Bank not undergoing construction activities.
- Observe a 20 mile per hour speed limit within the construction zone.

- Dewater areas with standing water two weeks prior to any excavation or fill work. Dewatered areas will be inspected for ponding that may concentrate prey and become attractants to snakes and other wildlife. Prey salvage may be necessary for these ponded areas in order to reduce the risk of attracting snakes and other wildlife.

Standing water may be present within the limits of construction, so limited dewatering may be necessary in order to complete construction. Excavation activities will also need to occur in jurisdictional habitats. A Nationwide permit will be secured prior to commencement of construction activities for any work below the mean higher high water mark of the sloughs or areas identified as jurisdictional wetlands under Section 404 of the Clean Water Act. Authorization will be obtained from all other applicable agencies (e.g., Yolo County, Regional Water Quality Control Board, California Department of Fish and Game, Central Valley Flood Protection Board, National Marine Fisheries Service, and U.S. Fish and Wildlife Service), as required. A Notice of Intent under section 402 of the Clean Water Act will be submitted. A SWPPP will be prepared and implemented.

4.2 Planting and Seeding

Large tule plugs will be installed along the interface between shallow habitats and the tidal channel habitat (Shag Slough). Plugs will be anchored in place to improve establishment and prevent plugs from washing away during flood events. Broadcast seeding of an erosion control mix will be used to apply seed to disturbed upland areas (levees). Seeding will occur prior to the rainy season in order to provide soil stabilization on the site. Seed mix containing suitable native and naturalized upland plant species will be applied to all disturbed upland areas. The seed mix will be developed in order to minimize the extent of weedy species establishment on the Bank. The seed mix will include California native species such as annual fescue (*Vulpia* spp.), California brome (*Bromus carinatus*), and blue wildrye (*Elymus glaucus*), and other naturalized species which have proven successful at other sites.

5.0 PERFORMANCE STANDARDS

The following performance standards have been developed to track the development of habitat over time. By meeting the performance standards outlined below, the Bank project will be considered successful.

5.1 Hydrologic Connections Performance Standards

The Year 2 Performance Standards for hydrologic connections are as follows:

- Constructed channels will flood (i.e., filling and partially or completely draining) in response to fluctuations in the daily tidal regime and seasonal river stages in Shag Slough and Liberty Cut.
- Connections/breaches shall remain open (not blocked or clogged with debris or sediment to the extent that it prevents hydrologic connectivity to Shag Slough and Liberty Cut).
- Verified tidal frequency - evidence of tidal water surface elevation indicates that tides occur in site areas as expected with more than 35 days inundation between February and June.
- Verified desired channel velocity based on design hydrologic modeling - evidence of frequent (more than 35 days inundation between February and June) would indicate unencumbered tidal action.

5.2 Native Vegetation Performance Standards

The following Performance Standards will be used to assess the successful establishment of emergent marsh vegetation:

- Year 1: The total (absolute) vegetative cover of the created emergent marsh habitat will be at least 10 percent and native freshwater marsh vegetation will provide at least 5% of relative cover (i.e. 5% of the absolute vegetative cover will be composed of native freshwater marsh vegetation).
- Year 3: The total (absolute) vegetative cover of the created emergent marsh habitat will be at least 50 percent and native freshwater marsh vegetation will provide at least 35% of relative cover (i.e. 35% of the total vegetative cover will be composed of native freshwater marsh vegetation).
- Year 5: The total vegetative cover of the created emergent marsh habitat will be at least 75 percent and native freshwater marsh vegetation will provide at least 50% of relative cover (i.e. 50% of the total vegetative cover will be composed of native freshwater marsh vegetation).

5.3 Phytoplankton and Zooplankton Performance Standards for Delta and Longfin Smelt

- Year 3: Verified desired phytoplankton/zooplankton presence.

- Year 4: Verified improved phytoplankton/zooplankton presence with low biochemical oxygen demand (BOD).

Comparative monthly site and offsite control sampling will be conducted between February and June to show that Bank has the greater catch per unit effort (CPUE) of desired species. The sampling will be conducted using acrylic light traps and egg/larval tow nets.

Phytoplankton and zooplankton species composition and relative seasonal abundance shall be similar to that of existing tidal sloughs at Liberty Island. BOD in the form of algal production shall be similar to that in existing sloughs on Liberty Island.

5.4 Invasive Species Performance Standards

- Year 3: Low invasive submerged aquatic vegetation (SAV)/floating aquatic vegetation (FAV) ratio as compared to offsite control sample locations.

- Year 4: Continuing low SAV/FAV ratio as compared to offsite control sample locations.

Shoreline transects across channel with photo points will be used to measure SAV/FAV presence & density and to ensure that the site continues to have a low SAV/FAV ratio compared to offsite control sample locations. Ratios of occurrence/coverage of invasive SAV and FAV shall be similar or better to existing channels on Liberty Island. Plant community composition shall be similar or better as well.

5.5 Fish Performance Standards

- Documented observed presence of target species (i.e., salmonids and smelt).

In years when smelt are observed in adjoining sloughs in fish agency monitoring programs, they will be considered as observed in the Bank’s restored tidal habitats as the fish community has been determined in agency and project monitoring programs to be similar in the lower Yolo Bypass.

6.0 MONITORING

To ensure that the Bank project is progressing toward the pre-established Performance Standards and success criteria, qualified biologists will monitor the preserved, enhanced, and restored/created habitats. Monitoring activities would involve vegetation and hydrology based on required success criteria for each type of habitat. Reference habitats within the site will be selected and monitored prior to, and in conjunction with, mitigation habitat monitoring in order to provide baseline standards by which to judge the performance of mitigation habitats. The monitoring results will help to:

- track habitat progression towards Performance Standards,
- guide Adaptive Management actions, and
- evaluate and guide site stewardship activities.

Gear, habitat locations, and frequency would be similar to that of fish agency monitoring programs. Primarily on-site monitoring would be the responsibility of this program.

6.1 Baseline Biological Monitoring for Existing Habitats

Baseline biological monitoring for preserved, enhanced, and restored habitat will begin the first year following construction. Baseline biological monitoring will establish a baseline, or reference condition, against which future long-term monitoring results can be compared in order to assess the overall function of the Bank's habitats over time. Comparison of long-term monitoring data against an established baseline condition will be useful in guiding Adaptive Management decisions to ensure the continued presence of emergent marsh, tidal channels, riparian vegetation, and seasonally inundated floodplain.

6.2 Channel Connections Monitoring

Levee breaches and channels will be monitored quarterly in Year 1 and annually in Years 2 through 5. Monitoring will consist of direct observations and aerial photograph assessment of the breaches and channels during low tide periods to establish that fish stranding will not occur (i.e., channels are adequately providing drainage or low flow conditions during periods of low river stages). Channel configuration will be mapped in Years 1 (as-builts), 3, and 5 to evaluate morphological changes vs. as-built conditions. Tidal inundation will be measured and documented through 360^{o} photo-point pictures and surface depth measurement at applicable photo-points located within the emergent marsh. In addition, the following data will be documented at sampling sites located near each created breach point:

- tidal period
- salinity
- temperature
- channel velocity

6.3 Emergent Marsh Vegetation Monitoring

Monitoring of emergent marsh vegetation will be conducted in Years 1, 3, and 5. Monitoring shall include aerial photographic documentation and analysis, as well as visual boat surveys of the emergent marsh vegetation. Aerial photographs will be taken of the Bank and scanned into a computer in order to derive a quantitative assessment of the amount of vegetative cover realized through construction. The extent of existing habitat will then be compared to construction drawings and design goals in order to assess the relative success of management efforts. A qualitative description of vegetation will also be provided (e.g., dominant species). Visual monitoring of emergent marsh vegetation shall be conducted by boat.

6.4 Phytoplankton, Zooplankton, and Fish Egg and Larvae Monitoring

Monitoring of phytoplankton and zooplankton will be conducted in years 3 and 4. Monitoring shall include comparative monthly February through June site and offsite control sampling:

- project and control site CPUE of desired species of phytoplankton and zooplankton using plankton nets consistent with fish agency monitoring in the lower Yolo Bypass in the area of Liberty Island,

- project and control site fish egg and larval CPUE gear including acrylic light traps and egg/larval tow nets consistent with fish agency monitoring in the lower Yolo Bypass in the area of Liberty Island.

The reference site(s) for the phytoplankton and zooplankton monitoring will be located in existing sloughs on or adjacent to northern Liberty Island.

6.5 Invasive Species Monitoring

It is anticipated that invasive species in the riparian and marsh habitats will be managed by the establishment and proliferation of native plants following restoration activities. In the riparian areas, invasive species will be controlled during the establishment phase.

SAV and FAV will be monitored by:

- Shoreline transects across channel with photo points to measure SAV/FAV presence and density.

The reference site(s) for the SAV and FAV monitoring will be located in existing sloughs on or adjacent to northern Liberty Island.

Monitoring will be used to determine if upland invasive species are colonizing the site and require eradication. These species may include, but are not limited to, yellow star-thistle, perennial pepperweed, and giant reed. Invasive species monitoring will occur during the riparian habitat and general monitoring events (i.e., Years 1 through 5). If monitoring reveals an increasing trend in invasive species then appropriate control measures will be implemented.

6.6 Juvenile and Adult Fish Monitoring

Fish will be monitored seasonally in aquatic portions of the Bank, provided the appropriate permits for fish sampling can be obtained. The primary methodologies used will include trap nets and seines to monitor juvenile and adult fishes. Other methods to conduct fish sampling may include small boat trawl. Basic water quality and habitat constituents will also be monitored with fish collections including water temperature, turbidity, dissolved oxygen, depth, substrate, cover, and habitat types. Sampling stations will be established along levee banks on boundary sloughs, in primary channels, in secondary channels, and in open marsh. Two samples shall be taken at each sampling station. Sampling will be conducted in winter, spring, and midsummer. During flooding, an additional station within flooded seasonal wetland or upland habitat shall be established (two samples shall be taken). Monitoring will occur beginning in the second year of the five-year establishment period. Monitoring will continue throughout the establishment period until presence of juvenile or adult delta smelt and/or juvenile or adult longfin smelt, and/or juvenile or adult salmon are documented. The continued presence of salmonids will be confirmed by seasonal monitoring during each year of the interim management period. The applicable “Fish Performance Standard” and associated Credit release (see Exhibit F-1 of the CBEI) will be considered to have been met only for those species documented. Preserved specimens will be sent to the NMFS (salmon) or CDFW (smelt) offices in Stockton for verification. Daily discharge in the Bypass and water levels will be obtained for one month around the survey periods. Fish surveys will also note bird use and any occurrence of aquatic plants by species, location, and relative abundance. Permits will be acquired from the Resource Agencies to authorize fish sampling, and sampling will adhere to all permit conditions.

6.7 Monitoring Schedule

All mitigation areas would be monitored until the hydrologic and vegetation performance criteria have been met or a minimum of 5 years. A table containing the approximate monitoring schedule for any given year is provided below. The month of monitoring indicated in the table is approximate and would be adjusted every year to account for rainfall, weather, and plant growth.

Monitoring reports, which summarize the results of the monitoring effort, will be submitted to the CBRT by December 31st of each Monitoring Year (“Monitoring Year” refers to each year in which sampling occurs). The monitoring reports shall document federally or state listed or candidate species identified during the monitoring surveys. Performance Standards have been developed for each of the enhanced, restored, and created habitat types on the site to ensure that the acreage and functions of the habitats provide suitable compensatory mitigation.

