

## LONGFIN SMELT

*Spirinchus thaleichthys*

USFWS: None

CDFG: Threatened

### Species Account

**Status and Description.** The longfin smelt is listed as a threatened species by the California Fish and Game Commission. Abundance of the longfin smelt has reached record lows in the San Francisco-Delta population, and the species may already be extinct in some northern California estuarine populations, resulting in an overall threat of extinction to the species within California (Federal Register 2008). The longfin smelt was also proposed for federal listing, but on April 8, 2009 the USFWS determined that the San Francisco Bay Estuary population does not qualify for listing as a distinct population segment under federal regulations. Further assessment of the entire population is being conducted, however, and future listing may be considered.



*Photo courtesy of California Department of Fish and Game*

Longfin smelt, once mature, are slim, silver fish in the family Osmeridae (true smelts). Moyle (2002) describes the species as being 90-110 mm (standard length) at maturity, with a translucent silver appearance along the sides of the body, and an olive to iridescent pinkish hue on the back. Mature males are often darker than females, with enlarged and stiffened dorsal and anal fins, a dilated lateral line region, and breeding tubercles on paired fins and scales. Longfin smelt can be distinguished from other California smelt by their long pectoral fins (which reach or nearly reach the bases of the pelvic fins), incomplete lateral line, weak or absent striations on the opercular bones, low number of scales in the lateral line (54-65) and long maxillary bones (which in adults extent just short of the posterior margin of the eye). The lower jaw projects forward of the upper jaw when the mouth is closed. Small, fine teeth are present on both jaws as well as on the tongue, vomer, and palatines. The number of dorsal rays is 8-10; anal rays, 15-22; pectoral rays, 10-12; gill rakers, 38-47; and pyloric caeca, 4-6 (Moyle, 2002).

**Range, Populations and Activity.** Longfin smelt are found along the Pacific coast from the San Francisco Bay-Delta Estuary north to Prince William Sound, Alaska (Moyle 2002). The longfin smelt in the San Francisco Bay Estuary are the southernmost occurrence of the species.

Historically, the longfin smelt occurred along the Pacific Coast from Prince William Sound in Alaska to the San Francisco Bay-Delta Estuary in California. The species were not found continuously along this stretch of coast, however, but rather in scattered estuaries and inlets; these included Dixon Entrance, Yakutat Bay, Cook Inlet, and Prince William Sound in Alaska; the Fraser River estuary in British Columbia; Skagit Bay, Grays Harbor, Willapa Bay, and Puget Sound in Washington; the lower Columbia River, along the Washington-Oregon Border; Yaquina and Coos bays in Oregon; and in California in Humboldt Bay, the estuaries of the Russian, Eel, Van Duzen, and Klamath Rivers, and the San Francisco Bay-Delta Estuary (Lee *et al.* 1980; USFWS 1994; Moyle 2002). There were landlocked populations of longfin smelt found in Harrison Lake, British Columbia, and Lake Washington, Washington State. Although the historic distribution covers a large geographic area,

each of these populations has not necessarily been connected to other nearby populations, leading to isolation and genetically unique populations over time.

The current range, distribution, and abundance of longfin smelt is not well studied outside of California, although it is believed to have drastically declined within the last twenty years in many locations (USFWS 1994).

The historic extent of longfin smelt distribution within California, as described above, included Humboldt Bay, the estuaries of the Russian, Eel, Van Duzen, and Klamath Rivers, and the San Francisco Bay-Delta Estuary (Moyle 2002; USFWS 1994). The San Francisco Bay-Delta Estuary population included the Sacramento and San Joaquin Rivers and delta; the connected Suisun, San Pablo, Central; and South Bays and Suisun Marsh, Montezuma Slough and other connected marshes and tributaries. A single fish was recorded from Monterey Bay (Eschmeyer *et al.* 1983), but the San Francisco Bay-Delta population is considered the most southerly self-sustaining population (Moyle 2002).

Within California, information regarding distribution and abundance of longfin smelt indicates a precipitous decline in abundance and range during the past 20 years. Longfin smelt have historically been among the most numerically abundant fish species in the San Francisco Bay-Delta Estuary and in Humboldt Bay (Moyle 2002). The once-large Humboldt Bay population has dwindled to the point that it is rarely caught, and there is a distinct possibility of its extinction (USFWS 1994; Pinnix *et al.* 2004). Populations on the Eel and Van Duzen Rivers and their estuaries have also vanished or dwindled to undetectable numbers (USFWS 1994), and the Russian River and Bodega Bay populations have dwindled to extremely low numbers, indicating that these populations are probably no longer self-sustaining (Moyle 2002). There are recent records of longfin smelt from the mouth of the Klamath River, so a small population may persist there (CDFG 1995).

