INTRODUCTION TO SPECIES AND SPECIES GROUP VISIONS

This section presents visions for species and species group ecosystem elements. Species and species groups included are those that occur in or are dependent on the Bay-Delta and listed or proposed for listing as threatened or endangered under the California or federal Endangered Species Acts (ESAs), designated as a species of special concern by the California Department of Fish and Game (DFG), or designated as a species of concern by the U.S. Fish and Wildlife Service (USFWS); are important recreational or commercial species; or are ecologically important as a prey or foodweb species. Table 1 identifies important fish and wildlife species and species groups and the visions in which they are addressed and Table 2 presents the basis for their consideration. Special-status plant species are included in the visions for the habitat types in which they occur.

Visions describe the role and importance of each species and species group, a description of their habitat requirements, stressors and changes to ecological processes and habitats that have affected their populations, and approaches for restoring ecological processes and habitats and reducing the effects of stressors to improve the health of their populations. Proposed population targets and programmatic actions to help achieve targets are identified in visions. The Ecosystem Restoration Program Plan (ERPP) implementation objectives, targets, and actions for restoring ecological processes and habitat types on which species and species groups are dependent 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 vision.

Table 1. Species and Species Groups Addressed in Visions

Vision	Species
Delta Smelt	Delta smelt
Longfin Smelt	Longfin smelt
Sacramento Splittail	Sacramento splittail
White Sturgeon and Green Sturgeon	White sturgeon; green sturgeon
Chinook Salmon	Sacramento fall-run chinook salmon; Sacramento late-fall-run chinook salmon; Sacramento winter-run chinook salmon; Sacramento spring-run chinook salmon; San Joaquin fall-run chinook salmon
Steelhead Trout	Steelhead trout
Striped Bass	Striped bass
American Shad	American shad

Vision	Species
Resident Fish Species	*Representative species:* Tule perch; hitch hardhead; Sacramento blackfish; Sacramento sucker; Sacramento squawfish; threespine stickleback; bluegill; white catfish; inland silverside; yellowfin goby; chameleon goby; threadfin shad; wakasagi
Marine/Estuarine Fishes and Large Invertebrates	*Representative species:* Starry flounder; Pacific herring; northern anchovy; prickly sculpin; staghorn sculpin
Western Spadefoot Toad and California Tiger Salamander	Western spadefoot toad and California tiger salamander
California Red-Legged Frog	California red-legged frog
Giant Garter Snake and Western Pond Turtle	Giant garter snake and western pond turtle
Swainson's Hawk	Swainson's hawk
Clapper Rail	Clapper rail
California Black Rail	California black rail
Greater Sandhill Crane	Greater sandhill crane
Western Yellow-Billed Cuckoo	Western yellow-billed cuckoo
Bank Swallow	Bank swallow
Suisun Song Sparrow	Suisun song sparrow
Salt Marsh Harvest Mouse	Salt marsh harvest mouse
Riparian Brush Rabbit	Riparian brush rabbit
Shorebird and Wading Bird Guild	*Representative species:* Great blue heron; great egret; western sandpiper; long-billed dowitcher
Waterfowl	*Representative species:* Canvasback; ring-necked duck; hooded merganser; northern pintail; mallard; greater white-fronted goose; snow goose; Canada goose; tundra swan
Upland Game	*Representative species:* California quail; mourning dove; common snipe; desert cottontail

Vision	Species
Neotropical Migratory Bird Guild	*Representative species:* Western kingbird; western wood-pewee; tree swallow; cliff swallow; northern oriole; Wilson's warbler; yellow-breasted chat
Lange's Metalmark, Delta Green Ground Beetle, and Valley Elderberry Longhorn Beetle	Lange's metalmark, delta green ground beetle, and valley elderberry longhorn beetle

Table 2. Basis for Selection of Species and Species Group Ecosystem Elements

Species and Species Groups	Basis for Selection as an Ecosystem Element
Delta smelt	The delta smelt is a native estuarine resident fish that has been listed as threatened under the California and federal Endangered Species Acts.
Longfin smelt	The longfin smelt is a native estuarine resident species and is designated as a species of special concern by DFG and a species of concern by USFWS.
Sacramento splittail	The Sacramento splittail is a native resident fish that is proposed for listing under the federal Endangered Species Act and a candidate for listing under the California Endangered Species Act. The Sacramento splittail also supports a small winter sport fishery in the lower Sacramento River.
White Sturgeon	The white sturgeon is an important native anadromous sport fish with high recreational and ecological value.
Green sturgeon	The green sturgeon is designated as a species of special concern by DFG and a species of concern by USFWS.
Sacramento fall-run chinook salmon	The chinook salmon is an important native anadromous sport and commercial fish with important ecological value. The fall-run race is the largest population of chinook salmon on the Sacramento River.
Sacramento late-fall-run chinook salmon	The chinook salmon is an important native anadromous sport and commercial fish with important ecological value. The late-fall-run race on the Sacramento River is designated as a species of special concern by DFG and a species of concern by USFWS.
Sacramento winter-run chinook salmon	The chinook salmon is an important native anadromous sport and commercial fish with important ecological value. The winter-run race is listed as endangered under the California and federal Endangered Species Acts.
Sacramento spring-run chinook salmon	The chinook salmon is an important native anadromous sport and commercial fish with important ecological value. The spring-run race on the Sacramento River is designated as a closely monitored species by DFG and a species of concern by USFWS.

Species and Species Groups	Basis for Selection as an Ecosystem Element
San Joaquin fall-run chinook salmon	The chinook salmon is an important native anadromous sport and commercial fish with important ecological value. The fall-run race on the San Joaquin River is designated as a species of special concern by DFG and a species of concern by USFWS.
Steelhead trout	The steelhead trout is an important native anadromous sport fish of high recreational and ecological value that is proposed for listing under the federal Endangered Species Act.
Striped bass	The striped bass is an important non-native anadromous sport fish with high recreational value. It also plays an important role as a top predator in the aquatic system.
American shad	The American shad is an important non-native anadromous sport fish with high recreational value.
Resident fishes	Resident fish species of the Delta include native and non-native species and are important ecologically and as indicators of ecosystem health. Some native species are important elements of the foodweb; others are important predators. Native resident fish have been in decline as a percentage of total fish species abundance in tributaries of the Bay-Delta/Central Valley watershed. Some non-native species are considered beneficial as prey species for other fish or as sport fish. Other species are considered undesirable because they compete with or are predators on native fish. Wakasagi is a close relative to delta smelt and could threaten the delta smelt population by interbreeding or by competing for habitat.
Marine fishes	Marine fishes include many species that are abundant and important ecologically in the Bay and coastal waters. Two ecologically significant species are the Pacific herring and northern anchovy, whose young are critical in the foodweb of important anadromous fishes, including salmon and striped bass. The Pacific herring and northern anchovy are also important foodweb species for wildlife that forage for fish in the Bay-Delta (e.g., cormorants and terns).
Western spadefoot California tiger salamander	The western spadefoot and California tiger salamander are designated as species of special concern and species of concern by DFG and USFWS, respectively.
California red-legged frog	The California red-legged frog is listed as a threatened species under the federal ESA.
Giant garter snake	The giant garter snake is listed as threatened under the California and federal ESAs.
Western pond turtle	The western pond turtle is designated as a species of special concern and a species of concern by DFG and USFWS, respectively.
Swainson's hawk	The Swainson's hawk is listed as threatened under the California ESA.

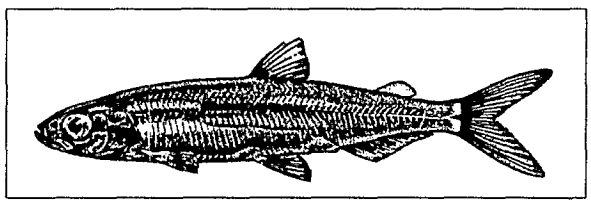
Species and Species Groups	Basis for Selection as an Ecosystem Element
California clapper rail	The California clapper rail is listed as endangered under the California and federal ESAs.
California black rail	The California black rail is listed as threatened under the California ESA.
Greater sandhill crane	The greater sandhill crane is listed as a threatened species under the California ESA. Act.
Western yellow-billed cuckoo	The western yellow-billed cuckoo is listed as endangered under the California ESA.
Bank swallow	The bank swallow is listed as threatened under the California ESA.
Suisun song sparrow	The Suisun song sparrow is being considered for listing under the California ESA.
Salt marsh harvest mouse	The salt marsh harvest mouse is listed as endangered under the California and federal ESAs.
Riparian brush rabbit	The riparian brush rabbit is listed as endangered under the California ESA.
Shorebirds and wading birds	Many species of shorebirds and wading birds migrate through, winter, or breed in the Bay-Delta. These species are significant components of the ecosystem, are of high interest to recreational bird watchers, and contribute to California's economy through sales of equipment and other bird-watching-related expenditures.
Waterfowl	Many species of waterfowl migrate through, winter, or breed in the Bay-Delta. Waterfowl are significant components of the ecosystem, are of high interest to recreational hunters and bird watchers, and contribute to California's economy through the sale of hunting and related equipment.
Upland game	Upland game species are of high interest to recreational hunters in the Bay-Delta and contribute to California's economy through the sale of hunting-related equipment and expenditures.
Neotropical migratory birds	Many species of neotropical migratory birds migrate through or breed in the Bay-Delta. These species are significant components of the ecosystem, are of high interest to recreational bird watchers, and contribute to California's economy through sales of equipment and other bird-watching-related expenditures.
Lange's metalmark	The Lange's metalmark is listed as endangered under the federal ESA.
Delta green ground beetle	The delta green ground beetle is listed as endangered under the federal ESA.
Valley elderberry longhorn beetle	The valley elderberry longhorn beetle listed as threatened under the federal ESA.

Table 3. Ecological Zones in Which Ecological Process, Habitat, and Stressor Implementation Objectives, Targets, and Programmatic Actions Are Proposed That Will Assist in the Recovery of Species and Species Groups

Species and Species Group Visions	Ecological Zone[1]													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Delta Smelt	●	●												
Longfin Smelt	●	●												
Sacramento Splittail	●	●	●											
White Sturgeon-Green Sturgeon	●	●	●					●						
Chinook Salmon	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Steelhead Trout	●	●	●	●	●	●	●	●	●	●	●	●	●	●
Striped Bass	●	●	●						●			●		
American Shad	●	●	●						●					
Resident Fish Species	●	●												
Marine/Estuarine Fishes and Large Invertebrates	●	●												
Western Spadefoot Toad and California Tiger Salamander	●	●												
California Red-Legged Frog	●	●												
Giant Garter Snake and Western Pond Turtle	●	●												
Swainson's Hawk	●	●												
Clapper Rail		●												

Species and Species Group Visions	Ecological Zone[1]													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
California Black Rail	●	●												
Greater Sandhill Crane	●													
Western Yellow-Billed Cuckoo	●													
Bank Swallow	●													
Suisun Song Sparrow		●												
Salt Marsh Harvest Mouse		●												
Riparian Brush Rabbit	●													
Shorebird and Wading Bird Guild	●	●												
Waterfowl	●	●												
Upland Game	●	●												
Neotropical Migratory Bird Guild	●	●												
Lange's Metalmark, Delta Green Ground Beetle, and Valley Elderberry Longhorn Beetle	●													

[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



INTRODUCTION

The delta smelt is a native estuarine resident fish that has been listed as threatened under the State and federal Endangered Species Acts. Major factors that limit this species' contribution to the health of the Delta are related to the adverse effects of low Delta outflow, and includes poor foodweb productivity, reduced low-salinity habitat, greater losses to water diversions, poorer larval and juvenile transport from spawning to rearing areas, and potentially higher concentrations of toxins that may limit its survival and production.

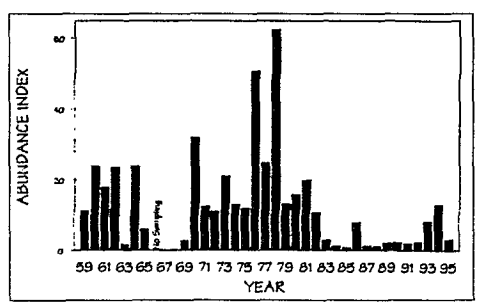
The vision for delta smelt is to ensure the recovery of this State- and federally listed threatened species in order to contribute to the overall species richness and diversity and to reduce the conflict between protection for this species and other beneficial uses of water in the Bay-Delta.

BACKGROUND

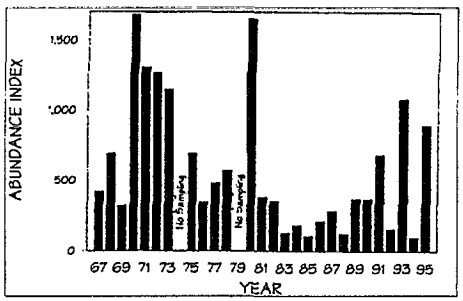
Delta smelt are endemic to the Sacramento-San Joaquin Delta estuary and represent an important component of the historic native fish fauna. Because it has a 1-year life span and relatively low fecundity, the delta smelt population is potentially very sensitive to short-term changes in habitat conditions and stressors. The population abundance of delta smelt is highly variable, and patterns of abundance are characterized by precipitous declines followed by dramatic recovery. Low abundance through the drought years (1987-1992) called attention to the need for actions to restore the delta smelt population.

Delta smelt are found within a relatively restricted geographical range (generally in upper Suisun Bay and the Delta) where the quality and quantity of shallow-water, marsh-slough habitat has been diminished from wetland reclamation. The amount of remaining shallow-water, low-salinity habitat is further reduced in dry water years by extensive water diversions from the Delta. Increased habitat and expanded distribution of delta smelt can be realized through habitat restoration accompanied by improvements in ecosystem processes including streamflow, stream channels, and floodplain inundation.

The delta smelt is listed as a threatened species under the federal Endangered Species Act (ESA) primarily as a result of modification of habitat by past and ongoing human actions. Rebound of the population abundance during 1993 and 1995 (relative to abundance during the 1987-1992 drought) suggests that recovery potential may be high. Precipitous population decline during drought conditions (as in 1994), however, illustrates the potential threat of poor conditions to the species' survival under existing habitat availability and species distribution. A low abundance index in 1996, a wet year, is further cause for concern.



Summer Abundance Index



Fall Abundance Index

Delta smelt tolerate a wide range of salinity but are most abundant in the Sacramento-San Joaquin Delta estuary, where salinity is around 2 parts per thousand (ppt). Spawning occurs in fresh water in the upstream areas of the Delta. Construction of levees in the 1800s created narrow channels and eliminated vast areas of marshes and interconnecting sloughs. These marshes and adjoining sloughs are very productive and support an abundance of zooplankton, on which delta smelt feed, and are important as spawning and rearing habitat for the species.

Reduced freshwater outflow during the late winter and spring of dry years shifts the estuarine salinity distribution upstream and reduces the amount of low-salinity habitat for delta smelt. The upstream shift changes the location of habitat that meets the salinity needs of the delta smelt, similar to effects on other Delta fish species such as striped bass, longfin smelt, and Sacramento splittail. Habitat location is shifted upstream from the relatively shallow, productive bays, marshes, and sloughs of Suisun Bay and into the narrow, deeper, and less-productive channels of the Delta.

The upstream shift also increases exposure to Delta diversions (e.g., hundreds of small agricultural diversions, Central Valley Project (CVP) and State Water Project (SWP) export pumps, and Pacific Gas & Electric (PG&E) power generation facilities). During most years, large numbers of delta smelt are entrained in Delta diversions, and effects of entrainment on delta smelt may be similar to effects described for other species, especially those species with similar life histories and planktonic life stages such as striped bass and longfin smelt.

Food availability, toxic substances, competition and predation (particularly from non-native species), and loss of genetic integrity through hybridization with the introduced Japanese pond smelt also are among the factors believed to influence smelt abundance.

RESTORATION NEEDS

Delta smelt would benefit from improvements in ecosystem processes and habitats, and reductions in stressors. Improvements in streamflow (Delta inflow and outflow) would better attract adults to spawning habitat, ensure transport or movement of larvae and early juveniles to productive rearing habitat, and maintain productivity and suitability of spawning and rearing habitat (including production of food). Additional freshwater flow could be provided during spring to maintain salinity requirements of delta smelt in areas that are good nursery areas of delta smelt, such as Suisun Bay and Marsh.

Delta smelt would benefit from restoration of spawning and rearing habitat. Spawning habitat includes shallow freshwater sloughs and edgewaters that incorporate spawning substrate (e.g., firm substrate, submerged vegetation, woody debris). Rearing habitat includes shallow brackish water (less than 6-8 ppt salinity) that provides a protective, food-rich environment.

Habitat restoration may be achieved by adding and modifying physical habitat and creating additional freshwater flow during critical periods. More habitat can be created by breaching levees to inundate lands once part of the Bay and Delta, setting levees back to increase shallow-water habitat along existing channels, protecting existing shallow-water habitat from erosion, and filling relatively deep water areas to create shallow-water habitat.

Reduction of stressors is a major component of delta smelt restoration. Of primary concern is reduction in losses to diversions. Actions to reduce losses include upgrading existing fish protection facilities, installing fish screens on currently unscreened facilities, reducing screen approach velocities, removing predators associated with diversions and fish protection facilities, relocating and consolidating existing diversions, changing the seasonal timing of diversions, and reducing or eliminating diversions. Delta smelt would also benefit from reduced pollutant input to streams and rivers in the Sacramento-San Joaquin River basin and less introductions of non-native species that prey upon or compete with delta smelt.

The following actions would improve the delta smelt populations:

- Improve Delta outflow during the late winter and spring to improve foodweb productivity and to disperse larvae and juveniles to downstream rearing habitat in Suisun Bay.
- Reduce adverse effects of CVP and SWP diversions during the period when larvae and juveniles appear in the Delta.
- Allow no net physical loss of shallow-water habitat in areas critical to spawning and rearing.
- Construct and improve fish facilities for Delta diversions, including agricultural diversions and CVP and SWP diversions. Remove predators and improve handling and salvage practices at diversions.
- Reduce water diversions from the Delta when larvae and early juveniles are present in the Delta.
- Develop and implement a program to reduce the adverse effects of introduced aquatic species and the potential for future introductions.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for delta smelt is to ensure the recovery of this species, which is State- and federally listed as threatened, in order to contribute to overall species richness and diversity and reduce the conflict between the need for its protection and other beneficial uses of water in the Bay-Delta.

Indicators of the health of delta smelt include indices of abundance as measured from DFG Summer Townet and Fall Midwater Trawl surveys. In addition to abundance, a further indicator of health and recovery of delta smelt is its presence or absence at various survey stations in the DFG Fall Midwater Trawl Survey.

LINKAGE TO OTHER PROGRAMS

Efforts to restore delta smelt involve cooperation and support of other established programs that are protecting and improving conditions for delta smelt and other species in the Bay and Delta. The recovery plan for the Sacramento/San Joaquin Delta native fishes (U.S. Fish and Wildlife Service 1995a) would be considered in developing actions implemented under the Ecosystem Restoration Program Plan. The Central Valley Project Improvement Act will implement actions that will benefit delta smelt, including changing the timing of diversions, restoring habitat, and dedicating flow during critical periods (U.S. Fish and Wildlife Service 1995b). Federal ESA requirements (biological opinions and habitat conservation plans) will ensure maintenance of existing habitat conditions and implement recovery actions. The State Water Resources Control Board will implement the Water Quality Control Plan for the San Francisco/Sacramento-San Joaquin Delta estuary, which includes provisions to limit entrainment in diversions and

protect habitat conditions for delta smelt, chinook salmon, striped bass, and other species.

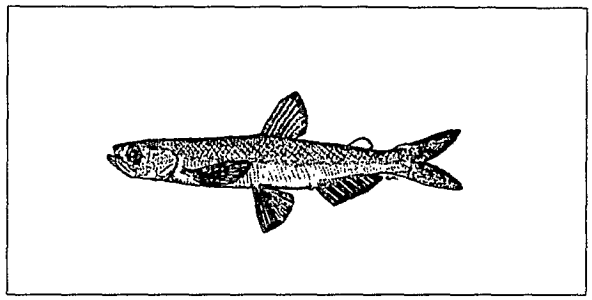
REFERENCES

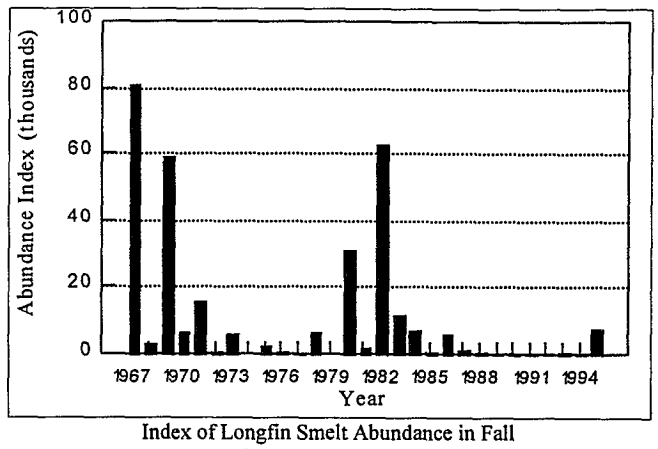
U.S. Fish and Wildlife Service. 1995a. Sacramento-San Joaquin Delta Native fishes recovery plan. Portland, OR.

_____. 1995b. Draft anadromous fish restoration plan. Sacramento, CA.

California Department of Fish and Game. 1993. Restoring Central Valley streams: a plan for action. Sacramento, CA.

LONGFIN SMELT





Index of Longfin Smelt Abundance in Fall Midwater Trawl Survey

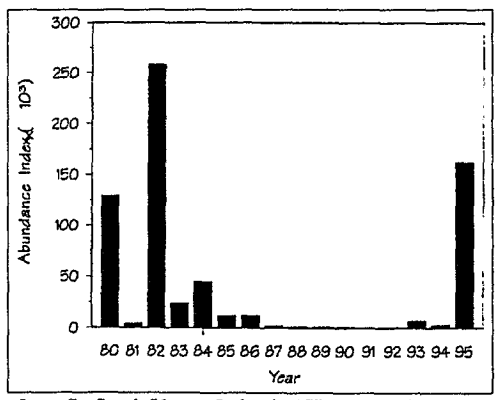
INTRODUCTION

Longfin smelt are small native fish that live in the brackish waters of San Francisco Bay and the Delta. They are an important element of the Bay-Delta foodweb as prey for chinook salmon, striped bass, and other predatory fish species. Because their abundance dropped sharply during dry periods over the past several decades, they are designated by the California Department of Fish and Game (DFG) and U.S. Fish and Wildlife Service (USFWS) as a species of special concern. Longfin smelt abundance was especially low during the 1987-1992 drought and showed signs of recovery only in 1995. Major factors that limit this species' contribution to the health of the Delta are related to the adverse effects of low Delta outflow and include associated poor foodweb productivity, greater effects of water diversions, poorer larval transport and habitat conditions, and potentially higher concentrations of toxins that may limit its survival and production during droughts. The vision for longfin smelt is to improve the population of this species of special concern in the Bay-Delta estuary.

BACKGROUND

A population of longfin smelt lives within the brackish and marine waters of northern San Francisco Bay and migrates upstream into the Delta to spawn. Longfin smelt are well adapted to the complex habitat conditions of the Bay-Delta estuary and are also found in other west-coast estuaries from northern California to southern Alaska. They are an important forage fish in the Bay-Delta foodweb. Because of their small size, they are prey for many predatory fish in the Bay and Delta.

Adult longfin smelt migrate upstream each winter from the Bay to spawn in freshwater portions of the upper Bay and Delta in habitats with hard-bottom or plant substrates. Most spawning takes place from late December through April. High winter and early spring flows transport newly hatched larvae downstream into Suisun and San



Longfin Smelt Young Index in IEP Bay Study Trawl Survey

Pablo Bays, where the plankton food supply is characteristically abundant and necessary for high survival of longfin smelt larvae and juveniles. Longfin smelt abundance, monitored each fall in the Bay and Delta since 1967 by DFG, has fluctuated sharply, with greatest abundance in wetter years in wet-year sequences (1967, 1969, and 1971 from 1967- 1971; and 1980, 1982, and 1983 from 1980-1983). Abundance has been very poor in drought periods (1976-1977 and 1987-1992). Low abundance in 1993, the first wet year following the drought from 1987 to 1992, may reflect a greatly reduced spawning population resulting from drought conditions. Improved abundance in 1995 indicates that they may be recovering from the effects of the drought.

A similar pattern of population abundance is evident since 1980 in DFG's Bay trawling survey and the University of California, Davis' trawl survey in Suisun Marsh. Abundance was high from 1980 through 1984, but declined to very low levels through the 1987-1992 drought and has recovered only slightly since 1995.

The decline in the longfin smelt population has occurred coincident with a number of changes in the estuary. Factors related and believed to contribute to this decline are listed below.

- Low flows in late winter and spring into and through the Delta are believed to have reduced survival of eggs and larval longfin smelt spawned in the Delta. Low flows are a consequence of climatic conditions (low rainfall and more precipitation as winter rains rather than snow) and upstream reservoir storage of winter and spring runoff in dry and normal years.

- Reduced freshwater flows through the Delta and into Suisun Bay may have limited the production of foodweb organisms during the critical early life stages of longfin smelt.

- Low Delta outflows may have limited the transport of larval and juvenile longfin smelt downstream into quality nursery grounds of Suisun and San Pablo Bays.

- Loss of larvae (about 5-15 millimeters long) and adults into water diversions in Suisun Bay, Suisun Marsh, and the Delta reduced production, especially in drier years when the percentage of fresh water diverted was sharply higher than that in wetter years. Pacific Gas & Electric Company's (PG&E's) power plants at Pittsburg and Antioch, the largest diversions (up to 3,000 cubic feet per second) in the prime nursery area of the western Delta and Suisun Bay, operate longer in winter and spring of dry years when there is less hydroelectric power produced to meet regional electricity demands. Similarly, Delta agricultural diversions are generally confined to from late spring through fall; however, spring diversions are generally greater in drier years, when irrigation needs are higher. Although larvae losses to south Delta Central Valley Project and State Water Project pumping plants are generally much lower than losses to more northern and western Delta diversions, they are higher in drier years when Delta outflow is insufficient to move larval longfin smelt out of the Delta into the Bay.

- In dry years, many larval and juvenile longfin smelt rearing in the Delta are drawn south across the Delta toward the south Delta pumping plants by the net southward flow caused by water exports from the Delta. Many probably perish before reaching the pumps as a result of poor food supply, poor water quality (mainly high water temperature), and high predation rates in the central and south Delta channels, and intake forebays and structures of the pumping plants. Of those reaching the pumping plants, some are recovered in fish salvage facilities and returned to the Bay, while others are lost in water pumped to the Delta-Mendota Canal.