If remedial activities are required to meet hydrologic and vegetation success criteria, annual monitoring of any remediated habitat will occur for three successive growing seasons after Remedial Actions were implemented in order to verify that hydrologic and vegetation Performance Standards have been met without further human intervention. Once the three years of consecutive monitoring are complete, enhanced, restored, and created wetland habitats will continue to be monitored during any successive Monitoring Years left within the 5-year initial monitoring period.

<table>
<tr><th colspan="14">Table 2. Monitoring Schedule</th></tr>
<tr><th>Biological Resource
Component</th><th>Monitoring Frequency</th><th>January</th><th>February</th><th>March</th><th>April</th><th>May</th><th>June</th><th>July</th><th>August</th><th>September</th><th>October</th><th>November</th><th>December</th></tr>
<tr><td colspan="14">**Channel Connections**</td></tr>
<tr><td>*Hydrology*</td><td>Years 1, 3, 5</td><td colspan="12">**X**</td></tr>
<tr><td colspan="14">**Emergent Marsh Vegetation**</td></tr>
<tr><td>*Vegetation*</td><td>Years 1, 2, 3, 4, 5,</td><td></td><td></td><td colspan="3">**X**</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="14">**Invasive Plant Species**</td></tr>
<tr><td>*Vegetation*</td><td>Years 1, 2, 3, 4, 5</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">**X**</td><td></td><td></td><td></td></tr>
<tr><td colspan="14">**Zooplankton/Phytoplankton**</td></tr>
<tr><td>*Plankton*</td><td>Years 1, 3, 4</td><td></td><td colspan="5">**X**</td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="14">**Fish**[1]</td></tr>
<tr><td>*Juvenile Surveys*</td><td>Years 2 through 5</td><td></td><td></td><td></td><td></td><td>**X**</td><td></td><td>**X**</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>*Spawner Surveys*</td><td>Years 2 through 5</td><td></td><td>**X**</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>**X**</td></tr>
<tr><td>**Aerial Photographs**</td><td>Years 1, 3, 5</td><td></td><td></td><td></td><td></td><td></td><td></td><td colspan="3">**X**</td><td></td><td></td><td></td></tr>
</table>

[1] Fish monitoring will be conducted during years 2 through 5 of the establishment period until target species (smelt and/or salmon) are documented onsite.

6.8 Photo Documentation

Photo documentation of the Bank will occur during all monitoring years. Twenty locations will be selected to illustrate year-to-year progress of the Bank. Photo locations will be recorded with Global Positioning System (GPS) equipment and subsequent photos will be taken from the same location each year.

6.9 Monitoring Reports

The Bank Sponsor shall submit reports to each member of the CBRT, in hard copy and in editable electronic format, on or before December 31st of each year following the Bank Establishment Date. Each report shall cover the period from November 1st of the preceding year (or if earlier, the Establishment Date for the first annual report) through October 31st of the current year (the "Reporting Period").

6.9.1 Habitat Monitoring Reports

During the habitat establishment period, Bank Sponsor shall submit habitat monitoring reports during years 1, 2, 3, 4, and 5. After the habitat is established, habitat monitoring reports will be submitted in Year 10 and every 10 years thereafter.

The original monitoring period may be extended upon a determination that hydrologic and/or vegetation Performance Standards have not been met or the plantings are not on track to meet them (e.g., high mortality rate of vegetation). The monitoring requirements may also be revised in cases where Adaptive Management or remediation is required.

The monitoring reports will provide the CBRT with sufficient information to assess whether the Bank is meeting Performance Standards, and to determine whether a compliance visit is warranted. Bank Sponsor may submit monitoring reports electronically or in hard copy. The CBRT may withhold Credit releases or suspend approval of Credit sales if Bank Sponsor fails to submit complete and timely monitoring reports.

Monitoring reports will include a Monitoring Report Narrative that provides an overview of site conditions and functions. This Monitoring Report Narrative should be concise and generally less than 10 pages.

Monitoring reports will also include appropriate supporting data to assist the CBRT in determining how the site is progressing towards meeting Performance Standards. Such supporting data may include plans (such as as-built plans), maps, and photographs to illustrate site conditions, as well as the results of functional, condition, or other assessments used to provide quantitative or qualitative measures of the functions provided by the mitigation area.

The monitoring report narrative will include the following:

1. Project Overview (1 page)
    a. Bank Name
    b. Name of party(ies) responsible for conducting the monitoring and the date(s) the inspection was conducted. All persons who prepared the report, did the monitoring, and/or wrote or edited the text will be listed.

c. A brief paragraph describing the purpose of the approved project, acreage and type of aquatic resources impacted, and mitigation acreage and type of aquatic resources authorized to compensate for the aquatic impacts.

d. Written description of the location, any identifiable landmarks of the compensatory mitigation project including information to locate the site perimeter(s), and coordinates of the mitigation site (expressed as latitude, longitudes, UTMs, state plane coordinate system, etc.).

e. Short statement on whether the Performance Standards are being met.

f. Dates of any recent corrective or maintenance activities conducted since the previous report submission.

g. Specific recommendations for any additional corrective or Remedial Actions.

2. Requirements (1 page). List the monitoring requirements and Performance Standards, as specified in the approved conservation banking agreement and evaluate whether the Bank is successfully achieving the approved Performance Standards or trending towards success. A table is a recommended option for comparing the Performance Standards to the conditions and status of the developing site.

3. Summary Data (maximum of 4 pages). Summary data should be provided to substantiate the success and/or potential challenges associated with the project. Photo documentation may be provided to support the findings and recommendations referenced in the monitoring report and to assist the CBRT in assessing whether the Bank is meeting applicable Performance Standards for that monitoring period. Submitted photos should be formatted to print on a standard 8 ½-inch by 11-inch piece of paper, dated, and clearly labeled with the direction from which the photo was taken. The photo location points should also be identified on the appropriate maps.

4. Maps and Plans (maximum of 3 pages). Maps should be provided to show the location of the Bank relative to other landscape features, habitat types, locations of photographic reference points, transects, sampling data points, and/or other features pertinent to the mitigation plan. In addition, the submitted maps and plans should clearly delineate the Bank perimeter. Each map or diagram should be formatted to print on a standard 8 ½-inch by 11-inch piece of paper and include a legend and the location of any photos submitted for review. As-built plans may be included.

5. Conclusion (1 page). A general statement should be included that describes the conditions of the Bank. If Performance Standards are not being met, a brief explanation of the difficulties and potential Remedial Actions proposed by Bank Sponsor, including a timetable, will be provided.

6. Additional Information. The monitoring reports shall provide the following additional information.

   a. Interim Management – The report shall contain an itemized account of the management tasks conducted during the reporting period in accordance with the Interim Management Plan, including the following:

      1) A description of each management task conducted, the dollar amount expended and time required; and

2) The total dollar amount expended for management tasks conducted during the reporting period.

b. Financial Operation – the report shall include information on financial operations including an itemized account of any and all activity of Bank Sponsor regarding the Construction Security, Performance/ Contingency Security, and the Endowment Fund.

c. Distribution list – the report shall include the names, titles, and companies/ agencies of all persons receiving a copy of the report.

7.0 REMEDIAL ACTIONS

Minor corrective measures not requiring notification or approval of the Resource Agencies (e.g., prevention of unexpected runoff, prevention of unauthorized access to the area by placing locks on gates, etc.) will be carried out by the Land Manager within sixty (60) days of identification of the problem, unless site conditions warrant delay (i.e., if soil is saturated and equipment would damage the upland habitat in the Bank, it may be necessary to delay work until conditions improve). All other corrective actions will take place when conditions are best suited for restoration to occur, and after the Resource Agencies have been notified or the Land Manager has received approval. A list of potential remediation guidelines are described in Table 3.

Table 3. Remediation Guidelines for the Bank

Type of Disturbance	Mitigation Guideline
Tules fail to establish in created emergent marsh complex	If tules fail to establish, replanting of well distributed tule root mass clumps may occur.
Lowered levee fails to created marsh areas	If marsh areas are not establishing along the lowered levee area, the potential causes of any deficiency will be evaluated. If natural causes, such as low water levels, or drought are not the cause of the deficiency, then re-excavating areas of the failed marsh areas will be considered.
Tidal pilot channels and breaches become blocked by debris or sediment	If tidal pilot channels or breaches become blocked by debris or sediment such that performance standards are not being met, the potential causes will be evaluated. If it is determined that conditions will not likely be remedied by natural processes, then re-excavating the areas of the blocked tidal channels will be considered.
Nuisance Vegetation establishes onsite during the interim period.	Should nuisance vegetation establish during the interim period, then the methods described in Element A.2 of the Long Term Management Plan (Exhibit D-5) will be employed until the problem vegetation is controlled.

8.0 INITIATING PROCEDURES

Prior to Bank closure, if Bank Sponsor or any member of the CBRT discovers any failure to achieve the hydrologic and vegetation Performance Standards or any injury or adverse impact to the Bank Property as preserved, restored, or enhanced, the CBRT may require Bank Sponsor, to develop and implement a Remedial Action Plan to correct such condition. It should be noted, however, that variations in conditions can affect the rate at which habitats establish. Mitigation habitats that do not meet one of the Performance Standards in the early phase of monitoring may still have functional value and may achieve the Performance Standard at a later point in the monitoring period. In scenarios where success criteria are not met, yet progressive improvement in habitat conditions is evident (e.g., yearly increase in vegetative cover), an appropriate alternative to remediation could include an extension of the Initial Monitoring Period.

In the event that Remedial Action becomes necessary, Bank Sponsor will develop a Remedial Action Plan and submit it to the CBRT within 60 days of the date of written notice from the CBRT. The Remedial Action Plan shall identify and describe proposed actions to achieve Performance Standards or repair adverse impacts to the Plan Area Property, and set forth a schedule within which Bank Sponsor will implement those actions. Bank Sponsor will, at Bank Sponsor's cost, implement the necessary and appropriate Remedial Actions in accordance with the Remedial Action Plan approved by the CBRT.

If Remedial Actions become necessary, the proposed location for these would be within the boundaries of the Bank site. No alternative locations are proposed.

Should disputes occur between the members of the CBRT about application of the Development Plan or proposed Remedial Actions, adjustments shall only occur once the CBRT have reached agreement on the actions to be taken.

9.0 CONTINGENCY FUNDING MECHANISM

Bank Sponsor will fund the interim management and long-term maintenance, monitoring and management of the Bank. Exhibit C and Exhibit D to the CBEI provide detailed information on some of the securities described below. To ensure the construction, performance, and interim management measures are fulfilled, Bank Sponsor will furnish the following securities:

- Construction Security: Prior to the first Credit Release, Bank Sponsor shall furnish to California Department of Fish and Wildlife (CDFW) a Construction Security in the amount of 100% of a reasonable third party estimate for habitat construction on the Bank Property in accordance with the Development Plan. The Construction Security shall be in the form of an irrevocable standby letter of credit. Bank Sponsor shall ensure that the full amount of the Construction Security shall remain in effect throughout the performance of habitat construction on the Bank Property in accordance with the Development Plan. Provided, however, that if all such activities are completed in accordance with the Development Plan prior to the date on which the Bank Sponsor would otherwise be required to furnish the Construction Security, and then no Construction Security shall be required.

