DEPARTMENT OF THE INTERIOR

Fish and Wildlife Service

50 CFR Part 17

[Docket No. FWS-R8-ES-2010-0013]

[MO 92210-0-0008-B2]

Endangered and Threatened Wildlife and Plants; 12-month Finding on a Petition to list the Sacramento Splittail as Endangered or Threatened

AGENCY: Fish and Wildlife Service, Interior.

ACTION: Notice of 12-month petition finding.

SUMMARY: We, the U.S. Fish and Wildlife Service, announce a 12-month finding on a petition to list the Sacramento splittail (*Pogonichthys macrolepidotus*) as endangered or threatened under the Endangered Species Act of 1973, as amended. After review of all available scientific and commercial information, we find that listing the Sacramento splittail is not warranted at this time. However, we ask the public to submit to us any new information that becomes available concerning the threats to the Sacramento splittail

or its habitat at any time.

DATES: The finding announced in this document was made on October 7, 2010.

ADDRESSES: This finding is available on the Internet at *http://www.regulations.gov* at Docket Number FWS-R8-ES-2010-0013. Supporting documentation we used in preparing this finding is available for public inspection, by appointment, during normal business hours at the U.S. Fish and Wildlife Service, San Francisco Bay Delta Fish and Wildlife Office, 650 Capitol Mall, Sacramento, CA 95814. Please submit any new information, materials, comments, or questions concerning this finding to the above street address.

FOR FURTHER INFORMATION CONTACT: Dan Castelberry, San Francisco Bay Delta Fish and Wildlife Office (see **ADDRESSES**); by telephone at 916-930-5632; or by facsimile at 916-930-5654. If you use a telecommunications device for the deaf (TDD), please call the Federal Information Relay Service (FIRS) at 800-877-8339.

SUPPLEMENTARY INFORMATION:

Background

Section 4(b)(3)(B) of the Endangered Species Act of 1973, as amended (Act) (16 U.S.C. 1531 *et seq.*), requires that, for any petition to revise the Federal Lists of Endangered and Threatened Wildlife and Plants that contains substantial scientific or commercial information that listing the species may be warranted, we make a finding within 12 months of the date of receipt of the petition. In this finding, we will determine that the petitioned action is: (1) Not warranted, (2) warranted, or (3) warranted, but the immediate proposal of a regulation implementing the petitioned action is precluded by other pending proposals to determine whether species are tendangered or threatened, and expeditious progress is being made to add or remove qualified species from the Federal Lists of Endangered and Threatened Wildlife and Plants. Section 4(b)(3)(C) of the Act requires that we treat a petition for which the requested action is found to be warranted but precluded as though resubmitted on the date of such finding, that is, requiring a subsequent finding to be made within 12 months. We must publish these 12-month findings in the **Federal Register**.

Previous Federal Actions

Please refer to the final listing rule (64 FR 5963) for a discussion of Federal actions that occurred prior to February 8, 1999. Please refer to the Notice of Remanded Determination of Status for the Sacramento Splittail (68 FR 55139) for a discussion of Federal actions that occurred after February 8, 1999, and prior to September 22, 2003. It is our intent, in this document, to reiterate and discuss only those topics directly relevant to this decision.

On September 22, 2003, the Service published a Notice of Remanded Determination of Status for the Sacramento Splittail in the **Federal Register** (68 FR 55139) that removed the Sacramento splittail from the List of Endangered and

Threatened Wildlife (50 CFR 17.11(h)). On August 13, 2009, the Center for Biological Diversity (CBD) filed a complaint in U.S. District Court for the Northern District of California, challenging the Service on the merits of the 2003 determination alleging improper political influence. In a settlement dated February 1, 2010 (Case4:09-cv-03711-PJH), the Service agreed to open a 30-day public comment period for a new 12 month finding to allow for the submission of additional information by the public. The Service also agreed to submit to the **Federal Register** a new status review and 12-month finding as to whether listing the Sacramento splittail is warranted or not warranted. If warranted, the Service further agreed to publish, concurrently with the 12-month finding, a proposed rule to list the Sacramento splittail before September 30, 2010 and a final determination on or before September 29, 2011.

Definitions

To assist the reader in understanding terminology used in this determination, we have provided below several terms with their corresponding definitions as they are used in this document. As used in this determination, the term “Delta'” refers to all tidal waters contained within the legal definition of the San Francisco Bay-Sacramento-San Joaquin River Delta, as delineated by section 12220 of the State of California's Water Code. Generally, the Delta is contained within a triangular area that extends south from the City of Sacramento to the confluence of the Stanislaus and San Joaquin Rivers at the southeast corner and Chipps Island in Suisun Bay at the southwest corner. The term “Estuary” as used in this determination, refers to the collective tidal waters contained in the Sacramento and San Joaquin Rivers, the Delta, and San Pablo and San Francisco bays.

Species Information

Species Description

The Sacramento splittail is a fish species native to central California and represents the only extant species in its genus in the world (Baerwald *et al.* 2007, p. 160). Splittail can grow to a length of 40centimeters (cm) (15 inches (in.)), and have an elongate body, small head, and enlarged upper tail lobe. Their body coloration is dusky olive gray on the back and silver on the sides. During breeding season, their fins become tinged with red-orange. Additionally, males develop white tubercles on their heads and become darker in color during the breeding season (Moyle 2002, p. 146).

Taxonomy

Splittail were first described in 1854 by W.O. Ayres as *Leuciscus macrolepidotus* and by S.F. Baird and C. Girard as *Pogonichthys inaeqilobus*. Although Ayres' species description is accepted, the species was assigned to the genus *Pogonichthys* in recognition of the distinctive characteristics exhibited by the two splittail species *P. ciscoides* and *P. macrolepidotus* (Hopkirk 1973, p. 24). *Pogonichthys ciscoides*, endemic to Clear Lake, Lake County, California, has been extinct since the early 1970s. The Sacramento splittail is currently classified as *Pogonichthys macrolepidotus*. Recent studies have revealed two populations of splittail that differ in their genetic makeup, one in the Napa/Petaluma drainages (hereafter referred to as the San Pablo population) and one in the greater Central Valley drainage (hereafter referred to as the Delta population) (Baerwald *et al.*2007, pp. 159-167).

Distribution

Historically, Sacramento splittail were found as far north as Redding on the Sacramento River. Splittail were also found in the tributaries of the Sacramento River as far as the current Oroville Dam site on the Feather River and Folsom Dam site on the American River (Rutter *et al.* 1908, p. 131). Along the San Joaquin River, splittail were harvested by native peoples in Tulare and Buena Vista Lakes where splittail bones have been found in archeological middens (Moyle *et al.*, 2004, p. 7). In the San Francisco Bay area, splittail have historically been reported at the mouth of Coyote Creek in Santa Clara County and the Southern San Francisco Bay (Snyder *et al.* 1905, pp. 327-338). Splittail were documented in Suisun and Napa marshes as well as Suisun Bay in the 1950's (Caywood . 1974, p. 29-65).

Splittail occur in the San Francisco estuary and its tributaries and are found most often in slow moving sections of rivers and sloughs including dead end sloughs and shallow edge habitats (Moyle 2002, p. 147; Daniels and Moyle 1983, p. 653; Feyrer *et al*. 2005, pp. 164-165). Recent studies have shown the splittail's range in the Sacramento, San Joaquin, Napa, Mokelumne and Petaluma rivers is significantly greater than previously thought when it was first petitioned in the early 1990's as a threatened species (Sommer *et al.* 2007, pp. 27-28; Sommer *et al.* 1997, p. 970). The following chart created by Sommer and featured in his splittail paper follows (Sommer *et al.* 2007, p. 28).

Table 1.

Upstream-most locations of historical and recent splittail collections (1998-2002). River kilometer (rkm) is the distance from the mouth of the river.

	Location (rkm) of splittail collection				
River System	*Historic (Rutter 1908)*	*1970s (Cawood 1974)*	*Mid- 1990s (Sommer et al. 1997)*	*Recent (Freyer et al. 05) unless noted otherwise*	*Distance to first dam[a]*
Sacramento	483	387	331	391[b]	387
Feather	109	Present	94	94[c]	109
American	49	37	19	No new data	37
San Joaquin	Widespread	Present	201	218.5[d]	295
Mokelumne	NA	25	63	96[e]	63
Napa	NA	21	10	32	NA
Petaluma	NA	25	8	28	NA

[a] Lowest dams in reach of river are Red Bluff (Sacramento), Oroville (Feather), Nimbus (American), Sack (San Joaquin), and Woodbridge (Mokelumne). Woodbridge is a seasonal dam. Napa River is not dammed within the range of splittail; first dam was removed from the Petaluma River in 1994.
[b] D. Killam, California Department of Fish and Game, personal communication.
[c] B. Oppenheim, NOAA Fisheries, personal communication.
[d] R. Baxter, California Department of Fish and Game, unpublished data.
[e] J. Merz, East Bay Municipal Utility District, November 2000.

Distribution on the Sacramento River over the past 30 years has consistently ranged at least 232 to296 river kilometers (rkm) (144 to184 miles (mi)) upstream of the estuary (Feyrer *et. al.* 2005, pp. 163-167). The consistent finding of splittail more than 200 rkm (124 mi) upstream of the Estuary may represent a population persisting there or may reflect the long distance that splittail migrate during dry years (Feyrer *et al.* 2005, pp. 165-166). Juvenile splittail have been recorded at the Glenn-Colusa Irrigation District Intake at rkm 331 (206 mi) on the Sacramento River year-round from 1994 - 2001. It is unknown why these individuals do not migrate downstream after spawning as do the majority of splittail (Feyrer *et al.* 2005, pp 165-166). Splittail have been documented on the Toulumne River to rkm 27.4 (mi 17) (Heyne 2003, pers. comm.) and on the Merced River to rkm 20.9 (13 mi) (Heyne 2003, pers. comm.). Splittail have been recorded in recent times from within Salt Slough (Baxter 1999a, p. 10; 1999b, p. 30). A 1998 California Department of Fish and Game (CDFG) gillnet survey of the tidal reaches of the Lower Walnut Creek found splittail to be the most abundant fish in the creek (Leidy *et al.* 2007). Splittail are found in the Napa Marsh during years with high freshwater flow, but are rare during years of low freshwater outflow (Baxter 1999a, p. 11).

Splittail can utilize a variety of habitats and having no known collection in an area does not mean that splittail are not there because it is impractical to survey the entire Delta. Splittail have been observed in a number of tributaries of major rivers such as the Sacramento and San Joaquin and are likely distributed much more widely in small creeks and marshes throughout the lower portions of the Estuary than known collections indicate (Kratville 2010, pers comm.). Suisun Marsh and Bay contain the largest areal extent of shallow water habitat available to the splittail and likely have the greatest concentrations of the species.

Splittail's spawning habitat includes the natural and newly-restored floodplains of the Cosumnes River, managed floodplains such as the Yolo and Sutter bypasses, and disjunct segments of floodplain adjacent to the Sacramento and San Joaquin rivers and tributaries. These areas approximate the large, open, shallow-water areas which once existed throughout the Delta (Sommer *et al.* 1997, p. 971). The largest portion of splittail spawning habitat occurs in the Yolo Bypass and higher splittail young-of-the-year abundances are strongly correlated with the flooding of the Yolo Bypass. The best spawning conditions for splittail occur in the bypass when water remains in the bypass until fish have completed spawning (at least 30 days), and larvae are able to swim out on their own during the draining process.

In years where the Yolo and Sutter bypasses are not inundated for at least 30 days, splittail spawning is confined primarily to the natural and newly restored floodplains of the Cosumnes River and the margins of rivers and other floodplain features that are inundated at lower river stages. The Cosumnes River is unique in that it is the only major river flowing into the Delta that does not host a major dam. There are indications, based on presence of larvae and juveniles, that spawning in the Sacramento River occurs relatively far upstream at Colusa (Baxter 1999a, p. 8; 1999b, p. 29). Splittail also utilize the San Joaquin River for spawning in wet years when river flow exceeds the capacity for storage and flooding occurs. The Tuolumne, Cosumnes, Feather, American, Napa, and Petaluma Rivers, and numerous other smaller waters also support splittail spawning activity.

In summary, the geographic distribution of the splittail has not decreased detectably over the last several decades and is in fact larger than estimated in our last listing decision (Sommer *et al.* 2007, pp.27-28; 68 FR 55139).

Habitat Requirements

Although primarily a freshwater species, splittail tolerate salinities as high as 10 to 18 parts per thousand (ppt) (Moyle and Yoshiyama 1992). Salinity tolerance in splittail increases in proportion to body length; adults can tolerate salinities as high as 29 ppt for short periods in laboratory conditions, but experience loss of equilibrium (bodily balance) when salinities exceed 23 ppt (Young and Cech 1996, p. 668). Hospitable temperatures for non-breeding splittail range from 5 to 24° Celsius (C) (75° Fahrenheit (F)) although acclimated fish can survive temperatures up to 33°C (91° F) for short periods of time (Young and Cech 1996, pp. 667-675). Splittail are also tolerant of low dissolved oxygen and can be found in water where levels are around 1 mg O^2 L^{-1} (Moyle *et al.* 2004, p. 13).

Splittail are frequently found in areas subject to flooding because they require flooded vegetation for spawning and rearing. Historically, the major flood basins (e.g., Colusa, Sutter, American, and Yolo basins; Tulare, Buena Vista, and Kern lakes) distributed throughout the Sacramento and San Joaquin valleys provided spawning and rearing habitat. These flood basins have all been reclaimed or modified for flood control purposes (i.e. as bypasses), and much of the floodplain area adjacent to the rivers is now inaccessible behind levees.

Splittail make use of the Sutter Bypass, and particularly heavy use of the Yolo Bypass, for spawning under certain hydrologic conditions. The shallow, vegetated waters of the bypasses provide excellent rearing conditions for juvenile fish (Sommer *et al.* 2001, p. 11). The bypasses are primarily flood control facilities and secondarily, passively operated as agricultural lands. These lands are also managed for waterfowl and other wildlife habitat. Splittail using the bypasses are subject to the same threats found elsewhere, such as habitat loss, environmental contamination, harmful reservoir operations, competition with and predation by non-native fish, and so forth.

The bypasses are only fully flooded when flows in the Sacramento River reach a certain level. The Yolo Bypass becomes inundated when the Sacramento River flow rate at the Freemont Weir exceeds 1,600 cubic meters per second (cms) (56,503 cubic feet per second (cfs)). This occurs when the River reaches approximately 9.0 meters (m) (30 feet (ft.) (National Geodetic Vertical Datum standard) in depth at the Freemont Weir (Sommer *et al.* 2001, pp. 7-8). Partial flooding of the Yolo Bypass via high flows from Cache and Putah creeks can occur independently regardless of Sacramento River flows. Due to the unpredictable flooding frequencies and duration of the bypass, splittail, having migrated long distances upstream, could arrive at floodplains that have not been inundated and therefore the splittail could be denied the opportunity to spawn. In those cases where adult splittail successfully spawn, the eggs or larvae could become trapped and killed if waters recede too rapidly. Insufficient duration of floodplain inundation could also force egress of juvenile splittail before they have attained a size and swimming ability sufficient to avoid predation. The annual splittail spawning and reproductive success is strongly correlated with frequency and duration of Yolo bypass inundation (Sommer *et al.* 2007, pp. 33-34).

