Introduction to Habitat Visions

This section presents visions for habitat ecosystem elements. Habitats are areas occupied by plants, fish, and wildlife that provide specific conditions essential to the needs of plant and animal communities. Habitats will benefit markedly from restoration activities related to ecological processes and stressors. In some cases, direct action may be necessary to restore important habitats. Habitat types that are included are those that have a strong effect on an ecological process or a species that is dependent on the Bay-Delta and can be restored and managed to improve the health of the Bay-Delta ecosystem and its resources. Table 1 identifies important habitat types and the visions in which they are addressed and Table 2 presents the basis for their consideration.

Visions describe the role and importance of each habitat type to dependent plants, fish, wildlife, and other organisms, a description of the current condition of habitats, stressors and changes to ecological processes that have altered habitat condition, and approaches for restoring habitats and their functions to improve the health of the Bay-Delta and its biological resources. The Ecosystem Restoration Program Plan implementation objectives, targets, and actions for each habitat type are described in "Ecosystem Restoration Program Plan, Volume II: Ecological Zone Visions". Table 3 presents the ecological zone in which implementation objectives, targets, and programmatic actions have been proposed to accomplish each habitat vision.

Table 1. Habitat Types Addressed in Visions

Vision	Habitat Type
Tidal Perennial Aquatic Habitat	Tidal perennial aquatic
Nontidal Perennial Aquatic Habitat	Nontidal perennial aquatic
Delta Sloughs	Dead-end sloughs; open-ended sloughs
Midchannel Islands and Shoals	Midchannel islands and shoals
Saline Emergent Wetland Habitat	Saline emergent wetland
Fresh Emergent Wetland Habitat	Fresh emergent wetland
Seasonal Wetland Habitat	Seasonal wetland and aquatic habitats
Riparian and Riverine Aquatic Habitats	Shaded riverine aquatic; riparian scrub, woodland, forest; valley oak woodland
Inland Dune Scrub Habitat	Inland dune scrub
Perennial Grassland Habitat	Perennial grassland
Agricultural Lands	Agricultural wetland; agricultural upland

Table 2. Basis for Selection of Habitat Ecosystem Elements

Habitat Type	Basis for Selection as an Ecosystem Element
Tidal perennial aquatic habitat	Tidal perennial aquatic habitats, particularly areas less than 9 feet deep from mean high tide, are important habitat-use areas for many species of fish and wildlife in the Delta. The substantial loss of historic shallow-water areas, primarily as a result of reclamation of tidally influenced habitat and channel dredging, has reduced the available habitat area for associated fish and wildlife. Loss of shallow-water areas has also caused a reduction in primary and secondary productivity, changing the historic foodweb of the Delta.
Nontidal perennial aquatic habitat	Nontidal perennial aquatic habitats, particularly areas less than 6 feet deep, are important habitat-use areas for many species of fish and wildlife in the ERPP focus area. The substantial loss or degradation of nontidal perennial aquatic habitats, particularly areas less than 9 feet deep, primarily as a result of reclamation of wetlands and alteration of streamflows has reduced the available habitat area for associated fish and wildlife.
Dead-end sloughs	Dead-end sloughs provide warmer, highly productive habitat for seasonal spawning, rearing, and foraging of important aquatic organisms, as well as important carbon production for other Bay-Delta habitats. Several smaller branches of tidal slough networks have been severed from the main slough channel by levees. For waterfowl and wildlife, dead-end sloughs have associated marsh and riparian corridors important for breeding, feeding, resting, and roosting.
Open-ended sloughs	Open-ended sloughs provide unique, generally low-velocity habitats and important migratory pathways for many species and important habitat for wildlife and waterfowl along the riparian corridors of the sloughs. Levee construction and channel dredging over many years has converted the gradual sideslopes supporting marsh and tideflat habitat along sloughs to steep-sided, high-velocity channels with narrow or nonexistent shoreline habitat.
Saline emergent wetland habitat	Saline emergent wetland habitats, including brackish and saline wetlands, are important habitat-use areas for fish and wildlife dependent on marshes and tidal shallows in the Bay-Delta and support several special-status plant species. The loss or degradation of historic saline emergent wetlands, primarily as a result of reclamation of tidally influenced wetlands for agriculture, has substantially reduced the habitat area available for associated fish and wildlife species. Several plant and animal species closely associated with tidal saline emergent wetlands have been listed as endangered under the State and federal Endangered Species Acts, primarily as a result of the extensive loss of this habitat type. Loss of this habitat has reduced water storage, nutrient cycling, and foodweb support functions in the ERPP focus area.
Fresh emergent wetland habitat	Tidal and nontidal fresh emergent wetland habitats are important habitat-use areas for fish and wildlife dependent on marshes and tidal shallows in the ERPP focus area and support several special-status plant species. The loss or degradation of historic fresh emergent wetlands has substantially reduced the habitat area available for associated fish and wildlife species.

Table 2. Continued

Habitat Type	Basis for Selection as an Ecosystem Element
Midchannel islands and shoals	Midchannel islands and shoals provide unique remnant shallow-water edge habitat in many Delta channels. They typically support willow scrub, tule marsh, and tidal mudflat habitats and associated wildlife and fish. Midchannel islands and shoals have been shrinking or disappearing as a result of progressive erosion. Loss of this habitat has reduced water storage, nutrient cycling, and foodweb support functions in the ERPP focus area.
Seasonal wetland habitat	Seasonal wetland and aquatic habitats are important habitat-use areas for many species of fish and wildlife in the ERPP focus area. Loss or degradation of historic seasonal wetlands, primarily as a result of urban development and reclamation of wetlands for agriculture, has substantially reduced the habitat area available for waterfowl, shorebirds, and other water birds. Loss of vernal pool habitat, in particular, has directly resulted in the listing of several species as threatened or endangered under the federal Endangered Species Act. The loss of seasonal aquatic floodplain habitat, primarily as a result of levee construction and alteration of riverflows, has substantially reduced floodplain refuge habitat for fish and spawning habitat for the Sacramento splittail. Loss of this habitat has reduced water storage, nutrient cycling, and foodweb support functions in the ERPP focus area.
Shaded riverine aquatic habitat	Shaded riverine aquatic habitats are important habitat areas for one or more life stages of most fishes that inhabit the ERPP focus area. The loss or degradation of historic riparian vegetation from river and stream channelbanks and alteration of nearshore aquatic habitat have primarily been caused by channelization, stabilization of channelbanks with riprap, and construction of levees and control of flows and diversion of water have altered the hydrologic conditions that historically supported riparian vegetation. The loss of shaded riverine aquatic habitat has directly contributed to declines in populations of associated native fishes and reduced an important source of nutrients and allochthonous material in streams and Delta sloughs.
Riparian scrub, woodland, and forest habitat	Many species of wildlife, including several species listed as threatened or endangered under the State and federal Endangered Species Acts and several special-status plant species in the ERPP focus area are dependent on or closely associated with riparian habitats. Compared with all other habitat types in California, riparian habitats support the greatest diversity of wildlife species. Degradation and loss of riparian habitat have substantially reduced the habitat area available for associated wildlife species. Loss of this habitat has reduced water storage, nutrient cycling, and foodweb support functions in the ERPP focus area. Valley oak woodland habitats are important habitat-use areas for many species of wildlife in the ERPP focus area. The loss or degradation of historic stands of valley oak woodland has substantially reduced the valley oak woodland habitat area available for associated wildlife.
Inland dune scrub habitat	Coastal scrub is associated with inland sand dunes and is limited in the ERPP focus area to the vicinity of the Antioch Dunes National Wildlife Refuge. This habitat area supports two plant and one butterfly species listed as endangered under the federal Endangered Species Act.

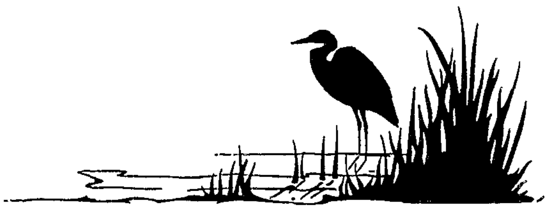
Habitat Type	Basis for Selection as an Ecosystem Element
Perennial grassland habitat	Grasslands are important breeding and foraging habitat areas for many species of wildlife and support several special-status plant species. Most perennial grassland in the ERPP focus area, historically common throughout most of the Central Valley, has been lost or has been converted to annual grassland.
Agricultural wetland habitat	Following extensive loss of native wetland habitats in the ERPP focus area, some wetland-associated wildlife species have adapted to the artificial wetland environment created by some agricultural practices and have become dependent on agricultural wetland areas to sustain their populations at current levels. Agricultural wetlands include rice lands; fields flooded with water for weed, salinity, and pest control; stubble management; and tailwater circulation ponds.
Agricultural upland habitat	Following extensive loss of some native upland habitats, upland- associated wildlife species have adapted to the artificial upland environment created by some agricultural land uses and have become dependent on agricultural upland areas and field-border shelter belts to sustain their populations at current levels.

Table 3. Ecological Zones in Which Habitat Implementation Objectives, Targets, and Programmatic Actions Are Proposed

Habitat Vision	**Ecological Zone**[1]													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Tidal Perennial Aquatic Habitat	●	●												
Nontidal Perennial Aquatic Habitat	●	●												
Delta Sloughs	●	●												
Midchannel Islands and Shoals	●													
Saline Emergent Wetland Habitat		●												
Fresh Emergent Wetland Habitat	●													
Seasonal Wetland Habitat	●	●												
Riparian and Riverine Aquatic Habitats	●	●	●		●		●	●	●	●	●	●	●	
Inland Dune Scrub Habitat	●													
Perennial Grassland Habitat	●	●												●
Agricultural Lands	●	●												●

[1] 1 = Sacramento-San Joaquin Delta
2 = Suisun Marsh/North San Francisco Bay
3 = Sacramento River
4 = North Sacramento Valley
5 = Cottonwood Creek
6 = Colusa Basin
7 = Butte Basin
8 = Feather River/Sutter Basin
9 = American River Basin
10 = Yolo Basin
11 = Eastside Delta Tributaries
12 = San Joaquin River
13 = East San Joaquin Basin
14 = West San Joaquin Basin

TIDAL PERENNIAL AQUATIC HABITAT



INTRODUCTION

Tidal perennial aquatic habitat consists of the estuary's edge waters, including mudflats and other transitional areas between open-water habitats and wetlands. Tidal perennial aquatic habitats are those shallow waters associated with natural wetland and riparian habitats that are so important to fish and wildlife of the Bay-Delta. The substantial loss of historic shallow tidal waters, primarily as a result of reclamation and channel dredging and scouring has led to the decline of many native fish, wildlife, and plant species in the Bay-Delta. Loss of such habitat has also reduced primary and secondary productivity in the Bay-Delta estuary, and has changed important characteristics in the natural foodweb of the system.

The vision for tidal perennial aquatic habitats is to restore large areas of connecting waters associated with tidal emergent wetlands and supporting ecosystem processes in order to assist in the recovery of special-status fish populations and provide high-quality aquatic habitat for other fish and wildlife dependent on the Bay-Delta. Restoring tidal perennial aquatic habitat would also result in higher water quality and increases in the amount of shallow-water and mudflat habitats; foraging and resting habitats for water birds; rearing, foraging, and escape cover for fish.

BACKGROUND

Tidal perennial aquatic habitat is important habitat for many fish, wildlife, and plants, supports many biological functions important to the Bay-Delta system. Nearly 100 animal and plant species identified as threatened or endangered under the California and federal Endangered Species Acts (ESAs) rely directly or indirectly on tidal perennial aquatic habitat during some portion of their life cycle.

Bay-Delta estuary tidal wetlands and associated perennial aquatic habitat are recognized as among the most valuable natural resources in the United States. The remaining tidal marshes of San Francisco, San Pablo, and Suisun Bays are scattered in isolated pockets or form linear strips along sloughs or bay-front dikes. The continued existence of tidal perennial aquatic habitats is closely linked to overall Bay-Delta system health.

Since 1900, 87,500 acres of wetlands associated with tidal perennial aquatic habitat in the Sacramento-San Joaquin Bay-Delta have been converted to farmland.

Restoring tidal perennial aquatic habitats is an important ingredient for successfully restoring the Bay-Delta. Being a transitional habitat, tidal aquatic habitats links wetlands with open-water habitats. Such habitat is used as foraging and resting habitat and escape cover for shorebirds, wading birds, and waterfowl. Resident and migratory fish use tidal perennial aquatic habitats for spawning, rearing, foraging, and escape cover. Young salmon forage in these productive waters and put on critical weight before entering the ocean. Striped bass, delta smelt, splittail, and many native resident Bay-Delta fish use this habitat, especially as rearing areas for young.