- Performance Security: Concurrent with the Transfer of the first Credit, Bank Sponsor shall furnish to CDFW a Performance Security in the amount of 20% of the construction cost. The Performance Security shall be in the form of an irrevocable standby letter of credit or cashier's check. Bank Sponsor shall ensure that the full amount of the Performance Security shall remain in effect until the CBRT determines that all of the hydrologic and vegetation Performance Standards have been met and all Remedial Action required under Section VIII.F has been completed.

- Interim Management Security: Concurrent with the Transfer of the first Credit, Bank Sponsor shall furnish to CDFW Interim Management Security in the amount specified in **Exhibit D-1**. The amount of the Interim Management Security shall be equal to the estimated cost to implement the Interim Management Plan during the first three years of the Interim Management Period, as set forth in the Interim Management Security Analysis and Schedule (Exhibit D-1). The Interim Management Security shall be in the form of an irrevocable standby letter of credit *or* a cashier's check. The Bank Sponsor shall ensure that the full amount of the Interim Management Security shall remain available in accordance with Section VIII.E.1.c.of the CBEI until the end of the Interim Management Period.

10.0 COMPLETION OF MITIGATION RESPONSIBILITIES

10.1 Notification

When final hydrologic and vegetation Performance Standards have been met, Bank Sponsor will include a notification in the annual report that the Initial Monitoring Period has been completed.

10.2 Agency Confirmation

If any of the CBRT members request a site visit to confirm the completion of the mitigation effort, Bank Sponsor will provide site access.

11.0 REFERENCES

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Figures

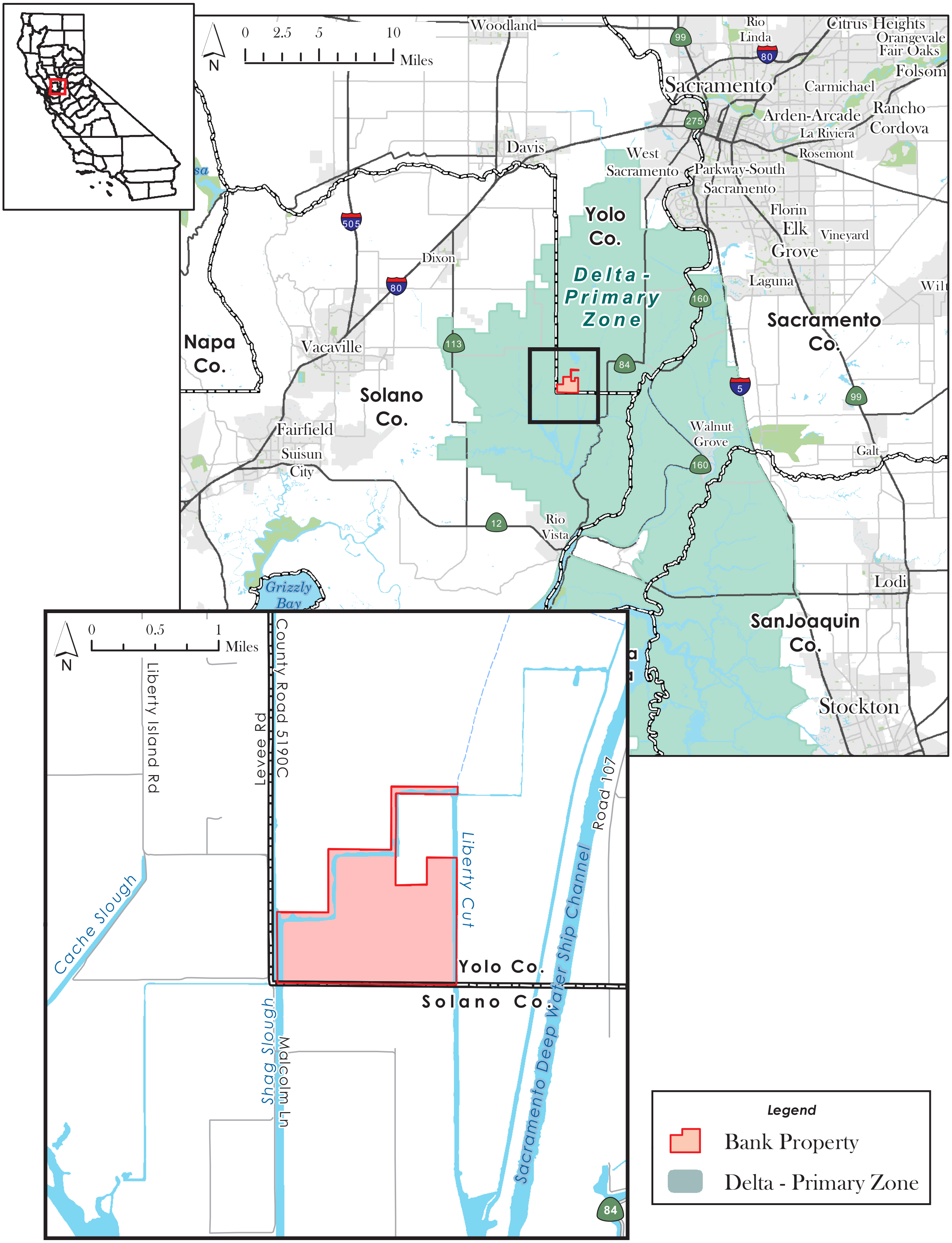
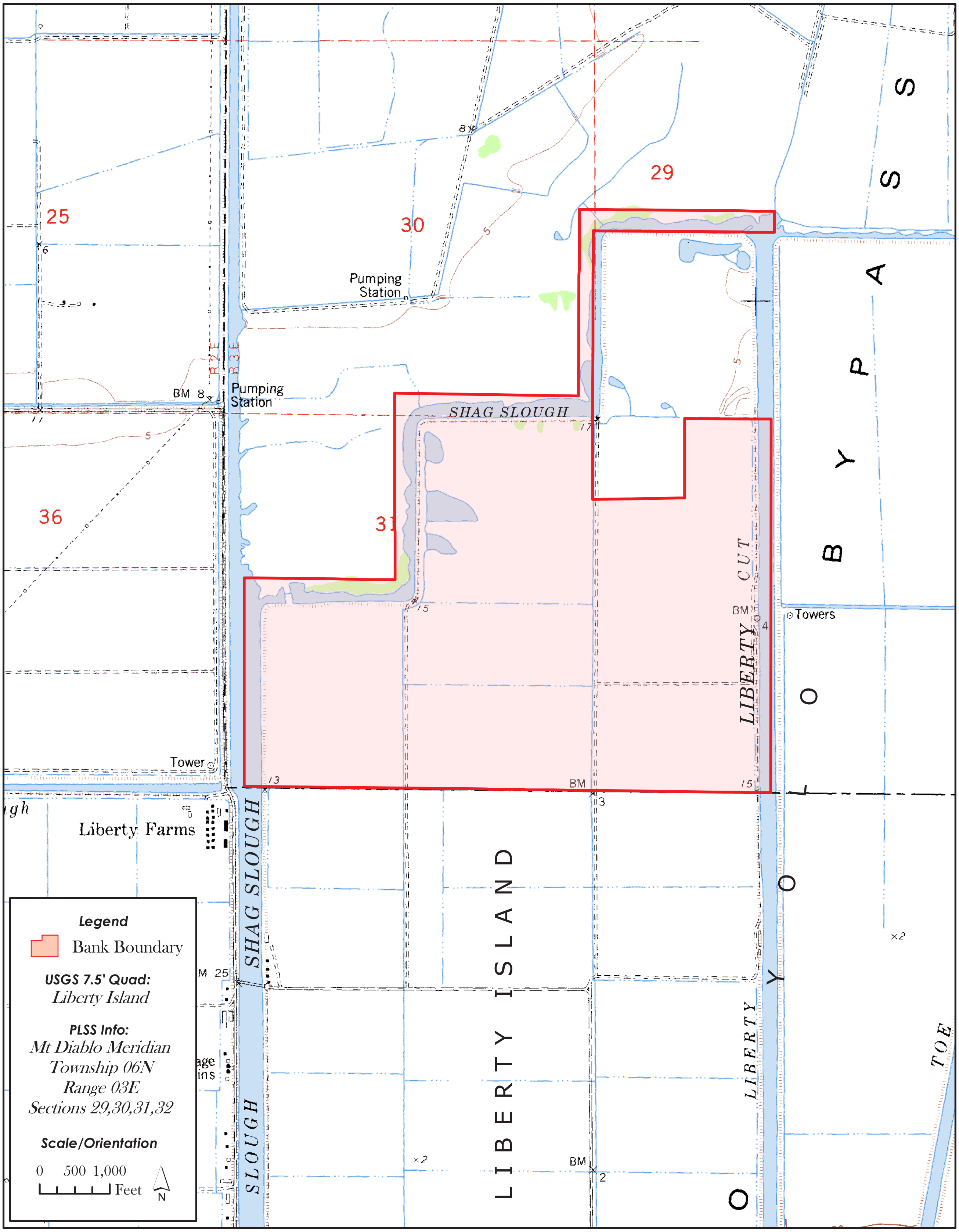