- The number of adults making the upstream spawning run has dropped to such low levels in recent years that they no longer spawn

sufficient numbers of eggs to bring about quick recovery in wet years. This may explain why production in 1993 was lower than expected.

- Contaminants in the Delta water may also reduce the survival of longfin smelt. The effect may be indirect through reduced planktonic food supply or direct from toxin-induced egg, larval, or juvenile stress or mortality.

Other more speculative causes of the decline and low abundance of longfin smelt include competition or predation by recently established non-native fishes, such as gobies, introduced from the ballast water of ships from Asia. Predation in dry years may also be a problem. For example, stocking over 11 million juvenile striped bass from 1985 through 1990 into San Pablo and Suisun Bays may have, in combination with the drought, contributed to the precipitous decline of longfin smelt after 1985. Similarly, stocking millions of hatchery-reared salmon smolts into San Pablo Bay in spring each year may also have, in combination with the drought and striped bass predation, reduced longfin smelt survival. Changes in the plankton abundance and community species composition of the Bay and Delta caused by the introductions of non-native species of zooplankton and Asian clams may also have contributed to the decline of longfin smelt by affecting their food supply.

RESTORATION NEEDS

Achieving consistently high production of longfin smelt in normal and wetter years, which historically produced more abundant year classes, will be critical to the recovery of longfin smelt. Good wet-year production would be ensured by (1) not allowing production to fall too low in drier years such that numbers of adult spawners in subsequent wet years remains low, (2) maintaining and improving spawning and rearing habitat, and (3) minimizing stressors in wetter years.

A major focus of longfin smelt recovery efforts will be on enhancing freshwater outflow during winter spawning and early rearing periods. Natural Delta outflows in dry and below- and above-normal water-year types have been reduced, particularly in late winter and spring, and such reductions are coincident with the longfin smelt decline. The 1995 Water Quality Control Plan for the Delta provided interim provisions for increasing February-through-June Delta outflows. Additional improvements in late-winter and spring outflows would:

- improve transport of larvae and juveniles from Delta spawning areas to Bay rearing areas,
- limit the extent of net southerly flows toward the south Delta pumps where larvae and juveniles are subject to being exported,
- improve survival and production of longfin smelt by stimulating foodweb productivity, and
- dilute concentrations of contaminants that may be detrimental to longfin smelt or their food supply.

Although deterioration of habitat is not considered a major factor in the decline of longfin smelt, protecting, improving, and restoring shallow-water habitat in the Bay-Delta would help to increase survival and production of longfin smelt by providing spawning and rearing habitat and increasing foodweb production. The increased spawning area and improved food supply may help to overcome other factors that have little potential for change (e.g., competition and predation from non-native species). Increases in tidal wetlands will provide tidal channels that are important spawning and rearing habitat. Improving and restoring shallow waters and riparian vegetation along levees and channel islands in the Delta will also provide additional important spawning habitat. Habitat improvements are expected to also increase

the abundance of plankton, on which longfin smelt feed, and lead to improved survival of larvae and juveniles.

The USFWS Recovery Plan for Native Resident Fishes of the Sacramento-San Joaquin Bay-Delta Estuary (Recovery Plan) identifies restoring spawning and rearing habitat in shallow Delta islands presently or recently protected by levees and under agricultural production (Prospect Island, Hastings Tract, Liberty Island, New Hope Tract, Brack Tract, and Terminous Tract) (U.S. Fish and Wildlife Service 1996). The Recovery Plan also recommends restoring tidal shallow-water habitat in Suisun Marsh by reclaiming leveed lands.

In addition to improving Delta outflow and habitats, reducing stressors will be important in restoring longfin smelt. Important stressors are water diversions, predation and competition from non-native organisms, and contaminants. Water diversions remove many longfin smelt and their food supply from the Bay and Delta, particularly during drier years. Losses to diversions could be reduced as follows:

- Relocate or add diversion options for the south Delta pumping plants to (1) alleviate net southerly flows in the Delta in drier years, (2) improve transport of young longfin smelt to the Bay and away from the south Delta pumping plants and Delta agriculture diversions, and (3) increase the foodweb productivity.

- Evaluate and implement options to reduce PG&E cooling-water diversions from February through July in drier years, when the power plants have their greatest impact on longfin smelt. Options include limiting power operations during critical periods; improving screening facilities to reduce entrainment of larval and early juvenile longfin smelt, life stages that are presently most vulnerable to the intakes; or retrofitting plants with alternative cooling technologies (e.g., cooling towers).

Reducing predation and competition from non-native organisms would increase survival and population abundance of longfin smelt. The timing and location for stocking striped bass and hatchery-reared chinook salmon in spring and early summer could be altered to avoid important juvenile rearing areas of longfin smelt in Suisun and San Pablo Bays. Developing and implementing a program to reduce the potential for further introductions of non-native species to the estuary from ballast water released from ships into Bay-Delta ports would help to ensure against future increases in predation and competition.

Longfin smelt would also benefit from actions to reduce sources of contaminants in streams and rivers in the Sacramento-San Joaquin River basin. Developing and implementing a program to reduce contaminant inputs to the Bay-Delta would indirectly improve production of longfin smelt.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for longfin smelt is to ensure the recovery of this species of special concern in order to contribute to overall species richness and diversity and reduce conflict between the need for its protection and other beneficial uses of water in the Bay-Delta.

The distribution and abundance patterns exhibited in the Interagency Ecological Program trawl surveys can be used as indicators of the health of longfin smelt. Achieving historical levels of abundance, as well as a breadth of historical geographic and habitat use for spawning, rearing, and adult feeding, will be indicators of recovery of the longfin smelt population.

LINKAGE TO OTHER PROGRAMS

Restoring longfin smelt in the Central Valley is an objective of the Recovery Plan for the Sacramento/San Joaquin Delta Native Fishes (U.S. Fish and Wildlife Service 1995a). Its purpose under the federal Endangered Species Act is to provide a strategy for the conservation and restoration of Delta native fishes. Longfin smelt are identified in this plan as requiring prompt restoration actions. The basic objective of this plan is to establish self-sustaining populations of the species of concern, including longfin smelt, that will persist indefinitely. The vision for longfin smelt includes facilitating implementation of the Recovery Plan.

Efforts to restore longfin smelt in the Central Valley would also involve cooperation and support from other programs underway to restore habitat and fish populations in the basin. The Central Valley Project Improvement Act (PL 102-575) calls for the doubling of the anadromous fish populations (including striped bass, salmon, steelhead, sturgeon, and American shad) by 2002 (U.S. Fish and Wildlife Service 1995b). This program involves actions that may indirectly benefit longfin smelt. DFG is required under State legislation (The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act of 1988) to restore numbers of anadromous fish in the Central Valley (California Department of Fish and Game 1993). Actions include restoring the food supply of anadromous fish; that food supply includes longfin smelt.

Other efforts to improve habitat and reduce stressors will be coordinated with existing State and federal programs and with stakeholder organizations whose objectives include restoring habitat and fish and wildlife populations in the Central Valley.

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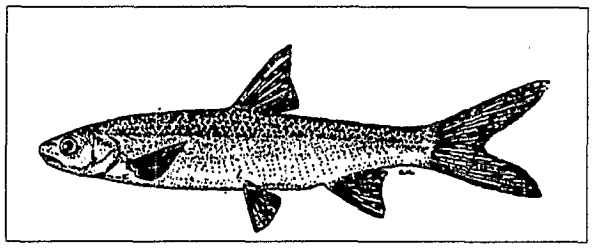


INTRODUCTION

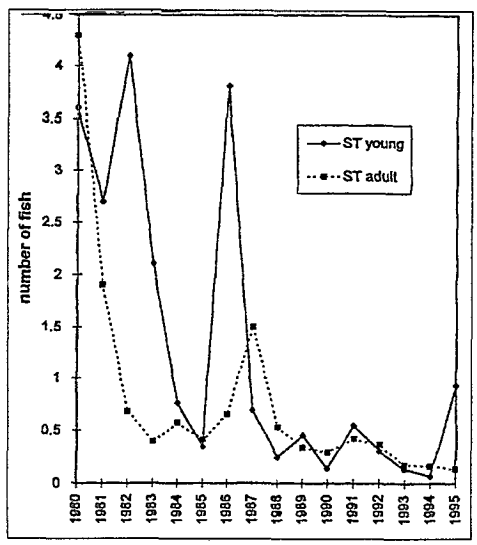
The splittail is a native resident fish that is proposed for listing under the federal Endangered Species Act and a candidate for listing under the State Endangered Species Act. The splittail also supports a small winter sport fishery in the lower Sacramento River. Major factors that limit its contribution to the health of the Bay-Delta include loss of floodplain spawning and rearing habitat, low streamflows that limit floodplain inundation and transport young to downstream nursery areas, and losses to water diversions.

The vision for splittail is to assist in the recovery of the species in order to contribute to the overall species richness and diversity, and to reduce the conflict between protection for this species and other beneficial uses of water in the Bay-Delta.

BACKGROUND

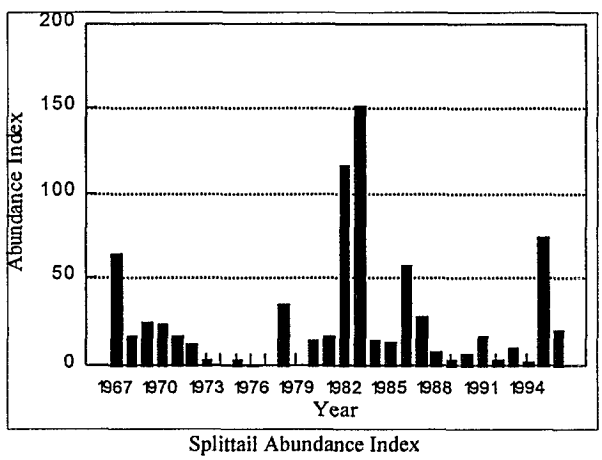
Splittail are endemic to the Sacramento-San Joaquin Delta estuary and to the lower reaches of major Central Valley rivers, including the Sacramento and San Joaquin. Splittail represent an important component of the historical native fish fauna. Similar to that of delta smelt and other native species, the population abundance of splittail is highly variable. Year-class abundance varies by orders of magnitude. Low year-class success occurred throughout the drought years (1987-1992) and called attention to the need for actions to restore the splittail population.

The geographic range of Sacramento splittail has been greatly diminished by human-caused actions. Restrictions to the floodplain, loss of marshes, and reduced winter-spring river flows from flood control and water supply development have reduced the species' range and abundance.



Index of Adult and Juvenile Splittail in Suisun Marsh Trawl Survey

Splittail are highly threatened, primarily from modification of habitat by past and ongoing



Splittail Abundance Index

human actions. Dams and levees restrict access to historical, seasonally flooded spawning and rearing habitat. Successful year classes are generally associated with winter and spring flows sufficient to inundate peripheral areas of the Delta and lower river reaches, including the flood bypass system of the Sacramento River and the floodplain of the San Joaquin River. Flood control reservoirs reduce flooding in the Sacramento, San Joaquin, American, Feather, Mokelumne, Stanislaus, Tuolumne, Merced, and Calaveras Rivers.

Splittail tolerate a wide range of salinity, but are most abundant in shallow areas where salinity is less than 10 parts per thousand (ppt). Spawning occurs in fresh water, primarily in areas upstream of the Delta. Levee construction in the 1800s created narrow channels and eliminated vast areas of fluvial marsh and seasonal wetlands, areas most likely important as spawning and rearing habitat for splittail.

Losses to Delta diversions (e.g., hundreds of small agricultural diversions, Central Valley Project [CVP] and State Water Project [SWP] export pumps, and Pacific Gas & Electric Company [PG&E] power generation facilities) reduce splittail abundance. Large numbers of splittail are entrained in Delta diversions, especially during years coinciding with high reproductive success.

Food availability, toxic substances, and competition and predation (particularly from striped bass and other introduced species) are among the factors influencing splittail abundance. In addition, harvest for food and bait by sport anglers may inhibit recovery of the splittail population.

RESTORATION NEEDS

Splittail would benefit from improvements in spawning and rearing habitat, late winter and spring river flows, and reductions in losses to water diversions. Increases in the frequency of floodplain inundation, and improvements to flow conditions would contribute most to their recovery. Additional freshwater flow could be provided during late winter and spring to attract adults to upstream spawning areas, transprot young to downstream nursery areas in the Bay-Delta, and to maintain low salinity habitat in the western Delta and Suisun Bay, which are important habitats for young and adult splittail.

A major component of restoring splittail is restoring seasonally flooded spawning and rearing habitat. Spawning habitat includes shallow edgewaters and easily flooded riparian zones and flood bypass areas that provide spawning substrate (e.g., submerged vegetation). Rearing habitat includes shallow- fresh- and brackish water (less than 10 ppt salinity) habitat that provide a protective, food-rich environment.

Habitat restoration may be achieved by adding and modifying physical habitat and additional freshwater flow during critical periods and includes breaching levees to inundate existing islands, setting levees back to increase shallow-water habitat along existing channels, protecting existing shallow-water habitat from erosion, and filling deep water areas to create shallow-water habitat.

Splittail would benefit from a reduction in losses to diversions in the Sacramento and San Joaquin Rivers and the Sacramento-San Joaquin Delta estuary. Actions to reduce losses include upgrading existing fish protection facilities, installing fish screens on currently unscreened facilities, removing predators associated with diversions and fish protection facilities, relocating and consolidating existing diversions, changing seasonal timing of diversions, and reducing or eliminating diversions.

Splittail would also benefit from actions to reduce pollutant input to streams and rivers in the Sacramento-San Joaquin River basin, and actions to prevent introduction of non-native species. High water temperatures and dissolved solids also reduce splittail use of the lower San Joaquin River.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for splittail is to assist in the recovery of this species, which is proposed for listing under the federal Endangered Species Act (ESA) and a candidate for listing under the California ESA, in order to contribute to overall species richness and diversity and reduce the conflict between the need for its protection and other beneficial uses of water in the Bay-Delta.

Indicators of the health of splittail are its index of abundance and distribution patterns in DFG's Fall Midwater Trawl Survey in the Bay-Delta.

LINKAGE TO OTHER PROGRAMS

Efforts to restore splittail would involve cooperation and support from other established programs that are protecting and improving conditions for delta smelt, striped bass, and other species. The Recovery Plan for the Sacramento/San Joaquin Delta native fishes (U.S. Fish and Wildlife Service 1995) will be considered in developing program actions. The Central Valley Project Improvement Act (CVPIA) will implement actions that will benefit splittail, including changing timing of diversion, restoring habitat, and dedicating flow during critical periods for co-occurring species. The State Water Resources Control Board (SWRCB) will implement the Water Quality Control Plan for the San Francisco/Sacramento-San Joaquin Delta estuary, which includes provisions to limit entrainment in diversions and protect habitat conditions for splittail, chinook salmon, striped bass, and other species.

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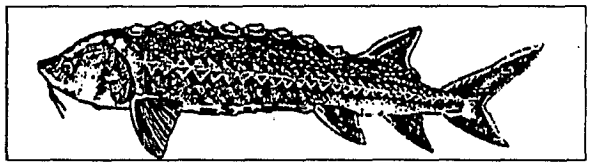
WHITE AND GREEN STURGEON



INTRODUCTION

The white sturgeon is an important native anadromous sport fish with high recreational and ecological value. The green sturgeon is designated as a species of special concern by the California Department of Fish and Game (DFG) and U. S. Fish and Wildlife Service (USFWS). Major factors that limit sturgeon populations in the Bay-Delta are adequate streamflows for attracting adults to spawning areas in rivers and transporting young to nursery areas, illegal and legal harvest, and entrainment into water diversions.

The vision for white and green sturgeon is to restore population distribution and abundance to historical levels. Restoration of these species would support a sport fishery for white sturgeon, ensure recovery of the green sturgeon population, and contribute to overall species richness and diversity and reduce conflict between the need for protection for these species and other beneficial uses of water in the Bay-Delta.

BACKGROUND

White and green sturgeon are native to the Sacramento-San Joaquin estuary and represent an important component of the historic native fish fauna. White sturgeon support a valuable sport fishery in the Bay and Delta. Sturgeon are long-lived species and change in abundance of older fish may reflect harvest of adults and habitat conditions that occurred decades ago during the larval and early juvenile life stages.

White and green sturgeon rear in the Sacramento-San Joaquin estuary and spawn in the Sacramento and San Joaquin Rivers and their major tributaries. Sturgeon may leave the Bay-Delta and move along the coast to as far as Alaska. Populations of white and green sturgeon are found in many of the larger rivers from California north to British Columbia.

White and green sturgeon inhabit both marine and fresh water and tolerate a wide range of salinity concentrations. Spawning occurs in fresh water upstream of the Delta. Low river flow during late winter and spring may reduce sturgeon spawning success. Levee construction and dredging that may affect channel attributes may also affect spawning success.

Water diversions may reduce sturgeon survival by directly entraining them or indirectly affecting prey species. However, relative to other species, the percentage of the sturgeon population entrained in diversions is low.

Food availability, toxic substances, and competition and predation are among the factors influencing the abundance of sturgeon. Sturgeon are long lived (e.g., some live over 50 years) and may concentrate pollutants in body tissue from eating contaminated prey and from the environment over long periods. Harvesting by sport fishers also affects abundance of the adult populations.

Recently, white sturgeon have been feeding on Asian clams in Suisun Bay, which may indicate a very important ecological role that could feed back through foodweb productivity of the Bay-Delta. Sturgeon predation may limit clam abundance and therefore potentially decrease the loss of plankton to clam feeding.

RESTORATION NEEDS

Ecosystem processes are closely tied to habitat restoration needs and actions. White and green sturgeon would benefit from improved ecosystem processes, including adequate streamflow to attract adults to spawning habitat, transport larvae and early juveniles to productive rearing habitat, and maintain productivity and suitability of spawning and rearing habitat (including production of food). Ecosystem processes to improve include streamflows, stream and channel configurations, and facility operations (including Delta diversions and channel barriers and gates). Additional streamflow could be provided during late winter and spring to provide attraction flows to rivers and maintain spawning flow requirements.

White and green sturgeon would benefit from restoring spawning and rearing habitat. Spawning habitat includes upstream river reaches that contain appropriate substrate (e.g., gravel, rock). Rearing habitat includes areas in the Sacramento and San Joaquin Rivers and the Delta that provide protective, food-rich environments.

Habitat restoration may be achieved by adding and modifying physical habitat and increasing freshwater flow during critical periods. Juvenile sturgeon frequent Delta sloughs and may benefit from increases in slough habitat.

Actions to improve sturgeon habitat include changing channel configuration to provide adequate velocity and protecting the watershed to reduce input of fine sediments from erosion.

Restoring natural meander belts and adding gravel substrates in upstream spawning areas will improve spawning and rearing habitat conditions. Restoring Delta and estuarine habitat, including breaching levees to inundate existing islands, setting levees back to increase shallow-water habitat along existing channels, and restoring riparian habitat, would also benefit sturgeon by providing habitat and potentially improving their food supply.

Reducing stressors is a component of restoring white and green sturgeon populations. Reducing losses to diversions from the Sacramento-San Joaquin Delta estuary would increase survival of young sturgeon. Actions to reduce losses include upgrading existing fish protection facilities, installing fish screens on currently unscreened diversions, relocating and consolidating existing diversions, changing seasonal timing of diversions, and reducing the number of diversions. White and green sturgeon would also benefit from actions to reduce pollutant input to streams and rivers in the Sacramento-San Joaquin River basin.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for white sturgeon and green sturgeon is to restore the distribution and abundance of the white sturgeon to historical levels in order to support a sport fishery, and assist in the recovery of the green sturgeon, a DFG species of special concern. Meeting this objective would contribute to overall species richness and diversity and reduce conflict between the need for their protection and other beneficial uses of water in the Bay-Delta.

Indicators of the health of white sturgeon and green sturgeon are population abundance estimates made by DFG every other year in the Bay-Delta and rivers. Creel census surveys of sport fishers conducted by DFG are another indicator of population health and the degree of potential effect of harvest rates on the population.

LINKAGE TO OTHER PROGRAMS

Efforts to restore white and green sturgeon would involve cooperation and support from other established programs protecting and improving conditions for delta smelt, striped bass, and other species. The Recovery Plan for the Sacramento-San Joaquin Delta native fishes (U.S. Fish and Wildlife Service 1995a) will be considered in developing actions, as will the State's Plan, Restoring Central Valley Streams: A Plan for Action (California Department of Fish and Game 1993). The Anadromous Fish Restoration Program (U.S. Fish and Wildlife Service 1995b) will implement actions that will benefit white and green sturgeon, including changing the timing of diversion, restoring habitat, and dedicating flow during critical periods for co-occurring species. The 1995 Water Quality Control Plan for the San Francisco/Sacramento-San Joaquin Delta estuary includes provisions to limit entrainment in diversions and protect habitat conditions for white and green sturgeon, chinook salmon, striped bass, and other species.

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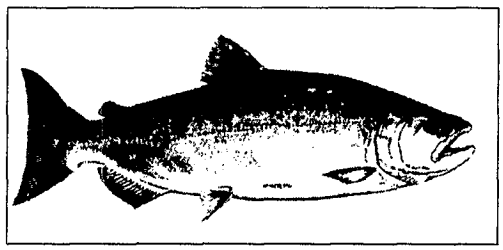


INTRODUCTION

Chinook salmon are medium to large bodied fish that spawn in freshwater, migrate to the ocean as juveniles, and grow to adulthood before returning to freshwater as adults. Four runs of chinook salmon are present in the Central Valley, distinguished by their timing of reentry to fresh water: fall, late-fall, winter, and spring (Boydstun et al. 1992). Winter-run chinook salmon were formally listed as an endangered species under the California Endangered Species Act in 1989, and as endangered under the federal Endangered Species Act in 1994 (NMFS 1996). The NMFS is reviewing the status of the other Central Valley chinook salmon runs and considering the potential need for additional listings under the ESA. Listing of the winter-run chinook population reflected poor ecological health of the Bay-Delta system and placed additional regulatory controls on water management operations in the Central Valley by constraining the diversion of water from the Sacramento River, the export of water in the Delta, and restricting ocean harvest.

The key to improving chinook salmon populations will be maintaining populations through periods of drought by improving streamflow patterns and habitat and reducing stressors such as unscreened water diversions, high water temperatures, and harvest of naturally spawned salmon.

The vision for Central Valley chinook salmon is to achieve naturally spawning population levels that support and maintain ocean commercial and recreational and inland recreational fisheries and that fully use existing and restored habitats. This vision will contribute to the overall species diversity and richness of the Bay-Delta system and reduce conflict between protection for this species and other beneficial uses of water and land in the Central Valley.

This vision is consistent with restoring the Sacramento River winter-run chinook salmon to levels that will allow it to be removed from the State and federal endangered species lists; increasing populations of other chinook stocks to levels that eliminate any future need for protection under the State and federal Endangered Species Acts (ESAs); and providing population levels for all chinook stocks that sustain recreational and commercial fisheries and other scientific, educational, and nonconsumptive uses of these valuable resources.

BACKGROUND

Chinook salmon represent a highly valued biological resource and a significant biological legacy in the Central Valley of California. Central Valley chinook salmon comprise numerous individual stocks, including the Sacramento fall-run, late-fall-run, spring-run, winter-run, and San Joaquin fall-run. The continued existence of Central Valley chinook salmon is closely linked to overall ecosystem integrity and health.

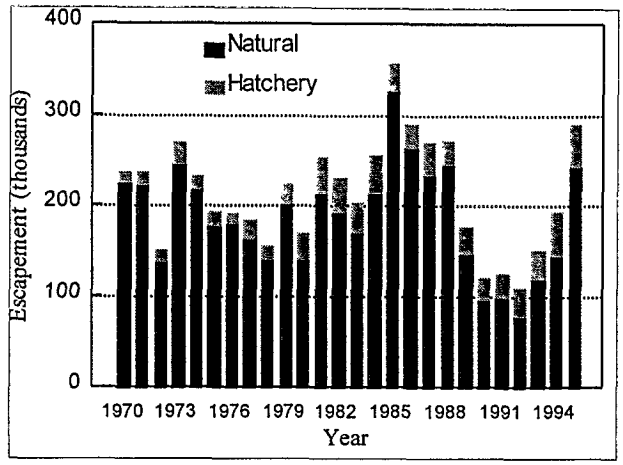
Because of their life-history requirements, typical of all Pacific salmon, Central Valley chinook salmon require high-quality habitats for migration, holding, spawning, egg incubation, emergence, rearing, and emigration to the ocean.

These diverse habitats are still present throughout the Central Valley and are successfully maintained to varying degrees by existing ecological processes. Even though the quality and accessibility of the habitats have been diminished by human-caused actions, these habitats can be restored through a comprehensive program that strives to restore or reactivate ecological processes, functions, and habitat elements on a systematic basis, while reducing or eliminating known sources of mortality and other stressors that impair the survival of chinook salmon.

Chinook salmon populations in the Central Valley are at varying degrees of health. Some populations, such as the winter-run and spring-run, have declined sharply over the past one to two decades, with the winter-run being designated as an endangered species and the spring-run and San Joaquin fall-run being considered for listing as threatened. Some populations remain healthy, especially those supplemented with hatchery production. Overall, the abundance of stocks has remained consistently high since 1970, except for depressions in run size (escapement) during and following the 1976-1977 and 1987-1992 droughts (Mills and Fisher 1994). Low flows and reservoir storage levels during droughts cause high water temperatures, poor spawning and rearing habitat conditions, high predations rates, high diversion losses, and increased harvest, which in turn reduce salmon survival.

Chinook salmon are found in virtually all ecological zones and many of their respective ecological units. Overall, the decline of the chinook salmon population resulted from the cumulative effects of degrading spawning, rearing, and migration habitats in the Sacramento and San Joaquin basins and the Sacramento-San Joaquin Delta. Specifically, the decline was most likely precipitated by a combination of factors that reduced or eliminated important ecological processes and functions, such as:

- excessively warm water temperatures during the prespawning, incubation, and early rearing periods of juvenile chinook;



Central Valley Chinook Salmon Spawning Population Abundance with Proportion Estimated from Natural Spawning and Hatchery Production (For Information on Abundance Patterns of Specific Populations, See Sections for Ecological Zones)

- interruption or blockage of the free passage of juveniles and adults at diversion and water storage dams;

- loss of natural emigration cues when flow regimes are altered as a result of the export of water from large diversions in the south Delta;

- heavy metal contamination from sources such as Iron Mountain Mine;

- entrainment in a large number of unscreened and poorly screened diversions; and

- degradation and loss of woody debris, shaded riverine aquatic (SRA) habitat, riparian corridors and forests, and floodplain functions and habitats from such factors such as channelization, levee construction, and land use.