Tidal perennial aquatic habitat plays a primary role in the formation and maintenance of tidal wetlands. As tidal aquatic habitats accumulate sediment, vegetation can increase and over time become wetland and riparian habitat. As these tidal aquatic habitats accumulate sediment and vegetation, they maintain their structure and function, even with gradual rises in sea level.

Stressors that adversely affect the health of tidal perennial aquatic habitats include urban and industrial development, dredging, hydraulic mining, levees and associated land reclamation, wastewater flows, and urban and agricultural runoff.

RESTORATION NEEDS

Reducing fragmentation of existing tidal perennial aquatic habitat should be a focus of restoration efforts. Many areas of open water in Bay-Delta are isolated by levee land or deeper open-water habitat. Considerable former open-water areas have been converted to managed marshes, saltponds, or agricultural use. Restoring historic habitats would involve reclaiming former tidal habitat behind levees.

Initial efforts should focus on protecting existing tidal perennial aquatic habitats. These existing habitats offer functions and values that may not be possible to recreate. Restoring former habitat should emphasize linkage with existing healthy habitats. Restored habitats should have natural gradients of open water, shallow water, wetland, riparian, and upland habitats to increase the habitat value for a greater diversity of species using the area.

Because many leveed lands in the Bay and Delta have subsided after many years of being reclaimed, these lands are too low to support shallow tidal perennial aquatic habitat, and thus cannot be readily restored. The greatest subsidence has occurred in the Central and West Delta Ecological Unit. A comprehensive long-term program to reverse subsidence through land-use management changes on these lands and possible use of suitable dredge or other "natural" materials should be implemented to gradually restore land elevations to suitable ranges so that more leveed lands can be restored to tidal shallow water habitat. Setback levees are a measure to add aquatic habitat along potential margins of the Bay and Delta. Opening or breaching levees would also open previously leveed lands to tidal flows.

Restoration efforts should focus on those leveed lands that are as yet not severely subsided. Prime candidates are existing managed marshes and salt ponds adjacent to San Pablo and Suisun Bays. Leveed agricultural lands and some industrial lands adjacent to Suisun Bay can be readily restored to tidal aquatic habitat. Some of the habitat would be mudflats, while deeper waters would be shallow productive bays not unlike the very productive Honker and Grizzly Bays of Suisun Bay, and much of northern San Pablo Bay.

IMPLEMENTATION OBJECTIVE AND INDICATORS

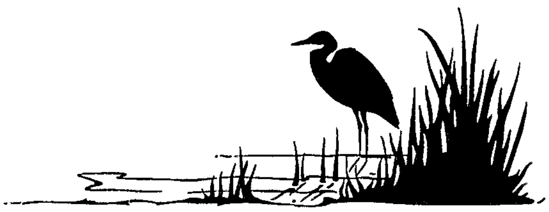
The implementation objective for tidal perennial aquatic habitat is to increase the area of shallow-water and intertidal mudflat habitat in order to improve conditions that support increased primary and secondary productivity; provide rearing, foraging, and escape cover for fish; and provide foraging and resting habitat for water birds.

Indicators of the health of tidal perennial aquatic habitat are area of habitat and connectivity among units. Quality is determined by state of habitat including associated open-water, wetlands, riparian, and upland habitat..

LINKAGE TO OTHER PROGRAMS

Many programs and projects aim to protect, restore, and enhance the San Francisco-San Joaquin Bay-Delta estuary. These include the Bay Area Aquatic Habitats Planning Group; Cache Creek Corridor Restoration Plan; California Wetland Riparian Geographic Information System Project; Governor's California Wetland Conservation Policy; Inland Wetlands Conservation Program; Montezuma Wetlands Project; National Estuarine Reserve Research System; North Bay Initiative; North Bay Wetlands Protection Program, San Francisco Bay Regional Water Quality Control Board, and San Francisco Bay Conservation and Development Commission - Regional Wetlands Management Plan; San Francisco Estuary Project; Tidal Wetlands Species Recovery Plan; Wetlands Reserve Program; and Yolo Basin Wetlands Project.

The Ecosystem Restoration Program Plan restoration targets and objectives reflect the goals of many of these programs. For example, the San Francisco Bay Area Wetlands Ecosystem Goals Project currently underway is a comprehensive science-based approach to determining where, how much, and what kinds of wetlands should be restored in the Suisun Bay and San Francisco Bay areas. Contributing to each of these program would help to restore critical ecological processes, functions, and habitats and reduce or eliminate stressors.



INTRODUCTION

Nontidal perennial aquatic habitat are important habitat for many species of wildlife in the Delta. In many places nontidal aquatic habitat has replaced the native tidal aquatic habitats of the Delta. Outside the Delta, the substantial loss or degradation of nontidal aquatic habitats associated with Central Valley wetlands has reduced the available habitat area for many native fish and wildlife. The major factor that limits the contribution of nontidal perennial aquatic habitats to the health of the Delta is land reclamation.

The vision for nontidal perennial aquatic habitat is to increase its area by creating open-water habitat as a component of saline and fresh emergent wetland restorations in order to provide high-quality habitat for waterfowl and other water birds.

Nontidal perennial aquatic habitat in the Bay-Delta estuary is present in certain low-elevation areas. Such areas have permanent open water on reclaimed lands no longer subject to tidal flow. The size, quantity, and quality of existing habitat do not equal the wildlife habitat values of sloughs and backwaters in the estuary before reclamation.

Permanent open-water areas could be restored as a component of nontidal saline, brackish, and fresh emergent wetland habitat restoration areas. The bottom gradient of restored wetland areas will provide the hydrologic conditions necessary to create a mosaic of permanent open-water areas. Waterfowl brood ponds can be constructed on agricultural lands next to suitable waterfowl nesting habitats.

Restoring nontidal perennial aquatic habitat would increase the ecological value of adjacent wetland and upland habitats and provide resting and foraging habitat for waterfowl and other water birds and foraging habitat for wading birds and shorebirds that feed in open shallow water. Improving the quantity and quality of brood habitat would increase the production of waterfowl and other water birds in the estuary.

BACKGROUND

Historically, most wetlands in the Bay-Delta estuary were tidal, and nontidal perennial aquatic habitats were largely nonexistent. Shifts in river alignments occasionally isolated oxbow lakes, and drainage divide ponds in Bay area tidal wetlands were subjected to limited tidal action. Most of the remaining nontidal perennial aquatic habitat areas were established as a result of disrupting tidal flow into historic wetland areas with dikes and levees constructed to reclaim wetlands. Land use on reclaimed lands is largely agricultural, and perennial aquatic habitats are primarily associated with large agricultural drains, small farm ponds, industrial ponds, Delta island blowout ponds (created by levee failures that scour island interiors deeply enough to maintain permanent water through seepage), and ponds managed for waterfowl and other wildlife.

The loss of permanent open water within historic tidal wetlands substantially reduced habitat for waterfowl, shorebirds, and other wetland wildlife species in the Bay-Delta system. Existing nontidal open-water areas generally have poor wildlife value because of insufficient emergent cover on shorelines, populations of non-native predatory fish, and adjacent lands that are relatively barren (e.g., farmed fields and land next to industrial ponds) of the type and quality of cover needed by nesting waterfowl and other species that require adjacent open-water and upland habitats. A notable exception is the unreclaimed blowout ponds around which native vegetation has been allowed to establish (e.g., ponds on Webb Tract).

Important ecosystem processes needed to restore and sustain nontidal perennial aquatic habitat include:

- the geologic and hydrologic condition, stream meander, and tidal function necessary to maintain permanent surface water;
- a gradient of elevations sufficient to support deep-water (greater than 3 feet in depth) and shallow-water areas; and
- adjacent wetland and riparian vegetation.

Land use and human disturbance are stressors on nontidal perennial aquatic habitat. Insufficient buffer areas around open water reduce habitat value for wildlife species that require adjacent quality upland habitats and increase the level of human disturbance that adversely affects wildlife using open-water areas.

The value of open-water habitat to wildlife greatly increases if emergent vegetation is found along shorelines and in shallow-water areas, and adjacent dense upland herbaceous vegetation and riparian woodland are present.

RESTORATION NEEDS

Restoring nontidal perennial aquatic habitat to quantity and quality sufficient to be deemed healthy will require reestablishing the ecosystem processes that allow for the establishment and maintenance of this habitat, reducing or removing stressors that reduce wildlife habitat values, and restoring associated adjacent habitats.

Restoration efforts should be accomplished through landowners, conservation groups, and land management agencies to restore open-water habitats on Delta islands and other former tidelands of the Bay-Delta.

The following actions would help to achieve restoration:

- Restore nontidal perennial aquatic habitat in concert with restoration of fresh emergent wetland habitats.
- Restore permanent open-water areas by establishing elevation gradients sufficient to maintain surface water through natural groundwater or surface water recharge, or by pumping water into excavated areas.

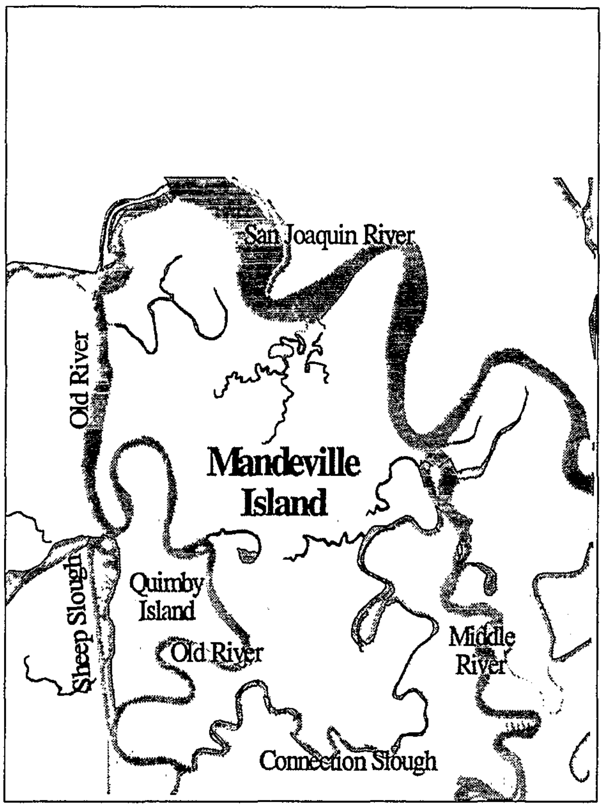
IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for nontidal perennial aquatic habitat is to increase its amount in the Delta in order to provide improved foraging and resting habitat for water birds, particularly diving ducks, and help to restore and maintain the ecological health of the terrestrial and aquatic resources in and dependent on the Delta.

Indicators of the health of nontidal perennial aquatic habitat are acres of total habitat and the quality of specific habitat areas .

LINKAGE TO OTHER PROGRAMS

Efforts to restore fresh emergent wetland habitat would involve cooperation with other wetland restoration and management programs, including the Agricultural Stabilization and Conservation Service's Wetland Reserve Program, the Wildlife Conservation Board's Inland Wetlands Conservation Program, restoration programs administered by Ducks Unlimited and the California Waterfowl Association, the Suisun Marsh Protection Plan, and ongoing management of State and federal wildlife refuges and private duck clubs. Cooperation will also be sought from agencies or organizations with responsibility or authority for restoring wetland and aquatic habitats, including California Department of Fish and Game, California Department of Water Resources, U.S. Fish and Wildlife Service, the U.S. Army Corps of Engineers, and the Delta Protection Commission.



INTRODUCTION

Sloughs are remnant natural Delta habitats that are important to many native fish and wildlife of Delta. Sloughs are tidal channels of the Delta that once connected the rivers and Bay through Delta marshes. Sloughs provide warmer, highly productive habitat for seasonal spawning, rearing, and foraging for many aquatic organisms, as well as important organic carbon productivity for all habitats of the Bay-Delta. Most of the Delta sloughs were lost with island reclamation. Many smaller sloughs have been lost in the Delta in the past several decades having been severed from main channels by levees. Slough habitat includes associated marsh and riparian corridors important for breeding, feeding, resting, and roosting waterfowl. Sloughs provide shallow, low-velocity refuge habitat for many native fishes. Unlike leveed river channels, sloughs have marsh and riparian fringes with shallow water and natural shaded riverine aquatic habitat. Levee construction and maintenance along sloughs has reduced the habitat value of many natural sloughs in the Delta. Boat traffic has also lead to shoreline erosion and loss of shallow water, marsh, and riparian habitat along many sloughs.