Figure 1
Regional Vicinity



WILDLANDS

North Delta Fish Conservation Bank
Habitat Development Plan

Figure 2
Bank Location

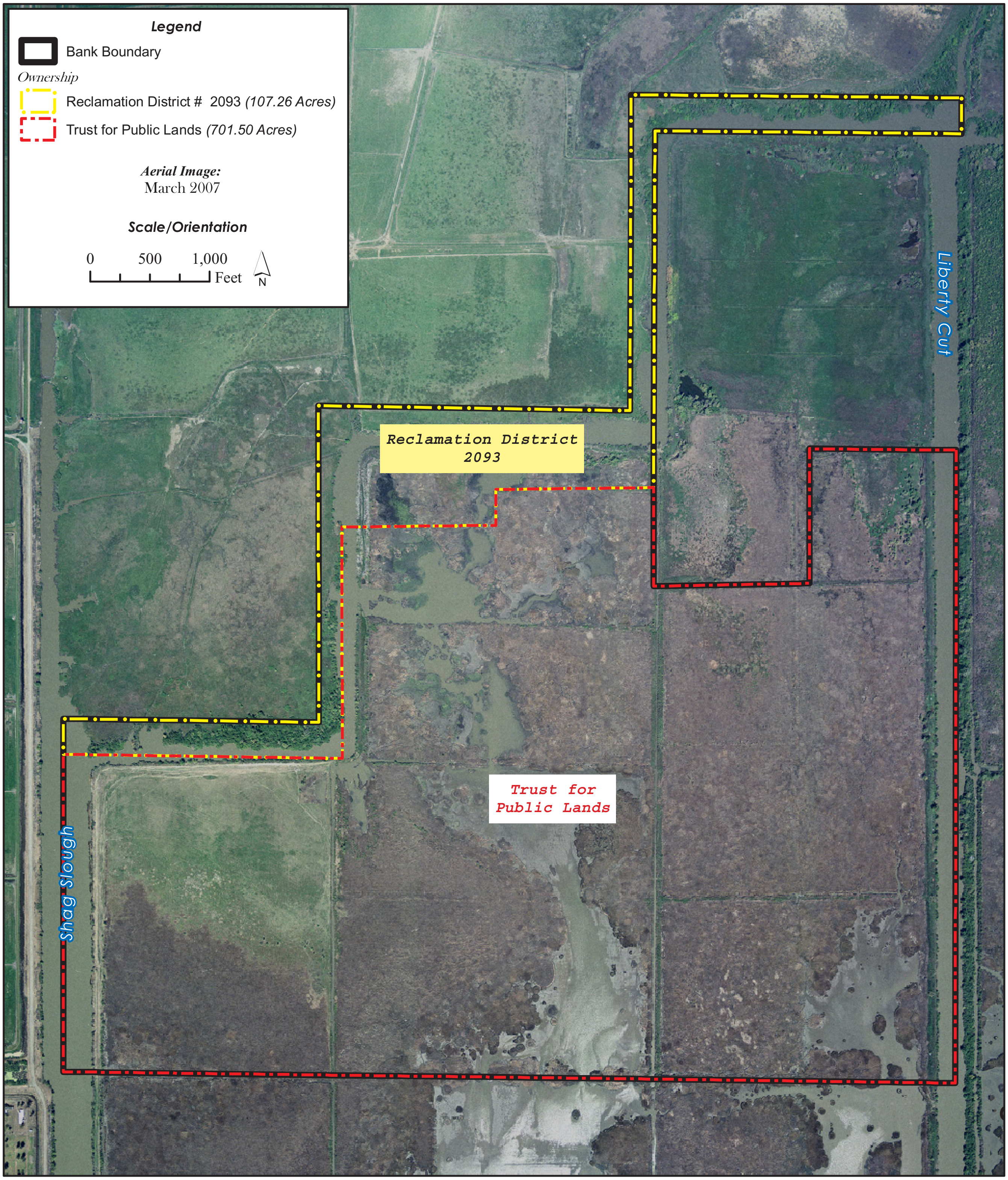
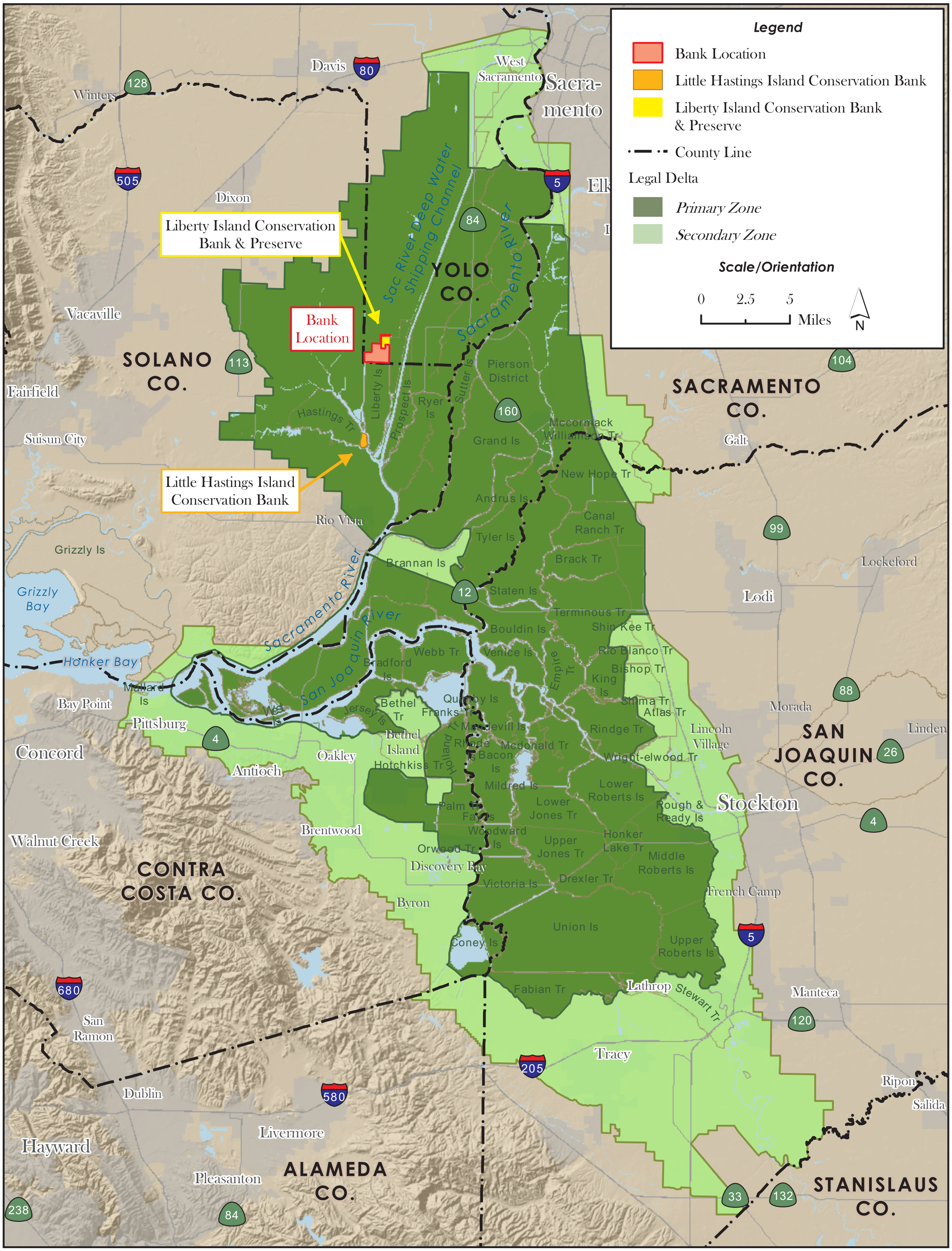


Figure 3
Property Ownership


Legend
Bank Location
Little Hastings Island Conservation Bank
Liberty Island Conservation Bank & Preserve
County Line
Legal Delta
Primary Zone
Secondary Zone
Scale/Orientation
0 2.5 5 Miles
N
Liberty Island Conservation Bank & Preserve
Bank Location
Little Hastings Island Conservation Bank
YOLO CO.
SOLANO CO.
SACRAMENTO CO.
SAN JOAQUIN CO.
CONTRA COSTA CO.
ALAMEDA CO.
STANISLAUS CO.
Sac River Deep Water Shipping Channel
Sacramento River
San Joaquin River
Davis
Winters
Dixon
Vacaville
Fairfield
Suisun City
Rio Vista
West Sacramento
Sacramento
Galt
Lodi
Lockeford
Stockton
Antioch
Pittsburg
Bay Point
Concord
Oakley
Brentwood
Discovery Bay
Byron
Walnut Creek
San Ramon
Dublin
Livermore
Pleasanton
Hayward
Tracy
Lathrop
Manteca
French Camp
Ripon
Salida
Morada
Linden
Lincoln Village
Grizzly Is
Grizzly Bay
Honker Bay
Pierson District
Grand Is
Andrus Is
Tyler Is
Brannan Is
Staten Is
Bouldin Is
Venice Is
Webb Tr
Bradford Is
Bethel Tr
Bethel Island
Hotchkiss Tr
Quimby Is
Mandeville Is
Bacon Is
Mildred Is
Palm Tr
Woodward Is
Orwood Tr
Victoria Is
Union Is
Coney Is
Fabian Tr
Stewart Tr
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Middle Roberts Is
Lower Roberts Is
Rough & Ready Is
Lower Jones Tr
Upper Jones Tr
Drexler Tr
Honker Lake Tr
Rindge Tr
Wright-elwood Tr
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Canal Ranch Tr
New Hope Tr
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Sutter Is
Hastings Tr
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Jersey Is
Holland Tr
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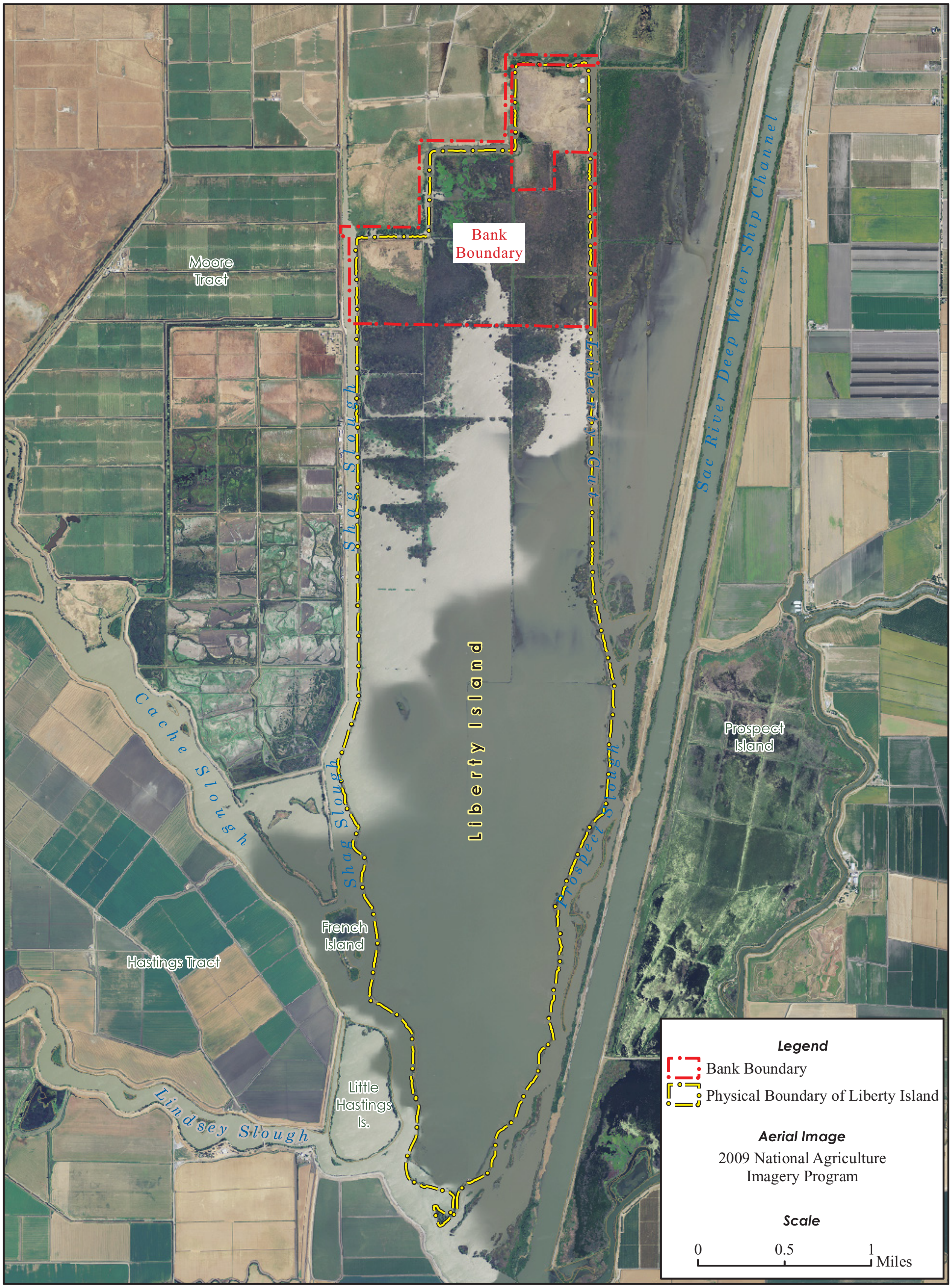
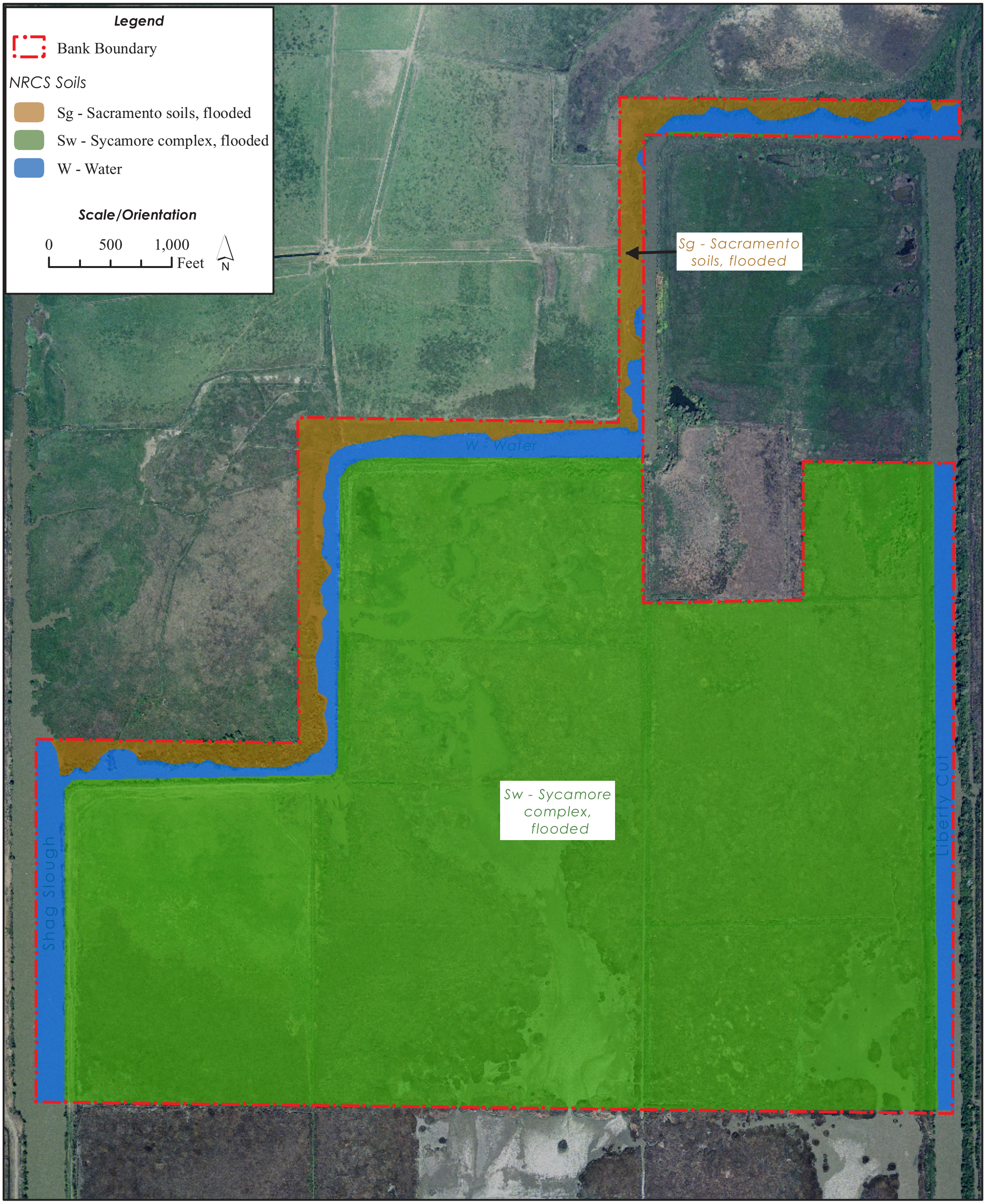