The San Francisco Bay-Delta longfin smelt population's current abundance information is measured through four surveys: the California Department of Fish and Game's Fall Midwater Trawl (since 1967); the Bay Study Midwater Trawl (since 1980); and Bay Study Otter Trawl (since 1980); and the University of California, Davis, Suisun Marsh Otter Trawl survey (since 1980). These surveys are conducted approximately once a month, and have yielded a consistent set of data indicating both a long-term and recent decline (in all age classes) in numbers of longfin smelt in the region. Average abundance levels (all age classes combined) from 2001 to 2006 were three percent (Fall Midwater Trawl) and eight percent (Bay Study) of 1980 to 1986 population levels. In Suisun Marsh, longfin smelt abundance during the 2001-2006 period was 70 percent lower than 1980 to 1986 levels. This decline can be broken down into two separate occurrences. From 1987 to 1992, a severe drought caused population levels of adult smelt to drop to 25 percent of their pre-drought levels; and from 2002 to 2004, abundance of adult longfin smelt fell to five percent of its 1980 level (approximately 22 percent of adult abundance levels measured during the 1987-1992 drought). Overall, a significant drop in numbers of the San Francisco Bay-Delta population is indicated.

The longfin smelt spawning season varies from year to year and may extend from November through June, although most spawning activity occurs between February and April (Federal Register 2008; CDFG 1995). Spawning occurs primarily in freshwater, although spawning may take place in brackish water during some years. Temperatures for spawning range from 7-14.5 degrees Celsius (Wang 1986; Wang 2007).

Longfin smelt deposit their eggs on gravel, cobble, or aquatic plant substrates, probably along the bottom of deep water channels in the San Francisco Bay-Delta Estuary. Historically, spawning took place in Suisun Bay, Suisun Marsh, Montezuma Slough, and West Delta, with Suisun Marsh acting as the major spawning ground in recent history (Moyle 1976; Wang 1986, 1991). Spawning probably does not occur above Rio Vista on the Sacramento River and above Medford Island in the San Joaquin River (Wang 1991), or below upper Suisun Bay near Montezuma Slough in Suisun Marsh (Wang 1986); however, adult longfin smelt of spawning age have been collected in Suisun Marsh only in very small numbers recently (The Bay Institute *et al.* 2007; Federal Register 2008).

The success, location, and timing of longfin smelt spawning may vary from year to year, and is probably based on a number of environmental factors. In 1992, a critically dry year, the greatest numbers of larvae were found in Suisun Bay and West Delta. Larvae were abundant in these areas, with peak spawning occurring in March. In 1993, an average to wet year, and 1994, a critically dry year, most of the spawning occurred in Suisun Bay, Montezuma Slough, and West Delta. Larvae were abundant from February to May. In 1995, a wet year, few larvae were found in any of the upstream sampled areas, and the duration of spawning was extremely short in those upstream areas. Overall, it appears that in dry years, longfin smelt move to the Suisun Bay to spawn. In wet years, longfin smelt descend to the San Pablo Bay to spawn (Wang 2007).

Longfin smelt are anadromous, with adult longfin smelt moving from San Francisco Bay and San Pablo Bay upstream to Montezuma Slough, Suisun Bay, West Delta, and the lower reaches of the Sacramento and San Joaquin Rivers during the fall. Eggs are deposited individually and in a single layer on the substrate. Longfin smelt have a fairly high fecundity rate, with 9,621-23,624 eggs per female reported in the Lake Washington population (Dryfoos, 1965) and 24,000 eggs per female reported by Moyle (1976). The eggs take approximately 40 days to hatch (Dryfoos 1965). Newly hatched longfin smelt larvae are five to eight mm long (Wang, 1991), and are planktonic, but become pelagic larvae shortly thereafter. They prefer the upper layer of the water column in inshore and offshore locations within channels. The larvae school with other longfin smelt and delta smelt (*Hypomesus transpacificus*) larvae, and occasionally with wakasagi (*Hypomesus nipponensis*). The majority of larvae remains in the Delta between February and April, and then become widely dispersed throughout the upper Estuary (Wang 2007). Larvae metamorphose into juveniles approximately 30-60 days after hatching, dependent on water temperature (The Bay Institute *et al.* 2007).