The vision for Delta sloughs is to maintain and increase the area of high-quality interconnected dead-end and open-ended sloughs throughout the Delta to conditions similar to those in the early 1900s by restoring sloughs to assist in the recovery of special-status fish and wildlife populations, provide shallow-water habitats for fish spawning and rearing, and provide aquatic, wetland, and riparian habitat for wildlife. Existing sloughs would be protected and enhanced and the area of tidal slough habitat would be increased. High-quality Delta sloughs would contribute to ecosystem processes needed to sustain fish and wildlife populations living in and dependent on the Delta.

BACKGROUND

Delta sloughs provide various beneficial habitats. They offer protection to plants, fish, and wildlife from wind and high-velocity flows. Sloughs support submergent aquatic plant communities, which are otherwise found only in small, sheltered pockets along open channels. The seasonal succession of native floating plants in sloughs is a valuable link in the estuary's food chain. First to appear is duckweed, which provides primary food production for insect larvae, crustaceans, and waterfowl and other birds. The duckweed community creates conditions favorable to water fern establishment. The water fern's pores contain a cyanobacterium that photosynthesizes and "fixes" (i.e., stores) nitrogen, which allows the water ferns to establish in nitrogen-deficient waters. Aquatic plants provide protective cover for fish; habitat for insects, fish, and birds; and an abundance of food organisms.

Sloughs are low-velocity, natural tributaries of the Delta rivers that vary in depth and width, have gently sloped, vegetated sides, and are connected to the Delta. Several resident species of Delta fish reside in sloughs, and splittail and delta smelt may use them for spawning. Wildlife use varies with the amount of open water and marsh, the extent and type of vegetation present, and surrounding land uses.

Delta sloughs provide habitat for biological functions necessary to the survival of resident and migratory species, including warm, highly productive habitat for seasonal spawning, rearing, and foraging, as well as a source of carbon for other Bay-Delta habitats. Sloughs have associated marsh and riparian corridors that provide breeding, feeding, resting, and roosting habitat for waterfowl and wildlife.

Dead-end sloughs include Beaver, Hog, and Sycamore Sloughs. These quiet backwaters provide essential habitat for native resident fish. Open-ended sloughs provide unique, generally low-velocity habitats and migratory pathways for many species. In addition, the associated riparian corridors provide habitat for wildlife and waterfowl.

Delta sloughs and the associated riparian scrub, riparian forest, and open-water habitats provide the complex structural diversity preferred by many fish and wildlife species, as well as critical habitat for State- and federally listed species such as the giant garter snake, splittail, and delta smelt.

Sloughs provide valuable transitional zones linking upland terrestrial with open-water habitats. Historically, these areas provided foraging, resting, and escape cover for shore- and wading birds and waterfowl. Resident and migratory fish use sloughs for rearing, foraging, and escape. The ability of most sloughs to provide these functions has been severely degraded because of dredging, increased water velocities, urban and industrial development, invasion and spread of non-native aquatic plants such as water hyacinth, reduced water quality, and reduced freshwater outflows. In addition, levee construction and channel dredging have converted gradual side slopes that once supported marsh and tidal flat habitat into steep-sided, high-velocity channels with narrow strips of emerging shoreline habitat.

RESTORATION NEEDS

Existing natural sloughs require protection and habitat improvement. Additional restoration efforts would be based on a thorough understanding of site-specific sediment transport, tides, hydrogeomorphology, and hydrodynamics. Restoration of a mosaic of slough and adjacent terrestrial and aquatic habitats would provide a rich diversity of complex habitats that would benefit a wide variety of aquatic and terrestrial species.

Several factors need to be addressed to ensure the success of protecting and restoring Delta sloughs. Bank protection, dredging, Delta outflow, non-native species (such as water hyacinth), contaminants, and land use practices may affect success. Bank protection removes vegetation, steepens slopes, narrows shoreline habitat, and increases water velocities. Setback levees offer more natural slopes and improved habitat potential while providing more secure levee protection.

Changes in tidal flows through sloughs and decreased human disturbance (e.g. reduced wake erosion) could improve slough habitat. Removal of invasive non-native aquatic plants would help restore many smaller sloughs to their natural function.

Actions that could be taken to improve slough habitat in the Delta include the following:

- Protect existing dead-end and open-ended sloughs from possible future degradation through cooperative agreements with land management agencies or conservation easements or purchase from willing sellers.

- Restore hydrologic conditions necessary for establishing Delta sloughs by constructing setback levees, removing dikes, constricting slough openings, and managing flows through Delta channels.
- Where consistent with flood control objectives, modify vegetation management practices along levees adjacent to sloughs to allow wetland vegetation to reestablish naturally.
- Identify and implement solutions to levee and channel island erosion that do not remove shallow-water habitat, increase water velocities, or remove overhanging vegetation.
- Reduce the adverse effects of boat wakes in sensitive habitat areas.
- Restore connectivity between high-quality habitats through cooperative agreements with land management agencies or through conservation easements or purchase from willing sellers.
- Where possible create new slough habitat where tidal saline and freshwater emergent wetlands are created in the Bay and Delta.

IMPLEMENTATION OBJECTIVE AND INDICATORS

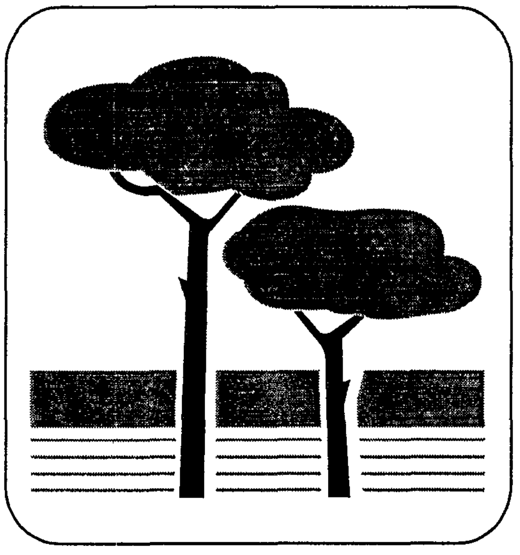
The implementation objective for Delta sloughs is to protect and improve existing tidal slough habitat and restore a portion of the historical distribution of sloughs in the Bay-Delta within tidally influenced freshwater emergent wetlands, mudflats, and seasonal floodplains in order to restore and maintain the ecological health of the aquatic resources in and dependent on the Delta.

Indicators of the health of Delta sloughs are the linear length of quality slough habitat within the Delta. Quality is a function of side slopes, and extent of marsh and riparian habitat.

LINKAGE TO OTHER PROGRAMS

Many projects associated with wetlands would benefit open-ended and dead-end sloughs. Some of these are sponsored by the San Francisco Estuary Project, Bay Area Wetlands Planning Group, California Wetland Riparian Geographic Information System Project, Governor's California Wetland Conservation Policy, Inland Wetlands Conservation Program, North Bay Wetlands Protection Program, San Francisco Estuary Project, and Wetlands Reserve Program.

MIDCHANNEL ISLANDS AND SHOALS



INTRODUCTION

Midchannel islands and shoals provide unique remnant shallow-water edge habitat in many Delta channels. They typically support willow scrub, tule marsh, and tidal mudflat habitats, and associated wildlife and fish. Some islands have remnant riparian woodlands with oaks, cottonwoods, alders, and willows. Midchannel islands and shoals have been shrinking or disappearing as a result of progressive erosion of the remaining habitat. Loss of islands and shoals affects not only habitat of fish and wildlife, but also foodweb productivity. Major factors contributing to the loss of midchannel islands and shoals are gradual erosion from (1) channels being used to convey water across the Delta to south Delta pumping plants, (2) boat wakes, and (3) dredging within or on adjacent waters.

The vision for midchannel islands and shoals is to protect existing islands and shoals in order to provide high-quality habitat for fish and wildlife dependent on the Bay-Delta.

BACKGROUND

Midchannel islands and adjacent shoals provide unique remnant shallow-water edge, riparian scrub, and emergent marsh habitat in selected Delta channels. Midchannel islands vary in size, shape, and elevation, creating a diversity of habitat types and associated wildlife benefits. The midchannel islands in some Delta locations retain many of these unique qualities because of their relative isolation. In other channels, high water velocities, heavy boat use, and associated wave-induced erosion have eroded and degraded these islands. Many of the Delta channels and their midchannel islands and shoals are in a dynamic state of change resulting from increased wakes from boats and changes in water velocities.

Midchannel islands and shoals are of value because of their relatively unaltered state and because of their continuity and connectivity within the Delta. Midchannel islands and shoals provide valuable riverine-edge and shallow-water habitat within main channels. The protection of the midchannel islands and shoals will help improve the overall quality and diversity of aquatic habitats and also improve the productivity of the Bay-Delta aquatic habitat foodweb needed to support the sustainable production and survival of fish.

The Delta formerly supported broad expanses of tule marshes, riparian forests, and shallow-water habitats. Today, most of these habitats have been replaced by intense agricultural production on levee-bounded islands separated by steep-banked waterways with few areas of shallow water. Natural vegetation is generally limited to midchannel islands and a narrow band along the edges of levees. In many areas, even this remaining vegetation has been displaced by bank protection. Any loss of natural vegetation has a significant detrimental impact on the Delta's fish and wildlife populations.

Midchannel islands and shoals in the Delta are the remnants of naturally occurring islands that existed prior to reclamation or are remants of natural or old man-made levees. The islands are what remains of an expanse of tule marsh with largely shallow and diffuse channels separating the stands. Early efforts to reclaim the Delta for agriculture included dredging in the vicinity of these islands for material to form levees. At first, dredging was simple because most of the land was intertidal marsh. In this effort, naturally meandering channels were straightened, resulting in the "leaving" of tule islands. In other areas, the distance between levees was wide and marsh was left between the levees. The sizes of these remainders varied considerably.

Midchannel islands and their adjacent shoals present a wide array of physiographic types and include a complex of habitats, ranging from small tule islands that are essentially freshwater marshlands to large upland sites with riparian woodland, dredge spoils, brushland, ponds, and a variety of marsh types.

An important attribute of these islands that contributes significantly to their wildlife habitat value is their isolation from mainland activities, which turns these islands into wildlife refuges during spring and summer months when recreational use of the Delta is at its peak.

Midchannel islands and their adjacent shoals provide a myriad of habitat types. Actual descriptions of midchannel islands would have to be made on a site-by-site basis, since their physiographic structure depends on parameters such as elevation, size, location, and amount of human disturbance. The value of midchannel islands to wildlife, especially listed species, depends largely on the extent of the island's isolation from human disturbance and the amount of disturbance to the terrestrial-aquatic interface.

The midchannel islands and shoals are important components of the landscape and contribute to the natural sediment supply, aquatic habitat, nutrient input, and areas of primary and secondary production. Shallow water habitat in the Delta is predominantly found along levees, islands, and shoals. Various life stages and species of fish require a mosaic of habitats and connectivity between habitat patches. These are important for the reproduction and survival of fish in flowing water ecosystems. The terrestrial-aquatic interface at the stream margins provides environmental conditions combining habitat diversity, a large supply of organic matter, and shallow habitats with few aquatic predators. Consequently, it is a critical area where most fish reproduction occurs. Land use activities on stream ecosystems are typically concentrated at the terrestrial-aquatic interface and can decrease the diversity and connectivity of physical habitats, shift functional interactions between terrestrial and aquatic landscape elements and between trophic levels, decrease the stability of the physical-chemical environment, and reduce the availability of refuge The result of these alterations is a reduction in fish diversity, a shift in fish trophic structure, and an increase in temporal variability of fish abundance in water ecosystems.

The terrestrial-aquatic interface experiences extreme physical-chemical variability associated with fluctuation in hydrologic conditions. Confinement of floodflow by levees and bank protection structures increases the fluvial energy flows that scour or incise the midchannel islands and shoals. Changes to flow or sediments reduces or halts the rate of midchannel island formation. Lack of sediment supply to the Delta causes midchannel islands and shoals to erode, decreasing both the quality and quantity of island and shoal habitat. Dredging the shoals immediately adjacent to channel islands undermines the structural stability of the islands and subjects them to slumping and increased erosion.

The main concern regarding midchannel islands is the rate at which they appear to be eroding. The use of midchannel islands as a buffer between the main stream and the island levees may also have deleterious effects. Boat wakes and boat-related recreational activities play a large role in the increased rate of erosion.