Bank Boundary
Moore Tract
Shag Slough
Sac River Deep Water Ship Channel
Liberty Island
Cache Slough
Prospect Island
Prospect Slough
French Island
Hastings Tract
Little Hastings Is.
Lindsey Slough
Legend
Bank Boundary
Physical Boundary of Liberty Island
Aerial Image
2009 National Agriculture Imagery Program
Scale
0
0.5
1
Miles



WILDLANDS

Figure 6
Soils

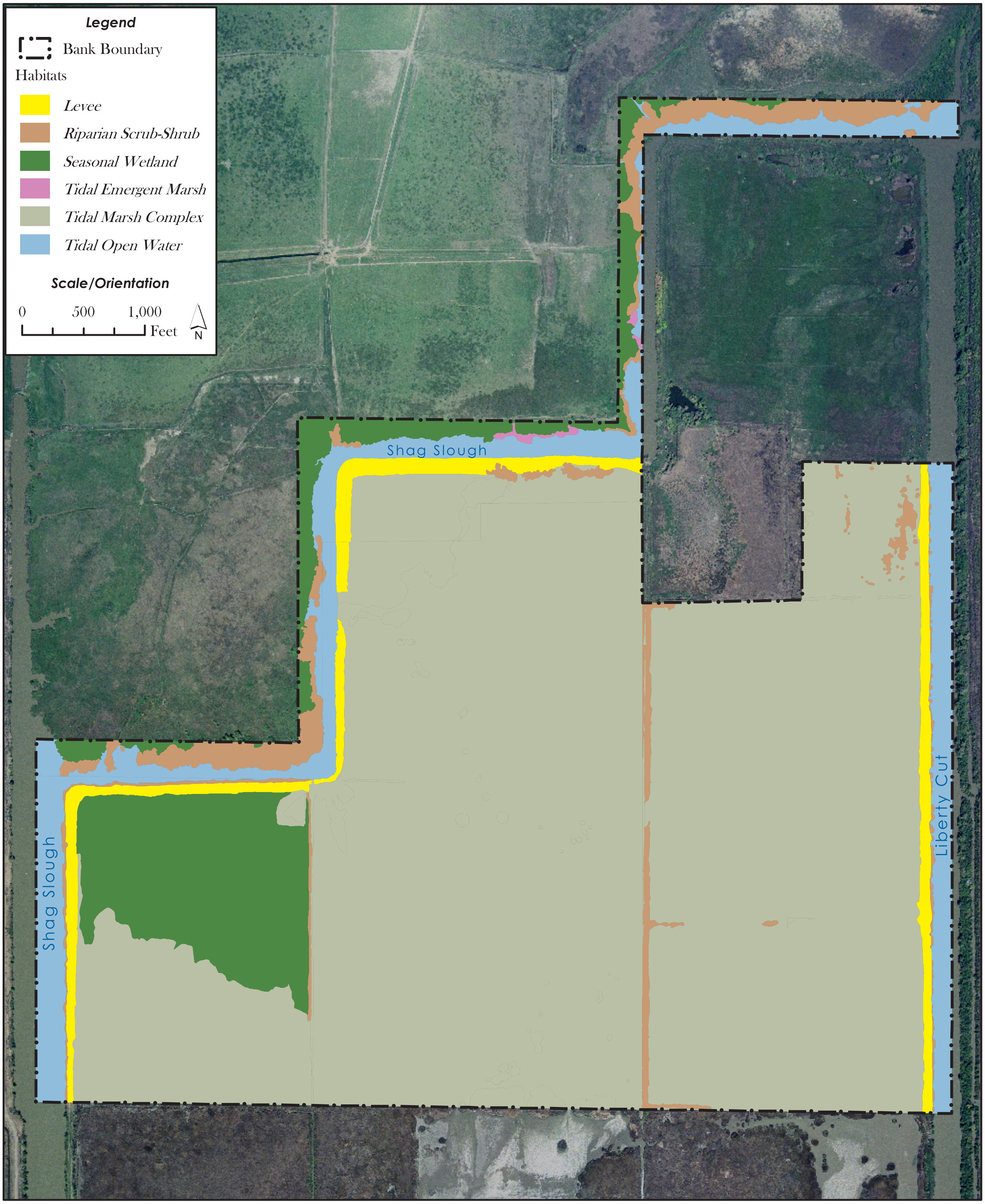


Figure 7
Existing Habitats

LEGEND

Bank Boundary

Existing

- Tidal Emergent Marsh Complex - Enhanced
- Riparian Scrub Shrub / Shaded Riverine Aquatic Cover (SRA) - Preserved
- Riparian Scrub Shrub and Seasonal Wetland Floodplain - Preserved
- Levee Upland - Preserved
- Tidal Channels - Enhanced
- Ditches
- Water Control Structure to be Removed

Proposed

- Tidal Emergent Marsh Complex - Created (Excavation and/or Rock Removal / Tule Planting)
- Tule Planting / Shaded Riverine Aquatic Cover (SRA)
- Channels
- Levee Breach
- Enhanced Tidal and Bypass Flow

0 500' 1000'

NORTH

Appendix A

Northern Liberty Island Fish Restoration Project Assessment by HT Harvey

MEMORANDUM

PROJECT # 3073-01

TO: **Julie Mentzer, Wildlands, Inc.**

FROM: **Ron Duke, Sharon Kramer, and John Bourgeois**

DATE: **26 January 2010**

SUBJECT: **Northern Liberty Island Fish Restoration Project Assessment**

INTRODUCTION

This memorandum summarizes H. T. Harvey & Associates' assessment of potential ecological benefits to delta smelt and salmonid habitat resulting from Wildlands, Inc.'s (Wildlands) proposed restoration activities on the Northern Liberty Island Fish Restoration Project (Project). Restoration of the Project area will occur after the restoration activities on Wildlands' Liberty Island Conservation Bank (Bank) are completed. The Project's restoration design ties into the Bank's design; the Project's purpose is to benefit fish habitat, specifically for delta smelt (*Hypomesus transpacificus*) and salmonids (*Oncorynchus spp*.). Liberty Island is located in unincorporated Yolo County, California at the southern end of the Yolo Bypass (Figure 1). The Project restoration design is represented in Figure 2.

The scope of our assessment was largely determined by the California Department of Fish and Game (CDFG), who performed a preliminary review of the initial Project design and provided feedback to Wildlands during several meetings. CDFG requested that Wildlands provide a biological basis by which to judge the extent of habitat enhancement likely to occur. CDFG also asked that the extent of some of the Project actions be reexamined given that natural channels are already evolving on the site. Therefore, we examined the restoration plan, provided suggestions for changes where appropriate, provided a rationale for the proposed changes, and assessed the potential net benefits to the target species.

The Project area is located to the south and west of the existing Bank, and includes the 1st and 2nd "stair step" levees. The Project area has limited hydrologic connectivity to the surrounding channels due to high levees on its north, east and west boundaries. A small breach and a faulty water control structure along the northern project boundary allow some hydrologic connectivity to the Project area, but most hydrologic connectivity is from the south, having been created when the levees on the south portion of Liberty Island breached in 1997. Extensive areas of shallow open water and freshwater tidal wetlands have developed over the past decade. As the site elevation increases to the north, the habitat transitions from shallow open water, to marsh, to seasonal wetland/grassland habitat. Remnant minor levees and ditches associated with the former agricultural uses of the site also remain on site.