The Fremont Weir has been overtopped―resulting in Yolo Bypass inundation―19 of the last 31 years with 10 of these years producing inundation durations of more than 30 days (DWR 2010a, pp. 1-2). Inundation durations of 30-90 days are needed to produce robust splittail year classes on the bypass (Kratville 2010, pers. comm.). According to the ST5 (T. C. Foin) model, the inundation of floodplains that splittail utilize as spawning habitat must occur at a minimum of every 7 years for a minimum of 30 days for splittail populations to persist. Bypasses and other floodplains have historically been exceeding these parameters and we have no evidence that suggests they will not continue to do so in the foreseeable future.

The Yolo Bypass supports agricultural crops such as corn and safflower and can support tomatoes in non-flood years. Optimal flooding conditions for the splittail (February through May) have negative effects on agricultural production in the area destroying and damaging crops, eroding soils and decreasing overall yields (Yolo Bypass Management Strategy 2001, ch. 2 p. 6). Because Yolo Bypass inundation is likely to be one of the most important factors in determining the continued production of high splittail population numbers, cooperation on the flood management between the landowners of the bypass and resource management agencies is essential.

Splittail spawning occurs over flooded vegetation in freshwater marshes, sloughs, and shallow reaches of large rivers with depths of at least 1m (3.3 ft) (Moyle *et al.* 2007 , pp. 1-27). Observations of splittail spawning have indicated the species spawns at depths of less than 1.5 m (4.9 ft) in the Cosumnes River floodplain and at depths of less than 2 m (6.6 ft) in Sutter Bypass (Moyle *et al.* 2004, pp. 16-17). These studies show that splittail spawn in water depths between 1 to 2 m (3.3 to 6.6 ft) depending on location of spawning. Splittail may not spawn again in the year following a successful effort (Moyle *et. al.* 2004, p. 32).

It is speculated that Suisun Marsh is the late-stage rearing area for juvenile splittail hatched and reared in the extensive spawning habitat found within the Yolo Bypass because water flowing out of the Yolo Bypass tends to stay on the north side of the delta and be drawn into Suisun Marsh (Moyle *et al.* 2004, p. 31).

Biology

Splittail are relatively long-lived and larger fish may be 8 to 10 years old (Moyle

2002). Splittail reach about 110 millimeters (mm) (4.3 in) standard length (SL) (tip of the snout to the posterior end of the last vertebra) in their first year, 170 mm (6.6 in) SL in their second year, and 215 mm (8.4 in) SL in their third year (Moyle 2002, p. 148). Male and female splittail generally mature by the end of their second year, but some males mature in their first year and some females do not mature until their third year (Daniels and Moyle 1983, p.650).

Estimates of splittail fecundity have shown high variability in numbers of eggs produced. Caywood (1974, p. 4015) found a mean of 165 eggs per mm of SL of fish sampled and reported a maximum of 100,800 eggs in one female. Feyrer and Baxter (1998, p. 123) found a mean of 261 eggs per mm of SL and a fecundity range of 28,416 to 168,196 eggs. Bailey *et al.* (1999) examined fish held for a considerable time in captivity and found that fecundity ranged from 24,753 to 72,314 eggs per female, which most closely agrees with Caywood's (1974, p. 4015) observations.

Splittail are benthic (feeding in the bottom of the water column) foragers that mainly feed in the daytime. Composition of splittail gut contents has revealed that they feed almost exclusively on aquatic invertebrates with chironomid larvae making up the largest portion of the diet in all areas except the Petaluma River where copepods make up the largest portion of the diet (Feyrer *et al.* 2007a, p. 1398). Until the 1980's, opossum or mysid shrimp (*Neomysis mercedis*), made up a large portion of the diet along with amphipods and harpacticoid copepods (Moyle *et al.* 2004, p. 14). Introductions of the Asiatic clam (*Corbicula fluminea*) in 1945 and more importantly the overbite clam (*Corbula amurensis*) first recorded from the estuary in 1986) were followed by a sharp decline in shrimp abundance that started in 1987 and continued through 1999 (Feyrer *et* *al.* 2003, p. 283). Splittail have shifted their diet from prey items such as mysid shrimp to a diet increasingly focused on bi-valves, in particular the overbite clam. Opossum shrimp in splittail gut contents were reduced from 24 percent (historically) to 2 percent by 2003 (Feyrer *et al.* 2003, pp. 277-288; Kratville 2010, pers comm.). In the Estuary, clams, crustaceans, insect larvae, and other invertebrates also are found in the adult diet. Larvae feed mainly on plankton composed of small animals (zooplankton), moving to small crustaceans and insect larvae as body size increases (Kurth and Nobriga 2001, EIP newsletter vol. 14, num.3, p. 41).

Splittail populations fluctuate annually, depending on spawning success, which is positively well-correlated with freshwater outflow and the availability of shallow water habitat with submerged vegetation (Daniels and Moyle 1983; Sommer *et al.* 1997). Sexual maturity is typically reached by the end of their second year. Splittail are a migratory species that travel upstream into freshwater floodplain habitat to spawn. The onset of spawning is associated with rising water levels, increasing water temperatures, and increasing day length. Peak spawning occurs from February through May, although records of spawning exist for late January to early July (Wang 1986). One temporally stable cue for splittail is the timing of the vernal equinox (Feyrer 2006, p. 221). Peak flow from the Central Valley enters the Estuary approximately at the same time as the vernal equinox (Feyrer 2006, p. 221) and these coinciding events commence splittail migration. In some years, most spawning may take place within a limited period of time. For instance, in 1995, a year of high spawning activity, most splittail spawned over a short period in April (Moyle *et al.* 2004, p. 16). Within each spawning season, older fish reproduce first, followed by younger individuals (Caywood 1974, p. 50).

Bailey (1994, p. 3) has documented that splittail eggs hatch in 3 to 5 days at 18.5° C, (65.3° F). Bailey (1994, p. 3) also found that at 5 to 7 days after hatching, the yolk sac is absorbed and the diet begins to include small rotifers. Splittail larvae remain in shallow, weedy areas close to spawning sites for 10 to 14 days and move into deeper water as they mature and swimming ability increases (Sommer *et al.* 1997, pp. 961-976). When the flood waters recede juveniles typically leave the flooded areas and move downstream in May, June, and July to rear in estuarine marshes (Moyle *et al.* 2004, p. 17). Splittail can be easily identified at 20 to 25 mm (0.8 to 1.0 in) total length (TL) and become fairly active swimmers at this time (Moyle *et al.* 2004, p. 17).

Abundance

History of abundance models and evaluations

An estimate of splittail abundance has never been performed; however, survey data have been used to construct indices of abundance that have been used in the past to assess population trends (Sommer *et al.* 2007, p 29; Moyle *et al.* 2004, p 7). In general, the applicability of survey data to a particular use arises from two factors: (1) How the data are collected; and (2) how the data are used to estimate or to index abundance. The key point with regard to the first factor is the degree to which the sample collected is representative of the sampled population. Gear type, configuration, and method of deployment all contribute to species, sizes, and life stages collected. Unequal vulnerability of different sizes of fish to a given sampling protocol results in systematic error in population estimation. Fish behavior, both between species and between life stages, also contributes to sampling error, as does habitat variation, because gear performance often differs among habitat types. The efficiency of open-water, or pelagic, sampling may be affected by physical factors such as flow velocity and turbidity, both in terms of gear performance and fish behavior.

Splittail are a benthic (near-bottom-dwelling) species, often occur in shallow edge habitat, and feed most actively in early morning (Moyle *et al.* 2004, p 8; Moyle 2002, p 148). Splittail would not be expected to be collected efficiently in surveys that do not sample channel edges and bottom habitats effectively. Further, while combining data from the various surveys provides reasonably good coverage of the geographic range of splittail, individual surveys are often fairly limited in geographic scope. All surveys suffer from selection biases due to the type of gear deployed and the method of deployment (Ricker *et al.* 1975, pp 70-73; 92). None of the surveys used to construct the indices used to monitor the relative abundance of splittail was designed specifically to sample splittail, and each is limited in some manner in its ability to adequately represent splittail population trends. Therefore, the data collected do not represent a quantitative estimate of population size.

The surveys and their limitations are described in the Service's Notice of Remanded Determination of Status for the Sacramento Splittail (68 FR 55139). Sommer *et al.* (2007, pp 29-30) and Moyle *et al.* (2004, pp 8-13) also explain some of the important limitations of the surveys with respect to splittail. A chart summarizing the surveys and their limitations is provided below.

Table 2. Summary of splittail sampling surveys

Survey	Brief Description	Years	Pros	Cons

CDFG Fall Mid-Water Trawl	Designed to sample juvenile striped bass. 100 sampling sites: San Pablo Bay in the west to Rio Vista on the lower Sacramento River and to Stockton on the San Joaquin River	1967–present	Catches all splittail size classes	–Targets striped bass –Low adult catch rate –Sampling does not cover entire range –Does not sample benthos or shallow channel edges –Some years yield no splittail –Splittail are better able to see nets in recent years due to decreased turbidity
San Francisco Bay Mid-Water Trawl and Otter Trawl Survey	Samples west of the Delta seaward to south San Francisco Bay	1980–present	–Two types of sampling equipment and frequent sampling –Capture all size classes	–Does not cover entire range –Non-specific; targets entire pelagic or benthic community –Incomplete data between 1989-1999 –Splittail only caught in 5 percent or less of samples
University of California at Davis (UC Davis) Suisun Marsh Otter Trawl	Long-term study of the ecology of the entire fish community of the marsh at 21 sites and 9 sloughs	1979–present	Samples all size classes	–Non-specific; targets entire fish community -Geographically limited –Larger fish less vulnerable to trawls

Chipps Island Survey	U.S. Fish and Wildlife Service conducts a sampling program for juvenile salmon in the deep water channel near Chipps Island, midwater trawl is pulled at the surface in 10 20-minute hauls per day during May and June	1976–present	—Samples well during high flow years –Good adult catch rates	–Designed to sample juvenile salmonids -—Geographically limited –Samples near-surface waters only –High turbidity in sampling area
FWS Beach Seine Survey	Samples 23 stations around Delta with 15-m beach seine in low velocity areas near shoreline	1979–present	–Broadest geographical coverage of all surveys –Good adult catches	–Inconsistent from 1983-1992 –Focused on out-migrating juvenile salmon -—Low adult catch
Salvage Operations	The Central Valley Project (CVP) and State Water Project (SWP) operate fish screening facilities to divert fish away from the pump intakes into holding facilities where fish are counted, measured, and released.	1979–present	Highest number of splittail caught out of any survey for both adult and juvenile catches	–Geographically localized-mainly reflective of San Joaquin River production –Catches are result of entrainment and often cause mortality

Please refer to February 8, 1999, final listing rule (64 FR 5963) for a full discussion of methods used to estimate abundance in that rule. Please refer to the September 22, 2003, Notice of Remanded Determination of Status for the Sacramento Splittail (68 FR 55139) for a full discussion of methods used to estimate abundance for that document. In our January 6, 1994, proposed rule to list the Sacramento splittail as threatened (59 FR 862), we initially evaluated and analyzed splittail survey data using a method published by Meng and Moyle (1995, p. 541) in the Transactions of the American Fisheries Society. Meng and Moyle used a common data set from the years 1980–1992 to compare point estimates with the Mann-Whitney U-test. We used this same method during the development of our 1999 final listing rule (64 FR 5963, February 8, 1999), using abundance data provided and updated by CDFG, California Department of Water Resources (CDWR), and UC Davis. Using the aforementioned method, the 1999 finding concluded that the splittail had declined by 62 percent in abundance over the last 15 years.

In a document we published in the **Federal Register** on August 17, 2001 (66 FR 43145), we requested public comments to assist us in reanalyzing our splittail abundance data. In that document, we presented a stratified Mann-Whitney U-test, which represented an improvement on what essentially remained a Meng and Moyle (1995, pp. 538-549) statistical approach. Following careful consideration of comments we received from numerous respondents to this document, including those provided through the peer review process, we concluded that the abundance indices and Multiple Linear Regression

(MLR) model jointly developed and submitted by CDFG and U.S. Bureau of Reclamation (USBR) in 2001 (hereafter referred to as the CDFG/USBR MLR Model) provided the best scientific data (method) available for statistically evaluating temporal trends of splittail abundance information. We used this CDFG/USBR MLR Model as the basis of our September 22, 2003, Notice of Remanded Determination of Status for the Sacramento Splittail (68 FR 55139), instead of the original Meng and Moyle (1995, pp. 540-542) methodology. We input 20 discrete sets of age-specific abundance monitoring data into the model. These data sets were obtained from the surveys described in Table 2 above. Running the model in a "worst case scenario" (alpha < 0.2 significance), we found nine significant downward-trending data sets and two significant upward-trending data sets, and we concluded that the population was in decline.

Current evaluation of models and abundance

In light of uncertainties in data for estimating splittail population abundance, alternative approaches for understanding population behavior and regulation have been developed. One such approach is the life history simulation model developed by T. C. Foin wherein splittail population characteristics can be explored and compared with known field biology to infer important life stage survival probabilities and potential conservation strategies (Moyle *et al.*, 2004, pp. 32-37). Life history simulation models can be parameterized to the extent possible using relevant field/survey information, and then used in a series of "what if" exercises to explore simulated population dynamics under selected conditions. Using the model in this way for sensitivity analysis allows the experimenter to discern which life stage or life stage characteristic is crucial to long-term simulated survival, for example, or how often "sub-optimal" conditions must occur for the simulated population to be at risk for extinction. Such population viability analyses (PVAs) can form part of the basis for the Act's listing decisions where sufficient life stage parameter estimates are well-known (Shaffer 1981, pp. 131-133; Meffe and Carroll 1994, pp. 181-182). In the Estuary such a model was used to confirm field observations that flood plain dynamics and subsequent spawning response by splittail populations were critical to long-term population persistence in the absence of other exogenous drivers of splittail mortality (Moyle *et al.* 2004, pp. 32-27).

In the present case of the Sacramento splittail, survey data appear sufficient to point to supra-annual patterns of abundance (abundance changes over several or many years), but do not appear to support parsing into sub-annual or life-stage specific characterization of splittail population biology. Inaccuracies associated with intra-annual sampling and both relative and absolute gear inefficiencies make it very difficult to discern splittail population dynamics on a sub-annual basis. Life history traits of the splittail including their dependence on floodplain hydrology and seasonal flooding of riparian and floodplain lands make this species quite suited to exploration using population simulation approaches (Moyle *et al*., 2004,pp. 13-18, 32).