Climatic events and water management decisions have exacerbated these habitat problems. Lengthy droughts have led to low flows and higher temperatures, and periodic El Niño conditions in the Pacific Ocean have reduced salmon survival by altering ocean current patterns and productivity. Numerous other factors have also contributed to the decline of the chinook, although

perhaps to a lesser degree. These include the various smaller water manipulation facilities and dams; extensive loss of rearing habitats in the lower Sacramento River, San Joaquin River, and Sacramento-San Joaquin Delta through levee construction and marshland reclamation; and the interaction with and predation by introduced species. Ocean and inland recreational and commercial salmon fisheries have probably impaired efforts to rebuild salmon stocks.

Efforts under existing regulatory measures for fisheries have not adequately maintained some chinook stocks as healthy populations and, as a result, the winter-run population was protected under the State and federal ESAs to avert its extinction. Since its listing, some significant problems in its critical habitat have been ameliorated to help preserve this and other chinook populations. These include improved water temperatures and flow management for spawning, incubation, and rearing; improved passage of juveniles and adults at diversions dams on the upper Sacramento River; reduced diversion efforts; and the installed positive-barrier fish screens on the larger water diversions along the Sacramento River. However, additional measures that focus on reactivating or improving ecological processes and functions that create and maintain habitat will be necessary for full recovery of the various chinook salmon stocks in the Central Valley.

Rebuilding chinook populations to a healthy state will require a coordinated approach to restoring ecosystem processes and functions, restoring habitat, reducing or eliminating stressors, and improving management and operation of the five salmon hatcheries in the Central Valley.

RESTORATION NEEDS

Within the broad context of ecosystem restoration, salmon restoration will include a wide variety of efforts, many of which are being implemented for other ecological purposes or which are nonspecific to chinook salmon. For example, restoring riparian woodlands along the Sacramento River between Keswick Dam and Verona will focus on natural stream meander, flow, and natural revegetational/successional processes. These factors will be extremely important in providing SRA habitat, woody debris, and other necessary habitats required by lower trophic organisms and juvenile and adult salmon populations.

Another example is to reactivate tidal flows into fresh and brackish marshes. Reactivating the tidal exchange in marshes will greatly increase the production of lower trophic organisms, thereby improving the foodweb, and will substantially increase the complexity of nearshore habitats in the lower mainstem rivers, the Delta, and the Bay, which will be valuable habitats for juvenile salmon.

Operating the water storage and conveyance systems throughout the Central Valley for their potential ecological benefits can be one of the more important elements in restoring a wide spectrum of ecological resources, including chinook salmon.

Ocean commercial and ocean and inland recreational fisheries annually remove a significant number of adult fish from the potential spawning population. Harvesting, in conjunction with the condition of inland migration, holding, spawning, and nursery areas, has contributed to the depleted status of most stocks.

Harvest management will play an important role in restoring healthy salmon populations. The Ecosystem Restoration Program Plan (ERPP) anticipates a highly synergistic relationship between restoring ecological processes and functions that create and maintain habitat and harvest management recommendations that are attuned to the productivity of the naturally spawning stocks when the stocks are rebuilding to desired levels.

Lack of adequate corridors between upstream holding, spawning, and rearing habitat in certain tributary streams has impaired or reduced the reproductive potential of some stocks such as spring-run chinook salmon. Unscreened diversions are ubiquitous in the Central Valley and are a known source of mortality to chinook salmon.

Many action-oriented activities are underway in the Central Valley that will assist in achieving the vision for chinook salmon. Some are short-term actions and some are long-term evaluations. All are designed to eliminate stressors and improve ecological processes and habitats.

The strategy for achieving the chinook salmon vision includes protecting existing populations, restoring ecological processes, improving habitats, and reducing stressors.

- Restore ecological processes in the Central Valley. Chinook salmon are dependent on adequate streamflows; gravel recruitment, transport, and cleansing; low water temperatures; and channel configurations.

- Maintaining adequate streamflows would improve gravel recruitment, transport, and cleansing; water temperatures; and channel conditions. Improving streamflow would also provide attraction flows for adult salmon migrating upstream to spawning grounds through the Bay, Delta, and lower rivers. Flows also support downstream transport for juvenile salmon migrating to the ocean and minimize losses to diversions and predators. Short-term improvements in flows may be possible with existing supplies. Necessary changes in streamflows may require long-term water supply improvements.

- Restore habitats required by chinook salmon. Where ecological processes cannot restore habitat to the desired level, habitats can be improved using direct measures. Important habitat components for chinook salmon include spawning gravel, water temperatures, and access to spawning habitat. In the short term, gravel can be introduced to rivers where needed. Fish passage facilities can be upgraded where deficient. Generally, habitat quality and availability along the lower reaches of the major rivers and in the Delta have been greatly diminished by the construction of levees; isolation of rivers from their floodplains; and removal or other loss of riparian, shaded riverine, and woody debris habitats. A major long-term commitment will be required to restore the habitats in these areas.

- Protect existing populations in the Central Valley. ERPP focuses on supporting efforts to protect existing natural populations of chinook salmon by supporting harvesting strategies that limit harvest of naturally spawned fish while emphasizing the harvest of hatchery-produced fish. A short-term action would be to evaluate mass marking of all hatchery-produced chinook salmon and limiting harvest to only marked salmon. Another short-term action would be to alter existing hatchery practices that do not embody the concepts of genetic conservation. A long-term action may involve considerations of restrictions on harvest gear, seasons, and fishing areas in commercial and sport fisheries.

- Eliminate stressors that cause direct or indirect mortality of chinook salmon. Important stressors on chinook salmon include insufficient streamflow, high water temperatures, blockage at diversion dams, predation near human-constructed structures, contaminants, unscreened diversions, and harvest. ERPP focuses on reducing each of these stressors in the short term and eliminating the conditions that bring about the stress factors in the long term by restoring natural processes and eliminating stressors where feasible.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for chinook salmon is to contribute to the recovery of the Sacramento winter-run chinook salmon, a species listed as endangered under the federal and California Endangered Species Acts (ESAs). Recovery of the winter-run chinook salmon would ensure overall species richness and diversity and reduce conflict between the need for its protection and other beneficial uses of water in the Bay-Delta. The objective is also to contribute to the restoration of Sacramento fall-run chinook, spring-run chinook, late-fall-run chinook, and San Joaquin fall-run chinook to support sustainable sport and commercial fisheries.

The annual estimation of chinook salmon spawner abundance, hatchery returns, estimates of ocean and inland harvest and the analysis of population dynamics through time by the use of cohort replacement rates can serve as indicators of the health of chinook salmon.

LINKAGE TO OTHER PROGRAMS

There are three major programs to restore chinook salmon populations in the Central Valley. The Secretary of the Interior is required by the Central Valley Project Improvement Act (PL 102-575) to double the natural production of Central Valley anadromous fish stocks by 2002 (USFWS 1995). The National Marine Fisheries Service is required under the federal ESA to develop and implement a recovery plan for the endangered winter-run chinook salmon and to restore the stock to levels that will allow its removal from the list of endangered species (NMFS 1996). The California Department of Fish and Game (DFG) is required under State legislation (the Salmon, Steelhead Trout and Anadromous Fisheries Program Act of 1988) to double the numbers of salmon that were present in the Central Valley in 1988 (Reynolds et al. 1993).

Each of the major chinook salmon restoration/recovery programs has developed specific goals for Central Valley chinook salmon stocks. ERPP embraces each of the restoration/recovery goals and will contribute to each agency's program by restoring critical ecological processes, functions, and habitats, and reducing or eliminating stressors. ERPP's approach is to contribute to the managing and restoring each stock with the goal of maintaining cohort replacement rates of much greater than 1.0 while the individual stocks are rebuilding to desired levels. When the stocks approach the desired population goals, ERPP will contribute to maintaining a cohort replacement rate of 1.0.

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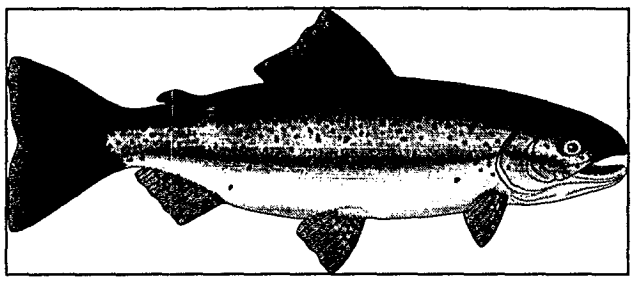
STEELHEAD TROUT



INTRODUCTION

Steelhead trout are an anadromous form of rainbow trout. This species spawns in freshwater, its juveniles rear in cool water for a year or more before migrating to the ocean. Steelhead spend one to three years in the ocean before maturing and returning inland to spawn. Due to their life history, young steelhead are susceptible to mortality resulting from water temperatures.

Present Central Valley annual steelhead run sizes, based on RBDD counts, is probably less than 10,000 adult fish. The is a substantial decline from the estimated 30,000 fish that returned to Central Valley rivers and streams in the early 1960s (Mills et al. 1996, Mills and Fisher 1994).

The vision for Central Valley steelhead trout is to achieve naturally spawning populations of sufficient size to support inland recreational fishing and that fully use existing and restored habitat areas, primarily by restoring degraded spawning and rearing habitats, enhancing fish passage to historic habitat, and supporting angling regulations consistent with recovery of steelhead trout populations. This vision is consistent with restoring populations of steelhead to levels that eliminate the need for any future protection under the State and federal Endangered Species Acts (ESAs). To achieve this vision, ecological functions and processes that create and maintain steelhead habitats would be maintained and restored and stressors and known sources of mortality would be reduced or eliminated.

The strategy for attaining this vision is to restore degraded spawning and rearing habitat in tributaries; restore access to historic habitat that is partially or completely blocked; support angling regulations consistent with restoring ecosystem processes and functions; support additional research to address large deficiencies in information regarding steelhead freshwater and ocean life history, behavior, habitat requirements, and other aspects of steelhead biology; and provide opportunities for angling and nonconsumptive uses.

In addition, the strategy is to operate Central Valley hatcheries to protect and maintain the existing genetic diversity of naturally spawning populations and provide hatchery-produced fish for a healthy recreational fishery.

BACKGROUND

Rainbow trout exhibit one of the most complex life histories of any salmonid species. Those that exhibit anadromy (i.e., migrate as juveniles from fresh water to the ocean and then return to spawn in fresh water as adults) are called steelhead, and those that reside their entire lives in fresh water are referred to as rainbow trout. Steelhead typically migrate to marine waters after spending 1-3 years in fresh water. They reside in marine waters for typically 2 or 3 years before returning to their natal stream to spawn as 3- to 5-year-old fish. Unlike Pacific salmon, steelhead are iteroparous (i.e., they are capable of spawning more than once before they die). However, postspawning survival rates are generally low, and the percentage of adults in the population that spawn more than once is low. It is likely that steelhead and resident

forms interbreed, thus forming a single population in streams where they coexist.

Biologically, steelhead can be divided into two reproductive ecotypes based on their state of sexual maturity at the time of river entry, the duration of their spawning migration, and behavior. These two ecotypes are termed "stream maturing" and "ocean maturing". Stream maturing steelhead enter fresh water in a sexually immature condition and require several months to mature and spawn. Ocean-maturing steelhead enter fresh water with well-developed gonads and spawn shortly thereafter. These two reproductive ecotypes are more commonly referred to by their season of freshwater entry (i.e., summer-run and winter-run steelhead). Central Valley steelhead stocks are typically of the ocean-maturing type and are called winter-run steelhead. Some evidence suggests that summer-run steelhead were once present but that the construction of large dams on the major tributaries, which would have blocked adults from reaching the deep pools they need to oversummer, most likely eliminated these populations.

The National Marine Fisheries Service (NMFS) has identified steelhead populations in the Central Valley as composing a single evolutionary significant unit (ESU) based on a variety of physical and biological data, including the physical environment (geology, soil type, air temperature, precipitation, riverflow patterns, water temperature, and vegetation); biogeography (marine, estuarine, and freshwater fish distributions); and life history traits (age at smolting, age at spawning, river entry timing, spawning timing, and genetic uniqueness).

The Central Valley steelhead ESU comprises the Sacramento and San Joaquin Rivers and their tributaries. Recent data from genetic studies show that samples of steelhead from Deer and Mill Creeks and Coleman National Fish Hatchery on Battle Creek are well differentiated from all other samples of steelhead from California.

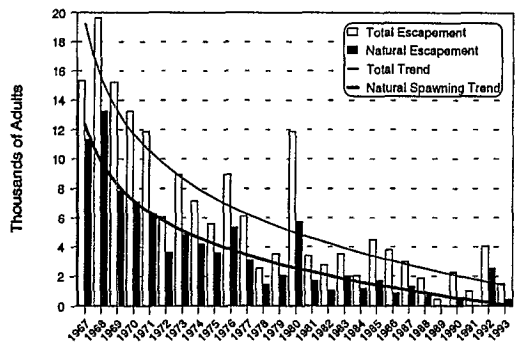
In reviewing the status of Central Valley steelhead, NMFS concluded that the ESU is in danger of extinction because of the widespread degradation, destruction, and blockage of freshwater habitats and the potential results of continuing habitat destruction, water allocation problems, and interactions between introduced and native stocks.

Steelhead are somewhat unique in that they depend on essentially all habitats of a river system: the estuary for rearing and acclimation to saltwater, the main channel for migration between the ocean and upstream spawning and rearing areas, and the tributaries for spawning and rearing. They are therefore found in virtually all ecological zones and many of their respective ecological units. Overall, the decline of the steelhead trout population resulted from the cumulative effects of degradation and loss of spawning, rearing, and migration habitats in the Sacramento and San Joaquin basins and the Sacramento-San Joaquin Delta. Specifically, the decline was most likely precipitated by a combination of factors that reduced or eliminated important ecological processes and functions, such as construction of dams on the larger rivers and streams, which eliminated access to critical habitat for adults and juveniles; excessively warm water temperatures during the prespawning, incubation, and early rearing period of juvenile steelhead; the interruption or blockage of the free passage of juveniles and adults at diversion dams; loss of natural emigration cues attributable to altered flow regimes resulting from the export of water from large diversions in the south Delta; entrainment to a large number of unscreened and poorly screened diversions; and degradation and loss of woody debris, shaded riverine aquatic, riparian corridors and forests, and floodplain functions and habitats attributable to such factors as channelization, levee construction, and land use.

A host of other factors has also contributed to the decline of the steelhead trout, but perhaps to a lesser degree. These include the various smaller water manipulation facilities and dams; extensive loss of rearing habitats in the lower Sacramento River, San Joaquin River, and Sacramento-San

Joaquin estuary through levee construction and marshland reclamation; and the interaction and predation by non-native species.

FIGURE 1. Sacramento River Steelhead
Adjusted Counts at Red Bluff Diversion Dam



RESTORATION NEEDS

NMFS has recommended general conservation measures for steelhead throughout their range along the Pacific coast. These conservation measures, when applied to the Central Valley, include the following:

- Implement land management practices that protect and restore habitat. Existing practices that may affect steelhead include timber harvest, road building, agriculture, livestock grazing, and urban development.
- Review existing harvest regulations to identify any changes that would further protect Central Valley steelhead.
- Incorporate practices to minimize impacts on native populations of steelhead into hatchery programs.
- Make provisions at existing dams to allow the upstream passage of adult steelhead.
- Provide adequate headgate and staff gage structures at water diversions to control and effectively monitor water usage, and enforce water rights.
- Screen irrigation diversions affecting downstream migrating steelhead.

Within the broad context of ecosystem restoration, steelhead restoration will include a wide variety of efforts, many of which are being implemented for other ecological purposes or which are nonspecific to steelhead trout. For example, restoration of riparian woodlands along the Sacramento River between Keswick Dam and Verona will focus on natural stream meander, flow, and natural revegetation/successional processes. These will be extremely important in providing shaded riverine aquatic habitat, woody debris, and other necessary habitats required by lower trophic organisms and juvenile and adult steelhead populations.

Operation of the water storage and conveyance systems throughout the Central Valley for their potential ecological benefits can be one of the more important elements in restoring a wide spectrum of ecological resources, including steelhead trout.

Inadequate connectivity between upstream holding, spawning, and rearing habitat in certain tributary streams has impaired or reduced the reproductive potential of some steelhead stocks. Reducing this stressor will contribute to efforts to rebuild steelhead populations.

One of the critical efforts is to conduct the necessary evaluations and analyses to determine the potential benefits and consequences of reintroducing certain steelhead stocks above major dams to provide access to historic spawning and rearing areas. The potential transfer of adult fish above the dams may be straightforward, but the successful emigration downstream by juveniles cannot be ensured. There has been limited success in the passage of juvenile salmonids at large dams in the Columbia River basin, but whether this will be a viable option to protect and restore naturally

spawning steelhead trout in the Central Valley is unknown.

The short-term approach for restoring steelhead populations is to contribute to the management and restoration of each stock to maintain the recruitment of young fish to the adult population at a ratio much greater than 1.0 while the individual stocks are rebuilding to desired levels. Recruitment rates greater than 1.0 indicate that the number of young fish reaching adulthood exceeds the size of the parental population that produced them.

The long-term approach is to contribute to maintaining cohort replacement rates at 1.0 when the stocks approach the desired population goals.

The following would help to achieve the short- and long-term approaches to restoration of Central Valley steelhead populations:

- Implement a coordinated approach to restore ecosystem processes and functions.
- Implement measures to restore habitat when restoration of ecosystem processes and functions is not feasible.
- Protect spawning and rearing habitat in upper tributary watersheds.
- Improve riparian corridors in lower tributaries and rivers.
- Improve estuary habitat.
- Manage and operate the four hatcheries in the Central Valley that propagate steelhead in manner to protect the genetic diversity of naturally and hatchery produced stocks.
- Provide sufficient flows in lower tributaries for immigration and emigration to improve migration success.
- Reduce losses to unscreened diversions.
- Reduce fish mortality in the recreational fishery.
- Implement programmatic actions proposed in the 14 ecological zone visions to help achieve steelhead targets by creating and sustaining improved habitat conditions and reducing sources of mortality.

Implementation Objective and Indicators

The implementation objective for steelhead trout is to achieve naturally spawning populations of sufficient size to support inland recreational fishing and fully use existing and restored habitat areas. Meeting this objective would contribute to the overall species richness and diversity and reduce conflict between the need for its protection and other beneficial uses of water in the Bay-Delta.

Direct and indirect measurement of adult and juvenile abundance derived from ladder counts, direct observation, and angler harvest estimates of adult fish, and estimates of juvenile abundance in streams tributary to the Sacramento and San Joaquin Rivers can be indicators of the health of steelhead trout.

Linkage to Other Programs

Two major programs to restore steelhead trout populations exist within the Central Valley. The U.S. Fish and Wildlife Service's goal, as established by the Central Valley Project Improvement Act (PL 102-575), is to double the natural production of Central Valley anadromous fish stocks by 2002 (USFWS 1995). The California Department of Fish and Game is required under State legislation (The Salmon, Steelhead Trout and Anadromous Fisheries Program Act of 1988) to double the numbers of steelhead estimated to have been present in the

Central Valley in 1988 (McEwan and Jackson 1996, Reynolds et al. 1993, and McEwan and Nelson 1991).

Each of these steelhead trout restoration programs has developed specific restoration goals for Central Valley steelhead trout stocks. Implementation of the steelhead vision strategy will contribute to each agency's program through the restoration of critical ecological processes and functions, restoration of habitats, and reduction or elimination of stressors.

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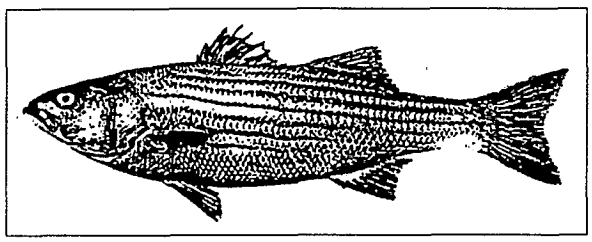
STRIPED BASS



INTRODUCTION

The striped bass is an important non-native anadromous sport fish with high recreation value. It also plays an important role as a top predator in the Bay-Delta and its watershed. Major factors that limit striped bass contribution to the health of the Delta are streamflow, water diversions, spawning and rearing habitat, legal and illegal harvest, predation and competition from non-native fishes, and reduce survival from contaminants in the water.

The vision for striped bass is to their 1960s level of abundance to support a sport fishery in the Bay, Delta, and tributary rivers, and to reduce the conflict between protection of striped bass and other beneficial uses of water in the Bay-Delta.

BACKGROUND

Striped bass were introduced into the Bay-Delta from the east coast in 1879 and have been an important sport fish, commercial fish, and top predator within the Bay-Delta and upstream rivers for the past century. They adapted well to the complex habitat conditions of the estuary and remain the premier sport fish of the Bay and Delta. Anglers seek out stripers along the coast, in the Bay and Delta, and in the lower portions of the Sacramento and San Joaquin Rivers and their tributaries. Striped bass are also an important recreational resource in the waterways of the State and federal water projects south of the Delta. In the Sacramento River, striped bass are commonly found from Princeton downstream to the Delta and in the lower Feather and American Rivers. In the San Joaquin basin, they are found in the lower Stanislaus, Tuolumne, and San Joaquin Rivers. Striped bass spawn primarily in the Sacramento River between Colusa and Sacramento and in the San Joaquin River portion of the Delta.

The number of adult striped bass and young produced each year has declined dramatically over the past several decades. The total population of adults has declined from about 3 million in the 1960's to 1.5 million in the early 1970s (when accurate estimates were first made) and to about 700,000 in 1994.

The decline in the adult population of striped bass has been accompanied by a decline in the production of young. The young bass abundance index for summer, when they are 1.5 inches long, has declined dramatically, especially during the recent drought of the late 1980s and early 1990s, and has not recovered. Factors related to and believed to contribute to this decline include the following:

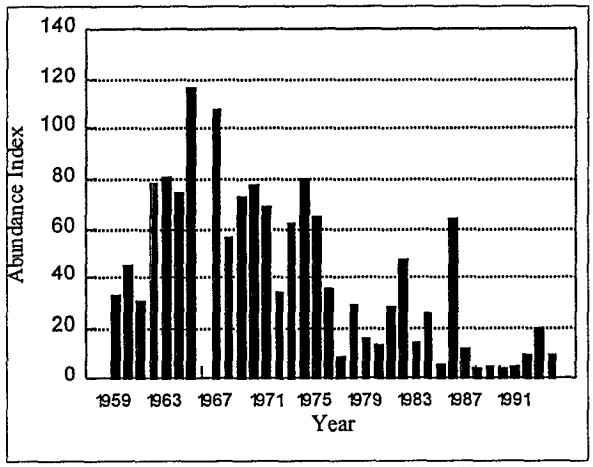
- Low flows in spring in the Sacramento River are believed to reduce survival of eggs and larvae by creating poor water quality conditions, reducing plankton food supply, and increasing vulnerability to water diversions.

- Low freshwater flows through the Delta and Suisun Bay may limit the production of food organisms during critical early life stages of striped bass.

- Low Delta outflow may limit transport of eggs, larvae, and juvenile striped bass into quality nursery grounds of Suisun Bay and away from water diversions in the Delta.

- Higher transport of Sacramento River water south across the Delta and toward the south Delta pumping plants moves more striped bass young into areas where they are more susceptible to entrainment into agricultural diversions or water project export pumps.

The number of juveniles lost at south Delta export facilities was in the tens of millions in some years during the 1960s to mid-1970s, and again in the mid- to late 1980s. The estimated loss in 1974 exceeded 100 million juveniles. Although subsequent export losses have decreased, the rate of loss per unit of population has greatly increased as population abundance has declined.



Summer Abundance Index of Striped Bass Young

The number of adult spawners has dropped to such low levels in recent years that there may no longer be sufficient eggs spawned to bring about quick recovery in the population through good juvenile production when flows and habitat are excellent for survival.

In addition to the lack of recruitment of young into the adult spawning population, mortality rates of adults have increased despite reduced harvest rates in the sport fishery. The higher mortality rates are particularly evident in older adults, and may be a result of effects of toxins, poaching, marine mammal predation, or combinations of these and other factors. According to the California Department of Fish and Game (DFG), population declines may be a result of adult striped bass leaving the Bay for other estuaries along the coast.

Other factors possibly contributing to the decline and low abundance of striped bass include toxins that reduce survival of young bass or their food supply, competition or predation by recently established, non-native fishes, such as gobies, or poor food production caused by the influx of Asia clams. Both the gobies and Asia clams were introduced from ballast water released from ships from Asia.

RESTORATION NEEDS

A major focus of striped bass recovery efforts over the past two decades has been Delta outflow enhancement and restrictions on water exports in spring and early summer. The recent 1995 Water Quality Control Plan provided interim provisions for improving spring Delta outflows and limiting exports, but did not target summer outflows or effects of water exports in summer or fall. This vision anticipates further improvements in spring Delta inflows and outflows in drier years when more flow is needed for successful spawning, Bay-Delta foodweb production, and transporting egg and larval striped bass to nursery grounds in Suisun Bay. Consideration will also be given to means by which to reduce the effects of water exports from the Delta, especially exports that reverse the natural flow patterns in the Delta.

Although deterioration of habitat may not be a major factor in the decline of striped bass, it could be an important detriment to their recovery. Protecting, improving, and restoring a substantial amount of shallow-water habitat in the Bay and Delta may improve the food supply for striped bass, as well as provide more area for rearing juvenile striped bass. An improved food supply and increased rearing area may help overcome other factors that have little potential for change (e.g., predation and competition from non-native species). Increases in tidal wetlands will provide tidal channels that are important rearing habitat

for juvenile striped bass. Improvement and restoration of shallow waters and riparian vegetation along levees and channel islands in the Delta may provide further important habitat for young striped bass. Habitat improvements are expected to also increase the abundance of shrimp and small fish that are important prey of young and adult striped bass and may lead to higher striped bass survival rates.