Project Goal and Objectives

The Project goal is to create and enhance delta smelt and salmonid habitat. To accomplish this goal, we reviewed the proposed restoration in consideration of four primary objectives:

1. Increase the frequency of inundation by flood flows from the Yolo Bypass
2. Increase the total area of habitat for native fish species;
3. Improve connectivity between areas of presumed high quality fish habitat;
4. Reduce the potential for predation on native fish species.

Existing fish habitat conditions are described below so that we have a baseline for comparing the potential effects and benefits of Project activities.

Existing fish habitat

The Project area is approximately the upper third of Liberty Island (excluding the Bank) and includes some limited shallow water habitat created by levee breaks. The Project area is hydraulically connected to a large deeper open water area to the south that eventually drains to the Sacramento River. Shag Slough lies to the west; the Liberty Cut lies to the north, and the Yolo Bypass toe drains to the east of the site. Tidal circulation currently occurs through hydraulic connections to the south with the main open water area of Liberty Island and the Sacramento River, and to the north through two levee breaks along the Liberty Cut. During sufficiently large rain and runoff events that flood the Yolo Bypass, flows can also overtop the levees on the north end of the site, but more typically, flows in the Yolo Bypass are diverted by these levees into Shag Slough or the toe drain.

Fish habitat types include open water or pelagic habitat similar to the habitat found in the southern portion of Liberty Island (0.3 m to 20 m depth; Lehman et al. 2009). Pelagic open water provides year-round habitat for juvenile and adult delta smelt; larval, juvenile and adult life stages of delta smelt are known to occur in Liberty Island (Sommer and Nobriga undated). Shallower tidal channels occur in the northern third of Liberty Island (likely <2 m depth and some are exposed at low tides), with emergent marsh vegetation and non-native floating aquatic vegetation. Tidal channel area and connectivity are currently restricted and likely promote non-native fish species habitat (Marshall et al. 2005). However, the deeper and larger slough surrounding Liberty Island provides habitat for sturgeon, most likely white sturgeon (http://www.sacdelta.com/fishing/index.html#STURGEON).

Liberty Island provides habitat for several native and non-native fish species (Table 1); species distribution is associated with habitat types found in Liberty Island. Relative abundance of native fish species and special status fish species is greater in the open water continuously submerged habitats to the south of the project area (Marshall et al. 2005, Nobriga et al. 2005), whereas larval stages of non-native species are more abundant in the northern tidally influenced channelized habitats, indicating that spawning occurs in that portion of Liberty Island (Marshall et al. 2005).

Table 1. Native and non-native fish species reported at Liberty Island.

Fish species[1]	Scientific name	Occurs at Yolo Bypass[3]
	Native species	
Delta smelt[2]	*Hypomesus transpacificus*	X
Sacramento splittail[2]	*Pogonichthys macrolepidotus*	X
Chinook salmon[2]	*Oncorhynchus tshawtscha*	X
Prickly sculpin	*Cottus asper*	X
Longfin smelt	*Spirinchus thaleichthys*	X
Sacramento sucker	*Catostomus occidentalis*	X
Hitch	*Lavinia exilicauda*	
Threespine stickleback	*Gasterosteus aculeatus*	X
	Non-native species	
Threadfin shad	*Dorosoma petenense*	X
Inland silversides	*Menidia beryllina*	X
Striped bass	*Morone saxatilis*	X
Common carp	*Cyprinus carpio*	X
Logperch	*Percina macrolepida*	
Shimofuri goby	*Tridentiger bifasciatus*	X
American shad	*Alosa sapidissima*	X
Crappie sp.	*Pomoxis* sp.	X
Golden shiner	*Notemigonus crysoleucas*	
Yellowfin goby	*Acanthogobius flavimanus*	X
Black crappie	*Poxomis nigromaculatus*	
White catfish	*Ameiurus catus*	X
Goldfish	*Carassius auratus*	X
White crappie	*Pomoxis annularis*	
Channel catfish	*Ictalurus punctatus*	
Sacramento blackfish	*Orthodon microlepidotus*	X
Wagasaki	*Hyomesus nipponensis*	X
Bluegill	*Lepomis macrochirus*	
Fathead minnow	*Pimephales promelas*	

[1] Marshall et al. 2005
[2] Sommer and Nobriga undated
[3] Sommer et al. 2004

RESTORATION PLAN ASSESSMENT

In this assessment, we first evaluated whether the Project design would meet the 4 project objectives stated above through literature review and professional judgment. We then determined if the Project activities could be modified such that additional delta smelt and salmonid habitat could be provided, or such that impacts on existing habitat could be minimized. Factors we considered in assessing the original Project activities included:

- Flood flows. The benefits of flood flows in the Yolo Bypass for juvenile salmonids, delta smelt and other native fishes has been well established (Sommer et al. 2004, Nobriga et al. 2005, Feyrer et al. 2006). The project's principal component, lowering the levees on the north side of the project area, is designed to increase the frequency of such flood flows between Yolo Bypass and the project area.

- Tidal drainage. Tidal drainage refers to how readily water can flow from within the Project area to outside of it; the degree of tidal drainage is demonstrated by the depth and duration of tidal inundation within the Project area, compared to tides outside of it. Poor tidal drainage can result in ineffective channels, and can delay or inhibit habitat development.
- Disturbance of protected habitats. While the Project objectives are to improve fish habitat, the restoration activities should minimize disturbance of protected habitats and loss of existing marsh habitat.
- Cost effectiveness. Construction costs of restoration features can be reduced if natural processes can be employed to further develop those features. Many restoration features can be constructed quickly but require significant construction activity (such as filling, excavation, planting); the same restoration features can often be allowed to evolve over time by constructing the primary restoration features and then allowing natural physical and biological processes (such as sedimentation, scour, vegetation recruitment) to complete the restoration development. Restoration can be more cost effective if the latter approach is taken.
- Potential for fish stranding. While considering improvements in hydraulic connectivity, restoration activities should not create ponded areas that are hydraulically isolated from the main channels at low tide because this would increase the potential of fish stranding.

Our evaluation of how well the Project design meets the Project objectives, and our suggested modifications to the Project design, are described below.

Objective #1: Increase the frequency inundation by flood flows from the Yolo Bypass

The primary feature of the Project design is to lower the levees on the Project's north end to approximately the same elevation as the adjoining land. This levee lowering is a common feature with the restoration plan for the adjoining Conservation Bank. This levee lowering will allow flood flows to pass directly over the site whenever there is flow exiting the Yolo Bypass. While no hydrologic modeling has been performed to predict the magnitude of the increase in frequency, we expect it to be significant.

As it functions now, the site floods as water surface elevations increase in the bypass, but does so indirectly through the levee breaches and through backwater flooding from the south; unless flows are sufficiently high to top existing levees at the project site, they divert to shag slough, Liberty cut or the toe drain. The levee lowering will allow the flood waters to directly flow onto the project site.

Objective #2: Increase the total area of habitat for native fish species

The increase in flood flow frequency across the site will inundate the higher portions of the site, including the seasonal wetland area which is predominant in the northern portion of the western stair step. Similar to other agricultural habitats in the Yolo Bypass, inundation of these seasonal wetlands will provide high quality foraging habitat for native fishes. Also, the remnant agricultural levee system will likely erode over time allowing more tidal flow to the site.

The Project proposes to excavate a series of channels on the site. This design is based on the long-standing concept that the best way to create habitat for delta smelt is to focus on establishing such channel systems. However, recent investigations at Liberty Island have shown that shallow open-water habitat with good turbidity is very important to the species (Sommer and Nobriga undated).

Our assessment is that channels within the Project will likely provide only a marginal increase in habitat area for native fish species. Moreover, studies suggest that non-native species are favored in tidal channels of Liberty Island, whereas native species are more abundant in open water habitats in the southern portion of Liberty Island (Marshall et al. 2005, Nobriga et al. 2005). Therefore, excavation of new channels increases the habitat area but the increase will likely favor non-native species, is only an incremental increase, and is likely not in proportion to the effort required. Based largely on this assessment, we suggest that the design could change somewhat, reducing the channel excavation and instead encouraging channels to form by more selectively excavating a few pilot channels. These suggestions are outlined in more detail below.

Objective #3: Improve connectivity between areas of presumed high quality fish habitat

Lowering the northern levees, adding some breaches, and improving internal channel connectivity, as described in the Project design, would improve connectivity and would therefore meet Objective #2. Increasing habitat connectivity and frequency of flooding throughout the Project site is an effective way to increase habitat values for native fish. In addition to providing improved access to high quality habitat areas for fish, nutrient flux and overall productivity may be improved through better connectivity to the larger Yolo Bypass area, as well as internally at Liberty Island between the existing marsh and the shallow open water areas. Yolo Bypass and the open water in the southern portion of Liberty Island are known to provide high quality native fish habitat (Sommer et al. 2004, Nobriga et al. 2005, Marshall et al. 2005); increasing connectivity is likely to provide benefits.

When examining the site, we noted that a natural drainage divide could be used to help refine the locations of levee breaches and channel creation (Figure 3). A drainage divide in a tidal marsh denotes the area between two hydrologic units, and acts much like a ridgeline dividing two watersheds. Review of available topography supported our observations made during the field visits to the marsh habitats on site. Thus, we suggest that the restoration plan be refined to recognize the divide, and help enhance this drainage pattern with a few selected ditch blocks in the remnant agricultural water system, eliminating the central excavated channel. To further improve the hydrology of the site's northern portion from what was originally proposed, we suggest creating more breaches in the levee and changing the design to emphasize and enhance this northern tidal exchange. To encourage better tidal exchange from the South, excavation of the southern portion of the originally proposed central channel would be a benefit. There is a remnant levee on the southern border that appears to be restricting tidal flows.

The recommended additional levee breaches include widening the existing small breach on the first (western) “step,” adding a breach at the western end of the second “step,” and removing the existing water control structure at the eastern end of the of the second “step”. These breaches will increase hydraulic connectivity at key locations and help facilitate flushing of the non-native floating aquatic vegetation (see below).

Our recommended modifications to the Project design include using ditch blocks and fewer connector channels to facilitate flow that promotes connectivity and future habitat development over time and along more sustainable pathways. The proposed internal channels are limited but strategically located to increase connectivity to high quality fish habitat within the site. Ditch blocks are recommended in the vicinity of the existing drainage divide to prevent the existing straight-line ditches from capturing all of the additional flows and becoming the primary channels through the site.

Objective #4: Reduce the potential for predation on native fish

Reducing the number and coverage of invasive aquatic weeds would likely reduce predation on native fish because the weeds are habitat for non-native predatory fish; therefore, these activities would likely meet Objective #4. The weed that is recommended as the focus to be removed is the creeping water primrose (*Ludwigia peploides* ssp. *peploides*), an invasive aquatic weed that grows rapidly in shallow, slow moving waterways and is present in large areas in the northern portions of Liberty Island. Although the subspecies is native to California, its statewide impact has been classified as high (California Invasive Plant Council no date).