The T. C. Foin splittail population simulation model (ST5) and related models have led to the following conclusions regarding Sacramento splittail population variability and longer-term population forecasts (Moyle *et al.*, 2004, pp. 32-37). Splittail populations are highly variable and driven in large measure by rainfall and flooding; high variability in splittail populations can be modeled focusing on reproductive effort in those years with substantial added floodplain inundation. Simulations indicate that several dry years in succession are not likely to imperil splittail populations. Despite downward trends in simulated populations of splittail, this model indicates that low numbers of splittail reproducing along river margins can sustain the population through long drought periods and that a long series of dry years is unlikely to drive the splittail to extinction (Moyle *et al.* 2004, pp. 36-37). However, a large-scale, regional catastrophe combined with low population might lead to stochastic extinction. Adult mortality considered in isolation does not appear to be driving the population dynamics of splittail in the Estuary or in the models. Periodic (i.e., a minimum of every 7 years) floodplain inundation seems essential to long-term population persistence. High variability is a fundamental property of splittail populations; therefore, little can be discerned regarding population status within a given survey year from annual indices of abundance.

The splittail population model ST5 and additional splittail models built in support of CALFED Science Program objectives use as a foundation biological characterization supplied by field biologists and species specialists (Moyle *et al.* 2004, pp.32-37). Noted in splittail life history is adaptation to "estuarine waters with fluctuating conditions" (Moyle 2002, p. 147). This includes the ability to respond to abrupt water level changes and the ability to utilize seasonally inundated floodplains for spawning. Sacramento splittail are highly fecund, with some large females reportedly able to produce over 100,000 eggs (Moyle 2002, p. 148). As an iteroparous (producing offspring in successive cycles), moderately long-lived (5 to 8 years) species with high reproductive potential, it is not surprising that splittail life history characteristics allow the species to persist even in the face of only moderately predictable conditions year-to-year. As long as favorable spawning conditions occur at a minimum of every 7 years, populations can remain at relatively low levels and rebound when favorable spawning conditions occur (Moyle 2002, pp. 34-38). Recent survey records provided via Interagency Ecological Program (IEP) survey efforts for the Sacramento splittail have shown this pattern (Meng and Moyle 1995, pp. 548; Sommer *et al.*, 1997;DWR 2010c, p. 16). This was demonstrated in 1995 when populations retained a high reproductive capacity after a substantial decline following several years of drought (Sommer *et al.* 1997, p. 971)., Due to the deficiencies in the survey data discussed above, we are unable to discern a trend in adult abundance. The young-of-year splittail population experiences a natural fluctuation in numbers due to drought cycles in the region.

Evaluation of Information Pertaining to the Five Threat Factors

Section 4 of the Act (16 U.S.C. 1533) and implementing regulations (50 CFR part 424) set forth procedures for adding species to, removing species from, or reclassifying species on the Federal Lists of Endangered and Threatened Wildlife and Plants. Under section 4(a)(1) of the Act, a species may be determined to be endangered or threatened based on any of the following five factors:

(A) The present or threatened destruction, modification, or curtailment of its habitat or range;

(B) Overutilization for commercial, recreational, scientific, or educational purposes;

(C) Disease or predation;

(D) The inadequacy of existing regulatory mechanisms; or

(E) Other natural or manmade factors affecting its continued existence.

In making this 12-month finding, information pertaining to the Sacramento splittail in relation to the five factors provided in section 4(a)(1) of the Act is discussed below. In making our 12-month finding on the petition we considered and evaluated the best available scientific and commercial information.

In considering what factors might constitute threats to a species, we must look beyond the exposure of the species to a factor to evaluate whether the species may respond to the factor in a way that causes actual impacts to the species. If there is exposure to a factor and the species responds negatively, the factor may be a threat and we attempt to determine how significant a threat it is. The threat is significant if it drives, or contributes to, the risk of extinction of the species such that the species warrants listing as endangered or threatened as those terms are defined in the Act.

Factor A. The present or threatened destruction, modification, or curtailment of its habitat or range

Habitat Loss

The Bay Institute has estimated that intertidal wetlands in the Delta have been diked and leveed so extensively that approximately 95 percent of the 141, 640 hectares (ha)(350, 000 acres(ac)) of tidal wetlands that existed in 1850 are gone (The Bay Institute 1998, ch. 4, p. 17), and that 90 percent of the riparian forest and riparian wetlands of the Sacramento Valley have been cleared, filled, or otherwise eliminated. Diking, dredging, filling of wetlands, and reduction of freshwater flows through more than half of the rivers, distributary sloughs, and the Estuary for irrigated agriculture and urban use have widely reduced fish habitat and resulted in extensive fish losses (Moyle *et al.* 1995, p. 166-168). San Joaquin River flows have been degraded to a higher extent than flows in the Sacramento River (Feyrer *et.al.* 2007a, p. 1396). Limited spawning can take place in river and stream habitats, but the persistence of the splittail is now dependent on seasonal floodplains including the Yolo and Sutter bypasses and Cosumnes River.

Loss and degradation of shallow, near-shore habitat is a historic, current and future threat to the splittail. Riparian and natural bank habitats are features that historically provided splittail with spawning substrate, organic material, food supply, and cover from predators. Vast stretches of the Sacramento and San Joaquin Rivers, their tributaries, and distributary sloughs in the Delta have been channelized and much of the shallow nearshore habitat has been leveed and riprapped. The prevention of channel meandering by the placement of riprap is causing a continual loss of low velocity shallow water breeding habitat (Feyrer *et. al.* 2005, p. 167).

Beneficial Actions Offsetting Adverse Effects

While habitat loss has occurred, a number of habitat restoration actions are also being undertaken.

CALFED Habitat Restoration: The CALFED Bay Delta Program (CALFED) leadership has recently transitioned from the CALFED Bay Delta Authority to the Bay Delta Stewardship Council. This changed the name and governing structure of the program, but did not change the 2000 Record of Decision (ROD) for CALFED or any goals or objectives of the CALFED plan.

The CALFED plan exists as a multi-purpose (water supply, flood protection, and conservation) program with significant ecosystem restoration and enhancement elements, The program brought together more than 20 State and Federal agencies to develop a long-term comprehensive plan to restore ecological health and improve water management for all beneficial uses of the Bay-Delta system. The plan specifically addresses ecosystem quality, water quality, water supply, and levee system integrity.

The CALFED Ecosystem Restoration Program (ERP) presented a strategic plan for implementing an ecosystem-based approach for achieving conservation targets (CALFED 2000a, pp. 1-3). The CDFG is the primary implementing agency for the ERP. The goal of ERP to improve the conditions for the splittail will remain whether the splittail is listed as threatened or endangered or not listed. In the CALFED process, the splittail’s status could be adversely affected by program elements to: Increase water storage in the Central Valley upstream of the Delta; modify Delta hydrologic patterns to convey additional water south, and upgrade and maintain Delta levees. However, as noted previously CALFED has an explicit goal to balance the water supply program elements with the restoration of the Bay-Delta and tributary ecosystems and recovery of the splittail and other species. Because achieving the diverse goals of the program is iterative and subject to annual funding by diverse agencies, CALFED has committed to maintaining balanced implementation of the program within an adaptive management framework. Within this framework of implementation, it is intended that the storage, conveyance, and levee program elements would only be implemented in such a way that the splittail's status would be maintained and eventually improved.

CALFED has identified 29 specific species enhancement conservation measures for splittail (CALFED 2000b. There are more than 150 projects that benefit the splittail or its habitat in the plan and more than half of those have been completed to date (2010 ERP database spreadsheets). Key accomplishments of the ERP include investments in fish screens, temperature control, fish passage and habitat protection and restoration (CALFED 2007, p. 2)

Additional projects such as Cosumnes River floodplain restoration and Liberty Island restoration are ongoing. Major obstacles to the completion of these projects , especially the acquisition of land have been overcome. Although discussion of all 150 programs currently benefitting splittail will not be practical in this document, we have highlighted several projects that have played an important role in offsetting threats to the splittail into the foreseeable future.

Liberty Island lies at the southern end of the Yolo bypass. After years of active agricultural production on Liberty island, the levees were breeched in 1997 and the island was allowed to return to a more natural state (Wilder 2010, PowerPoint s. 4). The CALFED program funded the purchase of the island in 1999 by granting money to the

Trust for Public Lands for the acquisition of the island (Wilder 2010, PowerPoint s. 5). Splittail are utilizing the flooded island and have been documented in a number of surveys including the beach seine survey in which they were the most abundant fish caught from August 2002 to July 2003 (Wilder 2010, PowerPoint s. 22; Liberty Island Monitoring Program 2005, p. 37; Marshall *et al.* 2006, p. 1). Splittail are utilizing the southern portion of the island more than the northern portion of the island (Webb 2009, p. 1). In 2007, the Delta Juvenile Fish Monitoring program was awarded $2.5 million from the CALFED program for the Breach III study at Liberty Island. Work has been initiated and results will assist agencies in understanding the ecological system and developing recommendations for future restoration projects (Hrodey 2008). There are currently plans to remove additional levees by Wildlands Corporation which has acquired a portion of Liberty Island that it plans to return to natural floodplain habitat. Wildlands Corporation's actions may be approved and initiated within the next year, but cannot be counted as a conservation measures at this time (Roper 2010, pers. comm.). When these actions are implemented, they are expected to further increase splittail spawning grounds on Liberty Island.

Restoration efforts have also been undertaken at the Cosumnes River Preserve (hereafter referred to as the Preserve) under management of the Bureau of Land Management (BLM), The Nature Conservancy, and a number of other agencies and private organizations. Restoration activities that benefit splittail include riparian enhancement and intentional breaching of levees to restore floodplain function. The Preserve opened 81 ha (200 acres) to flooding in October of 1995 by removing a 15.2 m (50 ft) section in a levee along the Cosumnes River (Cosumnes River Preserve

Management Plan March 2008). Following floods in 1995 and 1997, the decision was made by the Preserve in coordination with the U.S. Army Corps of Engineers to not repair the portions of the levees breeched by the floods thus allowing for a more natural flood regime (Cosumnes River Preserve Management Plan March 2008, ch. 2 pp. 6-7). Levees have been breached in a total of five locations to allow flooding of a variety of habitats including marshes and sloughs (Crain *et al.* 2004, p. 126). Restoration is ongoing and splittail are likely to benefit from these efforts, as the area has also been described as among the most important floodplain habitats still available to the species (Moyle *et al.* 2004, p. 17). Splittail used the Preserve floodplains during both years of a study conducted in 1999 and 2001 (Crain *et al.* 2004, p. 140). Splittail larvae were present in 2001 when only a small portion of the floodplain in the study area was inundated. Although spawning was not observed, it is presumed to have occurred in the last week of March or the first week of April since larvae appeared shortly after. Larvae moved off the floodplain during cold-water flow pulses in the last week of April and the first week of May (Crain *et al.* 2004, p. 140).

Other Habitat Restoration Projects:

The Yolo Bypass Wildlife Area (Wildlife Area), located within the Yolo Bypass, currently encompasses 6,787 ha (16,770 ac). This area has increased substantially since CDFG's original acquisition of approximately 1180 ha (2,917 ac) in 1991. The added area has allowed restoration actions that benefit splittail spawning efforts to proceed by creating new seasonal floodplains (Yolo Bypass Wildlife Management Land

Management Plan, 2008, ch.1).

In early 2002, the Sacramento River National Wildlife Refuge Complex (SRNWRC) began implementation of a Plan for Proposed Restoration Activities on the Sacramento River National Wildlife Refuge. The restoration activities have resulted in the reestablishment or enhancement of 1707 ha (4, 218 ac) of the SRNWRC (Silveria 2010, pers. comm.). This restoration is expected to benefit splittail through improvement of vegetative conditions on floodplains. Restoration and enhancement involve the removal of crops, orchards, and related infrastructure (pumping units, barns, sheds, etc.) followed by replacement with native vegetation appropriate to each site. In addition to restoration efforts, levees have been removed at the Flynn and Rio Vista units and a levee has been breached at the La Barracna unit (Silveira 2010, pers. comm.). These efforts allow for a more natural floodplain regime and increase native vegetation that benefits splittail.

Summary of Factor A

Rip-rapping of river and stream habitat constitutes a potential threat to the Sacramento splittail. The implementation and magnitude of the CALFED, Central Valley Project Improvement Act (CVPIA) (discussed under *Factor D*) and other habitat restoration activities, which focus on the restoration of habitats that directly and indirectly benefit splittail go far beyond any foreseeable future habitat losses. The overall effect of habitat restoration activities is also expected to continue to be beneficial for splittail into the future.

Efforts undertaken in the past decade have benefited the species by restoring its habitat. There is presently sufficient habitat to maintain the species, and inundation frequency and duration in key areas is sufficient to provide spawning to maintain the species. Furthermore, habitat restoration activities that have been completed are currently being implemented and those planned for the future are adding to the available habitat for the species.

We conclude that the best scientific and commercial information available indicates that the Sacramento splittail is not now, or in the foreseeable future, threatened by the present or threatened destruction, modification, or curtailment of its habitat or range.

Factor B. Overutilization for commercial, recreational, scientific, or educational purposes

Recreational Fishing

Splittail were historically abundant enough to be harvested by Native Americans and commercial fisheries, although no studies on abundance were begun until 1963 (Moyle *et. al.* 2004, p. 7). Today, splittail are harvested for bait by the sport fishery and as a food source, but take is limited by the California Fish and Gave Commission to two individuals per day as further discussed under *Factor D*. The largest splittail may be the first to engage in the spawning migration (Caywood 1974; Moyle *et al.* 2004, p. 15). The early-season fishery potentially targets and removes females with high reproductive potential. The effect of this fishery in the Sacramento River may be relatively greater in dry years, when splittail spawning is largely confined to river margins where fishing effort is concentrated. Splittail is known to be an effective bait fish for striped bass and is commonly caught by anglers for this use (Moyle *et al.* 2004, p. 19). The splittail fishery is the smallest fishery targeted in the CDFG angler survey (SFRA 2008). At present, there is no evidence of any trend in the available data suggesting that larger fish are being disproportionally removed from the population or that the size structure of the splittail population has been altered by this small fishery. There is no indication that the intensity of fishing or bag limits will increase in the future.

Scientific Collection

Monitoring surveys conducted throughout the year, including the Fall Mid-Winter Trawl (FMWT), Summer Tow Net Survey (TNS), Beach Seine Survey, Chipps Island Trawl, Suisun Marsh Survey, and Spring Kodiak Trawl Survey (SKT) capture and record adult and juvenile splittail. These surveys sometimes result in the unintentional mortality of some individuals. Data from the last 12 years of surveys conducted by the Service are in Table 3.

Table 3. Take (collection and release) and mortality by U. S. Fish and Wildlife Service surveys for 1999- 2010.

Survey	**Number Taken**	**Mortality**
Chipps Island	6887	339

Mossdale	146,854	1,856
Service Beach Seine	207,137	2,394

An average of 383 splittail are killed every year in the course of conducting Service surveys. Adult splittail spawn up to 100,000 eggs per individual per fecundity event and the loss of a few thousand individuals from scientific collection over a 10 year period is not expected to have a significant effect at the population level. We have no information to indicate use of the species for other commercial, recreational, scientific, or educational purposes.