RESTORATION NEEDS

Restoration of midchannel islands is dependent on restoring the local hydrologic conditions (e.g., water depth, water velocity, and wave action) and the deposition necessary for the establishment and maintenance of shoals and the terrestrial-aquatic interface at the stream margins and preserving its characteristic isolation.

Direct restoration of midchannel islands and shoals in conjunction with restoring the ecosystem functions and processes that naturally sustain heathy habitats will be the primary approach to achieving this vision.

The primary method of restoring midchannel islands would be to protect and improve existing channel islands. Restoration should include reconstructing the natural hydraulic regime that provided consistent and predictable flows and sediments. Some waterways within the Delta lack sufficient sediment while, in other areas, erosion exceeds deposition. Consequently, there is a need to restore a semblance of the prereclamation sediment supply that formed islands, shoals, and habitat for native fish and wildlife.

Reducing erosion rates and offsetting erosion losses by allowing deposits and wetlands to establish would reduce the effects of major stressors on these islands - boat wakes and excessive channel velocities. Establishing a linkage with larger islands would also provide greater protection for unique habitat features.

The following actions would help to protect and restore channel islands and shoals:

- Implement restoration projects currently proposed in the Delta by resource and cooperating agencies.
- Develop and implement an inventory and assessment of the existing midchannel islands in the Delta to provide information necessary for the development of long-term actions to protect and enhance the islands.
- Install structures, such as floating booms, to attenuate waves to reduce midchannel erosion in sensitive areas.
- Reduce boat traffic near high quality midchannel islands where the effects of boat wakes would be severe.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for midchannel islands and shoals is to protect and enhance existing remnant channel islands in the Delta that have the highest value and greatest chance to be maintained by restored streamflow patterns, hydraulic conditions, sediment transport, and other ecosystem processes that sustain the ecological health of the aquatic resources in and dependent on the Delta.

Indicators of the health of midchannel island and shoals are the extent of acreage and quality of habitats on existing islands and shoals.

LINKAGE TO OTHER PROGRAMS

The U.S. Army Corps of Engineers and U.S. Fish and Wildlife Service Deep Water Ship Channel Monitoring Program was a project to provide information to successfully design and create wetland habitats in the Delta. The project deposited dredged spoils to create new shallow-water, wetland, and upland habitats within two flooded islands in the Sacramento-San Joaquin Delta. The Levee Subvention Program demonstration projects for erosion control and habitat establishment is another related effort.

INTRODUCTION

Saline emergent wetland habitats, including brackish and saline wetlands, are important habitat-use areas for fish and wildlife dependent on marshes and tidal shallows in the Bay-Delta and support several special-status plant species. The loss or degradation of historic saline emergent wetlands, primarily as a result of reclamation of tidally influenced wetlands for agriculture, has substantially reduced the habitat area available for associated fish and wildlife species. Several plant and animal species closely associated with tidal saline emergent wetlands have been listed as endangered under the State and federal Endangered Species Acts, primarily as a result of the extensive loss of this habitat type. Major factors that limit this resource's contribution to the health of the Delta are related to adverse effects of reclamation of saline emergent wetlands for agricultural, industrial, and urban uses.

The vision for saline emergent wetland is to protect existing saline emergent wetlands from degradation or loss and increase wetland habitat in order to assist in the recovery of special-status plant, fish, and wildlife populations and provide high-quality habitat for other fish and wildlife dependent on the Bay-Delta.

BACKGROUND

Saline emergent wetlands, including the brackish water wetlands that provide a transition to fresh emergent wetlands, were once continuous from San Francisco Bay into the western Delta. Saline emergent habitat also is found in low-elevation areas of the Central Valley where salts have accumulated and groundwater is near the surface. Land use changes over the past century have reduced the amount of saline emergent wetland habitat and fragmented what was formerly a nearly contiguous zone of saline emergent wetland. In particular, diking of historic wetlands has substantially reduced the amount of tidally influenced saline emergent wetlands. Most remnant tidal saline emergent wetlands are narrow bands along the margins of San Pablo Bay and Suisun Marsh and Bay. Large areas of nontidal wetlands that were created largely by diking for reclamation are present in the Suisun Marsh and Bay areas. Before the development of California's reservoir system, saltwater intruded well into the upper Delta during summer months, creating a broad salinity gradient over a large portion of the estuary that fluctuated seasonally. Reservoir operations and other water management practices have reduced saltwater intrusion into the Delta by retaining water during winter and releasing water during summer. Consequently, the area that can support brackish wetlands has been reduced, the area that can support fresh emergent wetlands has increased, and complex water control systems are now required in Suisun Marsh to maintain the water salinity conditions necessary to preserve the largest single area of saline emergent wetland in California.

Reductions in land area subject to tidal inundation, conversion of historic wetlands to other cover types, and changes in the salinity gradient have decreased the habitat area and quality necessary to maintain populations of many native plant and wildlife species. A number of plant species that depend on saline emergent wetlands, including Ferris's milkvetch, soft bird's beak, palmate bird's beak, narrow-leaf gumplant, Suisun Marsh thistle, heartscale, San Joaquin spearscale, crownscale, brittlescale, Delta button celery, and hairy bird's beak, are now recognized as having special status because of their reduced populations.

More than 25 species of birds and mammals use saline emergent wetlands in the estuary.

Populations of some wildlife species that are heavily dependent on saline emergent wetlands, such as the endangered clapper rail and salt marsh harvest mouse, have been substantially reduced in the Bay-Delta and designated as special-status species. A few wetland-associated species, such as waterfowl and egrets, have adapted to foraging on some types of croplands. Saline emergent wetland also serves as an important transitional habitat between open water and uplands. Wildlife species that use tidally influenced areas, such as the salt marsh harvest mouse, have adapted to moving to seasonal wetlands and uplands above the saline emergent wetlands during high tides. Loss of adjacent seasonal wetlands and uplands has prevented species associated with these intertidal habitat areas from finding refuge in the higher tide zone elevations.

Approximately 70,000 acres of saline emergent wetland are estimated to have been lost in the Suisun Marsh and Bay and the west Delta since the turn of the century. The primary factor causing this loss has been reclamation of wetlands for agricultural and other land uses. Most remaining saline emergent wetlands are no longer influenced by tidal flows because of diking. Loss of tidal exchange has substantially reduced the exchange of nutrients between these wetlands and tidal aquatic communities. Wetlands within the intertidal zone are highly productive, supporting large numbers of microorganisms that are important to the foodweb, and important rearing areas for many species of fish. Consequently, loss of tidal exchange has greatly reduced the contribution of saline emergent wetlands to the Bay-Delta's aquatic ecosystem. The loss of tidal exchange can also affect the biochemical balance in the soil-water interface. As a result of excessive accumulation of salt, this loss of tidal exchange has created conditions unsuitable for plant growth in some areas. The loss of hydrologic connectivity with the Bay-Delta, in combination with agricultural and other land uses, has allowed non-native weedy plant species to become established in remaining wetlands, outcompeting native plants and changing the structure and diversity of the saline emergent plant community from historical conditions.

Tidal exchange is the primary process that supports healthy saline emergent wetlands in the Bay-Delta. Tides flush the wetland system, replacing nutrients and balancing salinity concentrations. Changes in the tidal flux and the accompanying salinity changes that occur seasonally and daily are critical to the functioning of the habitat. Saline emergent wetlands are recognized for their high productivity, which results from the complex interactions of dissolved nutrients with the saline or brackish water. The process of mixing fresh water that flows into the estuary with tide-driven intrusion of saltwater is critical for the functioning of the biochemical transformations for the entire estuarine ecosystem, including the plants, wildlife, aquatic invertebrates, fish, and soil/water microbial species.

Other factors that affect the health of saline emergent wetlands are controls placed on seasonal inflow of fresh water to the Delta, which affects the salinity gradient of the estuary, and land use practices, primarily those associated with agriculture, that result in the establishment of weedy plants that displace native saline-adapted plant species. An associated stressor is the loss of adjacent native upland habitats. Some wildlife species require these uplands as a temporary refuge when escaping high tides. Collectively, these stressors have substantially reduced the habitat quality of remaining saline emergent wetlands, and the combined effect of these actions could eventually be elimination of much of the remaining habitat.

RESTORATION NEEDS

Restoration of saline emergent wetlands would focus on protection and improvement of important existing wetlands and restoration of wetlands in the Suisun Marsh/North San Francisco Bay Ecological Zones. Restoring saline emergent wetland is dependent on restoring tidal flows, establishing and maintaining estuarine salinity gradients necessary to sustain healthy saline emergent wetlands, and reestablishing elevation gradients from open water to uplands. Tidal flows could be restored to diked wetlands by breaching dikes in suitable areas. Desirable estuarine salinity gradients can be established by manipulating water diversions and water releases from upstream reservoirs to control seasonal freshwater inflows to the Delta. Balancing seasonal flows from reservoirs for fisheries, water conveyance, flood control, and the needs of other habitats could be critical to providing opportunities for saline emergent wetland maintenance and restoration. Restoring a more natural elevation gradient in wetlands will allow the establishment of a greater diversity of native saline plant species, including special-status species, that are adapted to different elevations above and below mean high tide, and provide a broader range of habitats for wildlife. The enhancement and increase of saline emergent wetland habitat would also help to increase water quality and, in areas restored to tidal flow, will contribute to the aquatic foodweb of the Bay-Delta and provide fish rearing habitat and would improve the ecological value of adjacent associated habitats, including tidal aquatic habitats, and will provide an important transitional zone between open water and uplands.

Other habitat restoration efforts will be directed toward reestablishing native plant species, controlling competitive weedy plants, increasing the quality of adjacent upland habitats to provide refuge for wildlife during high tides, and modifying land use practices that are incompatible with maintaining healthy wetlands. Restoration of saline emergent wetlands would be coordinated with restoration of other habitats to increase overall habitat values. For example, restoring deep and shallow open-water areas and adjacent grasslands greatly increases wildlife habitat values if present with saline emergent wetland vegetation.

These protection and restoration strategies could be implemented by establishing cooperative efforts between government and private agencies to coordinate the efficiency of implementing existing restoration strategies and plans; developing and implementing alternative land management practices on public lands to improve wetland habitat quality or promote habitat recovery, and provide incentives to private landowners to implement desirable land use practices; establishing additional incentive programs to encourage landowners to establish and maintain saline emergent wetlands; and protecting existing habitat areas from potential future degradation through acquisition of conservation easements or purchase from willing sellers.

IMPLEMENTATION OBJECTIVE AND INDICATORS

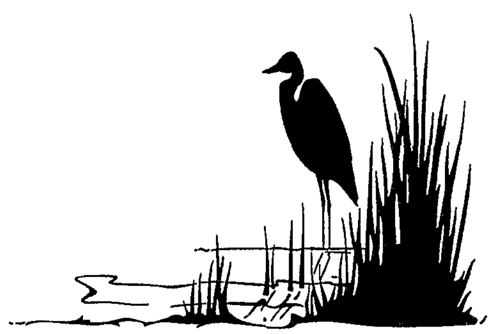
The implementation objective for saline emergent wetland habitat is to increase the area of saline emergent wetlands to provide high-quality habitat for waterfowl, shorebirds, and other associated wildlife; provide rearing habitat, foraging habitat, and escape cover for fish; and expand the populations and range of associated special-status and State- and federally listed plant and animal species.

The measurement of performance against the implementation objective is the quality and quantity of saline emergent wetland habitats in the Bay-Delta. Increasing the quality of existing and the quantity of saline emergent wetlands in the Bay-Delta will be the indicators for restoration of this habitat.

LINKAGE TO OTHER PROGRAMS

Efforts to restore fresh emergent wetland habitat would involve cooperation with other wetland restoration and management programs, including the Suisun Marsh Preservation Agreement, the Agricultural Stabilization and Conservation Service's Wetland Reserve Program, the Wildlife Conservation Board's Inland Wetlands

Conservation Program, restoration programs administered by Ducks Unlimited and the California Waterfowl Association, ongoing management of State and federal wildlife refuges and private duck clubs, and the San Francisco Bay Wetlands Ecosystem Goals Project. Proposed ERPP targets may be adjusted to reflect goals identified by the San Francisco Bay Wetlands Ecosystem Goals Project. Agencies or organizations with responsibility or authority for restoring wetland and aquatic habitats, including U.S. Bureau of Reclamation, California Department of Water Resources, California Department of Fish and Game, U.S. Fish and Wildlife Service, and the Delta Protection Commission, will be asked to cooperate.