Reducing the extent and effect of stressors on striped bass will also be important to their recovery. Reducing losses of young striped bass at water diversions in the Delta and Bay, particularly the very high losses at the south Delta pumping plants of the State and federal water projects, will be most important. Improvements are needed to upgrade the two fish protection facilities to reduce the loss of young bass to entrainment into the pumping plants, and to reduce indirect losses to predators associated with the fish protection facilities. Pumping plant operations could also be reduced during periods of high losses. Longer term actions may involve relocating the pumping plant intakes, screening or reducing the number of small water diversions to agricultural lands in the Delta, and continuing to find ways to reduce entrainment losses into cooling water diversions at Pacific Gas & Electric's (PG&E's) two power plant complexes in the Delta. Limiting further introductions of non-native species and reducing the input of contaminants into Central Valley waterways may also be important to striped bass recovery. In the short-term, recovery may depend on supplementing natural reproduction with hatchery and pen-reared striped bass, and possibly reducing illegal and legal harvest.

IMPLEMENTATION OBJECTIVE AND INDICATORS

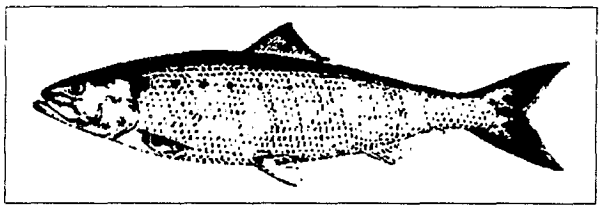
The implementation objective for striped bass is to restore its population levels to those of the 1960s to contribute to a recreational fishery in the Bay-Delta . Increased population levels of striped bass would reduce conflict between the need for its protection and other beneficial uses of water in the Bay-Delta.

Indicators of the health of striped bass include adult population abundance surveys and estimates, and trawl surveys conducted by DFG.

LINKAGE TO OTHER PROGRAMS

Efforts to restore striped bass in the Central Valley would involve cooperation and support from other programs underway to restore striped bass and other important fish. The Central Valley Project Improvement Act (CVPIA) (PL 102-575) calls for implementing changes in flows and project facilities and operations by 2002 that lead to doubling of the striped bass population. DFG is required under State legislation (The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act of 1988) to restore numbers of striped bass in the Central Valley.

Because striped bass are predators, they could affect efforts to recover populations of a number of native fishes of the Central Valley including chinook salmon, steelhead, delta smelt, longfin smelt, and Sacramento splittail. Consequently, it will be necessary to consult and cooperate with the National Marine Fisheries Service and U.S. Fish and Wildlife Service under the federal Endangered Species Act (ESA) and DFG under the California ESA.



INTRODUCTION

American shad is an important non-native anadromous sport fish with high recreational value. It migrates in spring from the ocean into the Delta and upstream to spawn in Central Valley rivers. Newly hatched young spend their first summer in the rivers and Delta before migrating downstream to the ocean in fall. Major factors that limit the contribution of the American shad to the health of the Delta are streamflow, aquatic habitat, and food supply.

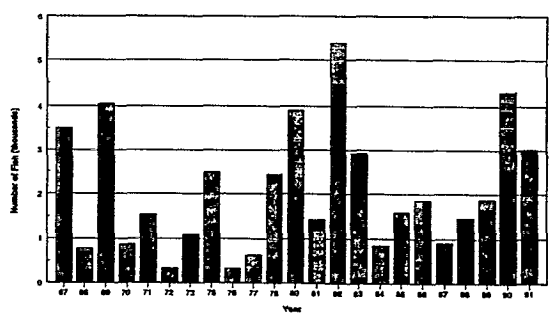
The vision for American shad is to maintain a naturally spawning population that supports a sport fishery similar to the fishery that existed in the 1960s and 1970s, and to reduce the conflict between protection of this species and other beneficial uses of water in the Bay-Delta.

BACKGROUND

American shad was introduced into Central Valley rivers from the east coast in the 1870s and 1880s. It adapted well to the complex habitat conditions of the rivers and estuary. It continues to be an important sport fish in the Sacramento, Feather, Yuba, and American Rivers and has extended its range as far north as the Columbia River. Adults (age 3-5) migrate into the rivers from the ocean to spawn from late April through June. Some may remain in the rivers through August before returning to the Bay-Delta and ocean. Many die during the spawning run, but about 30% of the runs are made up of repeat spawners. In the Sacramento River system, American shad are commonly found from Red Bluff downstream to the Delta and in the lower Feather, Yuba, and American Rivers.

Populations are small in the San Joaquin basin compared with those in the Sacramento basin. When the adult population was measured in 1976 and 1977, the total run was estimated at 3 million and 2.8 million, respectively. DFG has conducted annual fall midwater trawl surveys in the Delta since 1967 to monitor trends in the population's health. Juvenile shad catch has generally been higher in wetter years (1967, 1969, 1975, 1978, 1980, 1982, and 1983) and lower in dry years (1968, 1972, 1976, 1977, 1984, and 1987). The production index was relatively high, however, in two recent dry years (1990 and 1991).

Ocean, estuary, and river conditions affect overall shad abundance. Growth and survival in the ocean may be affected by El Niño. Water temperatures and flows are important habitat factors in the spawning rivers of the Central Valley. River flows trigger the shad to move into rivers and affect their selection of spawning locations among and within the rivers. Water temperatures determine the onset of spawning (59-68°F). High water temperatures (above 68°F) may reduce adult survival. Factors



Index of Juvenile American Shad Abundance in Fall Midwater Trawl Survey

believed to affect American shad production in the Central Valley include the following:

- Low flows in spring may delay or hinder shad from moving into the rivers to spawn. During their upstream migration through the Delta, adult shad may delay spawning or may die because of the higher water temperatures resulting from low flows. Low flows also may reduce downstream transport of eggs and larvae to productive nursery areas.

- Transport of Sacramento River water south across the Delta and toward the south Delta pumping plants may carry more American shad young into the southern Delta and away from their primary migration path to the ocean. Under low Delta outflow, shad young may be more susceptible to entrainment in agricultural diversions and water project export pumps. Annual losses of juveniles at south Delta export facilities reach into the millions.

- Poor water quality and low spring flows may limit production of American shad in the San Joaquin River and its tributaries.

- Diversion dams on valley rivers limit American shad from moving into potential spawning reaches. Examples include the Red Bluff Diversion Dam on the Sacramento River, Daguirre Dam on the Yuba River, and Woodbridge Dam on the Mokelumne River. Shad are generally unable to use fish ladders provided at these diversion dams.

- Pollutants may affect the production and run size of American shad by reducing survival of young and their food supply.

Harvest rates of adult shad in the sport fishery are low and have little impact on production of American shad.

RESTORATION NEEDS

A major focus of Central Valley fish recovery efforts over the past two decades has been on flow enhancement in streams and rivers. Natural river flows in dry and normal water-year types has been reduced, particularly in spring, by water development in the Central Valley. The 1995 December Delta Accord provided interim provisions for improving spring flows. Further improvements are anticipated under the Central Valley Project Improvement Act (CVPIA). The American shad vision anticipates further improvements in drier years when more flow is needed to attract American shad to upstream spawning areas in the rivers and major tributaries, including the American, Feather, and Yuba Rivers, and to transport egg and larval shad to nursery grounds in the lower rivers and Delta.

Although habitat deterioration in Central Valley rivers and the Delta may not be a major factor in the run size of American shad, habitat improvements could lead to increases in American shad runs. Protecting, improving, and restoring shallow-water habitat in rivers and the Delta may improve the food supply for American shad and provide better rearing habitat. Improved food supply and rearing habitat may help to overcome other factors that are unlikely to change (e.g., the presence of competing non-native species).

Reducing the extent and effect of stressors will further benefit American shad runs. Most important will be reducing loss of young American shad at water diversions in rivers and the Delta, especially large losses at the south Delta pumping plants of the State and federal water projects. The two fish protection facilities should be upgraded to reduce entrainment of young American shad in the pumping plants and the concentrations of predators associated with the fish protection facilities. Screening or reducing the number of the many small water diversions to agricultural lands in the Delta may also provide benefits. Limiting further introduction of non-

native species and reducing the input of toxic pollutants into Central Valley waterways will also provide benefits.

Actions that would help improve American shad populations in Central Valley rivers include the following:

- Provide additional Sacramento, Feather, Yuba, and American River flows in spring of dry years to attract adult spawners and transport young downstream to productive nursery habitat.
- Remove barriers to American shad migrations in the Sacramento, Yuba, and Mokelummne Rivers.
- Reduce adverse effects of water diversions on American shad in fall.
- Allow the first natural pulse of flow in the fall to pass through the Delta to the Bay to help juvenile American shad migrate to the ocean.
- Upgrade existing fish protection facilities at south Delta pumping plants of the Central Valley Project and the State Water Project.
- Reduce the number, screen or upgrade screening, or relocate diversions that entrain American shad in the rivers and Bay-Delta.

Actions to restore populations of salmon, steelhead, striped bass, and Delta native fishes are likely to benefit the runs of American shad.

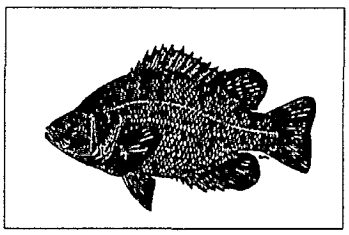
IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for American shad is to maintain naturally spawning populations that support sport fisheries similar to fisheries that existed in the 1960s and 1970s to contribute to the recreational use of the Bay-Delta. Meeting this objective would reduce conflict between the need for protection of this species and other beneficial uses of water in the Bay-Delta.

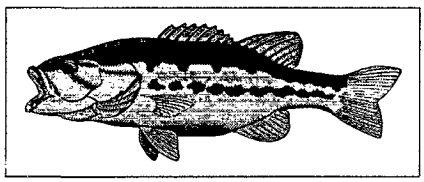
Indicators of the health of American shad are the catch rate in Central Valley river fisheries as measured in sport-fish "creel" surveys conducted on selected rivers and the abundance indices of young American shad as measured in the fall mid-water trawl surveys conducted each year by DFG.

LINKAGE TO OTHER PROGRAMS

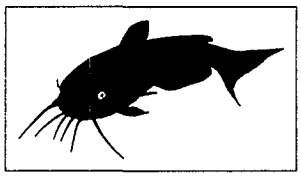
Efforts to maintain American shad runs in Central Valley rivers would involve cooperation and support from other established programs underway to restore American shad and other important fish. CVPIA (PL 102-575) calls for doubling the American shad population by 2002 through changes in flows and project facilities and operations. DFG is required under State legislation (The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act of 1988) to restore American shad in the Central Valley. Efforts to improve flows and habitat in the lower American River by the Lower American River Task Force, AFRP, and Water Forum will also benefit American shad.



Sacramento Perch



Largemouth Bass



White Catfish

INTRODUCTION

Native resident fish species of the Delta are important ecologically and as indicators of ecosystem health. Some, such as the tule perch, Sacramento sucker, and threespine stickleback, are important elements of the Bay-Delta foodweb. Other, such as the Sacramento squawfish, are important predators. Native resident fishes have declined as a percent of the total fish species abundance of the Bay-Delta and its watershed.

Non-native resident fishes include many species introduced to improve the foodweb and sport fishing in the Bay-Delta and its watershed, including threadfin shad, white catfish, and largemouth bass. Others, such as the yellowfin goby, have been accidently introduced in the ballast water of ships. While some species are considered desirable, other are undesirable because they compete with or prey upon desirable native and non-native fish. Wagasagi is a close relative of the delta smelt introduced to improve the foodweb of foothill reservoirs by DFG that now potentially threatens the delta smelt population through interbreeding and competition.

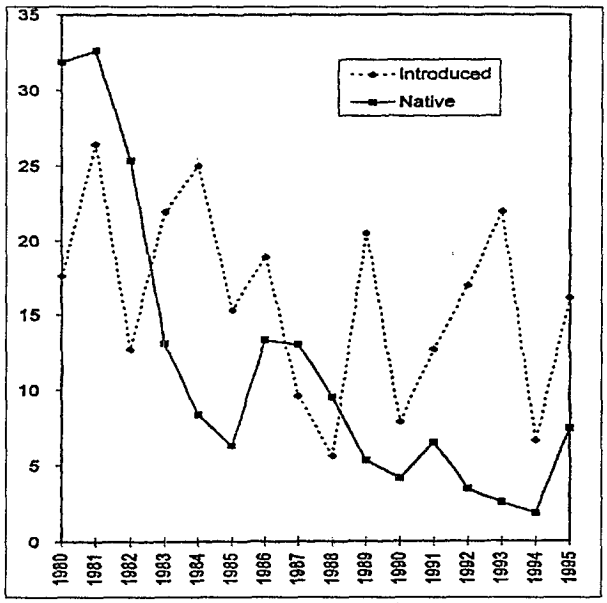
Factors contributing to the decline of some important resident species include predation and competition of non-native species, loss and degradation of habitat, poor foodweb productivity, losses to water diversions, and reduced survival from exposure to toxins in the water.

The vision for resident fish species is to maintain and restore the distribution and abundance of native species, such as Sacramento blackfish, hardhead, tule perch, and Sacramento perch; and non-native species, such as white catfish, largemouth bass, and threadfin shad, to support a sport fishery and healthy nongame fish populations. Although the Sacramento perch no longer occurs in the Delta, it is included with resident native species because actions to maintain and restore other resident species populations would benefit Sacramento perch in the event they were reintroduced to the Delta.

BACKGROUND

Resident species compose the bulk of species found in fresh and low-salinity water (i.e., less than 4 parts per thousand [ppt] salinity) of the Sacramento-San Joaquin Delta estuary. Resident species represent an important component of sport catch (e.g., white catfish, largemouth bass, and bluegill); the historical native fish fauna (e.g., tule perch, Sacramento blackfish); and forage fish (e.g., threadfin shad).

As with other Delta species, the habitat of resident fishes has been greatly diminished by human-caused actions. Increased habitat and expanded distribution and abundance of resident species can



Index of Native and Introduced Fishes in Suisun Marsh Trawl Survey

be realized through restoring habitat together with improving natural ecological processes and functions.

Many resident Delta species inhabit shallow areas that have structural diversity provided by riparian and aquatic vegetation. Levee construction in the 1800s created narrow channels and eliminated vast areas of tule marsh, areas most likely important as spawning and rearing habitat for Delta species. Levee maintenance programs that remove riparian vegetation and dredging continue to reduce the quality of shallow water habitat used by resident species. Erosion caused by increased flow velocity, changes in channel structure, and boat wakes continues to reduce remnant riparian, marsh, and channel island habitats. Water hyacinth and other exotic aquatic plants now clog many sloughs that are important habitat of resident fish.

Losses to Delta diversions (e.g., hundreds of small agricultural diversions, Central Valley Project [CVP] and State Water Project [SWP] export pumps, and Pacific Gas & Electric [PG&E] power generation facilities) may reduce resident species abundance through direct entrainment or indirect effects on the prey of resident fish. Large numbers of some resident species (e.g., white catfish, threadfin shad) are entrained in Delta diversions. Other resident species (e.g., largemouth bass) spend their lives in habitat that is in close proximity to where they were spawned and are not particularly susceptible to entrainment in Delta.

Food availability, toxic substances, and competition and predation are among the factors influencing abundance of resident species. In addition, harvest of many resident species for food and bait by sport anglers may affect abundance.

RESTORATION NEEDS

Ecosystem processes are closely tied to habitat restoration needs and actions. Resident species would benefit from conditions to maintain productivity and suitability of spawning and rearing habitat (including production of food). Actions to rehabilitate ecosystem processes include change in Delta configuration, facility operations (including Delta diversions and channel barriers and gates), and Delta inflow and outflow.

Resident species would also benefit from restoration of spawning and rearing habitat. Spawning and rearing habitat includes shallow edgewaters bordered by healthy riparian and aquatic plants that provide protective, food-rich environments. Productive edgewater habitats are currently very limited in the Delta. Adding and modifying physical habitat, including breaching levees to inundate existing islands, setting levees back to increase shallow-water habitat along existing channels, restoring riparian areas, protecting existing shallow-water habitat from erosion, and filling relatively deep water areas to create shallow-water habitat, can restore habitat. Eliminating water hyacinth and other noxious aquatic plants from Delta channels and sloughs will also improve resident fish habitat.

Stressor reduction is a major component of restoration and maintenance of resident species populations. A primary concern with regard to vulnerable species is the reduction of losses to diversions. Actions to reduce losses include upgrading existing fish protection facilities, installing fish screens on currently unscreened facilities, removing predators associated with diversions and fish protection facilities, relocating and consolidating existing diversions, changing seasonal timing of diversions, and reducing the number of diversions. Resident species would also benefit from actions to reduce pollutant input to streams and rivers in the Sacramento-San Joaquin River basin and may benefit from actions to prevent introduction of non-native species that would prey upon or compete with native species for habitat and food supply.

IMPLEMENTATION OBJECTIVE AND INDICATORS

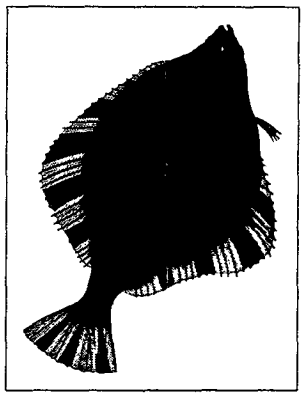
The implementation objective for resident fish species is to maintain and restore the distribution and abundance of resident native fish species, such as Sacramento blackfish, hardhead, tule perch, and Sacramento perch, and non-native species, such as white catfish, largemouth bass, and threadfin shad , to support a sport fishery and healthy forage populations.

Indicators of the health of resident fish species are their presence and absence, and distribution in various fish surveys including the Suisun Marsh survey by UC Davis, DFG's Delta Resident Fish Survey, various DFG trawl surveys, and the USFWS Beach Seine Survey.

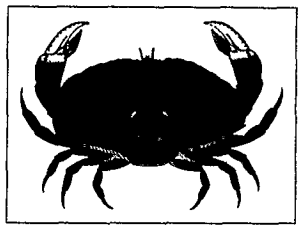
LINKAGE TO OTHER PROGRAMS

Efforts to restore and maintain resident species would involve cooperation and support from other established programs that protect and improve conditions for delta smelt, striped bass, and other species. The recovery plan for the Sacramento/San Joaquin Delta native fishes will be considered in the development of actions proposed by ERPP. Central Valley Project Improvement Act will implement actions that will benefit resident species, including changing the timing of diversions and restoring habitat. The State Water Resources Control Board will implement the Water Quality Control Plan for the San Francisco/Sacramento-San Joaquin Delta estuary that will include provisions to limit entrainment in diversions and protect habitat conditions for Sacramento splittail, chinook salmon, striped bass, and other species.

MARINE/ESTUARINE FISHES AND LARGE INVERTEBRATES



Starry Flounder



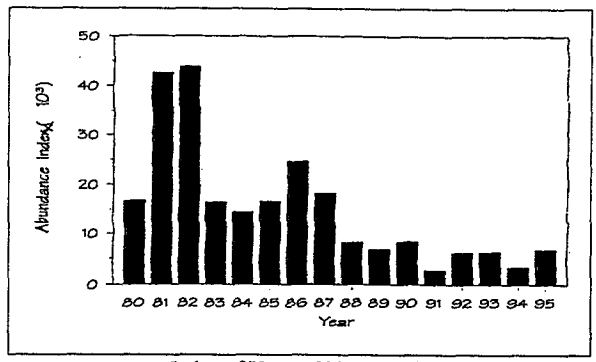
Dungeness Crab

Pacific Herring

INTRODUCTION

Marine fishes include many species that are abundant and important ecologically in the Bay and coastal waters. Two ecologically important species are the Pacific herring and northern anchovy, whose young are important in the foodweb of anadromous fish including salmon, sturgeon, and striped bass, as well as waterfowl such as cormorants and terns. Pacific herring, Dungeness crab, and Bay shrimp also support commercial fisheries. Starry flounder contribute to the local Bay-Delta sport fishery. The Bay and Delta are essential spawning and nursery areas for many marine fish and invertebrates found within the Bay and coastal waters. Factors that affect the survival and production of marine fish and invertebrates in the Bay-Delta include Delta outflow, water diversions, foodweb productivity, availability and quality of shallow water and wetland habitats, and water quality.

The vision for marine/estuarine fishes is to maintain, improve, and restore populations to levels that existed in the early 1980s to contribute to the overall species richness and diversity of the Bay-Delta, and to reduce the conflict between protection of these species and other beneficial uses of water in the Bay-Delta. Improvements in production and survival of marine and estuarine fishes in the Bay and Delta will provide ancillary benefits to important estuarine, anadromous, and resident fishes of Bay-Delta.



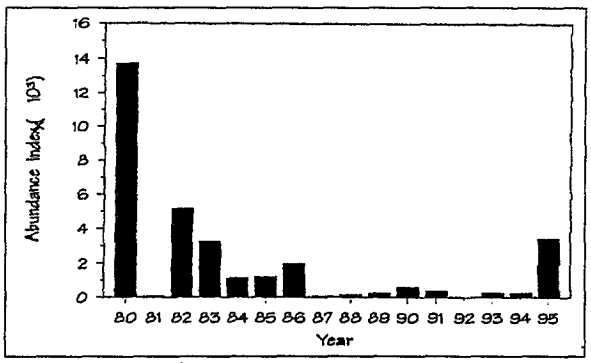
Index of Young Shiner Perch

BACKGROUND

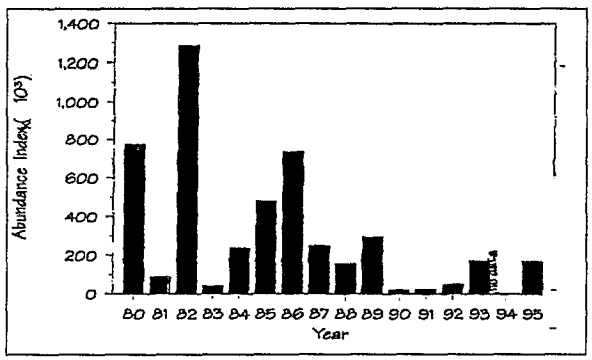
There are many species of marine/estuarine fish and larger invertebrates that live in and depend on the Bay or Delta for at least a portion of their life cycles. Some of these are important contributors to the ecological health and well being of estuarine, freshwater, and anadromous fish that inhabit the Bay-Delta. Some, such as the Pacific herring, northern anchovy, starry flounder, shiner perch, Dungeness crab, and bay shrimp, depend at least partially on the Bay-Delta as a nursery ground for young, taking advantage of the high productivity of the estuary. At times, some of these species are among the most abundant in the Bay-Delta and are essential elements of the foodweb that supports important fish such as chinook salmon, white sturgeon, and striped bass.

The abundance of starry flounder, Pacific herring, bay shrimp, shiner perch, and other species appears related to the amount of freshwater outflow to the Bay, probably through food production, estuarine hydrodynamics, habitat conditions, and possibly water quality. While some species, such as the Pacific herring, spawn

in the Bay, others spawn in the ocean and their young migrate into the Bay and Delta, aided by tidal and gravitational currents.



Index of Young Starry Flounder



Index of Young Pacific Herring

The abundance of starry flounder, Pacific herring, bay shrimp, and shiner perch as measured in DFG Bay trawling surveys declined during the 1987-1992 drought; some recovery was evident by 1995. Generally, low abundance occurred in drier years, with this pattern particularly apparent for bay shrimp, starry flounder, and Pacific herring. For most of the marine/estuarine species, factors relating to the marine environment are also important and effects are difficult to separate from estuary factors.

Low abundance of marine/estuarine species has occurred coincident with a number of changes in the estuary that individually or together could be at least a partial factor in suppressing populations. Factors related and believed to contribute to low abundance levels of marine/estuarine fish in the Bay-Delta include the following:

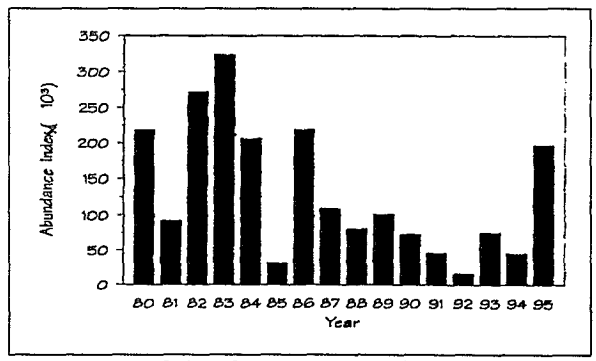
- Low flows in late winter and spring from the Delta are believed to reduce movement of young marine/estuarine fish into the Bay and Delta and, indirectly, may affect survival and production of marine/estuarine fish through limiting foodweb production. Low flows are a consequence of climatic conditions (low rainfall and more precipitation falling as winter rains than as snow) and limited winter and spring runoff in dry and normal years being held in basin storage reservoirs.

- Low Delta outflows limit transport of larvae and juveniles upstream into the Delta from the Bay by limiting estuarine circulation. (Higher Delta outflow of freshwater on the surface, provides greater up-estuary transport of marine waters along the bottom.)

- Loss of larvae and juveniles into water diversions in Suisun Bay, Suisun Marsh, and the Delta may reduce production, especially in drier years when the percentage of freshwater diverted is sharply higher than that in wetter years.

- Toxic water and sediment may also be reducing the survival of marine/estuarine fish in the Bay and Delta. The effect may be indirect through poor plankton food supply or direct through egg, larvae, or juvenile mortality induced by toxins in the water.

Other factors possibly contributing to the reduced abundance of marine/estuarine fish and large invertebrates include competition or predation by



Index of Immature Bay Shrimp

recently established non-native fishes, such as gobies, or from poor food production caused by the influx of Asia clams, both of which were introduced from ballast water of ships from Asia. Changes in the plankton foodweb from the introductions of non-native species of zooplankton and Asia clams may also be contributing to the decline.

RESTORATION NEEDS

A major focus of recovery efforts should be on enhancement of freshwater outflow in late winter and spring of dry and normal water-year types. Natural Delta outflows in dry and normal water-year types have been reduced particularly in late winter and spring, and such flows are coincident with the occurrence and productivity of marine/estuarine fish and large invertebrates in the upper Bay and Delta. The 1995 December Accord provided interim provisions for improving February-June Delta outflows. This vision anticipates further improvements in Delta outflows in late winter and spring in drier years, when more flow may be necessary to sustain a high abundance of marine/estuarine fish in San Pablo and Suisun Bays.

Although habitat deterioration may not be a major factor in the abundance and distribution patterns of marine/estuarine fish and larger invertebrates in the Bay and Delta, habitat restoration could play an important part in maintaining their abundance and ecological role. Protecting, improving, and restoring considerable shallow-water habitat in the Bay and Delta will improve the food supply for marine/estuarine fish and provide more rearing area. The improved food supply and rearing habitat area may help to overcome other factors that have little potential for change (e.g., non-native species). Increases in tidal wetlands will provide tidal channels that are important rearing habitat for many of the marine/estuarine species. Habitat improvements should also increase the abundance of plankton food for marine/estuarine species. A greater abundance of plankton will, hopefully, lead to improved survival of larvae and juveniles and increase the available food supply for such important species as chinook salmon, sturgeon, and striped bass.