Summary of Factor B

The new CDFG regulation enacted in March 2010 limiting take of splittail to two individuals per day has eliminated any potential threat that fisheries may have posed. The best available scientific and commercial data shows that this current level of take does not adversely affect the splittail population or that this level of mortality will increase in the future.

Annual Service surveys result in an average of 383 splittail being killed each year. However, due to the high fecundity rate of splittail, the average yearly loss has not had a significant effect at the population level and the information obtain from the surveys is being used to monitor the splittail populations.

We conclude that the best scientific and commercial information available indicates that the Sacramento splittail is not now, or in the foreseeable future, threatened by the overutilization for commercial, recreational, scientific or educational.

Factor C. Disease or predation

Disease

The south Delta is fed by water coming from the San Joaquin River, where pesticides (e.g., chlorpyrifos, carbofuran, and diazinon), salts (e.g., sodium sulfates), trace elements (boron and selenium), and high levels of total dissolved solids are prevalent due to agricultural runoff (64 FR 5963, February 8, 1999). Of specific concern are the threats posed by heavy metals such as mercury, selenium, and pesticides. There is some possibility that disease in splittail could be a function of increased contaminant loading and subsequent immune system depression. Disease related to contaminants is further discussed under *Factor E* below.

Splittail naturally carry parasites like most fish, but the effects of parasites such as anchor worms manifest primarily when fish are already stressed from other causes such as spawning (Moyle *et al.* 2004, p. 19). Post-spawn adult splittail and male fish in particular, are substantially weakened when migrating back to the estuary. We found no information to indicate disease is a threat to the species. We therefore, conclude that the best scientific and commercial information available indicates that disease does not constitute a significant threat to splittail now or in the foreseeable future

Predation

Predators of splittail include striped bass (*Morone saxatilis*), largemouth bass (*Micropterus salmoides*), and other native and non-native piscivores (Moyle 2004, p. 18). In the past, we have considered threats of predation to be minor because striped bass had coexisted with splittail for decades and because CDFG stopped hatchery rearing and release of striped bass in 2001 (59 FR 862, 64 FR 5963). Striped bass populations have undergone a substantial decline starting in the mid 1980's shortly after the overbite clam was introduced (Kimmerer *et al.* 2008, p. 84). Furthermore, they are just one example of the many species impacted by the larger Pelagic Organism Decline (POD) that began in the beginning of the new millennium (Ballard *et al*. 2009, p. 1). Changes in the foodweb, toxic effects, export pumping and lowered habitat quality are all potential causes of the POD. If non-native striped bass populations increase, all size classes of splittail could be under greater threat of predation. However, as stated above, striped bass populations are in decline.

In contrast to striped bass, the abundance of largemouth bass has increased substantially in the Delta in the past three decades (Brown and Michniuk 2007, p. 195; Nobriga 2009, p. 112). The evidence suggests that largemouth bass have taken advantage of the proliferation of submerged vegetation throughout much of the Delta and the increasing water clarity that has come with it (Brown and Michniuk 2007, p. 195). Although, largemouth bass are a greater source of splittail mortality than they were several decades ago, populations of largemouth bass in critical rearing areas are low and predation levels appear to be minor. Also, the high reproductive nature of splittail life history has enabled it to overcome the predation that is occurring from largemouth bass.

Based on a review of the best scientific and commercial information available, we find that predation is not a significant threat to the splittail now or in the foreseeable future.

Summary of Factor C

We found that disease occurs at low levels in the population, but does not constitute a significant threat to the species. Predation by striped bass appears to be unchanged from past levels. It is currently not a significant threat to splittail populations and is not expected to increase in the future. Largemouth bass populations have increased in the Estuary in the past three decades, but populations of largemouth bass in critical rearing areas are low, and therefore predation levels appear to be minor. We conclude that the best scientific and commercial information available indicates that the Sacramento splittail is not now, or in the foreseeable future, threatened by disease or predation.

Factor D. The inadequacy of existing regulatory mechanisms

State Laws

The Porter Cologne Water Quality Control Act establishes the State Water Resources Control Board (SWRCB) and nine Regional Water Quality Control Boards that are responsible for the regulation of activities and factors that could degrade California water quality and for the allocation of surface water rights (California Water Code Division 7). In 1995, the SWRCB developed the Bay-Delta Water Quality Control Plan to establish water quality objectives for the Delta. This plan is implemented by Water Rights Decision 1641, which imposes flow and water quality standards on State and federal water export facilities to assure protection of beneficial uses in the Delta (FWS 2008, pp. 21-27). The various flow objectives and export restraints are designed, in part, to protect fisheries. Objectives that benefit splittail by increasing water availability and in turn available habitat include specific outflow requirements throughout the year, specific water export restraints in the spring, and water export limits based on a percentage of estuary inflow throughout the year. The water quality objectives are designed to protect agricultural, municipal, industrial, and fishery uses; they vary throughout the year and by the wetness of the year.

Assembly Bill (AB) 360, the State Delta Flood Protection Act, has a primary purpose of strengthening Delta levees with various “hard'” structures, including rip-rap. Habitat restoration components of AB 360, considered mitigation for concurrent State projects' impacts to aquatic and terrestrial ecosystems in the Delta, require improvement rather than a strict mitigation approach which results in an increased habitat benefit and a net increase in habitat.

The State Senate Bill (SB) 1086-funded Sacramento River Conservation Area Forum is an interagency group chartered to promote and guide protection and enhancement of riparian resources and fluvial function along the reach of the lower Sacramento River between Red Bluff and Colusa. The Nature Conservancy, working with the Sacramento River Conservation Area and local stakeholders, has restored more than 1214 ha (3,000 ac) to date (The Nature Conservancy Website, Sacramento River, 2010). These restoration efforts have replaced farmland with potential splittail spawning and rearing habitat.

California Environmental Quality Act (CEQA)

The California Environmental Quality Act (CEQA) requires review of any project that is undertaken, funded, or permitted by the State of California or a local government agency. If significant effects are identified, the lead agency has the option of requiring mitigation through changes in the project or to decide that overriding considerations make mitigation infeasible (CEQA Sec. 21002). In the latter case, projects may be approved that cause significant environmental damage, such as destruction of listed endangered species or their habitat. Protection of listed species through CEQA is, therefore, dependent on the discretion of the lead agency. The CEQA review process ensures that a full environmental review is undertaken prior to the permitting of any project within splittail habitat.

Streambed Alteration

Section 1600 of the California Fish and Game Code authorizes CDFG to regulate streambed alteration. The CDFG must be notified of and approve any work that substantially diverts, alters, or obstructs the natural flow or substantially changes the bed, channel, or banks of any river, stream or lake. If an existing fish or wildlife resource including the splittail may be substantially adversely affected by a project, CDFG must submit proposals to protect the species to the person proposing to alter the streambed within 60 days (Section 1602 of the California Fish and Game Code).

Federal Laws

National Environmental Policy Act: The National Environmental Policy Act (NEPA) (42 U.S.C. 4321 *et seq.*) requires all federal agencies to formally document, consider, and publicly disclose the environmental impacts of major federal actions and management decisions significantly affecting the human environment. NEPA documentation is provided in an environmental impact statement, an environmental assessment, or a categorical exclusion, and may be subject to administrative or judicial appeal. However, the Federal agency is not required to select an alternative having the least significant environmental impacts, and may select an action that will adversely affect sensitive species provided that these effects are known and identified in a NEPA document. Therefore, we do not consider the NEPA process in itself to be a regulatory mechanism that is certain to provide significant protection for the splittail.

Central Valley Project Improvement Act: The Central Valley Project Improvement Act (CVPIA) (Public Law 102-575) signed October 30, 1992, amends previous authorizations of the Central Valley Project (16 U.S.C 695d-695j) to include fish and wildlife protection, restoration, and mitigation as project purposes having equal priority with irrigation and domestic water supply, and fish and wildlife enhancement having equal priority with power generation (Public Law 102-575, October 30, 1992).

Clean Water Act: The Clean Water Act (33 U.S.C. 1251 *et seq*.), established in 1977, is the primary federal law in the United States governing water pollution. The Environmental Protection Agency (EPA) which is responsible for administering the Clean Water Act has given the responsibility of issuing a “303 list” (impaired water body list) to the respective Regional Water Quality Control Board that has jurisdiction over the particular water bodies. Water bodies that do not meet applicable water quality standards are placed on the section 303(d) list of impaired water bodies and the State is required to develop a Total Maximum Daily Load Limit for the water body (TMDL). A TMDL is a calculation of the maximum amount of a pollutant that a water body can receive and still meet water quality standards.

San Joaquin Drain TMDL for Selenium

As discussed under Factor E, selenium has negative effects on splittail. The following paragraph discusses the regulatory mechanism in place to reduce selenium input into the Estuary. Selenium total maximum daily load limits have been established by the California Regional Water Quality Control Board (Waste Discharge requirement 5-01-234 2001, p. 12) for selenium discharged from the San Luis Drain. Selenium load limits are determined by wet or dry year classes and limits were incrementally lowered from 2994 kilograms (kg) (6600 pounds (lbs)) in 1996-1997 to 1604 kg (3236 lbs) in 2007-2008 (United States Bureau of Reclamation (USBOR) 2009, pp. 1-5). Following the implementation of these limits, selenium discharged from San Luis Drain was reduced from 3175 kg (7000 lbs) in 1996-1997 to 791 kg (1744 lbs) in 2007-2008 (USBOR 2009, pp. 1-5)). Although this will have limited immediate effect on reducing selenium concentrations in splittail habitat, it is a protective measure that will have a long-term effect on reducing selenium loads in the Estuary and reducing or stabilizing the threat of selenium to splittail in the future.

Lack of Total Maximum Daily Limits on contaminants at Wastewater Treatment Plants

As discussed under *Factor E*, ammonia has negative effects on splittail. The following paragraph discusses the lack of regulatory mechanism acting to reduce ammonia input into the Estuary. The Sacramento Regional Wastewater Treatment Plant SRWTP is responsible for 90 percent of the total ammonia load released into the Delta. Monthly loads of ammonia from the SRWTP released into the Sacramento River doubled from 1985 to 2005. Approximately 598 million liters (158 million gallons) per day were discharged from the SRWTP from 2001 to 2005 (Jasby *et al*. 2008, p. 15).

There are currently no regulations or limits on the amount of ammonia being discharged by waste water treatment plants that discharge into the Delta. The lack of Clean Water Act mechanisms limiting ammonia discharged from these plants constitutes a low magnitude threat to the splittail population. However, the EPA is currently updating freshwater ammonia criteria on ammonia discharged from the SRWTP (EPA 2009, pp. 1-46). On December 30, 2009 (74 FR 69086), the EPA announced the availability of draft national recommended water quality criteria for ammonia for the protection of aquatic life entitled, "Draft 2009 Update Aquatic Life Ambient Water Quality Criteria for Ammonia—Freshwater." The EPA accepted public comments on that draft document until April 1, 2010 (75 FR 8698, February 25, 2010). The EPA is currently reviewing the comments and expects to begin enforcement of the criteria within 12 months. Ammonia and its detrimental effects on the splittail population are discussed under the contaminants section under *Factor E*.

California Fish and Game Commission Take Limit

The State of California Fish and Game Commission reduced a potential threat to splittail on March 1, 2010, when a new harvest limit on splittail was enacted through the addition of section 5.70 to Title 14 of the California Code of Regulations (CDFG2010, p. 1). CDFG now limits the take of splittail species to two individuals per person per day. Secondary data collected during creel surveys for salmon and striped bass suggest that in the past, a total catch of hundreds of adult fish may have been caught on a daily basis (Moyle *et. al.* 2004, pp. 6-13). The creel limit has reduced the impact of fishing on splittail.

Summary of Factor D

Federal and State regulations described above provide protection for the splittail and its habitat by limiting adverse affects from new projects, restoring habitat and limiting contaminants discharged into the Estuary. We acknowledge however that steps are currently being taken by the California Central Valley Regional Water Quality Control Board to enact new revised criteria on the ammonia that is discharged from the SRWTP. Ammonia may be affecting individuals within the population as discussed under Factor E, but we have no evidence that the current lack of regulatory mechanisms limiting ammonia discharges are having a significant population level effect on the splittail.

We conclude that the best scientific and commercial information available indicates that the Sacramento splittail is not now, or in the foreseeable future, threatened by inadequate regulatory mechanisms.

Factor E. Other natural or manmade factors affecting its continued existence

We have identified the risk of water export facilities, agricultural and power plant diversions, poor water quality, environmental contaminants, climate change and introduced species as potential threats to the Sacramento splittail.

Water Export Facilities

The Central Valley Project (CVP) was devised to tame the flood waters of the Sacramento River and provide irrigation water for the Central Valley of California. The project today includes 20 dams, 800 km (500 mi) of aqueducts and up to 8.6 kilometers cubed ($\text{km}^{\wedge 3}$) (7 million acre-feet (maf)) of water exported annually for agriculture, wildlife and urban uses (USBR Central Valley Project, 2009). The CVP’s Jones Pumping

Plant consists of five pumps with a permitted diversion capacity of 130 cubic meters per second (cms) (4, 600 cubic feet per second (cfs)). The pumping plant raises water into the Delta-Mendota Canal, which supplies water to much of the San Joaquin Valley. This intricate system of water diversion and storage has changed the historical hydrological features of the watershed systems and affected the many species that are dependent on them including the splittail. Reservoir and flood control operations inadvertently drain shallow water spawning habitat along river corridors and exacerbate stranding of splittail. Operations of Shasta and Trinity Dams and water diversions including the Tehama-Colusa, Corning, and Glenn Colusa canals, and the Red Bluff diversion dam further reduce instream flows. These reductions in water flow have resulted in the elimination of large tracts of spawning habitat for the splittail. Furthermore, dams may have reduced the distribution of the splittail by restricting movement to potential spawning grounds and creating migration obstacles. These dams and diversions have altered and eliminated habitat for splittail, and have on-going affects.

The State Water Project (SWP) consists of a network of dams, reservoirs, canals and diversion facilities. Oroville Dam, on the Feather River, and Lake Oreville, have a maximum operating storage of 3,537,580 acre-feet. The Banks Pumping Plant has a capacity of 291 cms (10,300 cfs), which is effectively limited by regulation to 203 cms (7,180 cfs). Water is conveyed via the Old and Middle River channels, resulting in a net (over a tidal cycle or tidal cycles) flow towards the pumping plants. When combined State and Federal water exports exceed San Joaquin River inflow, the additional water is drawn from the Sacramento River through the Delta Cross Channel, Georgiana Slough and Three-Mile Slough. Combined flow in Old and Middle Rivers is referred to as

“OMR” flows while flow in the lower San Joaquin River is referred to as “QWEST.”