INTRODUCTION

Tidal and nontidal fresh emergent wetland habitats are important habitat-use areas for fish and wildlife dependent on marshes and tidal shallows and support several special-status plant species. The loss or degradation of historic fresh emergent wetlands has substantially reduced the habitat area available for associated fish and wildlife species. Major factors that limit this resource's contribution to the health of the Delta are related to adverse effects of reclamation of wetlands for agricultural, industrial, and urban uses.

The vision for fresh emergent wetland is to protect existing fresh emergent wetlands from degradation or loss and increase wetland habitat in order to assist in the recovery of special-status plant, fish, and wildlife populations, and provide high-quality habitat for other fish and wildlife dependent on the Bay-Delta.

BACKGROUND

Prior to the mid-1800s, extensive areas of tidal fresh emergent habitat occurred throughout the Central Valley, particularly in the Delta. A complex network of rivers, sloughs, and channels connected low islands and basins that supported a diverse and dense mosaic of freshwater emergent vegetation, which, in turn, supported a diversity of resident and migratory wildlife species and functions related to nutrient cycling, primary and secondary production, and escape cover that, in turn, supported a diverse assemblage of resident estuarine and anadromous fish. These areas commonly flooded in winter, connecting vast areas of the Sacramento and San Joaquin Valleys with a slow-moving blanket of silt-laden water. Land reclamation and flood control activities in the late 1800s and early 1900s led to the development of leveed Delta islands. The loss of fresh emergent wetlands in the Delta, in conjunction with substantial losses of nontidal, fresh emergent wetlands elsewhere in the Central Valley as a result of land reclamation, flood control, and water supply projects, has substantially reduced habitat for waterfowl, shorebirds, and other wetland wildlife species in the Bay-Delta system. Reduction in the area of fresh emergent wetland has also substantially reduced the area available for the biological conversion of nutrients in the in the Delta. Presently, there is insufficient wetland substrate to provide adequate levels of nutrient transformation, which results in lower quality water being transported to the San Francisco Bay.

Over the past 150 years, over 300,000 acres of fresh emergent wetlands have been lost in the Sacramento-San Joaquin Delta Ecological Zone, primarily as a result of land reclamation, and less than 15,000 acres remain.

Most remnant fresh emergent wetlands in the Delta occur as narrow, fragmented bands along island levees; channel islands; and shorelines of dead-end and open-ended sloughs, shorelines of breached islands (e.g., Little Holland Tract) and levee blowout ponds. There are small areas of nontidal fresh emergent wetlands on Delta islands, primarily associated with agricultural infrastructure (e.g., drainage ditches), levee blowout ponds, and areas managed for wetlands (e.g., duck clubs).

The loss of fresh emergent wetlands has substantially reduced habitat of several plant and wildlife species, leading to some species being designated as special-status and threatened with local extirpation. At least eight plant species, Suisun Marsh aster, California hibiscus, bristly sedge, Jepson's tule pea, Mason's lilaeopsis, marsh mudwort, Sanford's arrowplant, and marsh scullcap, are endemic to the Delta. Most of these plants are adapted to a complex tidal cycle and grow in association with more common vegetation such as tule, cattails, common reed, and a great diversity of other herbaceous plant species. Changes in habitat conditions have allowed the invasion of hundreds of non-native weedy plant species. Some of these species, such as water hyacinth, are now noxious pests that clog waterways and irrigation ditches and reduce overall habitat quality for native plants and wildlife.

Over 50 species of birds, mammals, reptiles, and amphibians use fresh emergent wetlands in the Delta. Populations of some wildlife species that are closely dependent on fresh emergent wetlands, such as the California black rail, giant garter snake, and western pond turtle, have been substantially reduced in the Delta and designated as special-status species. A few wetland-associated species, such as waterfowl and egrets, have been able to successfully adapt to foraging on some types of Delta croplands reclaimed from historic wetland areas.

The isolation of wetlands from tidal flows and removal of the Delta island fresh emergent wetlands changed the ecological processes that support wetlands. Removal of the perennial water and vegetation from the organic soils of the Delta islands has resulted in oxidation of the soil and, subsequently, the subsidence of the interior island elevations. Loss of these tidal flow to islands has reduced habitat for native species of fish, plants, and wildlife; reduced water quality; and decreased the area available for dispersion of floodwaters and suspended silt deposition.

High tidal velocities in confined Delta channels continue to erode remaining fresh emergent wetland at a greater rate than habitat formation. Continued erosion not only reduces the amount of fresh emergent habitat, but resultant changes in the elevation of the land affects the types of plant species that can grow depending on a species' ability to tolerate inundation. Flood protection and levee maintenance continue to impair wetland vegetation and prevent the natural reestablishment of fresh emergent wetlands in some locations.

Wind and boat-wake waves and high water velocities in confined channels actively erode the substrate needed to support remnant fresh emergent wetlands. Continued erosion of existing habitat substrates, such as midchannel islands and levees and levee berms, is currently the primary cause of habitat loss in the Delta.

RESTORATION NEEDS

Restoration of fresh emergent wetlands would focus on protection and improvement of important existing wetlands, such as channel islands, and restoration of wetlands in the Sacramento- San Joaquin Delta and Suisun Marsh/North San Francisco Bay Ecological Zones. A major factor in preventing further loss of existing fresh emergent wetlands will be to reduce erosion rates, particularly of inchannel islands and levee berms, and offsetting erosion losses by allowing deposition and wetland establishment. Loss of wetlands could be reduced in some areas by reducing boat speeds in portions of the Delta where wetlands are subject to boat-wake-induced erosion (e.g., Snodgrass Slough) or constructing protective structures around eroding channel islands to attenuate wave action (e.g., wave barriers and riprap groins) in a way that retains habitat value for fish and wildlife. Protecting inchannel islands from further erosion and establishing linkage with larger islands would provide greater protection for this unique habitat.

Restoring fresh emergent wetland is dependent on local hydrological conditions (e.g., water depth, water velocity, and wave action); land elevation and gradient; and the types and pattern of deposition of organic and inorganic sediments necessary for establishing and maintaining fresh emergent vegetation. The approach to restoring fresh emergent wetlands would include reestablishing the hydraulic, hydrologic, and depositional processes that sustain fresh emergent wetlands and inchannel islands and restoring a full spectrum of wetland elevations to allow the establishment of a greater diversity of plant species, including special-status species adapted to different elevations within the tidal or water (nontidal sites) column, and provide a broader range of habitats for wildlife. Restoration of fresh emergent wetlands would be coordinated with restoration of other habitats to increase overall habitat values. For example, restoring deep and shallow open-water areas and adjacent grassland and riparian habitats greatly increases wildlife habitat values if present with fresh emergent wetland vegetation. Restoration would also include reestablishment of the full diversity of fresh emergent wetland plant associations to ensure that the habitat needs of special-status and other species that are dependent on specific vegetation associations are met.

Protection and restoration of fresh emergent wetlands could be accomplished by implementing existing restoration plans; expanding State and federal wildlife areas to create additional wetland complexes; improving management of existing and restoring additional fresh emergent wetlands on private lands; and reestablishing connectivity between the Delta and Delta islands, and between channels with their historic floodplains. Major opportunities for restoring fresh emergent wetlands include setting back or breaching island levees to allow for the natural reestablishment of wetlands by reestablishing hydrologic connectivity of historic wetland areas to the Bay-Delta; restoring non-tidal wetlands and begin island accretion on the interior of Delta islands where subsidence has lowered land elevations to levels that cannot now support tidal emergent wetlands; create levee berms of substrate materials and at elevations necessary to allow establishment of fresh emergent vegetation; modifying, where consistent with flood control objectives, vegetation management practices along levees to allow for the natural reestablishment of wetland vegetation; and reintroducing native wetland plants into suitable sites. These protection and restoration strategies could be implemented by establishing cooperative efforts between government and private agencies to coordinate the efficiency of implementing existing restoration strategies and plans; developing and implementing alternative land management practices on public lands to improve wetland habitat quality or promote habitat recovery, and provide incentives to private landowners to implement desirable land use practices; establishing additional incentive programs to encourage landowners to establish and maintain fresh emergent wetlands; and protecting existing habitat areas from potential future degradation through acquisition of conservation easements or purchase from willing sellers.

Restoration of stream meander belts and the process of overbank flooding along major tributaries to the Bay-Delta proposed by ERPP in other ecological zones will also create the conditions necessary for the natural reestablishment of fresh emergent wetlands elsewhere in the Central Valley.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for fresh emergent wetland habitat is to increase its amount by restoring tidally influenced fresh emergent wetland in the Delta to provide high-quality habitat for waterfowl, shorebirds, and other associated wildlife and rearing, foraging, and escape cover for fish, and expand the populations and range of special-status and State- and federally listed plant and animal species to assist in their recovery.

The measurement of performance against the implementation objective is the quality and quantity of fresh emergent wetland habitats in the Bay-Delta. Increasing the quality of existing and the quantity of fresh emergent wetlands in the Bay-Delta will be the indicators for restoration of this habitat.

LINKAGE TO OTHER PROGRAMS

Efforts to restore fresh emergent wetland habitat would involve cooperating with other wetland restoration and management programs, including the Agricultural Stabilization and Conservation Service's Wetland Reserve Program, the Wildlife Conservation Board's Inland Wetlands Conservation Program, restoration programs administered by Ducks Unlimited and the California Waterfowl Association, the Suisun Marsh Protection Plan, and ongoing management of State and federal wildlife refuges and private duck clubs. Restoration efforts would be conducted in cooperation with agencies or organizations with responsibility or authority for restoring wetland and aquatic habitats, including the California Department of Fish and Game, California Department of Water Resources, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, and the Delta Protection Commission.

INTRODUCTION

Seasonal wetland and aquatic habitats are important habitat-use areas for many species of fish and wildlife. Loss or degradation of historic seasonal wetlands, primarily as a result of conversion to other land uses, has substantially reduced the habitat area available for waterfowl, shorebirds, and other wildlife, and the loss of seasonal aquatic floodplain habitat has substantially reduced refuge habitat for fish and spawning habitat for the Sacramento splittail. Loss of vernal pools, in particular, has directly resulted in the listing of several species as threatened or endangered under the federal Endangered Species Act. Major factors that limit this resource's contribution to the health of the Delta are related to adverse effects of reclamation for agricultural, urban, and industrial uses, and substantial reductions in seasonal overbank flooding of streams and rivers as a result of flood control projects.

The vision for seasonal wetlands is to improve the quality of this habitat by restoring ecosystem processes that sustain them and reduce the effect of stressors that can degrade the quality of seasonal wetlands to assist in the recovery of special-status plant and animal populations and provide high-quality habitat for waterfowl, water birds, and other wildlife dependent on the Bay-Delta.

BACKGROUND

Seasonal wetlands in the Bay-Delta include vernal pools, wet meadows or pastures, lands that are seasonally flooded such as State wildlife area, federal refuge, privately owned waterfowl hunting club, and private environmental refuge lands; and seasonally inundated areas within a streamcourse or its floodplain. Historically, seasonal wetlands occurred throughout the Central Valley. Vernal pools and wet meadows are probably best described as specialized components of terrestrial habitats such as perennial grassland or some other type of upland. The remaining seasonal wetland types are inundated for periods that are too long to support characteristic upland vegetation.

Vernal pools and wet meadows are associated with soils (basalt flow, claypan, hardpan, volcanic ash-flow, volcanic mudflow, mesa, and plateau) that maintain standing water after winter and spring rains. In some areas of the Central Valley, high spring flows from the rivers and creeks saturate soils, leaving puddles or small ponds in depressions and standing water in low-lying grass fields after the river flows recede. Although aquatic plants can establish in areas that are frequently inundated, upland plants cannot survive.

Wet meadows are grassy areas with saturated soils and standing water of varying depths that persist after winter and spring rains. This habitat is conducive to the proliferation of invertebrates that are the prey of migrating waterfowl and other birds that periodically inhabit these fields to forage. Sandhill cranes forage and roost, and many ducks, geese, and shorebirds also commonly forage in wet meadows throughout the valley. During the dry seasons, many ground-nesting birds, such as pheasants and meadowlarks, nest in meadow grasses. Most wet meadow habitat remaining in the Central Valley, now composed almost entirely of non-native grasses, is used as pasture for livestock.

Vernal pools are often referred to as hog wallows or ponds. These pools are common in grasslands in the northern part of the Central Valley where the natural geomorphology remains relatively unchanged. Many State- and federally listed plants, invertebrates, and wildlife, including the western spadefoot toad, California tiger salamander, and various fairy shrimp, are endemic to or associated with vernal pools. In addition, a variety of birds, including migrating waterfowl, shorebirds, and ground-nesting birds such as meadowlarks, commonly use this habitat.