Reducing the extent and effect of stressors will be critical to maintaining high seasonal population levels of marine/estuarine fish in the Bay and Delta. One factor will be reducing losses of larvae and juvenile marine/estuarine fish at water diversions in the Bay and Delta, particularly during drier years. Limiting further introductions of non-native species and reducing the input of toxic pollutants into Central Valley waterways may also be keys to high productivity of marine/estuarine fish.

Also essential to restoration is to to reduce the potential for further introductions of non-native species to the estuary through ballast water released from ships into Bay-Delta ports. Programs should be developed to reduce the potential for further introductions of non-native invertebrates and fish to the Bay-Delta.

Restoring marine/estuarine fish to healthy levels in the Bay and Delta will allow these species to serve their ecological role in the foodweb of the estuary. Their restoration will require a multifaceted approach of flow enhancement, habitat improvements, and stressor reductions.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for marine and estuarine fishes and large invertebrates is to maintain, improve, and restore populations of these species to levels that existed in the early 1980s . Meeting this objective would contribute to overall species richness and diversity and reduce conflict between the need for their protection and other beneficial uses of water in the Bay-Delta.

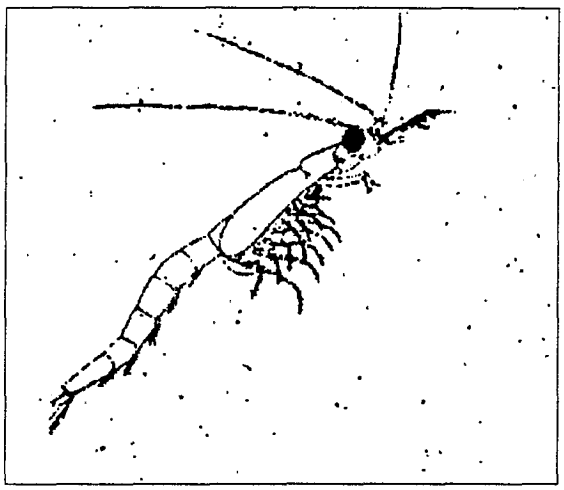
Indicators of the health of marine and estuarine fishes and large invertebrates are abundance

indices of selected populations and foodweb production as measured by DFG's Bay Monitoring Program.

LINKAGE TO OTHER PROGRAMS

Efforts to maintain a high abundance of marine/estuarine fish and large invertebrates in the Bay would also involve cooperation and support from other established programs to restore habitat and fish populations in the basin. Maintenance and protection of marine/estuarine fish populations in the Bay and Delta are the responsibility of the interagency program required under the Water Quality Control Program for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (May 1985) and Water Right Decision 1485 (1978). The Central Valley Project Improvement Act (PL 102-575) calls for the doubling of the anadromous fish populations (including striped bass, salmon, steelhead, sturgeon, and American shad) by 2002 through changes in flows and project facilities and operations. This program involves actions that may directly or indirectly benefit marine/estuarine fish populations in the Bay and Delta. The California Department of Fish and Game is required under State legislation (The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act of 1988) to restore numbers of anadromous fish in the Central Valley. Actions include restoring the food supply of anadromous fish; that food supply includes marine/estuarine fish.

BAY-DELTA AQUATIC FOODWEB ORGANISMS



INTRODUCTION

Foodweb organisms are essential for the survival and productivity of fish, shorebird and other higher order animal populations in the Bay-Delta estuary. Foodweb organisms include bacteria, algae, zooplankton (e.g., copepods and cladocerans), epibenthic invertebrates (e.g., crayfish, Neomysis and Crangon shrimp), and benthic invertebrates (e.g., clams). Some organisms are non-native speices (e.g., certain zooplankton and Asian clams) that may be detrimental to native species and the foodweb in general. The vision for the Bay-Delta aquatic foodweb is to restore the Bay-Delta estuary's once-productive food base of aquatic algae and organic matter and the microbes and zooplankton that feed on these resources by increasing the residence time of water in the Delta; restoring tidal action to diked wetlands; reducing concentrations and loadings of trace metals, herbicides, and other toxic substances in sediments and waters of the Central Valley; and reducing export losses. Increasing the amount and diversity of organic matter input from the Bay-Delta watershed would also help achieve this vision. The Bay-Delta foodweb would be restored when the abundance of phytoplankton, zooplankton and mysid shrimp reaches levels comparable to those that prevailed during the 1960s and early 1970s. The reduced trophic status (supply of phytoplankton and other forms of plant biomass) of the Bay-Delta in recent decades, particularly in drier years, has caused a reduction in important aquatic invertebrate groups, including rotifers, copepods, cladocera, and mysid shrimp. The estuary foodweb can be improved by increasing freshwater inflow to the estuary in spring of drier years; restoring aquatic, riparian, and wetland habitats within the Central Valley; and reducing the loss of foodweb resources from the system. Export losses can be reduced by modifying the structure and operation of Delta conveyance and pumping facilities. Such improvements in the foodweb would contribute significantly to restoring striped bass, delta smelt, chinook salmon, and other Bay-Delta fish populations.

BACKGROUND

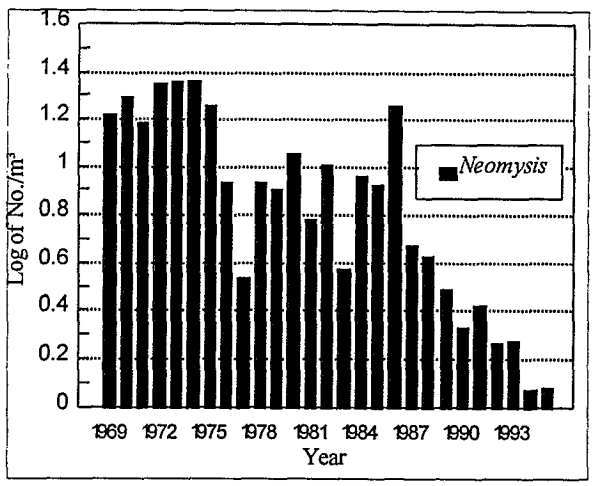
The foodweb of the Bay-Delta ecosystem consists of all the plants, invertebrates, and other lower trophic-level organisms that serve as prey for fish, water birds, and other higher trophic-level resources of the ecosystem. "Benthic" foodweb organisms are bottom dwelling, whereas plankton spend most of their time drifting in the water column. Foodweb productivity of the Bay-Delta estuary is dependent primarily on the supply of nutrients and plant biomass production and transport.

Plant contributions to the estuary foodweb consist mostly of benthic algae and phytoplankton produced in the estuary and its watershed, and vascular-plant debris input from terrestrial or wetland communities adjacent to the system. Algae are generally small (diameter <0.1 millimeters [mm]), easily transported, and highly nutritious. Most vascular-plant debris, by contrast, begins as coarse particulate organic

matter that must be colonized and partially decomposed by bacteria before being usable by invertebrates and fish. Plant detritus provides a dependable, "time-released" form of food and, in combination with algae, provides for a more stable foodweb. Bacteria produced from the processing of dissolved organic matter is another important food resource for smaller invertebrates, which in turn feed larger forms.

The Bay-Delta foodweb has undergone a number of changes since the 1960s. Most notably, phytoplankton abundance has declined in important fish nursery areas of Suisun Bay and the western Delta (Lehman 1996). A pattern of very low phytoplankton levels in Suisun Bay and the Delta beginning in 1987 concerns many scientists. Low levels in Suisun Bay and the Delta since 1986 may be the result of high densities of Asian clams (*Potamocorbula amurensis*) that colonized the Bay after being accidentally introduced from the ballast waters of ships. Large numbers of the clams colonized this area of the estuary during the drought period from 1987 to 1992 (Kimmerer and Orsi 1996).

Aquatic invertebrate population trends followed those of phytoplankton over the past three decades. Species that once dominated the aquatic invertebrate community have become relatively scarce, while some others have increased in relative abundance. Many native species have become less abundant or more narrowly distributed, while dozens of new non-native species have become well established and widely dispersed. In general, the abundance of plankton has declined, while populations of many bottom-dwelling invertebrates, most notably Asian clams, have increased . This transition has been most evident in Suisun Bay and other traditionally important fish-rearing areas. Also in these areas, populations of rotifers, copepods, and other relatively small species have declined substantially since monitoring began in the 1960s (Kimmerer and Orsi 1996). This pattern is perhaps most dramatic for the mysid shrimp, which have declined to less than one-tenth of their former abundance, particularly since 1986 (Orsi and Mecum 1996). The continued decline from 1993 to 1995, despite the return of higher flows, is of particular concern. These declines in zooplankton abundance have roughly coincided with the decline in algae, one of the main food sources for the zooplankton.



Concentration of Mysid Shrimp in Bay-Delta Estuary 1969-1995

The deterioration of the zooplankton community and its algal food supply in key habitat areas of the Bay-Delta is a serious problem because striped bass, delta smelt, chinook salmon, and other species that use Suisun Bay and the Delta as a nursery area feed almost exclusively on zooplankton during early stages of their life cycles. Research indicates that survival and growth of fish larvae generally increase with increased concentration of zooplankton. Declines in the production of juveniles of these fish species appear to coincide with the declines in algae and zooplankton. Modifying the Bay-Delta ecosystem in ways that will lead to increased algae and zooplankton abundance may be critical to restoring Bay-Delta fish populations and improving the health of its ecosystem.

Areas of the Bay-Delta where hydraulic conditions allow food resources to accumulate in the water column rather than settling or washing out are important habitats for plankton. This accumulation of food resources results from passive processes and from active algal, microbial, and zooplankton reproduction. The comparatively benign hydraulic conditions and

abundant food resources characterizing the western Delta and Suisun Bay permit the development of high zooplankton populations on which many estuarine resident and anadromous fish depend during their early life stages. Horizontal salinity stratification enhances this process, especially when the salinity front (sometimes referred to as X_2) or the "entrapment zone" is in Suisun Bay (Arthur and Ball 1979).

In addition to serving as a critical habitat area for food accumulation, Suisun Bay is an area of intense food consumption. Before the prolonged drought that began in the mid-1980s, high densities of copepods, young mysid shrimp, and other planktonic grazers usually accompanied relatively high phytoplankton densities in Suisun Bay. Dozens of species of filter-feeding clams and other benthic grazers joined in the intense food consumption. Since the drought ended in 1993, however, phytoplankton levels have remained low in Suisun Bay, even though flows early in the dry season have been managed to maximize the frequency with which salt- and fresh water converge in Suisun Bay. It is likely that the reason for this lack of plankton recovery is the Asian clam. This non-native marine bivalve was first detected in Carquinez Strait in 1986. Since then, it has become very abundant throughout San Pablo and Suisun bays and, in dry years, extends up into the western Delta. It is estimated that the clam can effectively filter the entire water column within 24 hours. The Asian clam is therefore considered an important "stressor" that will likely hamper efforts to restore the Bay-Delta foodweb; however, clam densities and upstream distribution in the estuary have declined since 1993 with the onset of higher freshwater inflows.

The decline of plankton populations in the Bay-Delta may also be a result, at least in part, of the effects of heavy metals, herbicides, pesticides or other toxic substances. Low concentrations of these substances in the water column may act individually or in combination to reduce productivity of plant and animal plankton. Research to determine the effects of these toxicants on plankton is currently underway.

RESTORATION NEEDS

Restoring the Bay-Delta foodweb would require enhancing plankton growth and reducing loss of plankton to water exports from the system, particularly in drier years. There are several options for enhancing plankton growth. Improving Delta inflow and outflow in spring of drier years will be an essential element of any plan. Other elements include reducing losses to exports from the system and reducing the amount of toxic substances entering the system.

Additional improvements can be gained by increasing shallow-water habitat and tidal wetlands in the Bay and Delta. Increasing the acreage of floodplain lakes, sloughs, and other backwaters in the Sacramento River drainage will increase organic matter inputs to the Delta. This increase in plankton food supply will help increase population growth. Actions to accomplish this include opening leveed lands to tidal or seasonal floodflows; increasing the array of sloughs in the Delta; protecting and restoring shallows, shoals, and channel islands in the Delta; and providing for a more natural floodplain and meander belt along the rivers. Restoring tidal action to leveed lands in San Pablo Bay and Suisun Marsh is another option. The Yolo and Sutter Bypasses offer potential opportunities to produce more permanent slough, riparian, and wetland habitats in the Sacramento River floodplain. Setback levees or improved riparian and shallow-water habitat along leveed reaches of the rivers and Delta offer additional opportunities to increase the abundance of foodweb organisms in the Bay and Delta.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for Bay-Delta aquatic foodweb organisms is to maintain, improve, or restore the population densities of

phytoplankton, zooplankton, mysid shrimp and other invertebrates to sustainable levels, with special emphasis on native species. Chlorophyll concentration, native zooplankton density and the population density of mysid shrimp and other invertebrate species targeted through adaptive management programs can be used as indicators of the health of the Bay-Delta aquatic foodweb.

LINKAGE TO OTHER PROGRAMS

Efforts to restore the abundance of Bay-Delta foodweb organisms would involve the cooperation and support from established programs underway to restore habitat and fish populations in the basin. Restoring the plankton food supply for native fishes is a primary focus of the recovery plan for the Sacramento-San Joaquin Delta Native Fishes. The Central Valley Project Improvement Plan (PL 102-575) calls for doubling the anadromous fish populations (including striped bass, salmon, steelhead, sturgeon, and American shad) by 2002 by changing flows and project facilities and operations. This program involves actions that may directly or indirectly benefit the Bay-Delta foodweb. The California Department of Fish and Game is required under State legislation (The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act of 1988) to restore numbers of anadromous fish in the Central Valley. Actions include restoring the food supply of anadromous fish. The Ecosystem Restoration Program Plan proposes to coordinate efforts by the State Water Resources Control Board and Regional Water Quality Control Boards to reduce the amount of toxic substances released into Central Valley waterways.

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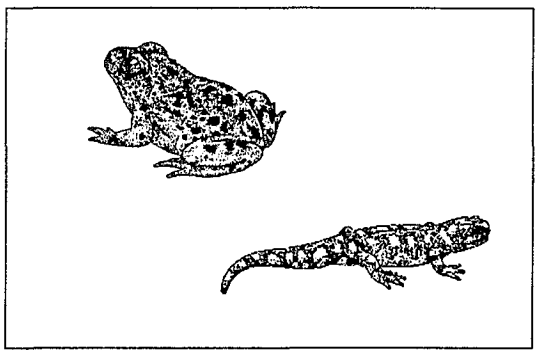
WESTERN SPADEFOOT AND CALIFORNIA TIGER SALAMANDER



INTRODUCTION

Western spadefoot and California tiger salamander populations have declined primarily as a result of habitat loss or degradation and competition or predation from non-native species. The loss of habitat and the declining condition of these populations have warranted their designation as species of special concern and/or species of concern by the California Department of Fish and Game (DFG) and U.S. Fish and Wildlife Service, respectively. Major factors that limit these resources' contribution to the health of the Delta are related to adverse effects of conversion of seasonal wetlands and adjacent uplands to other land uses and excessive mortality resulting from introduction of non-native predators and some land use practices.

The vision for the western spadefoot and the California tiger salamander is to assist in the recovery of these species in the Bay-Delta. Recovery of these species would contribute to overall species richness and diversity and reduce conflict between the need for their protection and other beneficial uses of land and water in the Bay-Delta.

BACKGROUND

The western spadefoot and California tiger salamander occur throughout much of the Central Valley, San Francisco Bay, and coast ranges and foothills below 3,000 feet, as well as along the coast in the southern portion of the State. The abundance from population to population is unknown but is influenced by the size and quality of habitat within the fragmented pockets that the species are known to inhabit.

The western spadefoot is primarily a species of the lowlands, frequenting washes, river floodplains, alluvial fans, playas, and alkali flats, but also ranges into the foothills and mountain valleys. Tiger salamanders typically inhabit scattered ponds, intermittent streams, or vernal pools that are associated with grassland-oak woodland habitat below 1,500 feet. Vernal pools covering more than 250 square feet, with fairly turbid water, provide optimal habitats. Most surface movements of the western spadefoot and California tiger salamander, including breeding activity, are associated with the onset of late-winter and early spring rains that fill traditional breeding ponds. Warm days followed by rains or high humidity levels at night trigger reproductive and foraging activities and adults of these species sometimes appear in large numbers.

The greatest threat to the continued existence of both species is habitat loss resulting from increased urbanization and conversion of native grasslands to agriculture. The spadefoot and salamander may be found in high densities in isolated areas but adjacent breeding habitat is increasingly being converted for other uses. Introduction of predatory fish and bullfrogs in known breeding ponds is also an important factor attributed to the decline of these species. Juvenile

bullfrogs are thought to compete with and prey on larvae of these native species. Other important stressors that affect the spadefoot and salamander are rodent control activities, which reduce the availability of summer estivation sites, and development of roads between breeding ponds and terrestrial habitats, resulting in deaths from automobiles during the species' migrations.

RESTORATION NEEDS

Protecting and restoring existing and additional suitable aquatic, wetland, and floodplain habitats and reducing the effect of other factors that can suppress breeding success will be critical to the recovery of the western spadefoot and California tiger salamander. The Ecosystem Restoration Program Plan's (ERPP's) proposed restoration of aquatic, seasonal wetland, and floodplain habitats in the Sacramento-San Joaquin Delta Ecological Zone will help recover this species by increasing habitat quality and area. ERPP's proposed restoration of ecosystem processes and habitats in other ecological zones will also allow natural floodplains, meander corridors, and seasonal pools to develop that will assist in the recovery of populations of these species elsewhere in their range.

Implementing guidelines developed by DFG for vegetation, grazing, traffic, and pest management would increase these species' reproductive success and reduce the level of mortality from unnatural sources. These guidelines recommend reducing the use of herbicides that adversely affect western spadefoot and California tiger salamander and their habitats; reducing mowing, to the extent feasible, to control vegetation and livestock grazing near occupied seasonal wetlands from October to March; reducing traffic, where feasible, on roads crossed by these species during migration periods; and using fumigants to control rodents from only October to March in known occupied habitats. Draining waterways used by the spadefoot and salamander during the periods when these species are dormant could be beneficial by reducing populations of non-native predatory fish and bullfrogs. These guidelines could be implemented through cooperative agreements with land management agencies and organizations and development and implementation of incentive programs to encourage land use practices that improve habitat conditions for and reduce mortality on these species.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for the western spadefoot toad and California tiger salamander is to assist in the recovery of these special-status species in the Bay-Delta in order to contribute to overall species richness and diversity and reduce conflict between the need for their protection and other beneficial uses of water in the Bay-Delta.

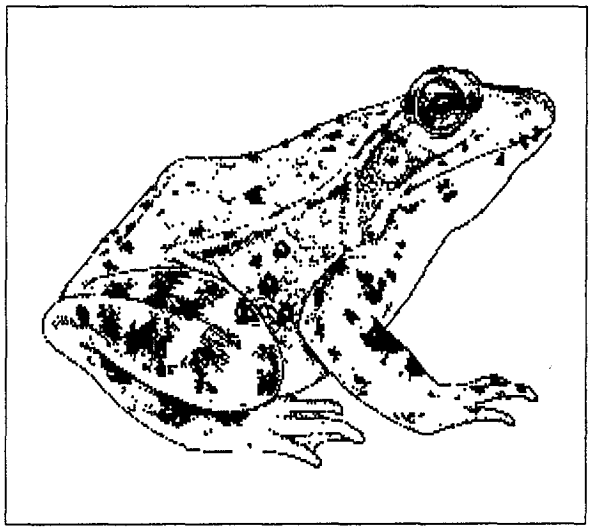
The measurements of performance against the implementation objective are the quality and quantity of suitable wetland and adjacent upland habitats and the abundance and distribution of western spadefoots and California tiger salamanders in the Bay-Delta. The quality and quantity of existing and suitable habitat and the degree to which former levels of abundance and distribution is achieved will be indicators of the recovery of western spadefoot and California tiger salamander populations.

LINKAGE TO OTHER PROGRAMS

Wetland restoration and management programs that would improve habitat for the western spadefoot and California tiger salamander include the Agricultural Stabilization and Conservation Service's Wetland Reserve Program, the Wildlife Conservation Board's Inland Wetlands Conservation Program, those administered by

Ducks Unlimited and the California Waterfowl Association, and ongoing management of State and federal wildlife refuges and private duck clubs.

CALIFORNIA RED-LEGGED FROG



INTRODUCTION

The California red-legged frog is associated with fresh emergent wetland and riparian habitat. The distribution and population of this species has declined substantially, primarily as a result of habitat loss or degradation and excessive predation. The loss of habitat and declining condition of the species' population have warranted its listing as threatened under the federal Endangered Species Act and a Species of Special Concern by DFG. Major factors that limit this resource's contribution to the health of the Delta are related to adverse effects of the loss or degradation of critical wetland and riparian habitats and the introduction of non-native predators.

The vision for the California red-legged frog is to assist in the recovery of this federally listed threatened species in order to contribute to the overall species richness and diversity and to reduce conflict between protection for this species and other beneficial uses of land and water in the Bay-Delta.

BACKGROUND

The California red-legged frog is California's largest native frog. Its habitat is characterized by dense, shrubby riparian vegetation associated with deep, still, or slow-moving water that supports emergent vegetation. The California red-legged frog historically occurred throughout the Central Valley and now exists only in small isolated populations scattered throughout its historical range. Its current range is chiefly west of the Cascade-Sierra crest from Redding in Shasta County, California to northwest Baja California. Small populations still exist in the Central Valley and Sierra Nevada, but numbers appear to be declining in both places. Reasons for the decline of this species include the degradation and loss of critical wetland breeding and adjacent terrestrial habitats, and the introduction of non-native fish, bullfrogs, and crayfish, all of which prey on larval, juvenile, or adult red-legged frogs.

In areas occupied by the species, some agricultural practices, such as disking, mowing, burning, and pest control, result in direct mortality or degradation of habitat. Some introduced predatory fish are large enough to injure some adults and eat juvenile red-legged frogs. The only reasonably protected population in the Central Valley is the Corral Hollow Ecological Reserve is currently threatened by siltation from off-road vehicle use and livestock grazing.

RESTORATION NEEDS

Protecting existing and restoring additional suitable aquatic, wetland, and riparian habitats and reducing mortality from non-native predators will be critical to achieving recovery of the California red-legged frog. The Ecosystem Restoration Program Plan's (ERPP's) proposed

restoration of aquatic, wetland, and riparian habitats in the Sacramento-San Joaquin Delta Ecological Zone will help in the recovery of this species by increasing habitat quality and area. Creation of canals, side channels, and back-flow pools containing emergent vegetation (*Salix* sp., *Typha* sp., and *Scirpus* spp.) within each ecological unit of the Sacramento-San Joaquin Delta Ecological Zone would provide breeding habitat, forage and escape cover, and would create dispersal corridors by linking habitat areas. Restoration of ecosystem processes and habitats proposed by ERPP in other ecological zones will also allow natural floodplains, stream meanderings, and seasonal pools to develop that will assist in the recovery of population elsewhere in the red-legged frog's range. Restoration of optimal red-legged frog habitat will also reduce its susceptibility to predation and will reduce suitable habitat conditions for non-native predators such as bullfrogs, largemouth bass, and sunfish.

Implementation Objective and Indicators

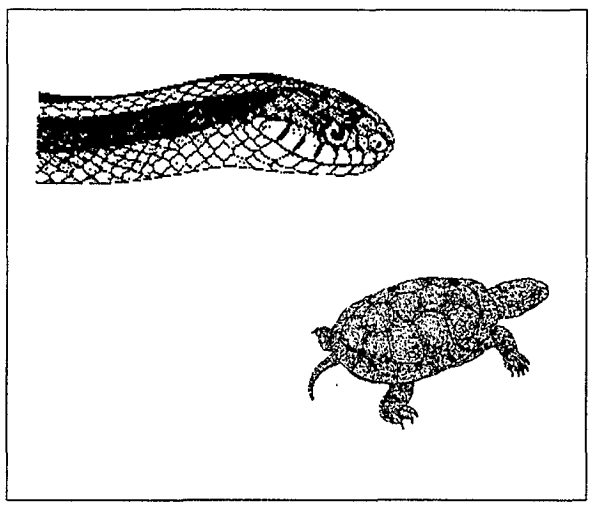
The implementation objective for the California red-legged frog is to assist in the recovery of this federally listed threatened species. Recovery of the California red-legged frog would contribute to overall species richness and diversity and reduce conflict between the need for its protection and other beneficial uses of land and water in the Bay-Delta.

The measurements of performance against the implementation objective is the quality and quantity of suitable wetland, riparian, and adjacent upland habitats and the abundance and distribution of California red-legged frogs in the Bay-Delta. Increasing the quality of existing and the quantity of suitable habitat and the degree to which former levels of abundance and distribution is achieved will be indicators of recovery of the California red-legged frog population.

Linkage to Other Programs

Wetland restoration and management programs that would improve habitat for the California red-legged frog include 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, and ongoing management of State and federal wildlife refuges and private duck clubs. Restoration efforts will be conducted in cooperation with agencies or organizations with responsibility or authority for restoring wetland 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 Delta Protection Commission.

GIANT GARTER SNAKE AND WESTERN POND TURTLE



INTRODUCTION

The giant garter snake and western pond turtle are associated with fresh emergent wetland habitat. The distribution and population of these species has declined substantially, primarily as a result of the loss or degradation of wetlands and nearby uplands. The loss of habitat and declining condition of these species' populations has warranted the giant garter snake being listed as threatened under the State and federal Endangered Species Acts and the western pond turtle being designated as a species of concern by USFWS and a Species of Special Concern by DFG. Major factors that limit these resource's contribution to the health of the Delta are related to adverse effects of conversion of aquatic, wetland, riparian, and adjacent upland habitats to other land uses and land use practices that degrade the value of otherwise suitable habitat areas..

The vision for the giant garter snake and western pond turtle is to assist in their recovery in order to contribute to the overall species richness and diversity and to reduce conflict between protection for this species and other beneficial uses of land and water in the Bay-Delta.

BACKGROUND

The giant garter snake is the only subspecies of western aquatic garter snake that lives in the Central Valley of California. It inhabits sloughs, low-gradient streams, and other waterways, where it feeds on small fish and frogs during the active season. Most populations are found in the Feather River/Sutter Basin and American River Basin Ecological Zones. The western pond turtle inhabits ponds, rivers, streams, lakes, marshes, and irrigation ditches with rocky or muddy substrates. Dense cover and exposed basking sites are important components of these wetland habitat types. The western pond turtle inhabits every region of California except drainages on the eastern slope of the Sierra Nevada. Population densities vary, however, and are highly influenced by the quality of isolated habitats. A disproportionately large percentage of giant garter snake and western pond turtle populations are adults, indicating poor reproductive success.