Four major water diversion facilities exported between 4.85 and 8.7 km^3 (3.93 and 7.05 maf per year from the Delta during the years 1995 through 2005 (Kimmerer and Nobriga 2008, p 2). Of these, the State and Federal facilities exported between 4.7 and 8.4 km^3 (3.81 and 6.81 maf) averaging 7 km^3 (5.7 maf) every year (DWR 2010b, p. 10). The Barker Slough Pumping Plant, with a capacity of 175 cfs, diverts water from the Barker Slough, south of the city of Dixon, into the North Bay Aqueduct for delivery to Napa and Solano Counties. Each of the ten pump bays is screened to exclude fish one inch or larger. The Old River intake for the Contra Costa Water District is located on Old River near State Route 4. It has a positive-barrier fish screen and a pumping capacity of 250 cfs. It supplies water to Contra Costa Canal and to Los Vaqueros Resovoir for use in the East Bay area.

The State Water Resources Control Board’s revised Decision 1641 established an expert-to-inflow operational objective that allow the SWP and CVP pumps to divert from 35 percent to 65 percent of the Delta inflow (SWRCB 2000). From July through January, the objective is 65 percent and from February through June, the objective is 35 percent, to protect fish and wildlife beneficial uses. The State Board also established additional water quality objectives that may further limit export pumping. Both pumping stations are equipped with their own fish collection facilities that divert fish into holding pens using louver-bypass systems to protect them from being killed in the pumps.

Operation of the CVP and SWP water export facilities directly affects fish by entrainment into their diversion facilities. Splittail are relocated if entrained. These salvaged fish are then loaded onto tanker trucks and returned to the western Delta downstream (Aasen 2009, p. 36). The movement of fish can result in mortality due to stress, moving procedures, or predation at locations where the fish are moved too. It is unknown how many fish survive this process, but mortalities could be high due to overcrowding in the tanks and predation at drop-off points. Splittail females migrating upstream to spawn are transported back downstream by truck if entrained and could potentially be forced to start their migration again. It is speculated that this could result in their removal from the spawning population for that year (Moyle *et al.* 2004, p. 20).

The fish collection facilities entrain a great number of splittail in hydrologically wet years (approximately 5 million splittail in 1995, 3 million in 1998 (Moyle *et al.* 2004, p 21), and 5.5 million in 2006 (Aasen 2007, p. 49)) when spawning on the San Joaquin River and other floodplains results in a spike in population numbers. However, entrainment is low during hydrologically dry years when recruitment is low (1,300 splittail in 2007 (Aasen 2008, p. 55) and about 5,000 in 2008 (Aasen 2009, p. 43)). These figures show the high annual variability of reproductive success. Research has shown no evidence that south Delta water exports have a significant effect on splittail abundance although that does not mean that entrainment never affects the species (Sommer *et al*. 2007, p. 32). Most entrained individuals tend to be young of the year migrating to optimal downstream rearing habitat, although some migrating adults do get entrained (Sommer *et al*. 1997, p. 973). If distribution of age 0 individuals was to shift toward the export pumps in a dry year with low reproductive output, there could be substantial effect on that year-class (Sommer *et al.* 1997, p. 973). However, this would only constitute a potential threat to that particular year class and still does not represent a significant threat to the overall population since it would occur only during a dry year. The pumping facilities do not represent a significant threat to the splittail because loss of substantial number of fish tends to occur during wet years in which the species is experiencing a high reproductive output.

Agricultural Diversions for Irrigation

Fish including splittail can become entrained in agricultural water diversions. This entrainment can result in injury or mortality. The diversion of water flows by agricultural pumping can also alter natural flow regimes and impede migration. Screening of agricultural diversions has been a common practice in recent years in order to conserve and restore populations of anadromous fishes in the Central Valley of California. There are over 3,700 diversions on the Sacramento and San Joaquin Rivers and their tributaries, and the Sacramento-San Joaquin Delta and Suisun Marsh. Over 2,300 of these diversions are located in the Sacramento-San Joaquin Delta, with over 350 in Suisun Marsh. Of these 3,700 existing diversions, over 95 percent are currently unscreened (CDFG 2010).

Under both the CALFED Bay-Delta Program and the Central Valley Project Improvement Act there have been significant efforts to screen agricultural diversions in the Central Valley and the Sacramento-San Joaquin Delta, particularly the larger unscreened diversions over 4.24 cms (150 cfs) on the Sacramento River. Entrainment of splittail at diversions is reduced if fish screens are installed at diversions within splittail habitat areas.

Currently, all of the unscreened diversions on the Sacramento River main stem over 4.24 cms (150 cfs) have been screened or are currently proposed to be screened.

There are a number of large unscreened diversions over 4.24 cms (150 cfs) on the San Joaquin River. Many of these larger diversions will be considered for screening as part of the San Joaquin River Restoration Program. The Sacramento-San Joaquin Delta region is the location of the majority of unscreened diversions, with most of these diversions under 1.41 cms (50 cfs) (Meier 2010, pers. comm.).

CALFED's Ecosystem Restoration Program includes a program to consolidate and screen the remaining small agricultural diversions in the Delta, and the Sacramento and San Joaquin rivers. The NOAA Fisheries Restoration Center has also begun to fund small fish screen projects in the Sacramento River within the range of the splittail. The amount of entrainment that may occur at the remaining unscreened diversions is not well-known, and efforts to determine the effect of entrainment on splittail have been limited. In July of 2001 and 2002, Nobriga *et al.* sampled fish entrained within a 61 cm (24 in) diameter pipe at the CDWR Horseshoe Bend Diversion facility (Nobriga *et al.* 2004, p. 1). They collected only one splittail during two sampling periods, finding entrainment to be exceptionally low (Nobriga *et. al.* 2002, p. 35-44). 115, 000 m^3 of water passing through an unscreened diversion was sampled over a 69 hour period (Nobriga *et al.* 2004, pp. 1-16). Another study at the Morrow Island Distribution System showed that the diversions there took 666 splittail young-of-the-year-individuals, but only nine individuals of age one or older (Enos 2010, p. 14). After sampling 2.3 million m^3 (81.2 million ft^3) of water, it was concluded that entrainment of special status species including the splittail was exceptionally low (Enos 2010, p. 17). In analyzing these results, it is helpful to compare this take to the 5million to 6 million splittail that can be entrained at the south Delta water export pumps in a single year. Research has shown no evidence that south Delta water exports have a significant effect on splittail abundance (Sommer *et al*. 2007, p. 32). Splittail adults can yield up to 100,000 eggs in a single spawning event, therefore the loss of thousands or even a million young-of-year is not expected to effect the longterm population viability of the species. Furthermore, splittail may not be as vulnerable to agricultural diversions as other fish species are because adult splittail migrate during winter to early spring when agricultural diversion operations are at a minimum.

We do not consider entrainment by agricultural diversions to be a significant threat to splittail. Additionally, these effects from agricultural diversions are expected to decrease in the future as additional diversions continue to be screened.

Power Plant Diversions

Two power plants located near the confluence of the Sacramento and San Joaquin rivers pose an entrainment risk to splittail: the Contra Costa Power Plant and the Pittsburg Power Plant. The intakes for the cooling water pumps of these power plants are located in close proximity to splittail rearing habitat (Moyle *et al.* 2004, p. 20). The maximum combined non-consumptive intake of cooling water for the two facilities is 91.7 cms (3,240 cfs), which can exceed 10 percent of the total net outflow of the Sacramento and San Joaquin rivers. Thermal and chemical pollution in the forms of raised water temperature and chlorine discharges may also have a detrimental effect on splittail (USFWS 2008, pp. 173-174). However, power plant operations have been substantially reduced since the 1970s, and the plants are now either kept offline, or are operating at very low levels, except as necessary to meet peak power needs. Due largely to this reduction in the operation of the power plants and their associated pumping for cool water, we do not consider the operation of these power plants to constitute a significant threat to the splittail population. We have no indications of future plans to use these pumps more frequently and therefore, do not consider these operations to be a threat in the future.

Water Quality and Environmental Contaminants

Although recent research funded by CALFED and carried out in a large part by UC Davis has shed some light on the dynamics and impacts of contaminants entering the Delta system, the overall effects of these contaminants on ecosystem restoration and species health are still poorly understood. All major rivers that are tributaries to the Estuary are exposed to large volumes of agricultural and industrial chemicals that are applied in the Central Valley watershed (Nichols *et al.* 1986, pp. 568-569), as well as chemicals originating in urban runoff that find their way into the rivers and Estuary. In addition, re-flooding of the Sutter and Yolo Bypasses and the use of other flooded agricultural lands by splittail for spawning can result in agricultural-related chemical exposures.

A majority of the Delta has been placed on the Clean Water Act's 303d list of impaired waterbodies due to the documented presence of polychlorinated biphenyls (PCBs), organophosphate pesticides, other legacy pesticides, and some metals – particularly mercury (CVRWQCB 2006, pp. 5-11). These contaminants can have adverse effects on fish (i.e., splittail), but the magnitude of effects are dependent upon: The chemical form of the contaminant in question; the contaminant's bioavailability under certain water quality parameters (i.e., hardness, pH, etc.); the nature of the response being measured in the fish (acute toxicity, bioaccumulation, reproduction, etc.); and the nature/status of the individual fish (age, weight, health, etc.).

All life stages of splittail are potentially exposed to varying amounts and mixtures of chemical contaminants in the Delta and associated water bodies. Acid mine drainage has been a serious environmental problem in the northern portion of the Sacramento River Basin (Alpers *et al*. 2000a, p.4; b, p. 5). Several streams are listed as impaired because of high concentrations of metals such as cadmium, copper, lead, and zinc. Metals concentrations in previous years have been toxic to fish in the upper Sacramento River near and downstream from Redding (Alpers *et al*. 2000a, p 4; b, p. 5). Recent mitigation efforts at one of the more contaminated sites in the Spring Creek drainage near Shasta Lake have significantly lowered concentrations of metals in the Sacramento River, and no toxic effects to fish were observed during the course of this investigation (Alpers *et al*. 2000a, p.3; b, p. 2). However, elevated levels of metals such as copper in streambed sediment can still be measured in the upper Sacramento River Basin downstream from Redding (MacCoy and Domagalski, 1999, p. 35). Copper and other metals may still affect aquatic organisms in upper portions of contributing watersheds of the Delta. However, five potential contaminant threats have been identified as a concern specifically with respect to the splittail: (1) selenium, (2) mercury, (3) organophosphates, (4) pyrethroids, and (5) ammonium/ammonia. A summary of each identified contaminant threat is provided below. In part, these contaminant threats are of concern because they may be focused, to varying degrees, on habitat features and biological characteristics tentatively identified as particularly relevant to splittail conservation.

Selenium

The primary risk posed by selenium is a direct result of its propensity to cycle through the food web, its dominant exposure pathway, and its ability to cause reproductive impairment in fish (Lemly 1999, p. 150-151; Lemly 2002, p.47). The primary source of selenium coming into the Delta system enters through the San Joaquin watershed in the form of agricultural run-off via the San Luis Drain (Luoma *et al.* 2008, p. 63). Recent studies on selenium toxicity in aquatic food chains have generally reached the conclusion that a water-based criterion is not suitable due to "…temporal [and spatial] changes in concentrations, speciation, and rates of transfer between water, sediment and organisms…" (Hamilton 2004, p. 8). Since the primary route of exposure to selenium is via the diet, and selenium is highly bioaccumulative, these differences can mean that a concentration of selenium in water that results in adverse effects in one location may not result in adverse effects to the same species in another location. Thus, the current recommendation (USEPA 2004, p. 82; Chapman 2007, p. 21; Hamilton 2002, p. 95; 2004, p. 22) for the appropriate media for regulation of selenium in the aquatic environment is not water, but rather tissue.

To examine the potential adverse effect levels of selenium on splittail, Teh *et al*. (2004, pp. 6085-6087) fed juvenile splittail organic selenium for 9 months in the laboratory. From this experiment, Teh *et al*. (2004, pp. 6087-6090) derived a no observed adverse effects level (NOAEL) and lowest observed adverse effects level (LOAEL) for deformities in juvenile splittail of 10.1 and 15.1 mg/kg-dry weight (dw) in muscle tissue and 23.0 and 26.8 mg/kg-dw in liver tissue, respectively. However, Rigby *et al*. (2010, p.77) performed a logistic regression using data from Teh *et al*. (2004, pp. 6087-6090) to derive a more precise estimate of the threshold for selenium toxicity in splittail and derived EC_{10} values of 0.9 mg/kg-dw in feed, 7.9 mg/kg-dw in muscle, and 18.6 mg/kg-dw in liver for juveniles. The derived EC_{10} values by Rigby *et al*. (2010, p. 79) represent the predicted selenium concentration at which deformities would be observed in 10 percent of the juvenile population.

In a laboratory setting, research by Teh *et al*. (2004, p. 6092) has shown that the prevalence of deformities among juvenile splittail in the laboratory increase at dietary concentrations greater than 6.6 mg/kg-dw while concentrations of 26.0 mg/kg-dw and greater significantly decrease body weight, total length, and condition factors of juvenile splittail. This may be due to the liver's inability to metabolize and excrete biochemicals due to its reaction to high selenium intake (Teh *et al.* 2004, p. 6092).

In field settings, selenium concentrations analyzed from tissues of adult splittail captured in the Suisun Bay/Marsh area show elevated concentrations in muscle ranging from 4 to 5 mg/kg (5 ppm), and liver concentrations ranging as high as 20 mg/kg (20 ppm) (Stewart *et al.* 2000, p. 1). The median selenium liver concentrations in splittail collected from Suisun Bay are about 13 μg/g-dw (13 ppm) (Stewart *et al*. 2004, p. 4523). Although deformities typical of selenium exposure including lordosis (spinal deformities) have been observed in splittail collected from Suisun Bay (Stewart *et al*. 2004, p. 4524), the known data on muscle and liver concentrations in splittail adults are below the EC_{10} values derived by Rigby *et al.* (2010, pp. 76-79).

Current threshold tolerances of selenium exposures by splittail may be higher than other species that use upper portions of the water column (Teh *et al.* 2004, pp. 6087-6090). However, laboratory and field studies cited above lead us to conclude that although selenium is considered elevated within the Delta, selenium exposures, although important, are not having a significant population-level effect on the species.

Bioaccumulation of selenium by splittail in the Estuary is a potential concern because the diet of adult splittail consists of bivalves (including Asiatic clam and overbite clam), amphipods, cladocerans, harpacticoid copepods, mysids, and detritus (Moyle *et al*. 2004, p. 22). Asiatic and overbite clams are benthic filter feeders that take up and accumulate selenium (Stewart 2004, p. 4522). The relationship between the bioaccumulation of selenium in the overbite clam and its predation by splittail may be significant because subsequent to the clam invasion, splittail shifted their diet from prey items such as estuarine copepods to a diet increasingly focused on bivalves, in particular, overbite clams (Feyrer *et al.* 2003, p. 285).