Juvenile longfin smelt exhibit patterns of migration similar to those of delta smelt. Most growth occurs during the first nine to ten months of life; juveniles reach 60-70 cm SL (Moyle, 1995). Longfin smelt reach sexual maturity at the end of their second year (Dryfoos, 1965), although some may reach sexual maturity in one year. The majority of delta smelt die after spawning, but some females may survive to spawn a second year (Moyle 1976).

Adult longfin smelt prey primarily upon opossum shrimp (*Acanthomysis* sp. and *Neomysis mercedis*) in the San Francisco Bay-Delta Estuary. In addition, Copepods and other crustaceans make up a significant component of the longfin smelt's diet, and may be of particular importance to juvenile fish (The Bay Institute *et al.* 2007).

**Habitat Use.** Longfin smelt are pelagic, meaning that they live in open water. They are euryhaline (adapted to tolerate a range of salinities) and anadromous (migrate to freshwater channels from the ocean for breeding). They typically inhabit estuaries with salinities between 15 and 30 psu (practical salinity units) (Baxter *et al.* 1999). Adults and Juveniles tend to occupy the middle or the bottom of the water column (Moyle *et al.* 1995). They prefer waters of below 20 degrees Celsius (Moyle 2002), which may influence their habitat choice, especially during summer months when they seek out deep channel waters. They have been detected in near-shore environments beyond the Golden Gate Bridge, indicating that at least some of the population uses marine habitats (City of San Francisco 1985). During the fall, the adult longfin smelt expand their range into the upper bays, delta, and sloughs (Wang 2007).

**Population Levels and Occurrence in Plan Area.** Within the Plan Area, longfin smelt are mainly associated with the open water portions of the Coastal Marsh vegetation in the Coastal Marsh Natural Community. There are currently no reported occurrences of this species in Solano County due to the recent review for listing under the California Endangered Species Act. However, records kept through the CDFG Fall Midwater Trawl (since 1967), Bay Study Midwater Trawl (since 1980), Bay Study Otter Trawl (since 1980), and the University of California, Davis, Suisun Marsh Otter Trawl survey (since 1980) provide records of historic and current occurrence and abundance for much of the Plan Area. Specific recent locations include the lower San Joaquin River, the lower Sacramento River, tributaries of Montezuma Slough and the Slough itself, West Delta, Suisun Bay, San Pablo Bay, and the upper Napa River (Wang 2007).

**Dispersal.** Longfin smelt utilize different portions of the San Francisco Bay and the delta and estuary areas throughout their life cycle. During the fall, adult longfin smelt migrate upstream into brackish sloughs and freshwater rivers for the winter and spring spawning season (Moyle 2002; Wang 2007). The larvae, once hatched, are transported by currents downstream to nursery habitat in the productive mixing zones of Suisun and San Pablo Bays. Adult longfin smelt spend the non-spawning months primarily in Suisun, San Pablo, and San Francisco bays, although they may use upstream waters to a greater extent during years of low river outflow (Federal Register 2008).

**Threats to the Species.** Longfin smelt are environmentally sensitive because they have a short lifespan (2 year life cycle), a limited diet, and relatively low fecundity for a fish with planktonic larvae. Additional factors contributing to their vulnerability include a narrow geographic range limited by suitable estuarine habitat, geographic isolation from other populations of the species, and reproductive dependence on seasonal freshwater inflows. The San Francisco Bay-Delta population, as well as other populations of the species, lacks geographic connectivity to other populations, reducing the resilience of the population to stress and decreases in numbers.

Specific factors posing threats to the San-Francisco Bay-Delta population include water diversions that alter the hydraulics and reduce the freshwater outflows in the estuary; subsequent entrainment of longfin smelt by the pumping plants and diversions in the south Delta; lethal and sub-lethal effects of toxic chemicals; direct and indirect impacts of non-native species on the longfin smelt food supply and habitat; disruption, injury, and death from pile-driving activities; disturbance of the substrates used for spawning and prey species' habitat due to dredging and other in-channel activities; and warming of estuary waters (Federal Register 2008).