Seasonal wetlands that maintain surface water for long periods may support cattails, bulrushes, and sedges. Historically, these emergent plant species were probably quite prevalent along the natural streamcourses where water remained for long periods of time and reduced the ability of upland species to establish. These types of seasonal wetlands play a vital role in the natural succession of plant communities by providing the essential building blocks for the future establishment of riparian scrub and eventually riparian woodland. In areas that were beyond the normal flows of the rivers, wetlands probably formed where rains and high flows left areas too wet for terrestrial plants to establish. These wetland areas provided high-quality habitat for species such as waterfowl, other migratory birds, shorebirds, red-legged frogs, giant garter snakes, tricolored blackbirds, and many other wildlife species.

The continued existence of these seasonal wetland types is closely linked to overall ecosystem integrity and health. Although many species that use seasonal wetlands are migratory (e.g., waterfowl and sandhill cranes), many others have evolved (e.g., spadefoot toad, fairy shrimp, and many specialized plants) and become endemic to seasonal wetlands such as vernal pools.

The amount and quality of seasonal wetlands has declined because of cumulative effects of many factors, including:

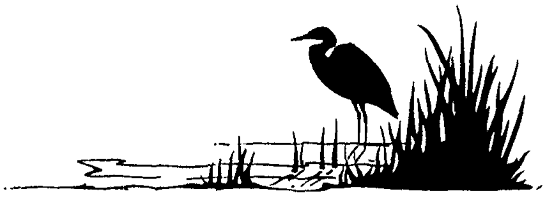
- reclamation for agriculture,
- modification of natural geomorphology such as ground leveling for agriculture and development,
- adverse effects of overgrazing,
- contamination from herbicides,
- establishment of non-native species that have an adverse effect on native wetland-associated plants and wildlife,
- flood control and water supply infrastructure that reduces overbank flooding and floodplain size, and
- reduction of the natural underground water table that hydrologically supported wetlands.

Efforts under existing wetland regulations have been in effect for several years in an attempt to prevent the further loss of wetlands. The protective status of wetlands has resulted in an extensive permitting process to complete any construction, and mitigation measures have been developed to offset losses to existing wetlands from that construction. These efforts have slowed the rate of wetland loss in many areas. Large-scale efforts in areas such as the Suisun Marsh, Grasslands Resource Conservation District, Yolo Bypass, and Butte Sink have been successful in maintaining and restoring seasonal wetlands.

RESTORATION NEEDS

Restoration of seasonal wetlands would focus on protection and improvement of important existing wetlands, reestablishment of vernal pools within and adjacent to existing ecological reserves, and restoration of seasonal wetlands in the Sacramento-San Joaquin Delta and Suisun Marsh/North San Francisco Bay Ecological Zones. Seasonal wetland restoration would be coordinated with restoration of other habitats, including shallow-water and riparian woodland and scrub. Restoration would include reestablishment of the full diversity of seasonal wetland plant associations to ensure that the habitat needs of special-status and other species that are dependent on specific vegetation associations are met.

RIPARIAN AND RIVERINE AQUATIC HABITATS



INTRODUCTION

Habitats associated with shorelines of rivers and the Delta include riparian and shaded riverine aquatic habitat. Riparian vegetation includes scrub, woodland, and forest habitats that support a great diversity of wildlife species. Habitat shaded by riparian vegetation is shaded riverine aquatic habitat, which is important habitat for many species of fish, waterfowl, and wildlife. Major factors that limit these habitats contribution to the health of the Bay-Delta include loss or degradation of historic riparian vegetation from river and stream channel banks, and alteration of near shore aquatic habitat from channelization, stabilization of channel banks with riprap, construction of levees, and control of flows.

The vision for riparian and riverine aquatic habitats is to protect and increase their area and quality in order to assist in the recovery of special-status fish and wildlife populations and provide high-quality habitat for other fish and wildlife dependent on the Bay-Delta. The vision includes restoring native riparian communities ranging from valley oak woodland associated with higher, less frequently inundated floodplain elevations to willow scrub associated with low, frequently inundated floodplain elevation sites such as streambanks, point bars, and inchannel bars.

Attaining this vision will involve restoring or improving natural physical processes, including streamflows, stream meanders, and sediment transport, that naturally create and sustain these habitats and increase the complexity and structural diversity of the habitat. The natural streamflow patterns, including winter and spring high flows and low summer-fall minimum flows, help to sculpt healthy natural riparian and riverine aquatic habitats. High winter and spring flows trigger seed dispersal and germination, move sediment, stimulate stream meander, and flood and scour riparian and riverine habitat. Natural unencumbered stream channel meanders (often termed "meander belts") provide healthy, high-quality riparian and riverine aquatic habitats. Channelizing rivers (e.g., constructing levees), protecting banks (e.g., adding riprap), and channel dredging hinder natural stream meander and natural channel river morphology. Natural sources of gravel and other sediments along rivers and floodplains provide materials needed to create and sustain healthy riparian and riverine aquatic habitats. Where improvement to physical processes do not adequately restore riparian and riverine habitats, direct modification may be necessary to restore habitats to their target acreage and quality.

A major increase in floodplain riparian habitat will help to balance the sediment and nutrient budget of rivers and estuaries, improve the foodweb, and provide critical habitat for threatened and endangered terrestrial wildlife species, such as the yellow-billed cuckoo and Swainson's hawk. More extensive and continuous riparian forest canopy on the banks of estuaries and rivers will stabilize channels; help to shape submerged aquatic habitat structure; benefit the aquatic environment by contributing shade, overhead canopy, and instream cover for fish; and reduce river water temperature. More extensive and continuous shoreline vegetation associated with woody debris and leaf and insect drop in shallow aquatic habitats will increase the survival and health of juvenile salmonids and resident Delta native fish species. Achieving this objective will also greatly enhance the scenic quality and recreational experience of our Delta and riverine waterways.

Protection and restoration of seasonal wetlands could be accomplished by implementing existing restoration plans; expanding State and federal wildlife areas to create additional wetland complexes; improving management of existing and restoring additional seasonal wetlands on private lands; and reestablishing connectivity between channelized streams and rivers with their historic floodplains. These protection and restoration strategies could be implemented by establishing cooperative efforts between government and private agencies to coordinate the efficiency of implementing existing restoration strategies and plans; developing and implementing alternative land use practices that will protect grasslands containing vernal pools and wet meadows and allow existing, compatible land uses, such as grazing, to continue; developing and implementing alternative land management practices on public lands to improve seasonal wetland habitat quality or promote habitat recovery, and provide incentives to private landowners to implement desirable land use practices; establishing additional incentive programs to encourage landowners to establish and maintain seasonal wetlands; protecting existing habitat areas from potential future degradation through acquisition of conservation easements or purchase from willing sellers; and setting back or breaching levees and dikes to create the hydrologic conditions necessary for establishing seasonal wetland vegetation.

Restoration of stream meander belts and the process of overbank flooding along major tributaries to the Bay-Delta proposed by ERPP in other ecological zones will also create the conditions necessary for the natural reestablishment of seasonal wetlands elsewhere in the Central Valley.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for seasonal wetland habitat is to restore and manage this habitat type in the Delta to restore and maintain the ecological health of the aquatic resources in and dependent on the Delta; restore foodweb and floodplain processes; reduce the effects of contaminants and water management on the Delta's aquatic resources; and provide high-quality foraging and resting habitat for wintering waterfowl, greater sandhill cranes, and migratory and wintering shorebirds.

The measurement of performance against the implementation objective is the quality and quantity of seasonal wetlands habitats in the Bay-Delta. Increasing the quality of existing and the quantity of seasonal wetlands in the Bay-Delta will be the indicators for restoration of this habitat.

LINKAGE TO OTHER PROGRAMS

Efforts to restore seasonal wetlands would involve cooperation with other restoration programs, including those of the Upper Sacramento River Fisheries and Riparian Habitat Council, Suisun Marsh Protection Plan, California Department of Fish and Game wildlife areas, U.S. Fish and Wildlife Service refuges, Jepson Prairie Preserve, Ducks Unlimited Valley Care Program, California Waterfowl Association, Cache Creek Corridor Restoration Plan, The Nature Conservancy, Putah Creek South Fork Preserve, Woodbridge Ecological Reserve, Yolo County Habitat Conservation Plan, and Central Valley Habitat Joint Venture.

BACKGROUND

Riparian habitats include the trees, shrubs, vines, herbaceous understory, and organic litter and snags that combine to create the complex mosaic of species mixes, age classes, and distribution patterns common to vegetation along estuaries, rivers, and streams. The landforms and dynamic fluvial processes that create and interact with riparian vegetation are also an important but often overlooked part of the habitat.

Historically, the Central Valley floor had approximately 922,000 acres of riparian vegetation (Katibah 1984) supported by a watershed of more than 40,000 square miles. Today, approximately 100,000 acres of riparian forest remain, about half of which is in a highly degraded condition, representing a riparian habitat decline of 90% (Katibah 1984). The Sacramento River once supported 500,000 acres of riparian forest; it now supports 10,000-15,000 acres, or just 2-3% of historic levels (McGill 1979, 1987). From about 1850 to the turn of the century, most of the forest was decimated for fuelwood as a result of the Gold Rush and river navigation and by large-scale agricultural clearing.

Additional clearing in the early and middle 20th century coincided with the aftermath of flood control reservoir and levee projects that allowed ongoing clearing of floodplain riparian stands for orchards, crops, flood bypasses, levee construction, and urban areas occupying the former floodplains. Similar patterns occurred along the San Joaquin River, which was also greatly affected by the drying up of major portions of the river following construction of Friant Dam and other Central Valley Project (CVP) reservoirs. Resulting major changes in river hydrologic conditions and sediment budgets triggered channel instability and downcutting of rivers and streams that caused additional riparian and riverine habitat loss and fragmentation.

Riverine aquatic habitats comprise the relatively shallow submerged and seasonally inundated zones in the beds of estuary and river channels, including gravel beds, bars, and riffles; transient sandy shoals; waterlogged woody debris piles; and the shaded riverine aquatic (SRA) habitat zone where the river meets the riparian canopy. Riverine aquatic zones provide essential habitats for fish and other aquatic organisms, including spawning substrate, rearing and escape cover, feeding sites, and refuge from turbulent stormflows. The condition of riverine aquatic and nearshore habitats is not well documented for most of the length of Central Valley and Delta estuaries, rivers, and streams. Their condition has been degraded by channel straightening; channel downcutting (i.e., incising); dredging and clearing; instream gravel mining and riparian zone grazing; flow modifications; removal and fragmentation of shoreline riparian vegetation; and the loss of sediment, bedload, and woody debris from watershed sources upstream of dams.

Riparian and riverine aquatic habitats are created and sustained by natural fluvial processes associated with rivers. The presence and pattern of riparian vegetation also affect fluvial dynamics and contribute to riparian and riverine aquatic ecosystem structure and functions described below. In general, riparian and riverine aquatic habitats are the most intact and self-sufficient where the ecosystem processes are in the most unaffected natural state. These sites are also the most resilient to human and natural disturbance. Ecosystem processes that are integral components of riparian and riverine aquatic habitats are described in greater detail in the ecosystem restoration visions for stream meander corridors, floodplains, natural geomorphology and sediment supply, and related stressors including levees, bridges and bank protection, gravel mining, and dams and other structures.

Sediment transport, deposition, and scour are the processes that support the recruitment, succession, and regeneration of riparian vegetation. These are secondary processes that require frequent winter and spring spikes of high flow that drive the "engine" of a stream meander migration and mobilize sediment and bedload. After new vegetation is established on sediment bars and freshly deposited floodplains, the primary physical factors that sustain riparian vegetation are adequate streamflow, winter inundation of the floodplain, and shallow groundwater during the dry season.

Sediment transport, deposition, and gravel cleansing are also the processes that create and replace riverine aquatic bed habitats. A high-quality aquatic bed habitat requires a permanent supply of sediment and bedload, including replenishment gravel in sizes suitable for gravel-spawning salmonids and resident native fish. Riverflows must periodically be high enough and of sufficient duration to move the materials composing the streambed. Riparian vegetation plays an important role in the maintenance of streambeds by resisting flow and causing fine sediment to aggrade within the dense stems and by redirecting flow, causing the channel water to scour the bed and form pool, riffle, and bar patterns. Tidal mudflats form in broad, low-velocity areas away from high-energy estuary channels when shoals of organic-rich fines that are exposed during low tides are deposited.