The recent increased reliance of splittail on overbite clams as a food source may be a risk factor for increased selenium accumulation in splittail. Concentrations of selenium in overbite clams in the San Francisco Bay Estuary rose three fold from the mid 1980's to 1997. Some of this rise may have been a result of high run-off during the wet years of 1995-1997 (Linville 2002, p. 56-59) when the survey was concluding. In the San Francisco Bay, selenium concentrations in Asiatic and overbite species range from 2 to 9 and 5 to 20 mg/kg-dw, respectively (Stewart *et al*. 2004, p. 4522; Presser and Luoma 2006, p. 48) compared with other native diet items of amphipods and mysids which range from 1 to 3 mg/kg-dw (Stewart *et al*. 2004, p. 4522). These concentrations exceed the previously discussed dietary EC_{10} of 0.9 mg/kg-dw derived by Rigby *et al*. (2010, p.78).

However, the EC_{10} value developed by Rigby *et al*. (2010, p. 78) reflects adverse effects upon juveniles from dietary exposures. In Suisun Marsh adult splittail gut contents are predominantly detritus (Feyrer *et al*. 2003, p. 281). Feeding behavior of splittail in Suisum Marsh suggest they are more dependent upon detritus food sources which would likely expose them to lower concentrations compared of selenium to bivalve and amphipod diet sources.

Moyle *et al.* (2004, p. 17) hypothesized that success of juvenile downstream migration is strongly linked to the size that juvenile splittail achieve prior to exiting the spawning areas. It was suggested that a minimum size of 25 mm (1 in) greatly enhances success of downstream migration. Moyle presented data demonstrating statistically-significant declining growth rates. The apparent declines in growth rates observed in Suisun Marsh splittail between 1980 and 1995 by Moyle *et al.* (2004, p. 14) were correlated to the invasion of the Estuary by the overbite clam, and the subsequent shift of splittail to an overbite clam-dominated diet. Moyle *et al.* (2004, pp. 14-15) suggested that this trend might reflect cachexia (contaminant-induced weight loss despite calorically sufficient dietary intake) which is a classic symptom of non-lethal selenium poisoning. However, Moyle *et al.* (2004, p. 30) also suggested this decline in growth rates may reflect poorer energetics from shifting to a non-mysid shrimp-dominated diet.

Steps have been taken to reduce the input of selenium into the Estuary (see discussion under *Factor D*) and selenium loads discharged from the San Joaquin drainage have been reduced over the last decade. In addition, the predominant source of selenium in the Delta (i.e., irrigation drainage from the San Joaquin River watershed) is somewhat removed from areas containing important spawning habitat for the species (Sacramento

River watershed). Furthermore, studies on the effects of the overbite clam on splittail abundance have been inconclusive. Feyrer *et al.* found that changes in the food web have had effects on the diets of older splittail (2003, pp. 278-285), but Kimmerer found no evidence that the splittail decline was directly related to the decline in opossum shrimp (2002, pp. 51-52). Therefore, we have no conclusive scientific data finding that the splittail growth rates are the result of any selenium induced bioaccumulation mechanism. While there is scientific information that indicates overbite clams do accumulate selenium, there is no indication that the bioaccumulation of selenium in splittail as the result of eating these bivalves has resulted in a population decline of the species. Therefore, we conclude that selenium does not constitute an immediate threat to the splittail through all or a part of its range at this time or in the foreseeable future. However, the potential long-term chronic threat that selenium may present to splittail condition and health cannot be discounted when combined with other potential water quality stressors and should be examined in more detail in the future.

Mercury

The Sacramento River watershed was the site of significant mining activity during the 19th century, including hard rock and hydraulic gold mining (primarily in the Sierra Nevada), mercury mining in the Coast Range (primarily to support gold mining), and hard rock mining for copper, silver, and other metals in portions of the Sierras and northern Coast Range. California's Coast Range represents one of the world's five major mercury mining areas (Jasinski 1995, p. 151). Historic hydraulic gold mining and gold dredging beginning in the 1850's in mountains upstream of the Delta set in motion a continual stream of mercury flowing into the Estuary from the Sacramento watershed that is still having residual effects today (Healy 2008, p. 23).

Analytical data indicate that mercury concentrations in aquatic biota in the San Joaquin River are exceeding screening thresholds and may pose ecological and human health risks (Davis *et al.* 2000, pp. 9-16). Laboratory studies by Deng *et al.* (2008, p. 200-202) found dietary mercury and a combination of mercury and selenium caused damage to liver, kidney and gill tissue of splittail after four weeks of exposure. Although liver glycogen depletion and kidney tubular dilation were observed by the Deng *et al*. study, these lesions did not seem to pose a direct threat to the survival of the splittail larvae (2008, p. 202). Because splittail require floodplain inundation to reproduce, they need habitats like the Yolo Bypass and the Cosumnes River floodplain. The reliance on these regions for reproduction creates a potential risk for eggs and juveniles to be exposed to mercury contamination. However, field studies regarding mercury toxicity to splittail eggs and juveniles are lacking.

Regarding risks from bioaccumulation of mercury via the food chain pathway, several research groups are currently addressing mercury accumulation in the Delta food web. However, no systematic study exists of mercury distributions in the food web of the Bay. Bioaccumulation processes depend on the amount of mercury in surficial sediments, the water quality at the sediment/water interface, and local food web dynamics.

Methylmercury is the most important form of mercury in the aquatic environment with regard to accumulation by biota and transfer through the food web. Methylmercury is produced through addition of a methyl group to Hg^{2+}, a process referred to as methylation. The precise mechanism for entry of methylmercury to the food chain is unknown. However, this initial step is critical, because concentrations of mercury in plankton can be about 10,000-fold higher than in water (Krabbenhoft 1996, p. 2). After this initial step, methylmercury concentrations increase approximately 0.5 log units per trophic level (Watras and Bloom 1992, p.1316), suggesting that each successive trophic level derives methyl-Hg from a progressively more concentrated source (i.e. the previous trophic level), in a process known as biomagnification. In this process consumers retain and further concentrate much of the methylmercury of their prey and subsequently pass this on to the next trophic level. Species at high trophic positions in the aquatic food web, such as predatory fish, attain concentrations that are approximately a million times higher than concentrations in water. Because methylmercury biomagnifies, trophic position is one of the primary factors influencing observed tissue concentrations.

Given that splittail are fairly low in trophic status and feeding guilds in the Estuary, the likelihood of accumulating and biomagnifying mercury from the food web is low. One study has linked elevated mercury to the Cosumnes River floodplain and the Yolo Bypass (Slotten *et al.* 2000, p. 44), which are both primary spawning grounds for splittail. However, this study found no increased levels of mercury in lower trophic level biota that occurred in these floodplains (Slotten *et al.* 2000, p. 44). Although laboratory studies have shown mercury to have adverse effects to splittail individuals and there are increased risks of mercury exposures in splittail spawning grounds, the Slotten study did not find that these mercury levels transferred into the food web and additional field studies regarding mercury toxicity to splittail are lacking.

We have considered mercury as a possible threat to the splittail, but there is limited information on the effects of mercury on splittail population dynamics. Therefore we have determined that mercury and its potential for bioaccumulation and/or biomagnifications does not constitute a significant threat to splittail now or in the foreseeable future.

Organophosphates

Organophosphate pesticides such as diazinon, chlorpyrifos, and malathion are toxic at low concentrations to some aquatic organisms. Several areas of the Delta, particularly the San Joaquin River and its tributaries, are listed as impaired under the Clean Water Act due to elevated levels of diazinon, chlorpyrifos, and other pesticides. Organophoshates enter agricultural drainage mainly in stormwater runoff because it is sprayed on orchards during the rainy winter season. The environmental fate of chlorpyrifos and diazinon are not well understood. Previous work shows that chlorpyrifos is adsorbed strongly onto sediment particles, reducing the aqueous concentration (Karen *et al*. 1998, p.1584). The fate of adsorbed chlorpyrifos is not known. For chlorpyrifos dissolved in water, volatilization, photolysis, and hydrolysis are major removal mechanisms (Howard, 1999; Racke, 1993). The role of biodegradation in chlorpyrifos removal is not well understood. Giddings *et al*. (1997) did find that the degradation of chlorpyrifos in water followed a first-order decay model (p. 2360). The environmental fate of diazinon is less known, but it is more soluble than chlorpyrifos and undergoes pH-dependent decomposition in water (Drufovka *et al*. 2008, p. 295).

Some species of zooplankton are affected by diazinon concentrations as low as 0.35 µg/L (Amato *et al*, 1992, p. 214). From 1988 to 1990, the Central Valley Regional Water Quality Control Board conducted an aquatic toxicity survey in the San Joaquin Valley. Surface water samples collected from certain reaches of the San Joaquin River watershed during this survey were acutely toxic to the water flea, *Ceriodaphnia dubia* (Foe and Connor 1991). The cause of toxicity was not determined but was attributed to pesticides in general. Further study was conducted in the Valley during the winter of 1991–92, and the resultant toxicity was attributed to the presence of chlorpyrifos and diazinon (Foe and Sheipline, 1993; Foe, 1995; Kuivila and Foe, 1995, p. 1149). Recognizing toxic concentrations of organophosphates can occur in tributaries to the San Joaquin and Sacramento River when agricultural areas contribute storm runoff, toxic concentrations rarely occur in the Sacramento River itself (MacCoy *et. al* 1995).

Although organophosphate pesticides commonly used in agricultural areas have been shown to be present in Delta waters and their tributaries at concentrations toxic to aquatic organisms (Werner et al. 2000, p. 226), little is known about the sensitivity of Sacramento splittail to these chemicals. Previous investigations of larval striped bass (*Morone saxatilis*) in the Delta indicated many larvae had been exposed to toxic compounds, potentially leading to slower growth and increased mortality rates (Bennett *et al*. 1995). It is possible that these contaminants also contribute to mortality and potentially affect juvenile splittail recruitment. Teh *et al*. (2005) conducted 96-hour acute toxicity tests on 7-day-old splittail larvae to determine the level of toxicity of orchard runoff water containing organophosphorus pesticides and observe potential biological effects. Spliital larvae were then transferred to clean water for three months to assess the survival, growth, histopathological abnormalities, and heat stress proteins. The results of although splittail larvae survived the 96 h exposure, Teh *et al*. (2005) observed exhibited reduced survival and growth and showed signs of cellular stress even after a three month recovery period.

Sublethal effects may play a more important role than acute mortality, but there is a lack of studies to identify and quantify sublethal responses to pesticides in splittail. In addition, although several studies have demonstrated the acute and chronic toxicity of two common dormant spray insecticides, diazinon and esfenvalerate, in other fish species (Barry *et al*. 1995, Goodman *et al*. 1979, Holdway *et al*. 1994, Scholz *et al*. 2000, Tanner and Knuth 1996), little work has been done integrating acute toxicity with biomarkers of exposure. Sublethal exposure to insecticides is expected to cause a wide range of responses (biomarkers) in individuals ranging from genetic to reproductive anomalies. The addition of sublethal responses to routine acute toxicity testing may provide advanced warning of potentially significant environmental impacts and risks associated with organophosphate pesticides and prevent underestimation of effects on splittail populations. However, based upon the limited data available, we do not consider organophosphates to be a significant threat to the splittail population at this time. Although residual organophosphates will continue to be present in the ecosystem and site specific exposures will occur in localized areas that may affect individuals, the reduction of organophosphates discharged into the Delta due to EPA restrictions in recent years has greatly reduced the potential threat that organophosphates may have posed in the past (Luoma 2008, p. 64).

Pyrethroids

Pyrethroid use in the Central Valley has steadily increased since 1991 and reached an annual use of 80, 740 kilograms (kg) (178,000 pounds (lbs)) in 2003 (Oros and Werner 2005, p 11). Many farmers have switched from organophosphate-based insecticides to pyrethroid-based insecticides (which adhere to soil more strongly) due to a decision by the EPA to phase out organophosphates due to their toxicity to humans (Luoma 2008, p. 64). Pyrethroids have a high absorption rate, andlow water solubility; they rapidly absorb to soil and organic matter (Werner 2004, p. 2719). Although pyrethroids bioaccumulate, food web exposure is not considered a significant route of exposure to fish (Hill 1985). The primary mode of transport for pyrethroids in aquatic systems is the adsorption of pyrethroids to surfaces of clay and soil particles that are suspended in the water column (Oros and Werner 2005, p 24). This combination of properties lends itself to accumulation of this substance in areas such as the Yolo Bypass.

All synthetic pyrethroids are potent neurotoxins that interfere with nerve cell function by interacting with voltage-dependent sodium channels as well as other ion channels, resulting in repetitive firing of neurons and eventually causing paralysis (Bradbury and Coats 1989, pp. 377-378; Shafer and Meyer, 2004). Pyrethroids are toxic to most aquatic invertebrates and fish, in many cases more toxic than the organophosphates they are replacing with LD_{50} values for aquatic organisms below 1 ppb (Smith and Stratton, 1986). The LD_{50} is the dose required to kill half the members of a tested population after a specified test duration. Aquatic insects are more sensitive to pyrethroids than fish, however, mollusks are relatively insensitive (Clark *et al*., 1989).

Acute effects of pyrethroids on aquatic insects could reduce available food resources for splittail. However, the magnitude of this potential effect is unknown and has not been studied.

Chronic exposures to pyrethroids can have significant impacts for immune function, reproductive success and survival for fish and their food organisms. Histopathological lesions in the liver were observed in splittail shortly (1 week) after 96-hour exposure to sublethal concentrations of organophosphate and pyrethroid insecticides. Fish recovered from these lesions, but showed high (delayed) mortality rates, grew slower and showed signs of cellular stress even after a 3 month recovery period (Teh *et al.* 2004b, p. 246).

Sub-lethal toxicity studies specific to splittail are limited but data exists for other fish species. One pyrethroid, esfenvalerate, exhibited both larval survival and immune effects in two fish species. Delayed spawning and reduced larval survival of bluegill sunfish (*Lepomis macrochrius*) were observed following two applications of 1 ppb of esfenvalerate (Tanner and Knuth 1996, pp. 246-250). Exposures of 0.08 ppb esfenvalerate dramatically increased the susceptibility of juvenile Chinook salmon (*Oncorhynchus tshawytscha*) to Infectious Hematopoietic Virus (Clifford *et al.* 2005, pp. 1770-1771).

We conclude that although pyrethroids have been shown to have potential chronic to sub-lethal effects on individuals, there is no evidence to suggest that splittail exposures to pyrethroids in the Estuary are having a significant effect at the population level. Therefore we have determined that pyrethroids do not represent a substantial threat to splittail now or in the foreseeable future.

Ammonium

The effect of ammonia on aquatic organisms depends on its form. Ammonia is un-ionized, and has the formula NH_3. Ammonium is ionized, and has the formula NH_4^+. The major factors determining the proportion of ammonia or ammonium in water are water pH and temperature. This is important as the unionized NH_3 is the form that can be toxic to aquatic organisms while NH_4 is the form documented to interfere with uptake of nitrates (NO_3) by phytoplankton (Dugdale *et al.* 2007, Jassby 2008). The chemical equation that drives the relationship between ammonia and ammonium is:

$$NH_3 + H_2O \leftrightarrow NH_4^+ + OH^-$$

When the pH is low, the reaction is driven to the right, and when the pH is high, the reaction is driven to the left. When temperature is high, the reaction is driven to the left and when temperature is low the reaction is driven to the right. Ammonia enters the Delta ecosystem through discharge from wastewater treatment plants, nitrogenous fertilizers, and atmospheric deposition. The largest source of ammonia entering the Delta ecosystem is the Sacramento Regional Wastewater Treatment Plant (SRWTP), which accounts for 90 percent of the total ammonia load released into the Delta. Monthly loads of ammonium from the SRWTP released into the river have doubled from 1985 to 2005 resulting in 598 million liters (158 million gallons) per day discharged from the SRWTP during 2001–2005 (Jasby *et al*. 2008, p. 15).