Historic habitat areas used by these species have been substantially reduced as a result of reclamation for agriculture, urban, or industrial uses or degraded as a result of ongoing land use practices. Remaining habitat areas, such as ponds, rivers, streams, lakes, marshes, and irrigation ditches, are largely fragmented, and the associated uplands used for reproduction are largely unavailable for hibernation as a result of development or excessive disturbance caused by land use practices, such as disking and tilling. Upland habitats adjacent to aquatic habitats are now mostly isolated in small riparian bands along the tributaries that supply water to the Sacramento and San Joaquin Rivers and along canals with small levees on either or both sides. Creating

buffer zones where none currently exist would improve habitat value.

Because much of the original habitat used by these species has been lost, irrigation canals and ditches (especially canals with nearby vegetation) now provide important replacement habitat for these species. Rice farming makes up a significant portion of the agricultural activity in the Sacramento Valley, and drainage ditches associated with rice farming practices provide much of this surrogate habitat. Adjacent breeding and hibernating cover, however, is often limiting for these species.

Other factors that limit these species populations include some agricultural practices (e.g., disking, mowing, burning, and applying herbicides and rodenticides) that degrade habitat or cause mortality; introduced large predatory fish that prey on juveniles and injure adults; and mortality caused by flooding of hibernation sites during heavy rains, floods, or flooding land for waterfowl.

RESTORATION NEEDS

Protecting existing and restoring additional suitable wetland and upland habitats will be critical to achieving recovery of the giant garter snake and western pond turtle. The Ecosystem Restoration Program Plan's (ERPP's) proposed restoration of aquatic, wetland, riparian, and upland habitats in the Sacramento-San Joaquin Delta Ecological Zone will help in the recovery of these species by increasing habitat quality and area. Protecting occupied habitat areas could be achieved by implementing a preservation plan that would protect these areas from adverse effects associated with human encroachment and recreation. Creation of canals, side channels, and backflow pools containing emergent vegetation within the South, East, and North Delta Ecological Units of the Sacramento-San Joaquin Delta Ecological Zone would provide forage habitat and escape cover, and would create dispersal corridors by linking habitat areas. Restoring on suitable adjacent upland habitat or modifying land use practices to render existing uplands as suitable habitat would reestablish connectivity between wetland and upland habitat areas, provide nest and hibernation sites, and would provide refuge habitat during floods.

Restoration of ecosystem processes and habitats proposed by ERPP in other ecological zones will also allow natural floodplains, stream meanderings, and seasonal pools to develop that will provide habitat for these species assist in the recovery of their populations elsewhere in their ranges.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for the giant garter snake, a federally listed threatened species, and western pond turtle, a species of special concern, is to assist in their recovery. Meeting this objective would contribute to overall species richness and diversity and reduce conflict between the need for their protection and other beneficial uses of land and water in the Bay-Delta.

The measurements of performance against the implementation objective is the quality and quantity of suitable wetland and adjacent upland habitats and the abundance and distribution of giant garter snakes and western pond turtles in the Bay-Delta. Increasing the quality of existing and the quantity of suitable habitat and the degree to which former levels of abundance and distribution is achieved will be indicators of recovery of the giant garter snake and western pond turtle populations.

LINKAGE TO OTHER PROGRAMS

Restoration projects to improve upland and wetland agriculture and seasonal wetland and riparian habitats would be closely linked to the restoration of these species. The American River Basin is ecologically important because it contains the most stable populations of giant garter snakes. Restoration and agricultural improvements will be developed for implementation both north and south of the Delta.

Efforts to recover giant garter snake and western pond turtle populations will involve cooperation and support from other established programs aimed at restoring habitat and populations.

Wetland restoration and management programs that would improve habitat for these species include 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, and ongoing management of State and federal wildlife refuges and private duck clubs. Restoration efforts will be conducted in cooperation with agencies or organizations with responsibility or authority for restoring wetland and aquatic habitats, including DFG, California Department of Water Resources, USFWS, U.S. Army Corps of Engineers, and the Delta Protection Commission. USFWS is also preparing a recovery plan for the giant garter snake that will establish population recovery goals.

GAP

NOTED

INTRODUCTION

The nesting population of the Swainson's hawk has declined substantially, primarily as a result of habitat loss and degradation, reduced reproductive success, and high rates of mortality during migration and on South American wintering areas. The loss of habitat and declining condition of the species' population have warranted its listing as threatened under the State Endangered Species Act. Major factors that limit this resource's contribution to the health of the Delta are related to adverse effects of habitat loss and degradation, toxic pesticides accumulated in the foodweb on reproduction, human-associated disturbances at nest sites, and increased competition with other species for nest sites,

The vision for the Swainson's hawk is to assist in the recovery of this State-listed threatened species in order to contribute to the overall species richness and diversity and to reduce conflict between protection for this species and other beneficial uses of land and water in the Bay-Delta.

BACKGROUND

Swainson's hawks occur throughout the Central Valley where riparian forest and oak savanna habitats are present. Agricultural crops, such as alfalfa, and dryland pasture provide habitat that supports a continual prey base for the Swainson's hawk. A large number of hawks may congregate near farming activities such as mowing, disking, and irrigation where prey, including some agricultural pests such as grasshoppers, is abundant. Valley oak and riparian woodlands are essential for Swainson's hawk nesting, and 78% of nest trees are located within riparian systems with adjacent foraging habitat. The Swainson's hawk typically returns to the same nest site; therefore, the preservation of nest sites is important to prevent extirpation.

The Swainson's hawk was common in the Central Valley at the end of the 19th century. Historical populations were estimated between 4,000 and 17,000 pairs, but declines were documented as early as the 1940s. In 1979, 110 active pairs were observed with estimates of 375 pairs present in the State. Today, the few remaining concentrations of breeding pairs are supported within the Yolo, Sacramento, San Joaquin, Sutter, and Colusa Counties, with steadily decreasing numbers to the north and south. Possible reasons for the Swainson's hawk's decline include loss or degradation of habitat on the breeding grounds, disturbance on the breeding grounds, thin eggshells, increased competition with other species, and mortality during migration and on the wintering grounds in South America.

To a large degree, the decline of the Swainson's hawk can be attributed to the long-term, cumulative effects of riparian and wetland habitat conversion and degradation. A combination of changes to Central Valley area ecosystems has added to the problem. These changes include:

- the conversion of perennial grassland to agricultural uses, eliminating foraging habitat;
- urban development adjacent to waterways and nesting areas;
- incompatible land use that disrupts breeding and nesting;
- levees and bank protection that eliminate nesting habitat;
- disturbance from human activities near nest sites; and
- contaminants from agricultural runoff and pesticide use.

Excessive harvest of Swainson's hawk on South American wintering grounds is also thought to be a major factor affecting the decline of the species.

RESTORATION NEEDS

Protecting existing and restoring additional suitable valley oak and other riparian habitats, grasslands, and improving management of agricultural lands and reducing the effect of factors that can suppress breeding success will be critical to recovery of the Swainson's hawk in the Bay-Delta. The Ecosystem Restoration Program Plan's (ERPP's) proposed restoration of these habitats in the Sacramento-San Joaquin Delta Ecological Zone will help achieve recovery of the Swainson's hawk by increasing the quality and quantity of its habitats. The Swainson's hawk will benefit from implementation of restoration and management strategies that protect known nest sites from loss, degradation, or disturbance during the nesting season and that increases prey populations (e.g., rodents) on agricultural and other lands to provide the prey base that would be necessary to support an expanding population. Land use changes can disrupt and destroy foraging and nesting habitat. It is important to protect these areas by establishing buffer zones that eliminate human disturbance during nesting and creating compatible land use management adjacent to important habitats. Many agricultural practices are compatible with Swainson's hawk foraging. Simply improving the timing of farming activities could further improve foraging habitat.

Such strategies could be implemented through working collaboratively with organizations to maintain and improve existing preserves that support Swainson's hawk habitat, cooperative agreements with land management agencies, or through conservation easements or incentives with participating landowners to improve land management practices for the Swainson's hawk.

Restoration of ecosystem processes and habitats proposed by ERPP in other ecological zones will also allow nesting and foraging habitats to develop that will provide habitat for Swainson's hawks elsewhere in the Central Valley.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for the Swainson's hawk is to assist in the recovery of this State-listed threatened species. Recovery of Swainson's hawk would contribute to overall species richness and diversity and reduce conflict between the need for its protection and other beneficial uses of land and water in the Bay-Delta.

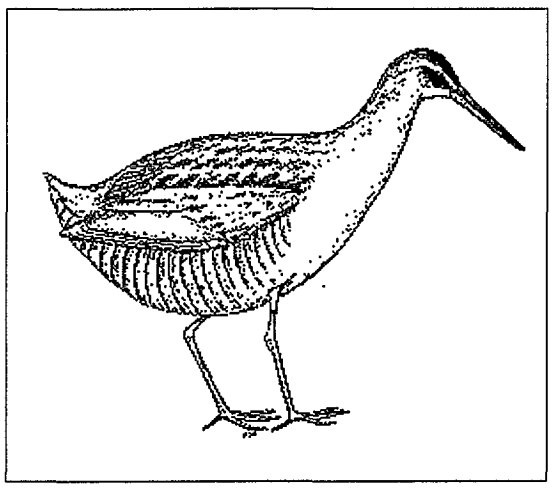
The measurements of performance against the implementation objective is the quality and quantity of suitable nesting and foraging habitats and the number of active Swainson's hawk nest sites. Increasing the quality of existing and the quantity of suitable habitat and the degree to which former nesting densities are achieved will be indicators of recovery of the Swainson's hawk population in the Bay-Delta.

LINKAGE TO OTHER PROGRAMS

Several organizations have plans that indirectly target the Swainson's hawk for recovery through habitat restoration. The Riparian Habitat Joint Venture includes 11 federal, State, and private organizations that signed a cooperative agreement to protect and enhance habitats for native landbirds throughout California. The Putah Creek - South Fork Preserve, which works to increase fish and wildlife populations dependent on riparian and wetland habitats, including species of special concern, plans to restore 130 acres of riparian habitat. The Upper Sacramento River Fisheries and Riparian Habitat Management Plan (SB1086) also targets riparian habitat for

restoration that will benefit the Swainson's hawk. Restoration and strategies should be coordinated with the Swainson's Hawk Technical Group, a group of agency and nonagency specialists dedicated to restoring the health of this species.

CALIFORNIA CLAPPER RAIL



INTRODUCTION

The California clapper rail is associated with saline emergent wetlands. The population and distribution of this species have declined substantially, primarily as a result of reclamation of its tidal saltmarsh habitats. The loss of habitat and declining condition of the species' population have warranted its listing as endangered under the State and federal Endangered Species Acts. Major factors that limit this resource's contribution to the health of the Delta are related to adverse effects of historical and current loss or degradation of tidal saltmarshes for agricultural, industrial, and urban uses, and excessive predation on nests and individuals by introduced predators.

The vision for the California clapper rail is to assist in the recovery of this State- and federally listed endangered species to contribute to overall species richness and diversity. Recovery of this species would reduce conflict between the need for its protection and other beneficial uses of land and water in the Bay-Delta.

BACKGROUND

The clapper rail is a year-long resident in coastal wetlands and brackish areas around San Francisco, Monterey, and Morro Bays; breeding from mid-March to July, when it builds a platform nest concealed by a canopy of cordgrasses and pickleweed. It may also use cattails and bulrushes in fresh emergent wetland habitats. Adjacent upper wetland or upland habitat with aquatic vegetation are also important because they provide nesting and escape cover during high tides and floodwaters. Within the Ecosystem Restoration Program Plan (ERPP) area, this species is found only in the Suisun Marsh/North San Francisco Bay Ecological Zone.

Significant loss of saline and fresh emergent wetland habitat and associated upland habitats and high marshes largely as a result of reclamation for agricultural, industrial, and urban uses and water management projects is the primary factor for the decline in this species' populations. The total area of these remaining habitats represents only a small percentage of their historic level. These habitat losses have reduced populations sufficiently that predation by non-native species, such as the Norway rat, red fox, and feral cats; swamping of nests by boat wakes; and contaminants, such as selenium, may now also be substantial factors affecting the ability of the species to recover.

RESTORATION NEEDS

Protecting existing and restoring additional suitable saline and fresh emergent wetlands and adjacent higher elevation habitats and reducing the effect of other factors that can suppress breeding success will be critical to the recovery

of the California clapper rail. The Suisun Marsh and San Francisco Bay areas once comprised a mosaic of large contiguous blocks of tidal saline emergent wetland in association with adjacent upland habitats. The Ecosystem Restoration Program Plan's (ERPP's) proposed restoration of saline and fresh emergent wetland and associated upland habitats in the Suisun Marsh/North San Francisco Bay Ecological Zone will help the recovery of this species by increasing habitat area. Habitat would be improved by protecting remaining tidal slough habitats supporting pickleweed, cordgrass, bulrushes, and cattails and maintaining adjacent higher elevation wetland and upland habitat to provide cover during high tides and floods. Upland cover could be improved by providing incentives to farmers to allow natural vegetation to reclaim portions of the upland habitat adjacent to tidal wetlands.

Improved habitat would also include water quality levels and other components necessary to support isopods, arthropods, mollusks, and insects on which clapper rails forage. These components could be provided by developing and implementing a program to reduce the level of toxins that adversely affect clapper rail populations in the Bay-Delta. Clapper rail breeding success could be improved by reducing the adverse effects of boat wakes on nests during the mid-March-to-July breeding period. Restoring high-quality clapper rail habitat would also reduce the adverse effects of predation by non-native species by creating habitat conditions that are more favorable for rails and less favorable for predators.

Implementation Objective and Indicators

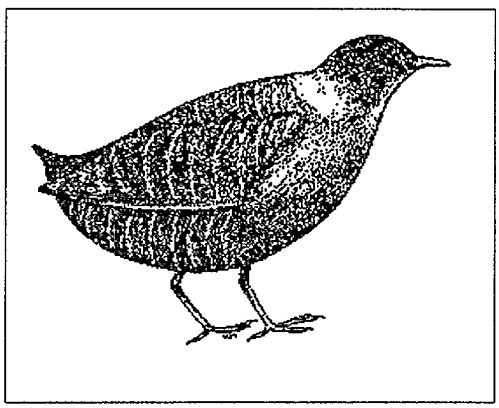
The implementation objective for the clapper rail is to assist in the recovery of this State- and federally listed endangered species in order to contribute to overall species richness and diversity and reduce conflict between the need for its protection and other beneficial uses of land and water in the Bay-Delta.

The measurements of performance against the implementation objective are the quality and quantity of suitable tidal emergent wetlands and the abundance and distribution of California clapper rails in the estuary. The quality and quantity of existing and suitable habitat and the degree to which former levels of abundance and distribution is achieved will be indicators of recovery of the California clapper rail population.

Linkage to Other Programs

Wetland restoration and management programs that would improve habitat for the clapper rail include 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 will 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 (USFWS), U.S. Army Corps of Engineers, and the Delta Protection Commission. USFWS is also currently revising the recovery plan for the clapper rail, which will establish population recovery goals.

CALIFORNIA BLACK RAIL



INTRODUCTION

The California black rail is associated with tidal and nontidal emergent wetlands. The population and distribution of this species have declined substantially primarily as a result of reclamation of its wetland habitats. The loss of habitat and declining condition of the species' population have warranted its listing as threatened under the California Endangered Species Act. The major factor that limits this resource's contribution to the health of the Delta is related to the adverse effects of historical and current loss or degradation of salt-, brackish, and freshwater marshes.

The vision for the California black rail is to assist in the recovery of this State-listed threatened species to contribute to overall species richness and diversity. Recovery of this species would reduce conflict between the need for its protection and other beneficial uses of land and water in the Bay-Delta.

BACKGROUND

The California black rail is a rarely seen, year-round resident of saline, brackish, and fresh emergent wetlands and viable populations of the species are found only in the Suisun Marsh, San Francisco Bay, and the Delta. Historically, the black rail was also a resident of coastal wetlands from Santa Barbara County to San Diego County.

Important habitats for the species include tidal perennial and nontidal perennial aquatic, dead-end and open-ended sloughs, seasonal wetland and aquatic, saline and fresh emergent wetland, and midchannel islands and shoals. Many tidal habitats, including those that support pickleweed, bulrushes, and saltgrass, are critical types for this species that need to be protected and currently exist as only a small percentage of their historical extent. In addition, upper wetland or upland areas adjacent to these habitat areas provide nesting and escape cover during high tides and floods.

Much of the California black rail's marshland habitat in California has been destroyed or modified since the mid-1800s. This decline in marshland has reduced population densities of black rail throughout its range. These habitats continue to be threatened by sedimentation, water diversions, recreational activities, and land use practices. Insufficient quantity and quality of emergent wetland habitat is the primary factor limiting recovery of the species' population in the estuary. Other factors that can also adversely affect the black rail include disturbance during its breeding period, contaminants, and excessive predation by non-native species.

RESTORATION NEEDS

Restoring suitable fresh and saline emergent wetlands and tidal sloughs in the Bay-Delta and adjacent higher elevation habitats to provide refuge for the California black rail during high-water periods is critical to the recovery of the species in the estuary. Although the black rail's range extends into other ecological zones, the primary focus for the restoration of habitat will be in the Sacramento-San Joaquin Delta Ecological Zone and the Suisun Marshland Ecological Unit in the Suisun Marsh/North San Francisco Bay Ecological Zone. Efforts outside the Delta and Suisun Marsh to restore natural tidal action to aquatic and wetland habitats within the Suisun Marsh/North San Francisco Bay Ecological Zone would also benefit the species.

Black rail habitat is directly influenced by sediment supply from the upstream portion of the Delta and tidal influences from the Bay. As sediment is deposited in a tidal marsh, the elevation of the marsh changes. Eventually, the marsh may no longer be affected by tidal action or support tidal marsh plants which depend on the interaction of compatible tides and sediment supply regimes. Water quality in habitat areas must be sufficiently high to support the invertebrates and vegetation that sustain black rails. Restoring the natural tidal action of aquatic habitats would improve the sediment supply and vegetation succession.

To preserve the remaining populations of black rail, tidal slough habitats that support pickleweed, bulrushes, and saltgrass should be protected. Enhancing and restoring connectivity between tidal sloughs and adjacent upland refugial habitats would help to conserve the black rail.

The condition most hazardous to the black rail's existence in salt marshes is the elevated water level associated with the highest tides and high outflow conditions. High water destroys nests and forces rails to leave the marsh temporarily in search of sufficient cover in uplands. Black rails use corridors between wetland and upland habitats to seek cover during high tides. However, these corridors have been fragmented by the extensive system of Delta levees, which are often devoid of vegetation. This lack of sufficient cover subjects black rails to predation, frequently by non-native species. Improving the connection between wetland and upland habitat areas would help to reduce the susceptibility of black rails to predation. Programs to manage small water diversions, disturbance, changes in land use, and contaminants would improve habitat, reproductive potential, and recruitment for black rails.

The existing distribution and abundance of black rails in the estuary could be maintained by protecting tidal sloughs and wetlands occupied by the black rail from land uses that could degrade habitat conditions. Protecting unoccupied but suitable habitats near occupied habitat areas from degradation would help to ensure that suitable habitat is available for natural expansion of the population. Protection of existing suitable habitats could be achieved through conservation easements or purchase from willing landowners, establishing incentive programs to encourage landowners to maintain suitable habitat, and developing and implementing alternatives to land management practices on public lands that continue to degrade the quality or inhibit the recovery of black rail habitats. Restoring, protecting, and improving emergent wetlands, tidal sloughs, and adjacent uplands as proposed by the Ecosystem Restoration Program Plan would provide the habitat conditions necessary to increase and help recover California black rail populations in the estuary.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for the California black rail is to assist in the recovery of this State-listed threatened species in order to contribute to overall species richness and diversity and reduce

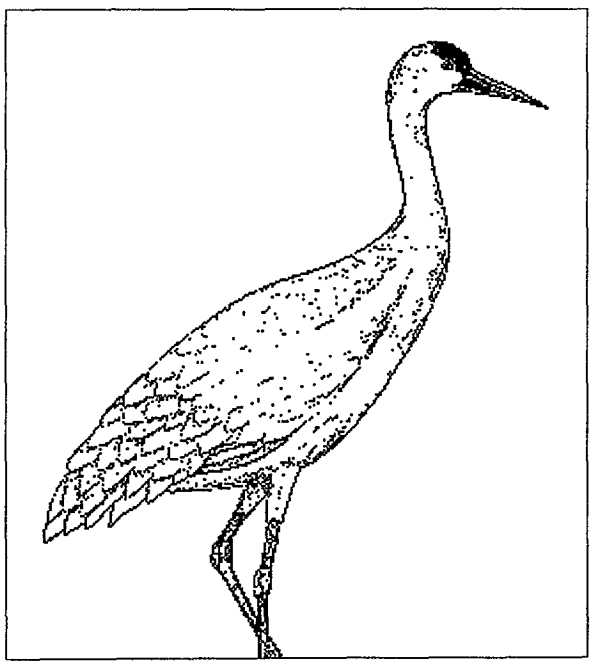
conflict between the need for its protection and other beneficial uses of land and water in the Bay-Delta.

The measurements of performance against the implementation objective are the quality and quantity of suitable emergent wetland and tidal slough habitats and the abundance and distribution of California black rails in the estuary. The quality and quantity of existing and suitable habitat and the degree to which former levels of abundance and distribution is achieved will be indicators of recovery of the California black rail population in the estuary.

LINKAGE TO OTHER PROGRAMS

Many programs designed to benefit broader groups of fish and wildlife that use or depend on wetlands, sloughs, or adjacent aquatic systems in the Bay-Delta also benefit the California black rail. Some of these are operated by the Bay Area Wetlands Planning Group, California Coastal Conservancy, Delta Native Fishes Recovery Team, San Francisco Bay National Wildlife Refuge, and the U.S. Fish and Wildlife Service San Francisco Bay Program; the Tidal Wetlands Recovery Plan also contributes to improvements for the species. The Ecosystem Wetland Goals Project is setting restoration goals for the Suisun and San Francisco Bay areas.

GREATER SANDHILL CRANE



INTRODUCTION

This subspecies of the sandhill crane primarily winters in the Delta and forages and roosts in agricultural fields and pastures. Because the winter range of the greater sandhill crane overlaps the winter range of other sandhill crane subspecies, all subspecies are considered important resources. The greater sandhill crane population has declined primarily as a result of loss of suitable wetland nesting habitats. The loss of habitat and declining condition of the subspecies' population have warranted its listing as threatened under the California Endangered Species Act. Major factors that limit this resource's contribution to the health of the Delta are related to adverse effects of conversion of grassland and wetland habitats for agricultural, industrial, and urban uses.

The vision for the greater sandhill crane is to assist in the recovery of this State-listed threatened species in the Bay-Delta. Recovery of the greater sandhill cane would contribute to overall species richness and diversity and reduce conflict between the need for its protection and other beneficial uses of land and water in the Bay-Delta.

BACKGROUND

The greater sandhill crane is an important part of the biological integrity and health of the Bay-Delta and Sacramento-San Joaquin Valley ecosystems. The greater sandhill crane is found throughout most of the Central Valley in winter and nests in northeastern California and Oregon. Habitats used by the sandhill crane include seasonal and fresh emergent wetlands, grasslands, and agricultural lands. Large wintering populations of greater and lesser sandhill cranes congregate in the Sacramento and San Joaquin Valleys. Generally, crane wintering habitat consists of shallowly flooded grasslands that are used as loafing and roosting sites and nearby agricultural areas that provide food sources, such as rice, sorghum, barley, and corn. In the Delta, adequate suitable roost sites relatively free from disturbance and quality and quantity of forage are potential limiting factors on the wintering population.

The State listed the greater sandhill crane as threatened and designated it as a fully protected species because the small remaining population depends on habitat that is threatened with loss or degradation. The conversion of grasslands, wetlands, and agricultural land to urban development is an ongoing process that is not likely to be reversed. The sandhill crane now depends primarily on artificially created areas where natural wetland and grassland habitats have been eliminated. Disturbance associated with human activities, illegal harvest, and predation have also affected the overall health of the crane

population, although less severely than the loss and degradation of its habitats.

Restoration Needs

Protecting and restoring existing and additional suitable seasonal and fresh emergent wetlands and grasslands and improving management of agricultural lands will be critical to the recovery of the greater sandhill crane population and maintenance of healthy populations of other sandhill crane subspecies by providing sufficient wintering habitat for the species in the Bay-Delta. The Ecosystem Restoration Program Plan's (ERPP's) proposed restoration of these habitats in the Sacramento-San Joaquin Delta Ecological Zone will help to maintain healthy populations by increasing the quality and quantity of habitats used by this species. The greater sandhill crane will benefit from restoration and management strategies that restore shallowly flooded wetlands for suitable roosting habitat and that increase the quality and quantity of available forage on agricultural lands, and from implementing existing crane recovery and waterfowl management plans. Such strategies could be implemented through collaborative work with organizations to maintain and improve existing preserves, cooperative agreements with land management agencies, or conservation easements or purchase from willing sellers.

Restoration of ecosystem processes and habitats proposed by ERPP in other ecological zones will also allow seasonal and fresh emergent wetlands and grasslands to develop that will provide habitat for wintering sandhill cranes elsewhere in the Central Valley.

Implementation Objective and Indicators

The implementation objective for the greater sandhill crane is to assist in the recovery of this State-listed threatened species in order to contribute to overall species richness and diversity and reduce conflict between the need for its protection and other beneficial uses of land and water in the Bay-Delta.

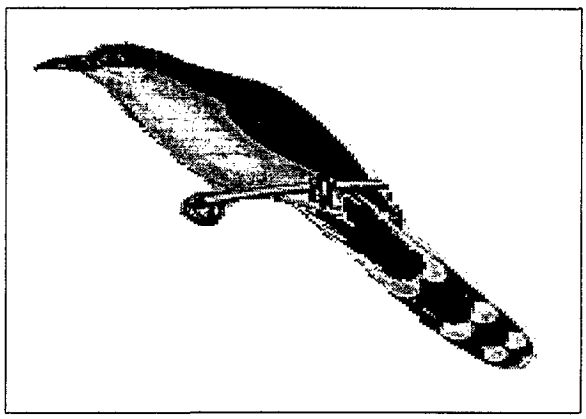
The measurements of performance against the implementation objective are the quality and quantity of suitable seasonal and fresh emergent wetlands, grasslands, and agricultural land and distribution of greater sandhill cranes. The quality and quantity of existing and suitable habitat and the degree to which former levels of distribution is achieved will be indicators of recovery of the greater sandhill crane population in the Bay-Delta.