Researchers are just beginning to understand the biology of *Ludwigia*, and control methods have not been developed and tested. Most *Ludwigia* research in California was in response to the invasion of *Ludwigia sp.* in the Laguna de Santa Rosa (Grewell and Futrell 2009). The Laguna de Santa Rosa system is a low energy, low-gradient system with frequent flooding, but with few scouring flows. High sediment retention and deposition occurs within the channels and floodplains. Factors that typically regulate aquatic weeds are light, hydrology, temperature, and nutrients and biological interactions (Grewell and Futrell 2009), yet some factors that typically decrease aquatic plant growth appear to benefit *Ludwigia* growth within the Laguna system; these factors include polluted stormwater, elevated water temperature, and low dissolved oxygen. Excess phosphorus and nitrogen in particular, combined with sunny conditions, favor plant growth and may be contributing to the success of the *Ludwigia* invasion at Laguna de Santa Rosa (Grewell and Futrell 2009).

The Invasive Management Plan for the Laguna de Santa Rosa suggests flooding or draining as options of management alternatives of *Ludwigia*. Other recommendations include mechanical or manual biomass removal, use of systemic herbicides, tarping, flaming or crushing, and extensive mechanical excavation and dredging. However, there is still considerable debate about the effectiveness of these methods. Efforts to control invasive plants typically rely on an adaptive management strategy with multiple methods of control and removal, and singular efforts to control invasive plants are rarely effective; this generality is likely to hold for *Ludwigia* control too. The available literature does not indicate that increased flows would necessarily control *Ludwigia*, however, the literature does support that slow moving water tends to increase the invasive potential for *Ludwigia,* with the worst infestations in the Laguna associated with thick sediments in shallow, slow-moving, nutrient rich waters in full sun (Sears et al. 2006). On that basis, we expect that increasing the daily tidal flows by creating new breaches, and increasing the frequency of flood flows by removing the northern levees will reduce the extent of Ludwigia present on the site.

Summary of Suggested Modifications to Project Design

The restoration plan as originally designed by Wildlands largely achieves the objectives outlined above. We suggest some design modifications that can achieve the same objectives while minimizing disturbance to the existing habitats on the site. The changes and modifications we suggest are provided graphically (Figure 3). However, these recommendations are intended to serve as a conceptual design, and further hydrologic analysis is also recommended to refine and further develop habitat enhancement features. The proposed restoration design, which is a combination of Wildlands' original design elements and our recommendations, is summarized below:

- **Levee lowering.** As outlined in the original Wildlands plan, the northern levees should be lowered to restore hydraulic and habitat connectivity, and to increase the frequency of flooding from the Yolo Bypass.
- **Levee breaches.** Levee breaches are excavations through the perimeter levees that open the site to tidal inundation and flow from the adjacent channels. The Wildlands plan showed two breaches, one in each stair step. We suggest retaining the breach in the second stair step, eliminating the proposed breach location in the first stair step, adding an additional breach in the second stair step, removing an existing water control structure, and widening a small existing breach to further increase hydraulic and habitat connectivity (Figure 3). Because the levee lowering will increase flood frequency of the site in a given year, these breaches will increase water circulation through the site on a daily basis. Increasing connectivity at annual as well as daily time scales is important for improving fish habitat.
- **Pilot channels.** Excavating pilot channels has been proposed through the existing marsh and/or upland areas to connect areas of existing high quality fish habitat. However, we suggest minimizing new pilot channels to prevent unnecessary impacts to existing habitat. In addition, we do not see much benefit to native fishes by creating an artificial channel through the existing seasonal wetland habitat in the northwest corner of the project (first stair step). Based on existing information, we believe that the pilot channels proposed in the northwest corner of the project are more likely to support non-native species than native fishes such as Delta smelt (Marshall et al. 2005, Sommer and Nobriga undated).
- **Ditch blocks.** Ditch blocks are intended to inhibit flow through the existing ditches, so that scour and flow are increased through the existing open water areas, channels, and/or pilot channels. This is a new feature added to the Wildlands plan, and is being suggested

to strategically reduce the number of pilot channels necessary while promoting natural channel development.

The general and underlying principle of our recommended modifications is to work with the natural drainage divide (approximated from elevations provided by CDFG), to maximize habitat connectivity, increase channel development, and ultimately improve fish habitat (Figure 3). This would be accomplished through minimal earthwork and reliance on tidal flows and increased flood flows that would scour a channel network that works with the existing internal drainage patterns.

POTENTIAL BENEFITS

Given that the Project area already provides some delta smelt habitat and that natural channels are developing, CDFG requested an evaluation of the additional habitat enhancement likely to occur. In this section, we describe the potential benefits and provide a qualitative assessment of the extent of the habitat enhancement that would result from the Project design activities and our recommended modifications.

Ultimately, the proposed restoration actions will increase habitat values compared with existing conditions. Support for this evaluation is given in the discussion below:

1) Benefits of increased Yolo Bypass connectivity

Project designs and our recommended design changes will increase the current Yolo Bypass connectivity with Liberty Island. Winter and spring flooding of restored marshes in the Sacramento-San Joaquin Delta was shown to support higher densities of native fishes while limiting access of non-native fishes (Grimaldo et al. 2004); this is because native fishes spawn when flows are greater and water temperatures are lower (Nobriga et al. 2005). Compared with the Sacramento River, the Yolo Bypass favors native fishes because of its greater hydrologic variation and seasonal flooding, and its large areas suitable for spawning and rearing (Sommer et al. 2004). Increased connectivity with Yolo Bypass would likely result in increased winter and spring flooding and lower water temperatures at Liberty Island because flows from the Yolo Bypass would reach the site more frequently. This increased seasonal flooding would improve habitat for native fishes at Liberty Island, and likely would provide the greatest benefits to achieving habitat objectives for delta smelt and salmonids (Nobriga et al. 2005).

2) Benefits of tidal channel/connectivity

Currently, tidal flows, not river discharges, are responsible for 90 percent or more of the flux of organic and inorganic materials out of the wetland at Liberty Island (Lehman et al. 2009). This indicates lack of connectivity between the Sacramento River, Yolo Bypass, and Liberty Island. In general, reduced connectivity can lead to nutrient limitations on productivity and reduce carrying capacity of aquatic ecosystems (Cloern 2007). In contrast, hydraulic connectivity amplifies production in food webs because it facilitates greater transport of nutrients from primary producers through consumers (Cloern 2007). Pelagic fishes, such as the delta smelt, depend on zooplankton-phytoplankton food web pathways, while fishes in littoral habitats gain energy from submerged aquatic vegetation and epiphytic algae (Grimaldo et al. 2009). Primary production of diatoms, green algae and chrysophyte phytoplankton in the Liberty Island wetland provides food resources for calanoid copepods (*Eurytemora affinis*) that are important food for juvenile fish, especially delta smelt (Lehman et al. 2009). Improving connectivity of tidal channels at Liberty Island would likely incrementally improve primary production, food resources, and food transport to open water habitats supporting delta smelt and other native pelagic fishes.

3) Benefits of reducing non-native aquatic vegetation at Liberty Island

We have no information on fish using *Ludwigia* in the delta, but we assume that this weed provides habitat similar to (or worse than) other non-native submerged vegetation. Recent studies have shown that submerged aquatic vegetation is used primarily by non-native fish species (Nobriga et al. 2005). Although fish biomass was found to be greater in habitats dominated by submerged aquatic vegetation, these areas had a low abundance of native special-status species including delta smelt, Chinook salmon (*Oncorhynchus tshawytscha*), and splittail (Nobriga et al. 2005). Non-native submerged aquatic vegetation, such as the regionally abundant Brazilian waterweed (*Egeria densa*), was also shown to favor non-native fish abundance (Brown and Michniuk 2007). Therefore, native fishes would likely benefit from restoration actions that maintain and enhance seasonally appropriate abiotic variation (i.e., seasonal flooding) and reduce submerged aquatic vegetation (Nobriga et al. 2005). The northern portion of Liberty Island had a greater abundance of non-native fishes than the southern portion, likely because the northern portion has areas with slow moving water, and has more submerged aquatic vegetation (Marshall et al. 2005). Increased seasonal flooding (achieved by decreasing the levee height along the northern portion of the site) will likely reduce the amount of submerged aquatic vegetation in the north part of Liberty Island and improve habitat for native fishes.

4) Benefits of reducing potential for invasion by the Asian clam, *Corbicula fluminea*

Corbicula fluminea is distributed throughout the Sacramento and San Joaquin drainages; it feeds on phytoplankton and can drastically reduce food availability for juvenile fishes (USGS 2001). Whether this clam occurs at Liberty Island is unknown, although the species is known to occur in close proximity at the confluence of Yolo Bypass and the Sacramento River (Parchaso and Thompson, no date). Large numbers of adults occur in the central Delta but not the north Delta (Parchaso and Thompson, no date), which suggests that habitat conditions are less favorable for the species in the north Delta. Greater variability in abiotic conditions (i.e., Yolo Bypass flows) that occur in the north Delta could be limiting adult growth and survival. Increased tidal connectivity could increase productivity at Liberty Island and enhance food resources for *C. fluminea*. However, a more likely scenario is that increased connectivity between the Yolo Bypass and tidal channels would increase variability in abiotic conditions and reduce potential habitat for this non-native clam.

5) Benefits of improved hydrology and connectivity in the marshes

In an effort to quantify these habitat improvements, we also referred to the hydrology attributes for estuarine wetlands as outlined in the California Rapid Assessment Method for Wetlands

(CRAM) framework (Collins et al. 2008). CRAM is a recently developed estuarine wetland monitoring framework that consists of four primary attributes: Buffer/Landscape Context, Hydrology, Physical Structure, and Biotic Structure. Within each of these attributes, several metrics address specific site conditions. We examined each of these attributes and concluded that: 1) some will not change (e.g., Landscape Context), 2) there will be minor improvements in both the physical and biotic structure of the marsh, and 3) there will be significant improvements in site hydrology due to increased tidal and flood flows. No formal CRAM was performed, but the metrics proved to be illustrative of the potential benefits of the Project.

CRAM's estuarine model assesses the functions of vegetated estuarine wetlands, and has been developed, peer reviewed, and subjected to verification testing. Each metric is assigned a ranking (A, B, C, or D) based on a detailed description of a range of situations for that metric from high quality (A) to degraded (D). Once a ranking has been assigned to each metric, CRAM ultimately develops a composite score for each wetland with values ranging from 1 to 100.

In this Liberty Island application, the hydrology metrics were considered in the context of marsh habitat changes resulting from the proposed restoration actions, and the CRAM framework was used to help understand the potential benefits of the Project. The three hydrology metrics considered in CRAM include Water Source, Hydroperiod, and Hydrologic Connectivity. We would not expect changes in the Water Source metric, but there will be improvements in both the hydroperiod and connectivity of the site.

The Hydroperiod metric examines the frequency and duration of wetland inundation. Artificial restrictions to the natural tidal prism in a tidal wetland from features such as levees, ditches and water control structures decrease the score of a given site. Given the focus of removing these restrictions as part of the Project, the existing conditions would likely be ranked as a B (muted tidal) and the future conditions would be ranked as an A (full tidal).

The Hydrologic Connectivity metric represents the ability of water to flow into or out of an area, and the ability of a wetland to accommodate flood flows. For our purposes, we also considered internal connectivity between areas of high quality fish habitat. The existing levees and berms between individual parcels, as well as the artificial ditch systems in place, correspond with a low CRAM ranking for existing conditions (C, flood waters limited on the site for 50-90% of the wetland by levees). The proposed habitat enhancements that specifically target internal and external hydrologic connectivity, based on the CRAM assessment descriptions, would probably raise the ranking to a B (less than 50% of the boundary constricts flood flows).