Ammonia can be toxic to aquatic organisms and its acute and chronic effects are dependent on both pH and temperature. Ammonia is an oxygen demanding substance requiring oxygen for nitrification and could contribute to dissolved oxygen depletion in receiving waters. Effects of elevated ammonia levels on fish range from irritation of skin, gills, and eyes to reduced swimming ability and mortality (Wicks *et al*. 2002, p. 67). In addition to direct effects on fish, ammonia in the form of ammonium may alter the food web by adversely impacting phytoplankton and zooplankton dynamics in the Estuary ecosystem. Ammonia can be toxic to several species of copepods important to larval and juvenile fishes; ammonium may impair primary productivity by reducing nitrate uptake in phytoplankton (Dugdale *et al.* 2007, pp. 27-28).

A conceptual research framework has been prepared to improve understanding of the role of anthropogenic ammonia in the Bay-Delta ecosystem (Meyer *et al*. 2009, pp. 3-14). No studies to date address the effects of ammonia on splittail specifically. However, concerns related to synergistic effects from ammonia and other contaminants on splittail and other fish species in the Sacramento River have been raised. One study conducted at the University of California Davis Toxicology Laboratory did not observe levels toxic to delta smelt, or two of its food organisms, in the Sacramento River downstream of SRWTP. However, treated effluent was found to be more chronically toxic than Sacramento River water seeded with ammonium chloride to equal concentrations, suggesting that additional toxicants are present in SRWTP effluent (Werner 2009, p. 21).

EPA is currently updating freshwater ammonia criteria that will include new discharge limits on ammonia (EPA 2009, pp. 1-46). There is no projected date for its adoption but a National Pollution Discharge Elimination System (NPDES) permit for the SRWTP is being prepared by the California Central Valley Regional Water Quality Control Board for public notice in the fall of 2010. The NPDES permit is expected to include new ammonia limitations which will reduce loadings to the Delta.

Although ammonia/ammonium is identified as a contaminant that is likely having a negative impact on the Estuary and may chronically or sub-lethally affect individual splittail within the population, there is no evidence that ammonia is having a population level effect on the species or will in the foreseeable future.

Summary of Contaminants

Most fish including splittail can be especially sensitive to adverse effects in their larval or juvenile stages when exposed to contaminants. Given splittail biology, adverse effects would be more likely to occur where sources of contaminants occur in close proximity to spawning and /or rearing habitats (i.e., floodplains, rivers and tributaries). Splittail are benthic feeders (feed on the bottom of water column) and are more susceptible than other fish to sediment contamination. They also face greater exposure to urban and agricultural runoff which tends to be concentrated in shoals where splittail reside (Moyle *et al.* 2004, p. 23).

Laboratory studies have shown certain contaminants to potentially have adverse effects on individual splittail. Field studies have shown that the contaminants of concern are elevated in the Delta and co-occur in areas important for splittail conservation. Although negative impacts to individual splittail from contaminants are suspected and have been shown on a limited basis, the overall extent of these impacts to the population remains largely unknown without further study and investigation. No information to date has conclusively shown that each of the contaminants identified above have a significant effect on splittail at the population level. In addition, several efforts are being undertaken to improve estuarine habitat and reduce the amount of contaminants discharged into the system. Therefore, we do not consider the contaminants of concern, as described above, to constitute an immediate threat to the species at this time or in the foreseeable future.

Climate Change

The Intergovernmental Panel on Climate Change (IPCC) has concluded that warming of the climate is unequivocal (2007, p. 5), and that temperature increase is widespread over the globe and is greater at northern latitudes (Soloman *et al.* 2007, p. 37). However, future changes in temperature and precipitation will vary regionally and locally, with some areas remaining unaffected or even decreasing in temperature.

Between 1995 and 2006, 11 of the 12 years have been the warmest on record (Soloman *et al.* 2007, p. 36). Over the next 20 years, climate models estimate that the Earth's average surface temperature will increase about 1.4 °C (0.8 °F). During the past decade, the average temperature in California, like that of much of the globe, was higher than observed during any comparable period of the past century (Soloman *et al.* 2007, pp. 31-32). Nighttime air temperatures in California have increased 0.18 °C (0.33 °F) per decade since 1920 while daytime temperatures have increased 0.05 °C (0.1 °F) per decade since 1920 (CEC 2009, p. 10).

By IPCC estimates for 2070-2099, California temperatures are expected to rise 1.6 to 2.7 °C (3.0 to 5.5 °F) under a low emissions scenario and 4.4 to 5.8 °C (8.0 to 10.5°F) under a high emissions scenario. However, recent studies have revealed that emissions are rising faster than even the most aggressive high emission scenarios used by IPCC in these calculations (CEC 2009 p. 41). Thus temperatures in the State are expected to rise faster than predicted unless global actions are taken to reduce emissions (CEC 2009 p. 41).

Similar to other California cyprinids, the splittail exhibits a high thermal tolerance. Acclimated fish can survive temperatures up to 33 °C (91.4 °F) for short periods of time (Young and Cech 1996, p. 670). Temperatures resulting from climate change in the next 50 years are not expected to stress splittail beyond their temperature range. Splittail have historically adapted to changes in the Delta system through migratory behavior and it is likely that they will continue to adapt and adjust their spawning and rearing grounds to areas with optimal temperature conditions (Moyle *et al.* 2004, p. 38).

Changes in precipitation are less certain than temperature; climate models project more frequent heavy precipitation events, separated by longer dry spells, especially in the western United States (IPCC 2007, p. 15). In California, snowfall in higher elevations has been increasing while snowfall in lower elevations has been decreasing (CEC2009, p. 16). This has led to an overall decrease in run-off of 19 percent in the San Joaquin Basin and 23 percent in the Sacramento Basin between the months of April to July over the last 100 years, meaning more runoff is coming in earlier months (CEC 2009, p. 17). Overall, California snowpack is predicted to decrease by 20 to 40 percent by the end of the century (CEC 2009, p. 44). However, due to the unpredictable nature of climate change, we are uncertain how the amount of run-off may vary over time and therefore we have no scientific evidence that potential drought conditions resulting from climate change pose a threat to the splittail.

Global sea level has risen at an average rate of 1.8mm (.07 inches) per year from 1961 to 2003, and an average rate of 3.1 mm (.12 in) year from 1993 to 2003 (IPCC 2007, p. 49). In California, sea level has risen about 18 cm (7 in) in the last century (CEC 2009, p. 24), which is similar to global sea level rise. The 2007 IPCC report modestly estimates that sea levels could rise by 0.18 to .58 m (0.6 to 1.9 feet) by 2100, but Rahmstorf (2007, p. 369) suggests that depending on the warming scenario employed, global sea level rise could increase by over 1.2 m (4 ft) in that time period (CEC 2009, p. 49). Even if emissions were halted today, oceans would continue to rise and expand for centuries because of their efficient heat storing abilities (CEC 2009, pp. 49-50). Current estimates put sea level rise at 20 to 50 cm (8 to 19 in) by 2050, which is likely to contribute to the flooding of at least some Delta islands (Knowles 2010, pers. comm.).

The San Francisco estuary will be more susceptible to sea-level rise due to its narrow bays and channels and because it already lies below or at sea level (Moyle *et al.* 2004, p. 38). Many of the Delta islands used for agriculture have been drained and armored with levees for flood protection and groundwater level maintenance. These reclamation and agricultural activities have caused island surface levels to subside due to rapid decomposition of their water logged peat soils. Many of the central and western Delta islands have experienced the most subsidence, now lying at 3 to 7.6 m (10 to 25 ft) below sea level (Ingebritsen *et al.* 2000, p. 2). These islands are at a high level risk from sea level rise because, as islands subside and water levels rise, levee banks are experiencing greater hydrostatic force, thereby increasing the risk of their failure.

Earthquake fault models also show a high degree of risk of a significant seismic event that could affect the islands in the central and western Delta (Mount *et al.* 2005, p. 13). Failure of the levees on some or all of these islands, as a result of liquefaction of the unstable soils that make up the levees' foundations during an earthquake, could turn part or the entire Delta into a brackish bay in the future. The encroaching ocean would increase salinity levels in the central and western Delta, with the result that the range of splittail would likely be curtailed to some location upstream of the confluence of the Sacramento and San Joaquin rivers.

Due to the divergence of two splittail population segments, one population is exposed to higher salinities in the Napa and Petaluma river systems for at least part of its life cycle (Feyrer *et al.* 2010, p. 12). This population may be better able to adapt to increased salinity levels that sea level rise may bring. Splittail have an unusually high salinity tolerance and populations have shown great resilience in waters with variable salinities (Moyle *et al.* 2004, p. 38; Young and Chech 1996, p. 673). Abundance indices soared in 1995 and 1998, in response to wet hydrological years following a decade of predominantly dry conditions, showing the resilience of this species. One problem climate change may pose to splittail is the reduced spawning habitat due to deeper water (Moyle *et al.* 2007, p. 38). However, new spawning habitat that may be created as a result of flooding will help to accommodate splittail spawning in the event of rising ocean levels. Liberty Island (discussed under *Factor A*) is one example of the benefits that island flooding could have on splittail if correctly managed. Under predicted future flooding conditions, splittail could spawn in the Sutter Bypass and rear in the Delta. Splittail have adapted to changes in the ecosystem through their migratory behavior

(Moyle 2004, p. 38) and may continue to do so in the future.

Introduced Species

Copepods (*E. affinis*, *Pseudodiaptomus forbesi*), a major prey item for splittail, have declined in abundance in the Delta since the 1970s (Kimmerer and Orsi 1996, p. 409). Starting in about 1987, declines were observed in the abundance of phytoplankton (Alpine and Cloern 1992, p. 951). These declines have been partially attributed to grazing by the overbite clam (*Corbula amurensis)* (Kimmerer *et al.* 1994, p. 86) which became abundant in the Delta in the late 1980s. Asiatic clams (*Corbicula fluminea*) can exceed 200,000 per square meter (m2) and overbite clam abundance can exceed 10,000 per m2 (Kimmerer *et al.* 2008, p. 82). Because the overbite clam consumes copepod larvae as it feeds, it not only reduces phytoplankton biomass but also competes directly with splittail for food (Kimmerer *et al.* 1994, p. 87). It is believed that these changes in the estuarine food web negatively influence pelagic fish abundance, including splittail abundance. In the Delta, phytoplankton production has declined 43 percent between 1975 and 1995 (Jasby *et al.* 2002, p. 703). The correlation of phytoplankton decline with the appearance of the overbite clam leads us to believe that the overbite clam is overgrazing the system.

Three non-native species of copepods (*Sinocalanus doerrii, Pseudodiaptomus forbesi, and Pseudodiaptomus marinus*) became established in the Delta between 1978 and 1987 (Carlton *et al.* 1990, pp. 81-94), while native *Eurytemora affinis* populations have declined since 1980. It is not known whether these non-native species have displaced *E. affinis* or whether changes in the estuarine ecosystem now favor *S. doerrii* and the two *Pseudodiaptomus* species. Meng and Orsi (1991) reported that *S. doerrii* is more difficult for larval striped bass to catch than native copepods because S. *doerrii* is fast swimming and has an effective escape response. It is not known whether this difference in copepod swimming and escape behavior has affected the feeding success of young splittail.

Limnoithona tetraspina (no common name) is a nonnative copepod that began increasing in numbers in the delta in the mid 1990s, about the same time that *P. forbesi* began declining (Bennett *et al.* 2005, p. 18). *L. tetraspina* is now the most abundant copepod species in the low salinity zone (Bouley and Kimmerer 2006, p. 219), and is likely an inferior prey species for splittail because of its smaller size and superior predator avoidance abilities when compared to *P. forbesi* (Bennett *et al.* 2005, p. 18; Baxter *et al.* 2008, p. 22).

Splittail have shifted their diet to utilize non-native species. Although the non-native copepods and bivalves discussed above have altered the food web in the Delta ecosystem, we have no compelling evidence to suggest that this has led to a decline in the splittail population. Please refer to the bioaccumulation section for a full analysis of the effects on splittail due to a shift in prey base from native species to the overbite clam.

Chinese mitten crabs (*Eriocheir sinensis*) could reach concentrations sufficient to intermittently impede the operation of fish screens and salvage facilities, thus reducing the effectiveness of splittail salvage and repatriation efforts. The US Bureau of Reclamation has installed a device, known as "Crabzilla" to remove Chinese mitten crab from their CVP fish salvage facility. However, Chinese mitten crabs have not appeared in large numbers at either of the fish salvage facilities in recent years. As a result of the apparent decline of this nonnative species subsequent to their initial appearance in the Delta, along with the measures taken at the CVP fish salvage facility, the existence of the Chinese mitten crab in the Delta is not a current threat to splittail.

Of some concern is the presence of Brazilian pondweed (*Egeria densa*) and water hyacinth (*Eichhornia crassipes*), both of which tend to form dense near-shore and slough-wide mats of vegetation that serve as retreat, foraging, and ambush sites for splittail predators. These vegetation mats also may divert upstream- and downstream-migrating splittail into channels rather than the more-productive bankside habitat by creating an obstacle (Moyle *et al.* 2004, p. 29).

Summary of Factor E

In summary, splittail are not significantly threatened by water export facilities, agricultural and power plant diversions, poor water quality, environmental contaminants, climate change, or introduced species.

Operation of the CVP and SWP water export facilities directly affects fish by entrainment into their diversion facilities. CVP and SWP dams and diversions changed the historical hydrological features of the watershed systems, have altered and eliminated habitat for splittail, and may have reduced the distribution of the splittail by restricting movement to potential spawning grounds and creating migration obstacles. Entrainment at SWP and CVP pumps has not been demonstrated to affect splittail at the population level because loss of substantial numbers of fish tends to occur during wet years in which the species is experiencing a high reproductive output. CALFED's Ecosystem

Restoration Program (discussed under Factors A and E, above) has been successful in restoring habitat for the splittail and reducing threats from entrainment at water diversion sites.

Splittail can become entrained in agricultural water diversions resulting in injury or mortality. Under both the CALFED Bay-Delta Program and the Central Valley Project Improvement Act, there have been significant efforts to screen agricultural diversions in the Central Valley and the Sacramento-San Joaquin Delta, and studies have found splittail entrainment to be exceptionally low. We do not consider entrainment by agricultural diversions to be a significant threat to splittail.