Linkage to Other Programs

A Pacific Flyway Management Plan for the Central Valley population of greater sandhill cranes to recover the population has been developed and is being implemented by the U.S. Fish and Wildlife Service and the California and Oregon Departments of Fish and Game.

The Central Valley Habitat Joint Venture Implementation Plan contains goals to protect and restore Central Valley aquatic and upland habitats that are needed for waterfowl. This plan provides indirect benefits for the greater sandhill crane and other species that use these wetland and upland habitats. In addition, the California Department of Fish and Game and The Nature Conservancy are working to protect and restore crane habitat in the area of the Woodbridge Ecological Reserve and the Cosumnes River Preserve.

WESTERN YELLOW-BILLED CUCKOO



INTRODUCTION

The western yellow-billed cuckoo is associated with mixed riparian and cottonwood forests. This species has been extirpated from the Delta. Elsewhere, the population and range of this species have declined primarily as a result of the loss or degradation of extensive, mature and successional riparian cottonwood forests. The loss of habitat and declining condition of the species' population have warranted its listing as endangered under the California Endangered Species Act.

Major factors that limit this resource's contribution to the health of the Delta are related to adverse effects of flood control and bank protection projects, which resulted in the direct loss of riparian forests and reduced or eliminated the processes that create and maintain floodplains that support riparian forests, and reclamation of riparian forests for agricultural, industrial, and urban uses.

The vision for the western yellow-billed cuckoo is to assist in the recovery of this State-listed endangered species. Recovery of this species would contribute to overall species richness and diversity and reduce conflict between the need for its protection and other beneficial uses of land and water in the Bay-Delta.

BACKGROUND

Historically, the yellow-billed cuckoo commonly occurred from the Mexican border along the coast belt through the San Francisco Bay region as far as Sebastopol, Sonoma County, and through the Sacramento and San Joaquin Valleys. Yellow-billed cuckoos inhabit extensive deciduous riparian thickets or forests with dense, low-level or understory foliage that abut rivers, backwaters, or seeps. The cuckoo, is limited to some reaches of the Sacramento River, Sanborn Slough in the Butte Sink, and the Feather River. The population of this species is critically low.

Dense, large patches of willow-cottonwood riparian habitat are the preferred nesting habitat for this neotropical migrant. This habitat was once much more common, particularly along the Sacramento and San Joaquin Rivers; however, conversion of land to agriculture, urbanization, and flood control projects have caused the loss of habitat. Other stressors that continue to adversely affect the species are loss of habitat as a result of bank protection projects, mortality associated with non-native nest parasites and predators, and inadvertent drift of some types of herbicides and pesticides into habitat areas.

RESTORATION NEEDS

Protection and restoration of existing and suitable mature riparian forest will be critical to the recovery of the yellow-billed cuckoo. The Ecosystem Restoration Program Plan's proposed restoration of riparian habitats in the Sacramento-

San Joaquin Delta, Sacramento River, Cottonwood Creek, Colusa Basin, Feather River/Sutter Basin, and American River Basin Ecological Zones will help to recover this species by increasing the quality and quantity of its habitat.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for the western yellow-billed cuckoo is to assist in the recovery of this State-listed endangered species in order to contribute to overall species richness and diversity and reduce conflict between the need for its protection and other beneficial uses of land and water in the Bay-Delta

The measurements of performance against the implementation objective are the quality and quantity of suitable riparian forest and the abundance and distribution of yellow-billed cuckoos. The quality and quantity of existing and suitable habitat and the degree to which former levels of abundance and distribution is achieved will be indicators of recovery of the western yellow-billed cuckoo population.

LINKAGE TO OTHER PROGRAMS

No program is specifically charged with restoring yellow-billed cuckoo populations. Restoration efforts sponsored by the Upper Sacramento Fish and Riparian Habitat Advisory Council (SB1086) have the potential for benefitting the species. The purpose of riparian habitat planning through the SB1086 program is to preserve remaining riparian habitat and reestablish a continuous riparian ecosystem along the Sacramento River.

BANK SWALLOW

INTRODUCTION

The bank swallow is associated with riparian and riverine habitats and nests in vertical cliff and bank faces eroded by rivers. The population and range of this species have declined primarily as a result of the loss or degradation of ecosystem processes that maintain suitable nesting substrates along streams and rivers. The loss of habitat and declining condition of the species' population have warranted its listing as threatened under the California Endangered Species Act. The major factor that limits this resource's contribution to the health of the Delta is related to the adverse effects of levees and bank-protection structures on stream channel migration. These structures inhibit or prevent the channels' ability to erode its banks and form the nesting cliffs and banks required by the species.

The vision for the bank swallow is to assist in the recovery of this State-listed threatened species. Recovery of the bank swallow would contribute to overall species richness and diversity and reduce conflict between the need for its protection and other beneficial uses of land and water in the Bay-Delta.

BACKGROUND

Once an abundant lowland species in California, the bank swallow is now limited to breeding in a small part of its former range. The bank swallow is found in only a small number of ecological units within the Central Valley's ecological zones that are adjacent to rivers and their tributaries. The species is not known to occur in the Suisun Marsh/North San Francisco Bay Ecological Zone. Nesting colonies are found extensively along the Sacramento River from mile 143 to 243, with 50-60 colonies remaining along the upper Sacramento River and Feather River. Other small colonies are found along other waterways, including:

- American River,
- Thomes Creek,
- Cache Creek,
- Cosumnes River, and
- Tuolumne River.

Bank swallows breed in vertical banks or in cliffs that are created when streams and rivers erode their banks. Their population is estimated to have been reduced by 50% since 1900. Only a few colonies remain within the State as a result of stream channelization, bank protection, and flood control projects, which have reduced the availability of breeding sites (i.e., cliffs) by constraining rivers from eroding their banks. As much as 75% of the current breeding population in California concentrates along the banks of the Central Valley's streams; 70-80% of remaining breeding habitat is found along a small stretch of the Sacramento River.

The decline of the bank swallow can be attributed primarily to human activities that have changed the ecosystem processes that create and sustain its cliff nesting habitat. Stream meander migration is necessary to maintain, enhance, and create the fine-textured or sandy-type vertical banks or cliffs that bank swallows use for nesting holes. Levees and riprapped banks along streams and rivers have impeded the creation of nesting cliffs by preventing channels from following the natural process of erosion, deposition, and meandering. Currently proposed projects for confining channels within the species' nesting range represent the largest threat to maintaining existing bank swallow colonies. The general deterioration or loss of adjacent floodplain habitats (e.g., shaded riverine aquatic, riparian corridors and forests, and open grasslands) has also, although to a lesser degree, contributed to the species' decline.

RESTORATION NEEDS

Protecting existing nesting colonies from activities that could result in their loss or degradation and restoring ecological process of channel migration to channels that are confined will be critical to the recovery of the bank swallow. The Ecosystem Restoration Program Plan's proposed restoration of stream meander and riparian habitat in the Sacramento River and Butte Basin Ecological Zones will help to protect the remaining nesting colonies along the Sacramento and Feather Rivers. Protecting the remaining nesting colonies is an essential requirement to preventing the bank swallow population from declining to a point where restoration efforts may offer little help to the species. Of particular importance, protecting existing nesting colonies along the Sacramento River together with restoring natural river process would increase and link potential nesting habitat for the bank swallow. Recent studies have shown that most nesting colonies are adjacent to open grasslands. Other colonies are associated with agricultural lands and riparian and oak forests. Restoring these habitats together with protecting and restoring streamside banks and levees would also help to maintain or increase existing bank swallow populations.

Restoring the meander belts along the Sacramento River and other confined streams and rivers is an approach that would restore, on a large scale, the processes that create nesting cliffs. Partially restoring the processes that create nesting sites would be feasible in some areas by modifying flood control and bank stabilization practices that result in confining stream channels to allow channels to migrate and cut banks.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for the bank swallow is to assist in the recovery of this State-listed threatened species in order to contribute to overall species richness and diversity and reduce conflict between the need for its protection and other beneficial uses of land and water in the Bay-Delta.

The measurements of performance against the implementation objective is the number of nesting colonies. The degree to which former numbers and distribution of nesting colonies is achieved will be indicators of recovery of the bank swallow population.

LINKAGE TO OTHER PROGRAMS

Other programs linked to restoring riparian systems and bank swallow habitat include the Central Valley Improvement Act, Anadromous Fish Restoration Program, Cosumnes River Preserve, Delta Native Fishes Recovery Team, Department of Fish and Game Central Valley Salmon and Steelhead Management and Restoration Program, Riparian Habitat Joint Venture, and California Department of Fish and Game's recovery plan for the bank swallow.

SUISUN SONG SPARROW

INTRODUCTION

The Suisun song sparrow is associated with saline emergent wetlands. The population and distribution of this species have declined substantially primarily as a result of reclamation of tidal saltmarshes. The loss of habitat and declining condition of this species' population have warranted its consideration for listing under the California Endangered Species Act. Major factors that limit this resource's contribution to the health of the Delta are related to adverse effects of historical and current loss or degradation of tidal saltmarshes for agricultural, industrial, and urban uses and excessive predation on nests and individuals by non-native predators.

The vision for the Suisun song sparrow is to assist in the recovery of this State-listed endangered species. Recovery of this species would contribute to overall species richness and diversity and reduce conflict between the need for its protection and other beneficial uses of land and water in the Bay-Delta.

BACKGROUND

Suisun song sparrows live only in and around the Suisun Marsh and Bay. The species is physiologically and behaviorally adapted to this area's naturally occurring brackish tidal conditions; it can drink brackish water; it breeds earlier than upland subspecies, thereby avoiding nest flooding during the highest spring tides; and it forages for invertebrates and seeds directly on the surface of mudflats.

Historically, much of the Suisun Marsh was a brackish tidal marsh. The Suisun song sparrow inhabited areas with suitable brackish marsh vegetation. The total area of historical tidal marsh habitat is estimated to have been about 66,600-73,700 acres. Between 70,000 and 77,000 pairs of Suisun song sparrows are estimated to have used the available marsh habitat annually. Recent estimates indicate that fewer than 6,000 pairs remain in 13 isolated populations, representing 8% of the species' former. The remaining populations number from about 1,300 pairs to about 20 pairs.

Since artificial levees were constructed beginning in the late 1800s, the managed marsh areas on the nontidal side of the levees are flooded seasonally and then drained or allowed to dry. These areas are consistently avoided by Suisun song sparrows. The birds require appropriate vegetation for nesting sites, song perches, and foraging cover. The vegetation must also produce seeds or harbor invertebrates that the birds pick up from the surface of mudflats. Each sparrow's territory must contain permanent water or moisture in the form of tidal ebb and flow. Typically, each territory contains at least one patch of tall, hard-stemmed bulrush that stands above the surrounding vegetation and is used as a singing perch. The birds apparently need these high song perches to establish territory, and the absence of song perches may be a limiting factor in the distribution of pairs.

The primary threat to the continued existence of the Suisun song sparrow is the severe fragmentation of brackish tidal marsh habitat in and around Suisun Marsh. The once-vast marsh has been reduced to small areas that are separated by barriers or connected only by narrow strips of vegetation along the banks of tidal sloughs. Interbreeding between populations in these areas is rare. As the southern shore of Suisun Marsh in Contra Costa County becomes increasingly industrialized and developed, habitat will continue to be degraded and, ultimately, the southern population may no longer be viable. Egg and nestling mortality is about 50% in the

first 3 weeks after eggs are laid. The primary causes of this mortality are predation on eggs and nestlings by the introduced Norway rat, predation on nestlings by feral house cats, and flooding of nests during periods of high tides. Maintenance of levees, dikes, and other structures during the breeding period may also create sufficient disturbance to cause nesting failure. Levees constructed in the sparrow's habitat are high enough above the surrounding marsh to allow the growth of upland plants that require fresh water. Although Suisun song sparrow territories may include these areas, the species avoids centering its territory in this type of vegetation.

Long-term changes in the salinity gradient of the Bay-Delta may also have an effect on the species' distribution and abundance. The normal brackish condition of Suisun Marsh is directly attributable to the amount of freshwater outflow it receives from the Delta. This fresh water mixes with saltwater transported on incoming tides through Carquinez Strait. The amount of freshwater outflow has been reduced since historical times during water-years that are now considered normal. Suisun song sparrows can withstand short-term alterations in brackish conditions because they can subsist on pure saltwater for several days. The vegetation they occupy in the brackish marsh is similarly adapted. If the water regime changes drastically or for long periods, however, a large-scale change in habitat could result. If salinity decreases, the Suisun song sparrow could face lowered reproductive rates, increased competition, and loss of genetic integrity as a result of breeding with invading upland subspecies that consume fresh water. If the water becomes too salty, saltwater marsh vegetation could displace brackish vegetation; saltwater marsh is not suitable habitat for the species, which is not adapted to consume saltwater for extended periods.

RESTORATION NEEDS

Protecting and restoring existing and additional suitable tidal saline and fresh emergent wetlands (including brackish marshes) and reducing the effect of factors that can suppress breeding success will be critical to the recovery of the Suisun song sparrow. The Ecosystem Restoration Program Plan's (ERPP's) proposed restoration of tidal emergent wetlands in the Suisun Marsh/North San Francisco Bay Ecological Zone, together with restoring associated higher elevation uplands to provide escape cover during high tides and flooding, will help to recover this species by increasing its habitat area. Restoring this habitat would allow the population to increase at existing protected habitat areas and would ensure the long-term survival of this species in its native habitat and range. The restoration of high-quality sparrow habitat would also reduce the adverse effects of predation by non-native species by creating habitat conditions that are more favorable for sparrows and less favorable for predators.

The potential adverse effects of disturbance on breeding success could be reduced by encouraging agencies, organizations, and private landowners, through cooperative agreements and incentive programs, to conduct infrastructure maintenance activities in occupied habitat areas so that tidal brackish marsh vegetation is disturbed as little as possible and adults are not disturbed during the breeding season. The possibility of managing breeding of the species to increase its reproductive success should be investigated (e.g., transferring eggs and/or young between nearby isolated populations to increase genetic interchange between populations). If the species is susceptible to responding to such manipulations, the period for its recovery would be reduced.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for the Suisun song sparrow is to assist in the recovery of this State-listed endangered species in order to contribute to overall species richness and diversity and reduce conflict between the need for its protection and other beneficial uses of land and water in the Bay-Delta.

The measurements of performance against the implementation objective are the quality and quantity of suitable tidal emergent wetlands and the abundance and distribution of Suisun song sparrows in the Bay-Delta. The quality and quantity of existing and suitable habitat and the degree to which former levels of abundance and distribution is achieved will be indicators of recovery of the Suisun song sparrow population.

LINKAGE TO OTHER PROGRAMS

Programs and projects designed to protect, restore, and enhance the Suisun Marsh/North San Francisco Bay Ecological Zone to provide direct or incidental benefits to the Suisun song sparrow include the San Francisco Estuary Project, Bay Area Wetlands Planning Group, Cache Creek Corridor Restoration Plan, California Wetland Riparian Geographic Information System Project, Governor's California Wetland Conservation Policy, Tidal Wetlands Species Recovery Plan, Wetlands Reserve Program, Inland Wetlands Conservation Program, Montezuma Wetlands Project, and National Estuarine Reserve Research System.

The proposed ERPP targets and objectives reflect the goals of many of these programs. For example, the San Francisco Estuary Project has goals of protecting existing wetlands, restoring and enhancing the ecological productivity and habitat values of wetlands, expediting a significant increase in the quantity and quality of wetlands, and educating the public about the values of wetland resources.

ERPP will contribute to these programs' goals by working to restore critical ecosystem processes and habitats and reduce or eliminate stressors. In particular, the San Francisco Bay Area Wetlands Ecosystem Goals Project is a comprehensive science-based approach to determining where, how much, and what kinds of wetland should be restored in the Suisun Bay and San Francisco Bay areas. Proposed ERPP targets may be adjusted to reflect the goals developed during that process.

SALT MARSH HARVEST MOUSE

INTRODUCTION

The salt marsh harvest mouse is associated with saline emergent wetlands. The population and distribution of this species have declined substantially, primarily as a result of reclamation of tidal salt marshes for agriculture. The loss of habitat and declining condition of this species' population have warranted its listing as endangered under the State and federal Endangered Species Acts. The major factors that limit this resource's contribution to the health of the Delta are related to the adverse effects of historical and current loss or degradation of saline tidal wetlands that support the dense stands of pickleweed on which the salt marsh harvest mouse is dependent.

The vision for the salt marsh harvest mouse is to assist in the recovery of this State- and federally listed endangered species to contribute to overall species richness and diversity. Recovery of this species would reduce conflict between the need for its protection and other beneficial uses of land and water in the Bay-Delta.

BACKGROUND

The salt marsh harvest mouse occurs only in saline emergent wetlands associated with San Francisco Bay and its tributaries. Historically, these areas supported extensive tidal wetlands, which sustained dense stands of pickleweed. These plants, in turn, supported the salt marsh harvest mouse.

With the gradual development of the Suisun Marsh and San Francisco Bay areas came the construction of dikes and levees for flood control and protection of lands reclaimed for uses such as for salt ponds and agriculture. These reclaimed areas supported livestock grazing and, in the Suisun Marsh, small grain crops and asparagus. The vegetation growing beyond the limits of high tide supported grazing, and settlers found that if they diked those areas, wetland plants would eventually recede and give way to upland plants favored by livestock. As more and more settlers arrived, development resulted in the loss of large areas of habitat and severe fragmentation of the habitat that remained. Barriers, such as a road or path no more than 10 feet across, isolated the mouse in fragmented habitats because it would not use or travel across areas lacking vegetation. Upland areas consisting of grasslands or salt-tolerant plants that offered refuge during extreme high tides and high outflow periods were adjacent to the saline emergent wetlands. Development altered the landscape and geomorphology in many of these areas, which contributed to the loss of habitat.

Saline emergent wetlands with pickleweed occur only within the Suisun Marsh/North San Francisco Bay Ecological Zone of the Ecosystem Restoration Program Plan (ERPP) area. The elimination of much of the salt marsh harvest mouse's habitat is the primary cause of the species' decline. Other factors or "stressors" that have contributed to the decline or potentially could inhibit the recovery of the species include human activities that disturb the species and predation by non-native species. Grazing; water management practices; land use practices; contaminants; and human-made structures, such as dikes and levees, continue to degrade the quality of remaining habitat areas.

RESTORATION NEEDS

The major components for restoring salt marsh harvest mouse populations are to protect existing occupied and unoccupied suitable habitat areas, restore saline emergent wetlands with dense

stands of pickleweed, reduce the adverse effects of other factors that stress the population, and establish new populations by introducing the mouse into unoccupied habitat areas.

Protection of existing suitable habitat areas from potential future activities that could adversely affect them could be achieved through cooperative agreements with land management agencies, conservation easements, or purchase from willing sellers. ERPP's proposed restoration of saline emergent wetlands and adjacent upland plant communities will help to recover this species by increasing habitat area and providing the mouse with refuge from flooding. Reducing the factors that contribute to degradation of saline emergent wetland communities would promote natural methods of restoring and maintaining the tidal saline emergent wetlands and reduce the level of salt marsh harvest mouse mortality associated with some stressors. Increasing the quantity and quality of salt marsh harvest mouse habitat and reducing the adverse effects of stressors would establish conditions necessary to maintain existing populations and allow them to naturally recover. However, introducing the mouse into unoccupied habitat areas within its historic range would speed the recovery of the species by establishing new populations before the species would be expected to naturally expand into these or restored habitat areas.

Many existing programs are underway to restore the Bay-Delta estuary; these should be expanded to increase the chances of recovery of the salt marsh harvest mouse. Current land management practices need to be examined and redefined to restore, enhance, and promote salt marsh harvest mouse habitat and ensure the growth and expansion of the species. Salt marsh harvest mouse management strategies should focus on managing known critical mouse habitat areas; provide for additional research to identify other factors limiting the population and determine corrective measures; and emphasize a broader species approach that addresses the needs of waterfowl and other migratory birds that also use saline emergent wetlands.

IMPLEMENTATION OBJECTIVE AND INDICATORS

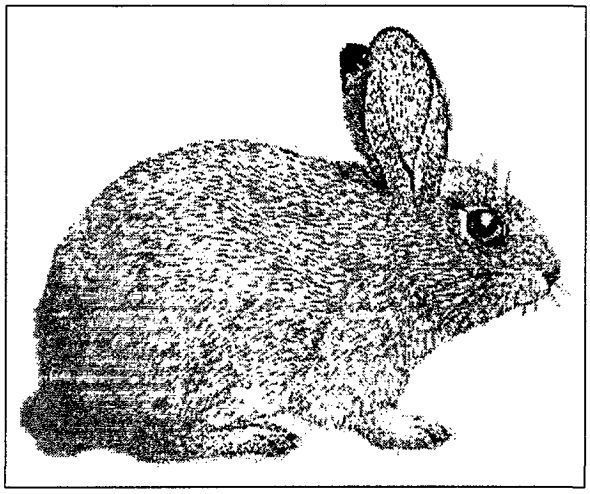
The implementation objective for the salt marsh harvest mouse is to assist in the recovery of this State- and federally listed endangered species in order to contribute to overall species richness and diversity and reduce conflict between the need for its protection and other beneficial uses of land and water in the Bay-Delta.

The measurements of performance against the implementation objective are the quality and quantity of suitable saline emergent wetland habitat and the abundance and distribution of the salt marsh harvest mouse in the estuary. The quality and quantity of existing and suitable habitat and the degree to which former levels of abundance and distribution is achieved will be indicators of recovery of salt marsh harvest mouse populations in the estuary.

LINKAGE TO OTHER PROGRAMS

Programs that already exist and that are compatible with the ERPP vision include the Suisun Marsh Recovery Plan, San Francisco Bay Joint Venture, Bay Area Wetlands Planning Group, California Coastal Conservancy, Delta Native Fishes Recovery Team, California Department of Fish and Game Delta/Bay Enhanced Enforcement Program, Grizzly Island Wildlife Area, National Estuarine Reserve Research System, North Bay Wetlands Protection Program, San Francisco Bay National Wildlife Refuge, Tidal Wetlands Species Recovery Plan, and San Francisco Bay Wetlands Ecosystem Goals Project. Proposed ERPP targets may be adjusted to reflect goals identified by the Wetland Goals Project.

RIPARIAN BRUSH RABBIT



INTRODUCTION

The riparian brush rabbit is associated with riparian habitats and has been extirpated from the Delta. Elsewhere, the population and distribution of this species have declined substantially, primarily as a result of the loss or degradation of its habitat. The loss of habitat and declining condition of this species' population have warranted its listing as endangered under the California Endangered Species Act. The major factor that limits this resource's contribution to the health of the Delta is related to adverse effects of the historical loss and degradation of the mature riparian forests, on which the riparian brush rabbit is dependent, in the Delta and San Joaquin River floodplain.

The vision for the riparian brush rabbit is to assist in the recovery of this State-listed endangered species in the Bay-Delta to contribute to overall species richness and diversity. Recovery of this species would reduce conflict between the need for its protection and other beneficial uses of land and water in the Bay-Delta.

BACKGROUND

The riparian brush rabbit is strictly associated with San Joaquin Valley riparian forests with dense brushy understory. Unlike other rabbits, the riparian brush rabbit occupies riparian forests that have an ample brushy understory within natural floodplains in association with suitable upland areas for cover and retreat from annual floods. Historically, this species' habitat was throughout the floodplain on the valley floor in northern San Joaquin Valley, but the original forest and floodplain have been cleared, altered, and degraded.

This species is now found only in Caswell Memorial State Park in southern San Joaquin County within the East San Joaquin Basin Ecological Zone. The population is restricted to 260 acres of remaining native riparian forest along the Stanislaus River and is considered the most sensitive mammal in California because of its susceptibility to floods, fire, disease, predation, disturbance, and flood control activities. The large-scale loss of riparian forest has resulted in over a 99% decline in the riparian brush rabbit population from historical levels. A census of the population was conducted during January 1993 and found that the current population size ranges from about 210 to 310 individuals.

Overall, the decline of the riparian brush rabbit was caused by the destruction, fragmentation, and degradation of the San Joaquin Valley native riparian forest habitat within the rabbit's historical range, which resulted in less than 6% of the original habitat remaining. Remaining suitable habitat is so severely fragmented that the rabbit has no means of naturally dispersing to other areas and establishing additional populations. Because the remaining riparian brush rabbit population occurs within one small area, any of

the following events threaten the remaining population:

- Caswell Memorial State Park is subject to periodic flooding that often inundates the entire area. Without adequate cover on adjacent upland areas, the rabbits become easy targets for both native and non-native predators.

- There is a normal buildup of downed logs, dried vegetation, and ground litter in the riparian forest and, although this type of habitat is preferred and typically occupied by the riparian brush rabbit, any wildfire occurring within the remaining habitat could cause direct mortality as well as massive habitat destruction.

- Human activities have modified the habitat. The modified habitat has "selected" against the riparian brush rabbit and for the desert cottontail. The desert cottontail presents two threats: one from competition and the other from diseases common to rabbits and carried by the species. These diseases are typically contagious and fatal; any disease becomes epidemic in this small and restricted population of rabbits.

RESTORATION NEEDS

Restoring suitable mature riparian forest, protecting and expanding the existing population, and establishing new populations will be critical to the recovery of the riparian brush rabbit. The Ecosystem Restoration Program Plan's (ERPP's) proposed restoration of riparian habitats in the South Delta Ecological Unit of the Sacramento-San Joaquin Delta Ecological Zone and the East San Joaquin Basin Ecological Zone and adjacent upland plant communities will help the recovery of this species by increasing habitat area and providing refuge from flooding for the rabbit. Mature riparian forests with a brushy understory of wild rose, blackberries, elderberries, and wild grape; a buildup of downed logs, dried vegetation, and ground litter; and adjacent upland habitat with sufficient cover during flooding would be suitable restored habitat. Restoring riparian habitat in the East San Joaquin Basin Ecological Zone to expand the area of suitable riparian brush rabbit habitat adjacent to occupied habitat along the Stanislaus River will help to protect and allow the existing population of brush rabbits to expand.