The primary concern for the San Francisco Bay-Delta population of longfin smelt is the reduction of freshwater outflow into the delta by State and federal water diversion projects. These projects, located in the south Delta, have diverted increasing proportions of water since 1983 (Moyle *et al.* 1992). Most of this water is from the Sacramento River, with some portion coming from the San Joaquin River. During years of low San Joaquin River inflows and high water export, the delta hydrology can be disrupted to the point that The San Joaquin River can reverse direction and flow towards the State and federal pumping plants in the southern Delta (Federal Register 1993; The Bay Institute *et al.* 2007). These conditions are significantly related to high levels of incidental take of longfin smelt and other sensitive fish species at the pumping stations (The Bay Institute *et al.* 2007). The San Francisco Bay-Delta population abundance, reproductive success, and recruitment success is significantly correlated with springtime freshwater outflow.

Longfin smelt are particularly vulnerable to the effects of water diversion projects at two points in their life cycle. The first is during their larval and juvenile stages, when the young fish hove downstream from their natal freshwater estuarine habitats to the brackish waters where they mature. The periodic backflow of the San Joaquin River during low-flow high export years can result in decreased downstream transport of young fish and lethal entrainment in the water diversion projects. The second is during the fall and winter up-estuary migration of the adult longfin smelt in preparation for spawning. During this time, disrupted hydrology and river backflow may cause confusion and misdirection of fish, and lethal entrainment of adults is also common. Entrainment has been increasing in recent years, most likely due to markedly increased export of water (The Bay Institute *et al.* 2007).

Other hydrologic alterations of the Delta and estuary pose threats to longfin smelt as well. These include the installation of agricultural barriers in the Delta by DWR, which are designed to retain more freshwater outflow for agricultural and water diversion purposes. According to the USFWS 2005 biological opinion for Delta smelt, a closely related species, these barriers could become permanent. The barriers are correlated with increased entrainment losses at State and federal water diversion facilities (USFWS 2005). Dredging activities are another factor impacting the longfin smelt by altering the hydrology of their habitat. When the lower river channels and estuaries that support young fish and spawning activities are dredged, habitat is degraded and fish and eggs can become entrained in the dredging equipment (USACOE 2001). The petition for listing, submitted by The Bay Institute *et al.* (2007) also discusses pile driving activities associated with construction and repair as a significant threat to longfin smelt, citing research that indicates that high intensity sounds can disrupt fish movements and physiologically damage fish.

Toxic substances present in Delta, estuary, and Bay waters also threaten longfin smelt. These toxins come from many sources, including Agriculture, urban runoff, and heavy metal contaminants from industry and mining. The USFWS discussed significant proposed increases in contaminants introduced to the bay in 1993 (USFWS 1993), when it listed the delta smelt, and since then, chemical contamination has increased.

Invasive species pose a threat to longfin smelt in addition to the factors discussed above. The non-native clam *Corbula amurensis*, whose successful invasion has been linked to the higher salinities and lower outflows discussed previously, has become established in upper Suisun Bay and the western Delta in recent years. This species filter feeds on plankton, and its negative impacts on the estuarine planktonic food web have been credited with affecting the drastic recent decline in longfin

smelt levels (Kimmerer 2004). Introduced fish species that prey on plankton such as inland silverside (*Menidia beryllina*) and threadfin shad (*Dorosoma pretense*), and the closely related Japanese smelt, or wagasaki (*Hypomesus nipponensis*), may compete with longfin smelt for food or prey on larval longfin smelt. Predation by striped bass, which have been introduced in an effort to enhance their populations, may be an important factor affecting longfin smelt abundance as well (USFWS 1996).

**Critical Habitat.** This species is not currently federally listed. As such, critical habitat has not been designated. Important habitat for this species includes spawning and rearing grounds with appropriate substrate, salinity and prey species.

**Conservation Issues.** The longfin smelt will experience few direct effects from the Solano Habitat Conservation Plan's covered activities. The majority of the longfin smelt's habitat lies outside of the Plan Area, or occurs in areas that is already covered by existing regulatory protection (such as Suisun Marsh). Issues that may arise are associated with impacts to water quality in the Delta and Suisun Marsh from urban runoff. The water diversion activities and related reduced outflow impacts are not activities covered under the Solano Habitat Conservation Plan.

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