Riparian vegetation serves many important ecological functions, including absorbing nutrients, cooling and shading the channel and floodplain, dissipating the energy of sediment-laden high flows that create new landforms, providing nesting sites for birds and small mammals that use tree cavities and protective canopy foliage, and producing primary and secondary biomass at very high rates that feed numerous fish and wildlife species. Riparian vegetation also stabilizes channels and banks, thereby rendering the characteristic geomorphology of estuaries, rivers, and streams.

Primary stressors that affect the health of riparian habitats include channel straightening and clearing; levee construction and bank hardening (e.g., with riprap); instream gravel mining and riparian zone grazing; flow modifications affecting sediment transport and spring germination; removal, burning, and fragmentation of mature riparian vegetation; and the loss of sediment and bedload from watershed sources upstream of dams. Other stressors increasing in importance and magnitude include displacement by invasive non-native trees and shrubs (e.g., tamarisk and giant reed), new expansion of orchards and vineyards into the riparian floodplain, human-set wildfires along river parkways, unusually high summer stage in rivers that supply increasing demand for downstream water diversions, groundwater lowered below the root zone, and expanded clearing of channel vegetation in response to recent flood events that called into question the capacity of levee-confined rivers and streams.

Important stressors that affect the health of riverine aquatic habitats include channel straightening, dredging, and clearing; instream gravel mining and riparian zone grazing; flow modifications; removal and fragmentation of shoreline riparian vegetation; and the loss of sediment, bedload, and woody debris from watershed sources upstream of dams. On some streams, there may be an oversupply of fine sand and sediment from excessive watershed and floodplain erosion that buries aquatic gravel beds, suffocating fish eggs and insect larvae. Most of these factors have an indirect but lasting effect on the physical structure and postdisturbance recovery of streambed habitat. Collectively, these stressors have substantially reduced the quality and resilience of riverine aquatic habitats, thereby diminishing their effectiveness in providing for the life cycle requirements of fishes of the Delta and Sacramento and San Joaquin Rivers and their tributaries.

RESTORATION NEEDS

The simple preservation of remaining natural riparian areas and riverine aquatic zones will not ensure the biodiversity, sustainability, and resilience of these habitats because of the scarcity, degradation, and fragmentation of existing river and estuary systems. Most riparian restoration projects in the Central Valley have been implemented on a relatively small scale, primarily as mitigation for project impacts or infill of existing protected preserves. The National Research Council (1992) has recommended a national strategy for restoring rivers and aquatic ecosystems through integrated restoration of large landscape units.

If the floodplain, meander width, sediment supply, and natural spring flows are in place, the river will respond by creating natural landforms that support self-sustaining vegetation communities and streambed habitats. Even partial restoration or simulation of natural physical processes and floodplains will amplify ecosystem characteristics and resultant habitat quality. Rivers and Delta estuaries where natural fluvial processes and landforms are relatively intact need to be identified and highlighted as potential reserves of riparian and riverine habitat.

River reaches targeted for potential restoration and enhancement of ecosystem processes supporting riparian and riverine aquatic habitats include the following initial listing, although complete restoration on many segments may be limited by unalterable levee confinement and bridge crossings:

- Sacramento River from Colusa to Verona;
- westside tributaries of the Sacramento River (e.g., Cottonwood, Elder, Thomes, Stony, Cache and Putah Creeks);
- lower reaches of eastside tributaries of the north Sacramento Valley and Butte Basin;
- Feather River and tributaries below Marysville;
- American River below Nimbus Dam;
- San Joaquin River from Gravelly Ford to Vernalis; and
- eastside tributaries of the San Joaquin River (e.g., Merced, Tuolumne, Stanislaus, Mokelumne, and Cosumnes Rivers).

Landscape-scale restoration of riparian and riverine aquatic habitat depends on recovery of, simulation of, or compensation for natural fluvial processes and landforms. Revegetation and artificial alteration of stream channels will be contemplated only where overwhelming limitations prevent recovery of these physical processes and ecosystem functions. Recovery and simulation of natural fluvial processes and landforms will be accomplished using several integrated steps, including strategically locating levee setbacks to expand potential riparian floodplain; expanding the storage, detention, and bypass capacity of the Sacramento and San Joaquin River flood control project to allow natural expansion of riparian vegetation within levees and the Sutter and Yolo Bypasses; and designating, acquiring title or easements for, and deliberately managing river corridor meander zones on appropriate rivers and stream throughout the Central Valley.

Sediment supply to rivers and streams can be restored or enhanced by reducing bank hardening by creating meander zones and floodplain widening; selectively removing small, nonessential dams on gravel-rich streams; eliminating mining instream and on low floodplains near channels; and widening bridges to broaden out-of-bank flow and eliminate the need to riprap vulnerable bridge abutments. Alternative approaches for water diversions and associated intake and screenings facilities on the mainstem river will be explored to avoid hardening the bank in some sections of the river. In the Delta and San Pablo Bay, nonessential levees restricting former tidelands can be breached or removed entirely to capture a greater proportion of sediment passing through to San Francisco Bay and thus build tidal mudflat and estuary landforms. These measures will significantly increase the extent and distribution of shallow-water and nearshore habitats that are productive generators of the Delta foodweb and provide essential new rearing habitat for juvenile Delta and anadromous fish. In some locations of the Delta where land elevations are suitable, levee systems can be set back or altered to allow out-of-bank shallow flooding during high flood stage. Floodplain inundation will provide additional foodweb support, spawning and rearing habitat for native fish (e.g., splittail), and additional flood storage and stage attenuation to decrease the risk of flooding elsewhere in the Delta.

Opportunities for reducing stressors affecting riparian habitat include eliminating, in phases, instream gravel mining; designating and acquiring "stream erosion zones" to reduce the use of bank riprap and allow greater natural recolonization; designing biotechnical slope protection that allows shoreline riparian vegetation within levees; gradually removing or reducing livestock grazing in riparian zones, use of conservation easements for purchase of land or using other incentives to reduce or eliminate cropland conversion of riparian forest, and identifying levee-confined channels and banks where routine vegetation removal by local reclamation districts can be safely discontinued. Ambitious weed control programs in natural areas along rivers will be needed to suppress the expansion of tamarisk, giant reed, locust, and other invasive non-native plants degrading habitat quality and native flora.

Opportunities for reducing stressors affecting riverine aquatic habitat include the eliminating (in phases) instream gravel mining (especially downstream of dams and on streams that support salmon and steelhead spawning), designating and acquiring "stream erosion zones" to reduce the use of bank riprap and allow natural meander patterns that foster streambed and SRA habitat formation, designing biotechnical slope protection that allows shoreline riparian vegetation within levees, gradually removing or reducing livestock grazing in riparian and aquatic zones (especially on tributary streams that support salmon and steelhead spawning), and identifying levee-confined channels and banks where routine channel clearing and grading can be safely discontinued. Reservoir operations will be evaluated to determine whether winter and spring releases can be augmented with flood simulation spikes every 1-10 years that mobilize bed and bank deposits to redistribute, sort, and clean spawning gravels and scour deep pools between riffles.

Restoring riparian and riverine aquatic habitat should be accomplished by eliminating the stressors and recovering or simulating the physical processes and fluvial landforms described above. Habitat restored in this way will be more resilient to future perturbations; require little or no long-term maintenance; be self-sustaining in perpetuity; and be more compatible with future flood safety for people, cities, and farms.

However, overcoming habitat fragmentation and severe limitations of the physical environment will not allow ecosystem process and function to fully recover on many segments of valley streams and Delta estuaries. In these situations, some active stream channel sculpting, gravel introductions, and riparian replanting may be necessary on a large scale, particularly where there are abandoned river floodplains and a near-absence of sediment supply, such as along the lower American River. Revegetation projects should be contemplated only where native trees and grasses may no longer germinate naturally but have a high probability of unaided survival and vigorous growth following 1-5 years of artificial irrigation.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for riparian and riverine aquatic habitats is to restore riparian scrub, woodland, and forest habitat along largely nonvegetated riprapped banks of Delta island levees, the Sacramento and San Joaquin Rivers, and major tributaries of the Sacramento and San Joaquin Rivers in order to create corridors of riparian vegetation to provide shaded riverine aquatic cover for anadromous and other fish species, and to create high-quality habitat for associated special-status plant and animal species and other wildlife.

Indicators of the health of riparian and riverine aquatic habitats include the extent and quality of the habitats.

LINKAGE TO OTHER PROGRAMS

Efforts to achieve the vision for riparian and riverine aquatic habitats may involve coordination with other programs, including U.S. Army Corps of Engineers' proposed reevaluation of the Sacramento River flood control project and ongoing bank protection project, including more comprehensive floodplain management and river ecosystem restoration opportunities; SB1086 Advisory Council efforts and river corridor management plan for the Sacramento River; the San Joaquin River Parkway and Management plans; proposed riparian habitat restoration and floodplain management and riparian restoration studies for the San Joaquin River, including potential new flood bypass systems and expanded river floodplains on lands recently acquired by State and federal agencies and land trusts; ongoing Sacramento Valley conservation planning by The Nature Conservancy and other private nonprofit conservation organizations; expansion plans and conservation easements underway for the Sacramento River National Wildlife Refuge and California Department of Fish and Game's Sacramento River Wildlife Management Area; ongoing coordination efforts and programs of the Wildlife Conservation Board, including the Riparian Habitat Joint Venture; all county-sponsored instream mining and reclamation ordinances and river and stream management plans; and the California Department of Conservation reclamation planning assistance programs under the Surface Mining and Reclamation Act.

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INTRODUCTION

Inland dune scrub is associated with inland sand dunes and is limited in the ERPP focus area to the vicinity of the Antioch Dunes Ecological Reserve. This habitat area supports two plant and one butterfly species listed as endangered under the federal Endangered Species Act. Major factors that limit this resource's contribution to the health of the Delta are related to adverse effects of sand mining, conversion of dunes to other land uses, stabilization of dunes, and continuation of land use practices that maintain the dominance of non-native plants.

The vision for inland dune scrub habitat is to protect and enhance its existing areas and restore former habitat areas in the Bay-Delta in order to provide high-quality habitat for associated special-status plant and animal populations.

BACKGROUND

Inland dune scrub is localized in areas of wind-modified stream deposits in the south and western Delta between Antioch and Oakley, south of Rio Vista, and on Brannan Island. Inland dune soils are poor for agriculture and are used primarily for industry and urban development. Based on information on soils, the total inland sand-dune habitat within Contra Costa, Solano, and Sacramento Counties was historically less than 10,000 acres. As a result of the relatively recent land use changes on the inland dune scrub areas, recognition of this habitat as unique and supporting several special-status plant and wildlife species has led to protection of important remaining habitat areas. Most protected inland dune scrub is located within the Antioch Dunes Ecological Reserve and Brannan Island State Park. These protected areas represent important, but relict, examples of this unique habitat.

Two special-status plant species, the Antioch Dunes evening primrose and the Antioch Dunes wallflower, are closely associated with inland dune scrub. The Lange's metalmark, a butterfly federally listed as endangered under the Endangered Species Act (ESA), is known only from the Antioch Dunes, where it feeds on naked buckwheat. The low nutrient conditions of the soils and natural low stability of dune sands limit the amount of vegetation that becomes established on the inland dunes. The dunes represent a localized habitat that is not conducive to supporting other types of upland vegetation.

As in other dune ecosystems, such as coastal dunes and desert sand dunes, wind is the major process that maintains dunes and dune structure. The presence of the wind-modified, river-deposited sands, in combination with the Delta wind patterns, maintains a natural disturbance threshold that favors the establishment of the plant species that are characteristic of dunes and prevents the establishment of species less tolerant of these conditions.

Factors related to the decline of inland dune scrub and its associated plants and animals include direct loss of habitat from sand mining; urban development; disturbance of the dune surface from excessive foot traffic, offroad vehicle traffic, and grazing; and indiscriminate application of herbicides, pesticides, and fertilizers. Structures or activities that change the wind-caused disturbance regime (e.g., reducing or accelerating winds) or barriers to movement of wind-driven sand, such as fences, indirectly affect the health of inland dune scrub by disrupting the processes that sustain dunes. Direct disturbances inhibit the ability of dune-associated plants to establish and result in loss of plant vigor or mortality. Barriers to sand movement create conditions unfavorable for establishment of native dune vegetation. These types of disturbances create site conditions conducive to establishment of invasive weedy plants that compete with native dune plants and reduce overall habitat quality. The continuation of these practices in potentially restorable habitat adjacent to existing protected habitat areas could interfere with protecting and restoring additional areas of high-quality habitat by affecting dune structure and destroying buckwheat, Antioch evening primrose, and Antioch Dunes wallflower plants.