Establishing additional populations within the riparian brush rabbit's historical range in the Sacramento-San Joaquin Delta Ecological Zone would help to avoid the potential extinction of the species that could be caused by excessive predation or catastrophic events, such as wildlife or disease, on the remaining population. To ensure the survival of introduced populations, newly occupied habitat areas should be maintained in a condition that is suitable only for the riparian brush rabbit to reduce the likelihood for transmission of diseases from the desert cottontail, and hunting regulations should be modified to preclude hunting of rabbits and hares in and near reintroduction sites to reduce the likelihood of unintentional harvest of riparian brush rabbits until the species has recovered.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for the riparian brush rabbit is to assist in the recovery of this State-listed endangered species in the Bay-Delta in order to contribute to overall species richness and diversity and reduce conflict between the need for its protection and other beneficial uses of land and water in the Bay-Delta.

The measurements of performance against the implementation objective are the quality and quantity of suitable riparian forest and the abundance and distribution of riparian brush rabbits. The quality and quantity of existing and suitable habitat and the degree to which former

levels of abundance and distribution is achieved will be indicators of recovery of the riparian brush rabbit population in the estuary.

LINKAGE TO OTHER PROGRAMS

There are no current programs aimed at restoring the riparian brush rabbit population. The California Department of Fish and Game should establish the interagency coordination and commitment necessary to halt the further loss and deterioration of habitat and begin restoration and preservation of suitable habitat deemed essential to maintaining the subspecies in perpetuity.

SHOREBIRD AND WADING BIRD GUILD

INTRODUCTION

Many species of shorebirds and wading birds migrate through, winter, or breed in the Bay-Delta. These species are a significant component of the ecosystem, are of high interest to recreational bird watchers, and contribute to California's economy through sales of equipment and other bird-watching-related expenditures. There have been substantial losses of historic habitat used by these species and available information suggests that population levels of many of these species are declining. Major factors that limit this resource's contribution to the health of the Delta are related to adverse effects of conversion of native habitats for agricultural, industrial, and urban uses and land and water management practices that degrade habitats used by these species.

The vision for the shorebird and wading bird guild is to maintain healthy populations of shorebirds and wading birds. Healthy populations would contribute to overall species richness and diversity and reduce conflicts between the need for their protection and other beneficial uses of land and water in the Bay-Delta.

BACKGROUND

Representative species of the shorebird and wading bird guild include the great blue heron, great egret, western sandpiper, and long-billed dowitcher. Some species are winter migrants limited to specific areas; others are statewide, year-round residents. Shorebirds and wading birds are dependent on many different habitats, although each species may be dependent on only one or a few habitats. These habitats include perennial aquatic, tidal slough, seasonal and emergent wetland, midchannel island and shoal, riparian, and agricultural.

Shorebirds and wading birds are present in all of the Ecosystem Restoration Program Plan (ERPP) ecological zones. Herons and egrets are common year-round residents that breed and winter throughout the ERPP study area. Most shorebirds are only winter residents, with a small number remaining to breed. Wetland habitat conversion has eliminated 95% of the historic wetland habitat, resulting in smaller, disjunct patches of suitable habitat for nesting and foraging. Riparian habitats suitable for use by colonial-nesting species, such as egrets, have been lost or fragmented and are subject to increased disturbance during the nesting period.

RESTORATION NEEDS

Protecting existing and restoring additional suitable perennial aquatic, tidal slough, seasonal and emergent wetland, midchannel island and shoal, and riparian habitats and improving

management of agricultural lands and reducing the effect of factors that can suppress breeding success will be critical to maintaining healthy shorebird and wading bird populations in the Bay-Delta. ERPP's proposed restoration of these habitats in the Sacramento-San Joaquin Delta and Suisun Marsh/North San Francisco Bay Ecological Zones will help to maintain healthy populations by increasing the quality and quantity of habitats used by these species. Shorebirds and wading birds would also benefit from management strategies that protect and maintain important existing habitat areas, including wetlands and wading bird nesting areas, in a manner that improves habitat quality for shorebirds and wading birds. Such strategies could be implemented through cooperative agreements with land management agencies or through conservation easements or purchase from willing sellers.

Restoration of ecosystem processes and habitats proposed by ERPP in other ecological zones will also allow natural floodplains, meander corridors, seasonal pools, and riparian vegetation to develop that will provide habitat for these species elsewhere in the Central Valley.

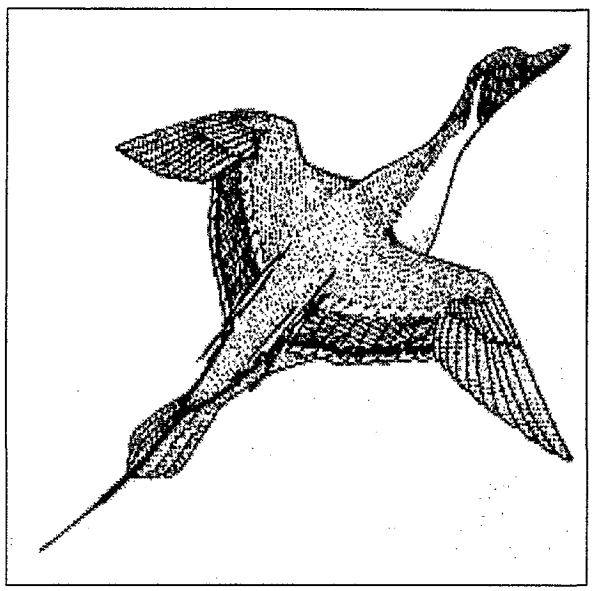
IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for the shorebird and wading bird guild is to maintain healthy populations in order to contribute to overall species richness and diversity and reduce conflict between the need for their protection and other beneficial uses of land and water in the Bay-Delta.

The measurements of performance against the implementation objective are the quality and quantity of suitable perennial aquatic, tidal slough, seasonal and emergent wetland, midchannel island and shoal, riparian, and agricultural habitats and the abundance and distribution of shorebirds and wading birds in the Bay-Delta. The quality and quantity of existing and suitable habitat and the degree to which former levels of abundance and distribution is achieved will be indicators of maintaining healthy populations of shorebirds and wading birds.

LINKAGE TO OTHER PROGRAMS

Other existing programs that will directly or indirectly improve and restore habitat for shorebirds and wading birds are the Bay Area Wetlands Planning Group, Central Valley Habitat Joint Venture, Cosumnes River Preserve, Grizzly Slough Wildlife Area, San Francisco Bay National Wildlife Refuge, Sonoma Baylands Project, Tidal Wetlands Species Recovery Plan, Yolo Basin Wetlands Project, and San Francisco Bay Wetlands Ecosystem Goals Project.



INTRODUCTION

Many species of waterfowl migrate through, winter, or breed in the Bay-Delta. Waterfowl are a significant component of the ecosystem, are of high interest to recreational hunters and bird watchers, and contribute to California's economy through the sale of hunting and related equipment. Historical waterfowl wintering habitat areas have declined by approximately 95% and, as a result of substantial losses of wetland and grassland habitats, waterfowl breeding populations have declined from historical levels. Major factors that limit this resource's contribution to the health of the Delta are related to adverse effects of conversion of wetland and grassland habitats to agricultural, industrial, and urban uses.

The vision for waterfowl is to maintain healthy populations at levels that can support consumptive and nonconsumptive uses.

BACKGROUND

Central Valley waterfowl populations are a highly valued and diversified biological resource and are found in all ecological zones within the Ecosystem Restoration Program Plan (ERPP) study area. Large numbers of ducks, geese, and swans winter in the Central Valley after migrating from northern breeding areas. Some species, such as the mallard, gadwall, and Canada goose, are also year-long residents and breed locally in wetlands and nearby uplands. Migration over long distances requires a great amount of energy and, on arrival to wintering grounds, waterfowl depend on high-quality foraging habitat to replenish their energy reserves. These habitats include seasonal, permanent, tidal, and agricultural wetlands; deepwater; riparian woodlands; grasslands; and agricultural uplands and other associated habitats. These diverse habitats are still present throughout the Central Valley and are maintained to varying degrees by existing ecological processes.

Recent declines in waterfowl populations are attributed primarily to the cumulative effects of degradation or loss of breeding, wintering, and foraging habitats in the Central Valley and outside of California. Population declines are most likely caused by a combination of factors that have reduced or eliminated important ecosystem processes. These factors include:

- loss of natural wetlands because of altered flow regimes, resulting in the loss of natural floodplains;
- fragmentation or loss of large areas of wetlands as a result of land reclamation;
- loss of shallow-water habitat as a result of flood management practices;

- loss of riparian habitat resulting from channelization and levee protection practices;
- loss of tidal wetlands as a result of dikes and levees for flood control;
- heavy metal contamination from sources such as subsurface agriculture drainage; and
- loss of the natural mosaic of habitats required to meet the life requirements of waterfowl.

Many other factors have also contributed to the decline of waterfowl, although perhaps to a lesser degree. These include high concentrations of waterfowl in relatively small areas, which exposes greater portions of the population to diseases (such as botulism and cholera) and predation on nests and young by non-native species. Other factors that can affect waterfowl populations, such as extended periods of drought, are natural and will remain.

RESTORATION NEEDS

Protecting and restoring existing and additional suitable seasonal, permanent, and tidal wetlands; deepwater; riparian woodlands; and grasslands; and other associated habitats and improving management of agricultural lands and reducing the effect of factors that can suppress breeding success will be critical to maintaining healthy waterfowl populations in the Bay-Delta. Large-scale restoration of nesting, brood, and foraging habitat will help to reduce predation on nests and young and the likelihood of large-scale outbreaks of disease by creating habitat conditions that render waterfowl less susceptible to these stressors. ERPP's proposed restoration of these habitats in the Sacramento-San Joaquin Delta and Suisun Marsh/North San Francisco Bay Ecological Zones will help to maintain healthy populations of waterfowl by increasing the quality and quantity of habitats used by these species.

Waterfowl would also benefit from management strategies that protect and manage important existing habitat areas, increase the quantity and quality of breeding habitat and forage on agricultural lands through establishment of new programs or expansion of existing programs that provide incentives for landowner participation, restore and improve wetlands in conjunction with adjacent herbaceous uplands to improve breeding habitat, expand existing State and federal wildlife areas by creating additional wetland complexes, and establish programs that allow government agencies and waterfowl conservation organizations to work cooperatively to increase the efficiency of existing strategies and waterfowl management plans. Efforts under existing migratory bird management programs have significantly improved critical habitats, including water management for seasonally managed agriculture fields, development of permanent habitat on federal refuges in the State wildlife areas, and incentives for private landowners to provide wintering habitat for migratory waterfowl.

Restoration of ecosystem processes and habitats proposed by ERPP in other ecological zones will also allow floodplain wetland, riparian, and upland habitats to develop that will provide habitat for waterfowl elsewhere in the Central Valley.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for waterfowl is to maintain healthy populations at levels that can support both consumptive and nonconsumptive uses.

The measurements of performance against the implementation objective are the quality and quantity of suitable seasonal, permanent, tidal, and agricultural wetlands; deepwater; riparian woodlands; grasslands; agricultural uplands; and other associated habitats and the abundance and

distribution of waterfowl that winter and breed in the Bay-Delta. The quality and quantity of existing and suitable habitat and the degree to which former levels of abundance and distribution is achieved will be indicators of maintaining healthy populations of waterfowl.

LINKAGE TO OTHER PROGRAMS

Some of the programs that are restoring populations and habitat for waterfowl in the ERPP study area are the Upper Sacramento River Fishery and Riparian Habitat Council (SB1086) Program, Suisun Marsh Protection Plan, California Department of Fish and Game wildlife areas, U.S. Fish and Wildlife Service refuges, The Nature Conservancy's Jepson Prairie Preserve, Ducks Unlimited Valley Care Program, California Waterfowl Association, Cache Creek Corridor Restoration Plan, Putah Creek South Fork Preserve, Woodbridge Ecological Reserve, Yolo County Habitat Conservation Plan, and Central Valley Habitat Joint Venture.

UPLAND GAME

INTRODUCTION

Upland game species are of high interest to recreational hunters in the Bay-Delta and contribute to California's economy through the sale of hunting-related equipment and hunting-related expenditures. Major factors that limit this resource's contribution to the health of the Delta are related to adverse effects of conversion of native upland habitats for agricultural, industrial, and urban uses, and land use practices that degrade habitats used by these species.

The vision is to maintain healthy populations of upland game species at levels that can support both consumptive and nonconsumptive uses.

BACKGROUND

The upland game guild includes those species defined in the California Department of Fish and Game (DFG) hunting regulations as resident and migratory upland game birds and small game. Of the three groups of upland game species that define the guild, only the coastal and Central Valley group (Table 6) is addressed in this vision. The montane upland game group includes species that typically inhabit the upper elevations of the Coast Ranges, Cascade Range, and Sierra Nevada and the eastern upland game group includes those species inhabiting the eastern slopes of the Sierra Nevada and eastern high deserts within California.

Upland game species commonly occur in upland habitat types, including agricultural cropland, riparian habitats, and oak woodlands. The ring-necked pheasant and wild turkey are non-native species that have successfully established in the Central Valley and are popular game for hunting. These species occur in the Ecosystem Restoration Program Plan (ERPP) management zones from the Central Valley floor to the foothills. Native species' population densities, with the exception of that of the American crow, are currently lower than they were before lands in the Bay-Delta were reclaimed. Native species are an integral part of our heritage, providing recreation and food for thousands of people. They are exceptional indicators of the health and viability of the vegetative communities on which they rely.

Throughout California, upland game habitat has been degraded or lost as a result of some types of land uses, such as logging, land conversion, water projects, intensive farming, overgrazing, and urban encroachment. Wildfires and floods also destroy many acres of nesting and escape cover.

RESTORATION NEEDS

Protecting and restoring existing and additional suitable grassland, seasonal and emergent wetland, midchannel island and shoal, and riparian habitats, and improving management of agricultural lands and reducing the effect of factors that can suppress breeding success will be critical to maintaining healthy upland game populations in the Bay-Delta. The ERPP's proposed restoration of these habitats in the Sacramento-San Joaquin Delta and Suisun Marsh/North San Francisco Bay Ecological Zones will increase their quality and quantity and will help maintain healthy populations of upland game species. Restoring habitat over a range of elevations above mean-high-tide water levels in the Bay-Delta would allow a greater diversity of plant species to establish and provide a broader range of habitats for upland game. Upland game species would also benefit from management strategies that would improve habitat quality by protecting and maintaining important existing

habitat areas and encouraging establishment and maintenance of agricultural and upland habitats used by these species. Such strategies could be implemented through cooperative agreements with land management agencies, landowner incentive programs, or conservation easements with or purchase from willing sellers.

Restoration of ecosystem processes and habitats proposed by ERPP in other ecological zones will also allow natural floodplains, meander corridors, seasonal pools, and riparian vegetation to develop that will provide habitat for upland game species elsewhere in the Central Valley.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for upland game is to maintain healthy populations at levels that can support both consumptive and nonconsumptive uses.

The measurements of performance against the implementation objective are the quality and quantity of suitable grassland, seasonal and emergent wetland, midchannel island and shoal, riparian, and agricultural habitats and the abundance and distribution of upland game in the Bay-Delta. The quality and quantity of existing and suitable habitat and the degree to which former levels of abundance and distribution is achieved will be indicators of maintaining healthy populations of upland game species.

LINKAGE TO OTHER PROGRAMS

Groups that are involved in efforts to restore upland game include DFG, Pheasants Forever, the Turkey Federation, and Quail Unlimited. DFG's Game Bird Heritage Program continues to actively improve upland game habitat and hunting opportunities throughout the State.

Table 6. Upland Game Species and the Groups in Which They Appear

Species	Coastal and Central Valley Group	Montane Upland Game Group	Eastern Upland Game Group
Ring-necked pheasant	X		
California quail	X		X
Wild turkey	X	X	
Common snipe	X	X	X
Dove	X	X	X
American crow	X	X	X
Tree squirrels	X	X	X
Cottontail/brush rabbit	X	X	X
Black-tailed hare	X	X	X
Band-tailed pigeon	X	X	X
Chukar*		X	X
Mountain quail*		X	X
Sage grouse*			X
Blue/ruffed grouse*		X	
Ptarmigan*		X	

*These species are not addressed by this vision.

NEOTROPICAL MIGRATORY BIRD GUILD

INTRODUCTION

Many species of neotropical migratory birds migrate through or breed in the Bay-Delta. These species are a significant component of the ecosystem, are of high interest to recreational bird watchers, and contribute to California's economy through sales of equipment and other bird-watching-related expenditures. There have been substantial losses of historic habitat used by these species and available information suggests that population levels for many of these species is declining. Major factors that limit this resource's contribution to the health of the Delta are related to adverse effects of conversion of native habitats for agricultural, industrial, and urban uses, and land use practices that degrade habitats used by these species.

The vision for the neotropical migratory bird guild is to maintain healthy populations of neotropical migratory birds in order to contribute to the overall species richness and diversity and to reduce conflict between protection for this species and other beneficial uses of land and water in the Bay-Delta.

BACKGROUND

The neotropical migratory bird guild comprises bird species that breed in North America and winter in Central and South America. Representative species of the neotropical migratory bird guild are the western kingbird, western wood-pewee, tree swallow, cliff swallow, northern oriole, Wilson's warbler, and yellow-breasted chat. Individual visions are developed for some neotropical migrants, such as the Swainson's hawk and yellow-billed cuckoo, and those visions contain more specific targets relating to those species. All species of the neotropical migratory bird guild depend on the flora of California to forage and reproduce, typically from about May until September. The birds normally spend the rest of the year in Central and South America.

Neotropical birds occur throughout the California and are associated with most of California's habitat types, including forested woodlands, riparian and montane riparian habitats, unforested lowlands, grasslands, shrub habitats, valley foothill hardwood, valley foothill hardwood-conifer, and wetlands. Population levels of many of these species has declined, primarily as a result of the loss and degradation of habitats on which they depend, both in California and on their Central and South American wintering areas. In California, the quality and quantity of important neotropical migrant bird habitats have been substantially reduced primarily by their conversion to agricultural, industrial, and urban uses, and land use practices that degrade the values provided by these habitats.

RESTORATION NEEDS

Protecting existing and restoring additional suitable wetland, riparian, and grassland habitats will be critical to maintaining healthy neotropical migrant bird populations in the Bay-Delta. Large-scale restoration of nesting habitat will help reduce nest parasitism and predation by creating habitat conditions that render neotropical birds less susceptible to these stressors. The Ecosystem Restoration Program Plan's (ERPP's) proposed restoration of these habitats in the Sacramento-San Joaquin Delta and Suisun Marsh/North San Francisco Bay Ecological Zones will help maintain healthy populations by increasing the quality and quantity of habitats used by these species. Restoration of ecosystem processes and habitats proposed by ERPP in other ecological zones will also allow natural floodplains, stream

meanderings, seasonal pools, and riparian vegetation to develop that will provide habitat for these species elsewhere in the Central Valley.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective for the neotropical migratory bird guild is to maintain healthy populations. Healthy populations of neotropical migratory birds would contribute to overall species richness and diversity and reduce conflict between the need for their protection and other beneficial uses of land and water in the Bay-Delta.

The measurements of performance against the implementation objective is the quality and quantity of suitable wetland, riparian, and grassland habitats in the Bay-Delta. Increasing the quality of existing and the quantity of suitable habitat will be indicators of maintaining the environmental conditions necessary to sustain healthy populations of neotropical migratory birds.

LINKAGE TO OTHER PROGRAMS

Related restoration programs include the Central Valley Project Improvement Act, Cache Creek Corridor Restoration Plan, Cosumnes River Preserve, Riparian Habitat Joint Venture, Upper Sacramento River Advisory Council's Riparian Habitat Committee (SB1086 program), San Joaquin River Management Program, and the U.S. Fish and Wildlife Service's Anadromous Fish Restoration Plan.

LANGE'S METALMARK, DELTA GREEN GROUND BEETLE, AND VALLEY ELDERBERRY LONGHORN BEETLE

INTRODUCTION

The Lange's metalmark and the delta green ground beetle, both federally listed endangered species, and the valley elderberry longhorn beetle, a federally listed threatened species, are respectively associated with inland dune, vernal pool, and riparian habitats. The distribution and populations of these species have declined substantially, primarily as a result of the loss or degradation of these habitats within their range. The loss of habitat and declining condition of these species populations have warranted their listing 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 conversion of native habitats for agricultural, industrial, and urban uses, and land and water management practices that degrade habitats used by these species.

The vision for the Lange's metalmark, the delta green ground beetle, and valley elderberry longhorn beetle is to assist in maintaining the existing Lange's metalmark population by maintaining its abundance, and to assist in the recovery of the delta green ground beetle and valley elderberry longhorn beetle by increasing their populations and abundance in order to contribute to the overall species richness and diversity and to reduce conflicts between protection for these species and other beneficial uses of land and water in the Bay-Delta.

BACKGROUND

The preferred habitat of Lange's metalmark, a butterfly, is inland dune scrub. The Lange's metalmark is dependent on its host plant, naked buckwheat. The present range of Lange's metalmark has been reduced to only 15 acres of suitable habitat within the Antioch Dunes Ecological Reserve. Over a 9-day sampling period in 1977, biologists estimated that only 400 adult butterflies remain at the Little Corral site. A wide variety of stressors (e.g., land use, wildfire, non-native plant species, gravel mining, fences, and human-related disturbance) that degrade this species' habitat have contributed to the endangered status of Lange's metalmark.

The Delta green ground beetle is found at the Jepson Prairie Preserve in Solano County, which is in the Yolo Basin Ecological Zone. The Delta green ground beetle and its soft-bodied prey species depend on moist environments such as those provided by Olcott Lake and vernal pools within the Jepson Prairie Preserve. Vernal pools and aquatic seasonal habitats supply the critical needs of the Delta green ground beetle. Entomologists believe that appropriate conditions for the species are found in open, moist habitats with limited vegetative cover.

Since 1974, entomologists have seen or collected only 75 adult beetles in the preserve area. Although the historical distribution of the Delta green ground beetle is unknown, the widespread disruption of wetland and grassland habitats, on which the species is dependent, in the Central Valley in the last 150 years strongly suggests that the range of the beetle has been reduced and fragmented. Today, the beetle predominately inhabits the borders of vernal pools and Olcott Lake at the Jepson Prairie Preserve. The primary threats to the survival of the Delta green ground beetle have been, and continue to be, loss and alteration of its wetland habitat primarily because of agricultural conversion (i.e., the plowing and leveling of land); grazing; river channelization; and construction of dams, drainageways, and pipelines.

VELB has been found only in association with its host plant, elderberry (*Sambucus* spp.). Elderberry is a component of the remaining riparian forests and adjacent grasslands of the Central Valley. Entomologists estimate that the range of this beetle extends from Redding at the northern end of the Central Valley to the Bakersfield area in the south. Important stressors on VELB are fragmentation of riparian habitat; grazing; and excessive collection of the species for commercial, recreational, scientific, or educational purposes. Local populations can also be severely damaged by pesticides inadvertently drifting from nearby agricultural lands into occupied habitat areas.

RESTORATION NEEDS

Protecting existing and restoring additional suitable inland dune scrub habitat will be critical to maintaining and increasing the abundance of the Lange's metalmark population in the Bay-Delta. The Ecosystem Restoration Program Plan's (ERPP's) proposed restoration of these habitats in the Sacramento-San Joaquin Delta Ecological Zone will help maintain healthy populations by increasing the quality and quantity of this species habitat. The Lange's metalmark would also benefit from implementation of management strategies in cooperation with the Antioch Dune Ecological Reserve that protect and and manage existing habitat areas, including maintaining healthy populations of its host plant, the naked buckwheat; reducing the adverse effects of fences or other structures that can impede dune formation; and establishing buffers, such as firebreaks, to protect the population from potential catastrophic events that could lead to its extirpation.

Protecting existing and restoring additional suitable seasonal wetlands, including vernal pools, and associated grasslands will be critical to recovery of the delta green ground beetle in the Bay-Delta. The Ecosystem Restoration Program Plan's (ERPP's) proposed restoration of these habitats in the Sacramento-San Joaquin Delta Ecological Zone will help maintain healthy populations by increasing the quality and quantity of habitats used by this species. The delta green ground beetle would also benefit from implementation of management strategies in cooperation with The Nature Conservancy's Jepson Prairie Preserve that protect and and manage existing habitat areas and design and manage restored seasonal wetlands and grasslands in locations near beetle populations in a manner that improves habitat quality for the species.

Protecting existing and restoring additional suitable riparian habitats and establishing new populations will be critical to recovery of the VELB in the Bay-Delta. The Ecosystem Restoration Program Plan's (ERPP's) proposed restoration of riparian habitats in the Sacramento-San Joaquin Delta Ecological Zone will help maintain healthy populations by increasing the quality and quantity of habitats used by these species. The period required to achieve recovery of the VELB could be reduced by introducing the species into unoccupied or restored habitat areas. Such a strategy could be implemented through cooperative agreements with land management agencies or cooperative agreements with willing landowners. The VELB would also benefit from development and implementation of alternative designs for and maintenance of flood control, bank protection, and other structures that reduce their potential adverse effects on existing riparian habitats. Restoration of ecosystem processes and habitats proposed by ERPP in other ecological zones will also allow riparian vegetation to develop that will provide habitat for these species elsewhere in the Central Valley. The benefit of these restorations for recovery of the VELB would be increased by implementing restoration of riparian habitats in a manner that links isolated areas supporting existing VELB populations.

IMPLEMENTATION OBJECTIVE AND INDICATORS

The implementation objective is to assist in maintaining populations of the Lange's metalmark, a federally listed endangered species, by increasing its abundance, and assist in the recovery of the delta green ground beetle, a federally listed endangered species, and Valley elderberry longhorn beetle, a federally listed threatened species, by increasing their populations and abundance. Meeting this objective would contribute to overall species richness and diversity and reduce conflict between the need for their protection and other beneficial uses of land water in the Bay-Delta.

The measurements of performance against the implementation objective is the quality and quantity of suitable inland dune scrub, seasonal wetland, and riparian habitats within the range of the Lange's metalmark, delta green ground beetle, and valley elderberry longhorn beetle and the abundance and distribution of these species in the Bay-Delta. Increasing the quality of existing and the quantity of suitable habitat and the degree to which former levels of abundance and distribution is achieved will be indicators of achieving recover of these species in the Bay-Delta.

LINKAGE TO OTHER PROGRAMS

The success of the proposed ERPP actions is dependent on cooperation with agencies with responsibility or authority in restoring habitats used by these species, including the U.S. Fish and Wildlife Service, California Department of Fish and Game (DFG), and California State Parks and Recreation. Other related programs and agencies include habitat restoration activities conducted by the Riparian Habitat Joint Venture, DFG's Calhoun Cut Reserve, and TNC's Jepson Prairie Preserve.