Although not designed to assess open water habitat, the hydrology metrics in CRAM provided a qualitative framework to discuss habitat improvements resulting from better hydrologic functioning at Liberty Island. Incremental improvement between existing and future conditions is supported by quality increases in the Hydroperiod and Hydrologic Connectivity metrics.

6) Benefits of integrating other habitat restoration plans

The proposed Yolo Bypass/Cache Slough Complex Restoration Opportunity Area (ROA) is a conservation measure of the Bay Delta Conservation Plan that would restore between 5,000 and

11,000 acres of land adjacent to Liberty Island to tidal action and vegetated tidal marsh; the restoration calls for breaching levees and improving tidal channel connectivity (Harlow et al. 2009). Combining the Yolo Bypass/Cache Slough Complex ROA and the Northern Liberty Island Delta Fish Restoration Project would cumulatively improve tidal connectivity and increased tidal prism over a large area. Additional tidal marsh acreage and increased primary productivity from both restoration projects is expected to increase food resources and available habitat for delta smelt, juvenile Chinook salmon, and juvenile splittail. Food availability and production in the Delta should also increase by exporting organic material and organisms produced in the intertidal channels downstream. However, the Yolo Bypass/Cache Slough Complex ROA would not improve connectivity with Yolo Bypass and increase seasonal freshwater flooding. As a result, the amount of submerged aquatic vegetation and deep-water habitat may increase at the site. This could have the negative effect of increasing habitat for centrarchid fishes that prey on and compete for resources with delta smelt and other native fishes. In contrast, the Liberty Island Project is expected to improve connectivity with the Yolo Bypass and increase seasonal freshwater flooding. These actions are expected to reduce the amount of submerged aquatic vegetation and reduce habitat for non-native fish predators at Liberty Island. Thus, these two restoration projects will likely fulfill different but complementary ecological objectives; the Liberty Island Project could play a more important role in increasing habitat and refugia for delta smelt and other native fishes, while the Yolo Bypass/Cache Slough Complex ROA may improve general productivity and tidal connectivity in the Delta.

OVERALL ASSESSMENT

Although quantitative models could provide numerical estimates of habitat increases from Project designs and our recommended changes, we have used literature review and professional judgment to describe a quantitative anticipated improvement. It is challenging to assign a percent net benefit to native fish when there are still many unknowns about the life history of species such as delta smelt. However, given the rationale discussed above and after considering the CRAM hydrology metrics, we estimate that the proposed improvements at Liberty Island would result in a up to 20% improvement in habitat value. The site will flood more frequently from Yolo Bypass flood flows promoting native species; it will have increased daily tidal circulation (increasing nutrient production and flux); the open water habitats will be better connected, and the invasive *Ludwigia* will be reduced. We feel that the plan proposed by Wildlands would have achieved almost the same benefits to the system, but with greater disturbance to existing habitats, and that the central channel would likely have reverted to two-way flow with deposition at the drainage divide.

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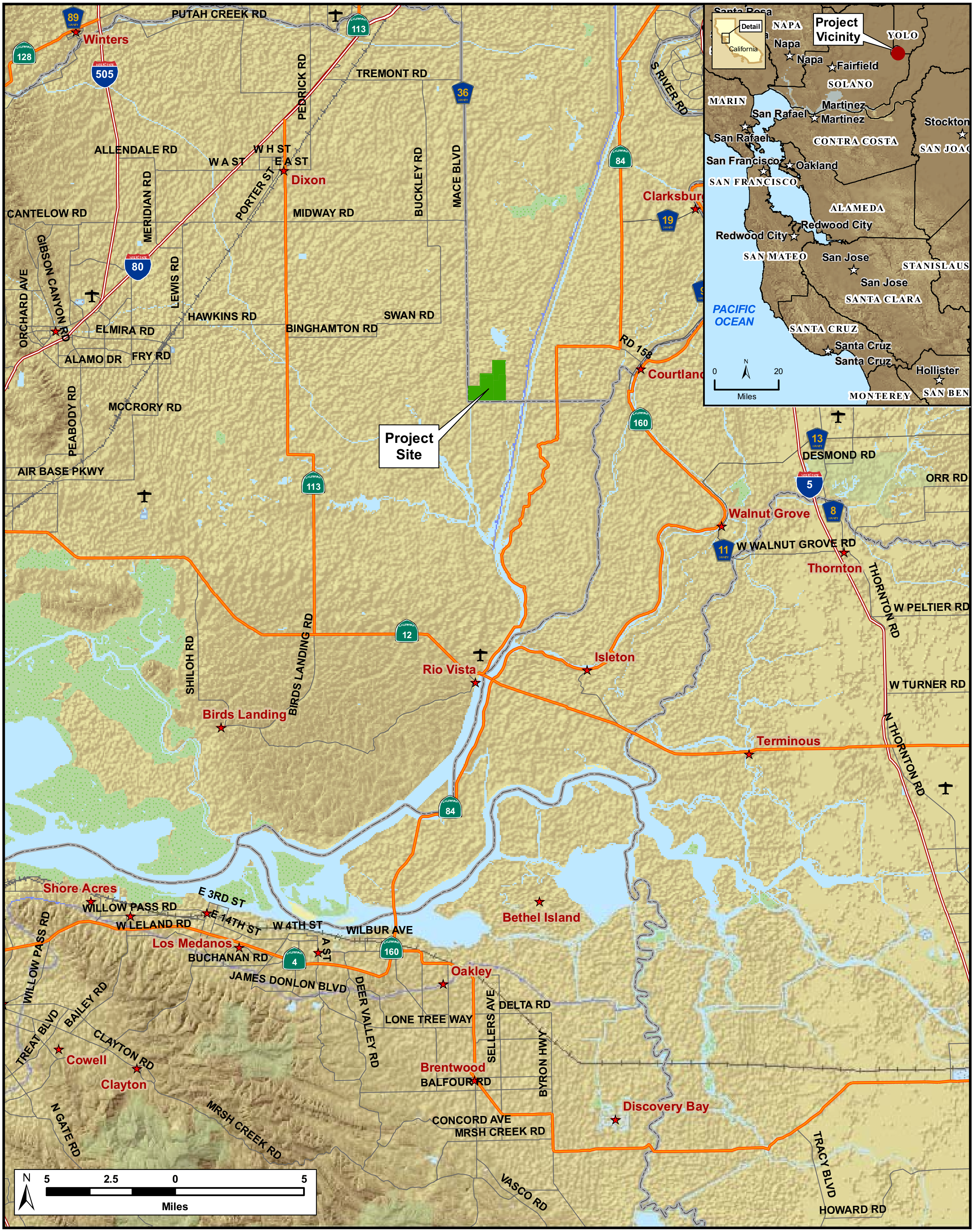
Attachments:

Figure 1. Vicinity Map

Figure 2. Wildlands, Inc. Project Design Plan

Figure 3. H. T. Harvey & Associates Recommendations



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H. T. HARVEY & ASSOCIATES

ECOLOGICAL CONSULTANTS

Figure 1: Vicinity Map

Liberty Island (3073-01)

January 2010

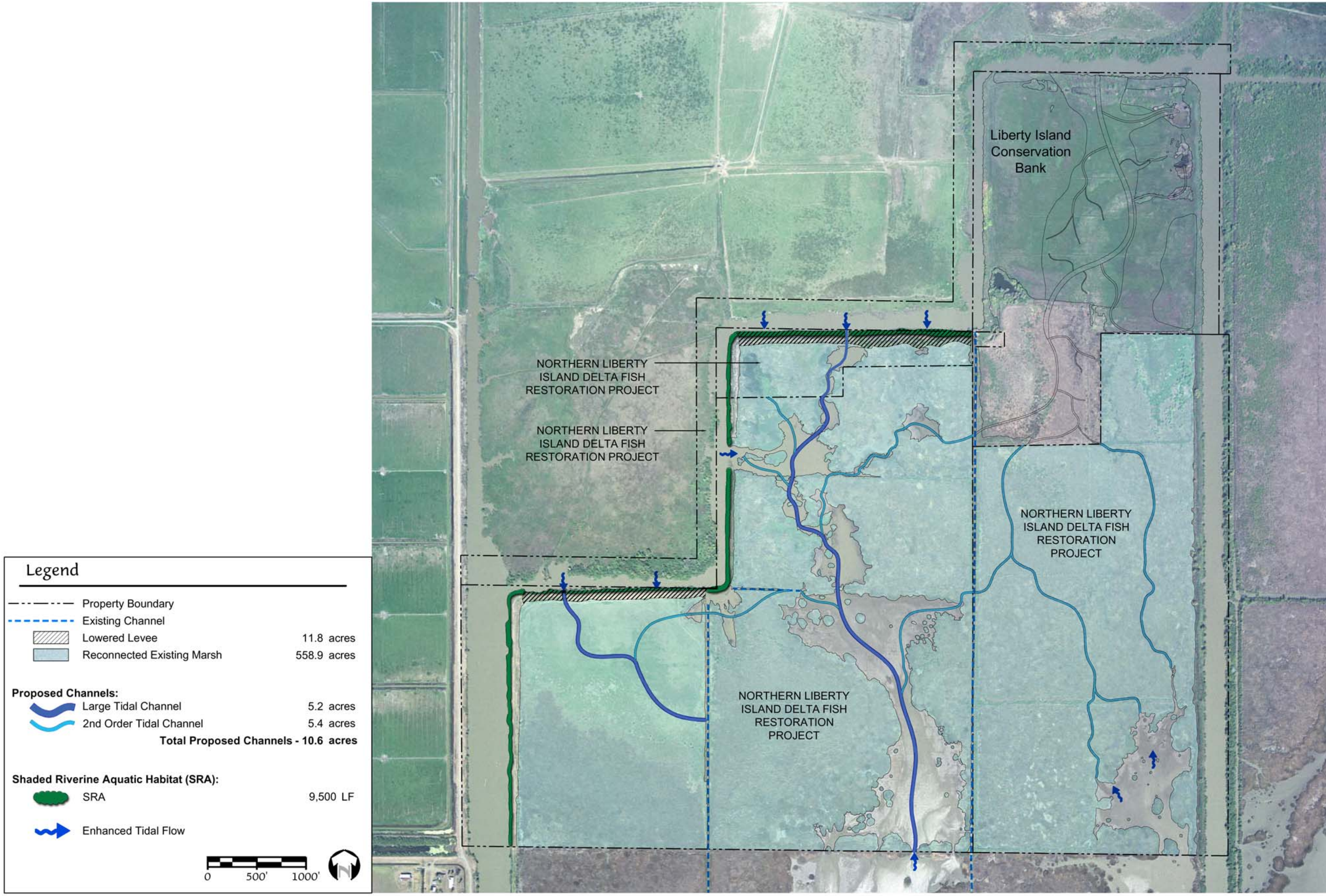

Figure 2
Concept Plan - September 25, 2009

H. T. HARVEY & ASSOCIATES
ECOLOGICAL CONSULTANTS

Figure 3: Proposed Habitat Enhancements

Liberty Island (3073-01)
January 2010