RESTORATION NEEDS

Restoration of inland dune scrub would focus on protection and improvement of important existing habitat areas and reestablishment of historic inland dunes adjacent to existing ecological reserves in the Sacramento- San Joaquin Delta Ecological Zone. Protection and restoration would be initiated by identifying inland dune scrub habitat areas that are not currently managed for their resource values, identifying appropriate methods to protect and restore those areas, and evaluating protected habitat areas to determine means of restoration management to increase habitat value. The results of these evaluations would determine how habitat would be protected and restored.

Managing protected areas could include reducing disturbance of dunes and dune vegetation. This could be accomplished by reducing vehicle and pedestrian access to the dune areas or installing protective structures, such as small boardwalks, to reduce disturbance in areas where recreational access or interpretive trails are needed. Methods used to restore inland dunes could include removing barriers to wind-driven sand-dune movement to increase the area that would be available for natural expansion of the sand-dune base; importing sands from areas proposed for development or clean sand dredged from channels in the Bay-Delta to increase restoration potential and dune area; controlling non-native weeds to recreate conditions suitable for the natural reestablishment of native dune plants; and reducing the use of herbicides, pesticides, and fertilizers that adversely effect native dune vegetation and animals. Dune habitat protection and restoration strategies could be implemented through cooperative efforts with existing ecological reserves to implement existing protection and restoration programs, cooperative agreements with land management agencies or through conservation easements or purchase from willing sellers.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for inland dune scrub habitat is to improve low- to moderate-quality inland dune habitat in the Delta to provide high-quality habitat for special-status plant and animal species and other associated wildlife populations.

The measurement of performance against the implementation objective is the quality and quantity of inland dune scrub habitat in the Bay-Delta. Increasing the quality of existing and the quantity of inland dune scrub will be the indicators for restoration of this habitat.

LINKAGE TO OTHER PROGRAMS

Efforts to restore inland dune habitats will involve cooperation with programs managed by the Antioch Dunes National Wildlife Refuge. Cooperation from agencies with responsibility or authority for restoring inland dune habitat, including the California Department of Fish and Game, U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers, and the Delta Protection Commission, will be solicited.

INTRODUCTION

Perennial grasslands are important breeding and foraging habitat areas for many species of wildlife and support several special-status plant species. Most perennial grassland, historically common throughout most of the Central Valley, has been lost or has been converted into annual grassland. Major factors that limit this resource's contribution to the health of the Delta are related to the adverse effects of reclamation of grasslands for agricultural, urban, and industrial uses and continuation of land use practices that maintain the dominance of non-native annual grasses in historic perennial grassland habitat.

The vision is to protect and improve existing perennial grasslands and increase grassland area as a component of restoring wetland and riparian habitat to provide high-quality habitat for special-status plant and wildlife populations and other wildlife dependent on the Bay-Delta.

BACKGROUND

Perennial grassland provides habitat for many plant and wildlife populations. Many annual plant species are endemic to vernal pools that occur in the small depressions and low-lying valleys of the undulating landscape. Within the pools, communities of flowering annuals, invertebrates, and amphibians (many of which are listed as threatened or endangered under the State or federal Endangered Spècies Acts) evolved in mutual, and in some cases obligate mutual, relationships. In addition to supporting vernal pools, perennial grasslands provide valuable habitat for many wildlife species, such as deer, San Joaquin kit fox, ground squirrels, kangaroo rats, and blunt-nosed leopard lizards, and nesting habitat for waterfowl. Where grassland still occurs, it also provides an extremely valuable transition zone and area of support for adjacent habitats.

Perennial grasslands and associated vernal pools historically were present at drier, higher elevations in the Delta adjacent to wetland and riparian habitats that occupied wetter, lower elevation sites. These grasslands have largely been reclaimed for other uses. Most remaining grasslands are now dominated by non-native annual grasses that have outcompeted and replaced perennial bunch grasses over most of the Central Valley.

Factors related to the decline in perennial grasslands in the Bay-Delta estuary include reclamation of grasslands for agricultural, urban, and industrial uses; introduction of non-native species that outcompete native grassland plants; fire suppression (fires are a natural method of promoting succession), which has aided the intrusion of fire-sensitive non-native plants; and continuation of land use practices that maintain the dominance of non-native annual grasses.

RESTORATION NEEDS

Restoration of perennial grassland would focus on reestablishing historic grasslands and protecting and improving important existing grassland areas in the Sacramento-San Joaquin Delta and Suisun Marsh/North San Francisco Bay Ecological Zones. Grasslands would be restored as a component of restoring wetland and riparian habitat. Restoring grasslands in conjunction with wetland and riparian habitats increases overall habitat value for species that require both grassland and wetland or riparian habitats that are in close proximity to each other (e.g., grasslands adjacent to wetlands provides nesting habitat for several species of ducks and refuge habitat for small mammals during flooding) and provides a buffer area around wetland and riparian habitats that protects them from potential adverse effects of adjacent land uses.

Reducing land use changes and practices and the introduction of non-native species will decrease the major stressors affecting perennial grasslands and vernal pools. The promotion of fire as a natural method for succession would aid in managing non-native plants that are not evolved to survive fire. Alternatives to the use of herbicides and other contaminants to control vegetation should be encouraged to promote more natural revegetation.

Increasing the quantity and quality of grasslands would provide the habitat conditions necessary to help recover special-status plant and wildlife populations, and maintain or increase populations of other species that are dependent on grasslands in the estuary. Restoration, protection, and improvement of grasslands could be achieved through conservation easements or purchasing land from willing landowners to protect important existing habitat areas from potential future degradation, establishing incentive programs to encourage landowners to establish and maintain perennial grasslands, and developing and implementing alternatives to land management practices on public lands that continue to degrade habitat quality or inhibit habitat recovery.

Restoration of ecological processes and habitats proposed by the Ecosystem Restoration Program Plan (ERPP) in other ecological zones will also create the conditions necessary for the natural reestablishment of grasslands elsewhere in the Central Valley.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective is to preserve and restore perennial grassland habitat in conjunction with restoration of wetland and riparian habitats in order to provide high-quality habitat conditions for associated special-status plant and wildlife populations.

The measurement of performance against the implementation objective is the quality and quantity of perennial grassland habitats in the estuary. The quality and quantity of suitable perennial grassland in the estuary will be the indicators for restoration of this habitat.

LINKAGE TO OTHER PROGRAMS

Protecting and restoring perennial grasslands are objectives of agencies and organizations that operate many protected habitat areas, including the Cosumnes River Preserve, Grizzly Slough Wildlife Area, Jepson Prairie Preserve, Putah Creek South Fork Preserve, Stone Lakes National Wildlife Refuge, and Woodbridge Ecological Reserve. Restoring perennial grassland is also an objective of the Cache Creek Corridor Restoration Plan and Yolo County Habitat Conservation Plan.

INTRODUCTION

Following extensive loss of native habitats in the Central Valley, some wildlife species have adapted to the artificial wetland and upland environments created by some agricultural practices and have become dependent on these agricultural areas to sustain their populations at current levels. Major factors that limit this resource's contribution to the health of the Delta are related to adverse effects of clean farming practices that reduce the availability and quantity of forage and field border shelterbelts, conversion of agricultural lands for urban or industrial uses, converting production from crops that provide relatively high-values for wildlife to relatively low-value crop types, and agricultural practices that degrade the quality of agricultural lands for wildlife.

The vision for agricultural lands is to improve wildlife habitat values associated with them in order to provide high-quality habitat for special-status wildlife populations and other wildlife dependent on the Bay-Delta.

BACKGROUND

Agricultural lands are located throughout the Central Valley. These lands comprise many different types of agricultural land uses ranging from nonirrigated grazing land to drip-irrigated vineyard. Soil type, topography, and availability of water usually dictate the type of crops grown on any particular parcel. Intensively managed agricultural lands or croplands are located on flat or slightly rolling terrain. Flat cropland is usually the product of extensive surveying and laser land-leveling activities, which provide more efficient use of water, less soil erosion, and higher crop yields. A variety of fragmented habitats that supports various resident and migratory wildlife species is closely associated with these agricultural lands and includes naturally occurring wetland types (creeks, vernal pools, and gullies).

Agricultural lands, depending on the crop type and cultivation practices, can provide significant habitat for some species of wildlife. For example, rice lands support millions of wintering waterfowl using the Central Valley. Lands where wheat and corn have been harvested, particularly if it is shallowly flooded after harvest, also support large populations of wintering waterfowl and the State-listed greater sandhill crane.

Major stressors that determine the wildlife values provided by agricultural lands include activities such as water quantity and quality management, crop type conversion from relatively high-wildlife-value crops to relatively low-wildlife-value crops (e.g., conversion from pastureland rowcrops to vineyards), the use of "clean farming techniques", deep postharvest disking, practices that reduce crop and grain residue within the field, cropland management with varied pesticide application, and the timing of these activities. Implementing appropriate land use management techniques accompanied by reimbursement programs to the agricultural stakeholder can reduce the adverse impacts of stressors on diverse agricultural habitat.

RESTORATION NEEDS

Protection and enhancement of agricultural lands for wildlife would focus on encouraging production of crop types that provide high wildlife habitat value, agricultural land and water management practices that increase wildlife habitat value, and discouraging development of important agricultural lands for urban or industrial uses in the Sacramento-San Joaquin Delta and

Suisun Marsh/North San Francisco Bay Ecological Zones. Vegetation management of agricultural lands could provide wildlife habitat at many locations, including rice checks, irrigation ditches, lowlands, ponds, fallow lands, fence rows, and other areas unsuitable for agricultural land use. Agricultural crop types that present excellent opportunities for enhancement include rice, alfalfa and pasture, corn and grain, and certain rowcrop farmland. Enhancement of agricultural lands adjacent to existing important wildlife habitat areas, such as refuges, would be particularly beneficial. The value of enhanced land could be increased if nearby nonfarmed or fallow lands could be managed to provide other habitats required by wildlife that use agricultural lands. In some situations, altering common management practices can greatly increase wildlife habitat value with little or no change in crop production. For example, deferring fall tillage until later in the year can increase the quantity of forage on cornfields for waterfowl and greater sandhill cranes, and fall/winter shallow flooding of seasonal croplands can greatly increase the availability of forage for wintering waterfowl. Wildlife habitat provided by flooding seasonal cropland and maintaining upland habitats could be further improved by retaining a percentage of the unharvested crop in the agricultural field. Incidental benefits to agricultural stakeholders from improving conditions for wildlife would be groundwater recharge to aquifers used for summer irrigation, leaching salts from soils, biological decomposition of crop residue, reduction in soil erosion, and an increase and a diversification of farming income and potentially a resulting increase in property values.

Protection and enhancement of agricultural lands would be achieved through participation and cooperation with agricultural stakeholders, including farmers, ranchers, and other landowners and lessees. Mechanisms to protect and enhance agricultural lands include various multiyear agreements, conservation easements, and purchases through specific payment programs between resource agencies and willing participants. Governmental and private agencies and agricultural stakeholders involved in current agricultural land enhancement and management include the California Department of Fish and Game, California Department of Water Resources, California Department of Transportation, U.S. Fish and Wildlife Service, U.S. Bureau of Land Management, U.S. Bureau of Reclamation, U.S. Natural Resources Conservation Service, Ducks Unlimited, The Nature Conservancy, resource conservation districts, farm bureaus, county agricultural commissions, and various county land planning agencies.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for agricultural lands is to comanage agricultural upland and wetland habitat to provide wildlife forage and resting area habitat for wintering and migrating waterfowl, shorebirds, and other associated wildlife in the Delta.

The measurement of performance against the implementation objective is the quality and quantity of agricultural habitats in the Bay-Delta. Increasing the quality of existing and the quantity of agricultural habitats in the Bay-Delta will be the indicators for enhancement of this habitat.

LINKAGE TO OTHER PROGRAMS

Numerous agricultural habitat improvement projects involving a number of project proponents are proposed and in various stages of development throughout the ecological zones. Some of the more notable projects are Stones Lakes National Wildlife Refuge, Cosumnes River Preserve, and Yolo Bypass Wildlife Management Area. There are also many voluntary landowner incentive programs that involve various agricultural habitat improvements in the ecological zones, including the Wetland Reserve Program, Agricultural Conservation Program, Water Bank Program, Partners for Wildlife, California Waterfowl Habitat Program, Inland Wetland Conservation Program, Conservation Reserve Program, and Permanent Wetland Easement Program.