Two power plants located near the confluence of the Sacramento and San Joaquin rivers pose an entrainment risk to splittail. The intakes for the cooling water pumps of these power plants are located in close proximity to splittail rearing habitat (Moyle *et al.* 2004, p. 20). Thermal and chemical pollution may also have a detrimental effect on splittail (USFWS 2008, pp. 173-174). However, due largely to the reduction in the operation of the power plants and their associated pumping for cool water, we do not consider the operation of these power plants to constitute a significant threat to the splittail population. We have no indications of future plans to use these pumps more frequently and therefore do not consider these operations to be a threat in the future.

Laboratory studies have shown certain contaminants to be detrimental to individual splittail and the co-occurrence of splittail with contaminants has been documented. Although negative impacts to individual splittail from contaminants have been shown, the overall extent of such cases, and impacts to the population as a whole, remain largely undocumented. No studies to date have shown contaminants to have a significant effect on splittail at the population level. Bioaccumulation of selenium and mercury in the overbite clam is occurring and the overbite clam is a substantial prey item for splittail. However, we have no evidence that the bioaccumulation of selenium or mercury is having a detrimental effect on splittail at the population level or will in the foreseeable future.

Climate change in California is expected to bring increased temperatures, changes in precipitation and run-off, and increased salinity levels associated with sea level rise. These changes may restrict splittail range or reduce spawning habitat. However, splittail exhibit high thermal salinity tolerances and are known to adapt to changes in the Delta through migratory behavior. In addition, new spawning habitat may be created as a result of flooding. We have no scientific evidence that potential drought conditions resulting from climate change pose a threat to the splittail.

Introduced species are having an effect on the food web and ecology of the Estuary. Bivalves such as the overbite clam have displaced native food sources of the splittail. However, splittail have shifted their diets to utilize non-native food sources. Although the non-native copepods and bivalves discussed above have altered the food web in the Delta ecosystem, we have no compelling evidence to suggest that this has led to a decline in the splittail population.

We conclude that the best scientific and commercial information available indicates that the Sacramento splittail is not now, or in the foreseeable future, threatened by other natural or manmade factors affecting its continued existence.

Finding

As required by the Act, we considered the five factors in assessing whether the Sacramento splittail is endangered or threatened throughout all or a significant portion of its range. We have carefully examined the best scientific and commercial information available regarding the past, present, and future threats faced by the Sacramento splittail. We reviewed the petition information available in our files, reviewed other available published and unpublished information, and consulted with recognized Sacramento splittail experts and other Federal, State, and tribal agencies, including the California Department of Fish and Game and the U.S. Bureau of Reclamation.

We identified and evaluated the risks of the present or threatened destruction, modification, or curtailment of the habitat or range of the Sacramento splittail. The rate of habitat loss in the Estuary that occurred the 1900's is no longer occurring today and efforts undertaken in the past decade have benefited the species by restoring its habitat. There is presently sufficient habitat to maintain the species; inundation frequency and duration in key areas is sufficient to provide spawning to maintain the species. The implementation and magnitude of the CALFED, CVPIA (discussed under Factor D) and other habitat restoration activities, which focus on the restoration of habitats that directly and indirectly benefit splittail are greater than any foreseeable future habitat losses. The overall effect of habitat restoration activities is also expected to continue to be beneficial for splittail into the foreseeable future. Based on a review of the best scientific information available, we find that the present or threatened destruction, modification, or curtailment of Sacramento splittail habitat or range (*Factor A*) is not a significant threat to the splittail now or in the foreseeable future.

The new CDFG regulation enacted in March 2010 limiting take of splittail to two individuals per day has eliminated any potential threat that fisheries may have posed. There is no indication that the current level of scientific take adversely affects the splittail population, and there is no indication that the level of mortality will increase in the future. Based on a review of the best scientific information available, we find that overutilization for commercial, recreational, scientific, or educational purposes (*Factor B*) is not a significant threat to the Sacramento splittail. We found disease occurs at low levels in the population, but does not constitute a significant threat to the species (*Factor C*). Predation by striped bass appears to be unchanged from past levels, is currently not a significant threat to splittail populations, and is not expected to increase in the future. Largemouth bass populations have increased in the Estuary in the past three decades, but populations of largemouth bass in critical rearing areas are low, therefore predation levels appear to be minor. Based on a review of the best scientific information available, we find that disease and predation (*Factor C*) are not significant threats to the Sacramento splittail, now or in the foreseeable future.

Federal and State regulations provide protection for the splittail and its habitat by limiting adverse effects from new projects, restoring habitat and limiting contaminants discharged into the Estuary. Based on a review of the best scientific information, we find that a lack of regulatory mechanisms (*Factor D*) does not constitute a significant threat to the Sacramento splittail population now or in the foreseeable future.

Based on the best available science, we find that other natural or manmade factors affecting the continued existence of the splittail (as described under *Factor E*) have not been shown to be significant threats to the splittail at this time. Furthermore, there is no evidence to suggest that these factors will increase and become threats to the splittail in the foreseeable future. Splittail are not threatened by water export facilities, agricultural and power plant diversions, poor water quality, environmental contaminants, climate change, or introduced species (*Factor E*). Entrainment at SWP and CVP pumps has not been demonstrated to affect splittail at the population level. CALFED's Ecosystem Restoration Program (discussed under *Factors A and E* above), the CVPIA, and the provisions of the OCAP BOs, have been successful in reducing threats from entrainment at water diversion sites. Under both the CALFED Bay-Delta Program and the Central Valley Project Improvement Act, there have been significant efforts to screen agricultural diversions in the Central Valley and the Sacramento-San Joaquin Delta, and studies have found splittail entrainment to be exceptionally low. Therefore, we do not consider entrainment by agricultural diversions to be a significant threat to splittail. Due to reduction in the operation of two power plants and their associated pumping for cool water, we do not consider the operation of these power plants to constitute a significant threat to the splittail population. We have no indications of future plans to use these pumps more frequently and therefore do not consider these operations to be a threat in the future.

Laboratory studies have shown certain contaminants to be detrimental to individual splittail and the co-occurrence of splittail with contaminants has been documented. Although negative impacts to individual splittail from contaminants have been shown, the overall extent of such cases, and impacts to the population as a whole, remain largely undocumented. No studies to date have shown contaminants to have a significant effect on splittail at the population level. Bioaccumulation of selenium and mercury in the overbite clam is occurring and the overbite clam is a substantial prey item for splittail. However, we have no evidence that the bioaccumulation of selenium or mercury is having a detrimental effect on splittail at the population level or will in the foreseeable future.

The existing data fails to show a significant long term decline of the species. Natural fluctuations of population levels do not constitute an overall decline in the species, but rather show a pattern of successful spawning during wet years followed by reduced spawning during dry years. The model deployed in this finding simulates the species fluctuations and is compatible with known life history traits of the species. Population levels are directly correlated with inundation of floodplains and simulation models predict that these habitats must flood at a minimum of every 7 years for the species to persist in sufficient numbers to maintain a robust population level (Moyle *et al.* 2004, p. 38). We have no evidence to show that the frequency of inundation events on floodplains will decrease to the point that these events will not be sufficient to maintain robust population levels. Therefore, based on the best available data, we do not find an overall declining trend in the species' population.

Although global warming will change hydrography in the Delta, predictions do not foresee an imminent reduction in flooding of the Yolo Bypass. Splittail have continually adapted to changes in the ecosystem including salinity variation and we have no evidence to show that this will not continue to be the case. The Yolo and Sutter Bypasses and the Cosumnes River floodplain are serving as refuge for the species and there is no evidence that these areas will not continue to do so in the future. These floodplains are currently being expanded through public and private partnerships including CALFED ERP, CVPIA, Cosumnes River Preserve restoration efforts, and the acquisition and restoration of Liberty Island.

Our review of the best available scientific and commercial information pertaining to the five threat factors, does not support a conclusion that there are independent or cumulative threats of sufficient imminence, intensity, or magnitude to indicate that the Sacramento splittail is in danger of extinction (endangered), or likely to become endangered within the foreseeable future (threatened), throughout its range. Therefore, listing the Sacramento splittail as endangered or threatened is not warranted at this time.

Distinct Vertebrate Population Segments

After assessing whether the species is endangered or threatened throughout its range, we next consider whether a distinct vertebrate population segment (DPS) exists and meets the definition of endangered or is likely to become endangered in the foreseeable future (threatened).

Under the Service's DPS Policy Regarding the Recognition of Distinct Vertebrate Population Segments Under the Endangered Species Act (61 FR 4722; February 7, 1996), three elements are considered in the decision concerning the establishment and classification of a possible DPS. These are applied similarly for additions to or removal from the Federal List of Endangered and Threatened Wildlife. These elements include:

(1) The discreteness of a population in relation to the remainder of the taxon to which it belongs;

(2) The significance of the population segment to the taxon to which it belongs; and

(3) The population segment's conservation status in relation to the Act's standards for listing, delisting, or reclassification (i.e., is the population segment endangered or threatened).

In this analysis, we will evaluate whether the San Pablo population of splittail is a DPS. This analysis is being conducted because recent studies by Baerwald *et al.* (2007) have revealed genetic variation between the San Pablo and Delta populations of splittail. The San Pablo population of splittail represents a fraction of the overall splittail population. For the purposes of this analysis, splittail individuals that spawn in the Napa and Petaluma rivers will be referred to as the San Pablo population and individuals that spawn in other rivers including the Sacramento, San Joaquin and Cosumnes rivers will be referred to as the Delta population.

Discreteness

Under the DPS policy, a population segment of a vertebrate taxon may be considered discrete if it satisfies either one of the following conditions:

(1) It is markedly separated from other populations of the same taxon as a consequence of physical, physiological, ecological, or behavioral factors. Quantitative measures of genetic or morphological discontinuity may provide evidence of this

separation.

(2) It is delimited by international governmental boundaries within which differences in control of exploitation, management of habitat, conservation status, or regulatory mechanisms exist that are significant in light of section 4(a)(1)(D) of the Act.

The data used to determine genetic differences between two splittail populations were collected in 2002 and 2003 and first published in (Feyrer *et al.* 2005, pp. 164-167) to show upstream distribution limits of splittail. Young of the year splittail individuals were collected from the Napa, Petaluma, Cosumnes, Sacramento and San Joaquin rivers and salinities were recorded at these sites. Individuals collected from the farthest upstream locations on the rivers were chosen for genetic analysis in an attempt to ensure that they were collected in the natal rivers in which they were spawned (Baerwald *et al.* 2007, p. 160).

Baerwald *et al.* (2007) used 13 microsatellite markers to genetically distinguish 489 young-of-the-year splittail collected from these five drainage areas (2007, pp. 160-161). Two genetically distinct populations were found, one in the Napa/Petaluma (San Pablo population) drainages and one in the greater Central Valley drainages (Delta population) (Baerwald *et al.* 2007, p 162). Microsatellite markers are neutrally inherited. Neutrally inherited genes come from the mother and are always passed on to the next mother, where as the fathers genes may or may not be passed on. The most likely reason for finding a statistical difference in gene frequencies is isolation of spawning populations (Israel and Baerwarld *et al.,* 2010, pers. comm.). Both splittail populations use Suisun Bay as rearing habitat in the nonspawning season; however Suisun Marsh was used as foraging ground almost exclusively by the Delta population (Baerwald *et al.*

2008, p. 1341). The majority (88 percent) of individuals collected foraging in Suisun Marsh assigned to the Delta population; however, less association was seen in individuals in the Ryer and Chipps Islands with 54 to 74 percent assigning to the Delta population (Baerwald *et al.* 2008, p. 1341). Although some overlap in foraging grounds was observed, these populations largely maintain themselves in different habitats and possess different genetic make-ups.

Thus, these studies demonstrate that the San Pablo population segment, composed of individuals from the Napa and Petaluma rivers, is markedly separate from the Delta population segment composed of individuals from the Sutter Bypass and Sacramento, Cosumnes and San Joaquin rivers as a consequence of genetic variation (Baerwald *et al.* 2007, pp. 164-165). Baerwald *et al*. noted that their results appear to be correlated with differences in salinities between spawning grounds and migration routes. Our analysis of the peer reviewed work done by Baerwald *et al.* (2007 and 2008) leads us to conclude that the San Pablo population is discrete under the Service's DPS policy.

Significance

If a population segment is considered discrete under one or more of the conditions described in the Service's DPS policy, its biological and ecological significance will be considered in light of Congressional guidance that the authority to list DPSes be used "sparingly" while encouraging the conservation of genetic diversity. In making this determination, we consider available scientific evidence of the discrete population segment's importance to the taxon to which it belongs. Since precise circumstances are likely to vary considerably from case to case, the DPS policy does not describe all the classes of information that might be used in determining the biological and ecological importance of a discrete population. However, the DPS policy describes four possible classes of information that provide evidence of a population segment's biological and ecological importance to the taxon to which it belongs. As specified in the DPS policy (61 FR 4722), this consideration of the population segment's significance may include, but is not limited to, the following:

(1) Persistence of the discrete population segment in an ecological setting unusual or unique to the taxon;

(2) Evidence that loss of the discrete population segment would result in a significant gap in the range of a taxon;

(3) Evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historic range; or

(4) Evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics.

A population segment needs to satisfy only one of these conditions to be considered significant. Furthermore, other information may be used as appropriate to provide evidence for significance.

(1) Persistence of the discrete population segment in an ecological setting unusual or unique to the taxon.

Salinity concentrations were recorded between April and July in 2002 and 2003 on the Sacramento, San Joaquin, Napa, and Petaluma rivers at various locations where splittail were collected. Salinity concentrations on the Petaluma River averaged 13.0 ppt in 2002 and 6.0 ppt in 2003. Napa River salinity concentrations averaged 5.0 ppt in 2002 and 0.0 ppt in 2003. The San Joaquin and Sacramento rivers averaged 0.0 ppt for both years (Baerwald *et al.* 2008, p. 165). Sacramento and San Joaquin rivers never contained salinity concentrations higher than 1.0 ppt. Salinity concentrations on the Napa River ranged between 0.0–8.5 ppt while Petaluma River salinity concentrations ranged between 5.5–14.1 ppt (Feyrer *et al.* 2010, p. 8). It is speculated that high salinities are creating a barrier between these populations that is only broken during high outflow years (Feyrer *et al.* 2010, p. 11). This barrier likely occurs in the area of Carquinez Straight between Suisun Bay and San Pablo Bay.

Napa River populations mostly associate with the San Pablo population although a small number of individuals caught in 2003 when the salinity was 0.0 ppt on the Napa River associated with the Delta population. The presence of the Delta population in the Napa River in 2003, when the salinity was 0.0 ppt and absence in 2002 when salinities were higher may reflect the Delta population's limited ability to tolerate high salinities for spawning.

The data we have clearly shows that the Napa and Petaluma rivers had higher salinities than other areas of the Delta where the splittail persists for the 2 years that surveys were conducted. However, we feel that 2 years of data are not sufficient to conclude that this constitutes a unique ecological setting that is persistent over time. A larger data set covering more years is needed to assess the salinities of these rivers particularly at splittail spawning grounds before we can conclude the range of the San Pablo population constitutes a unique ecological environment. Therefore, we are lacking convincing evidence that shows the San Pablo population persists in an unusual or unique ecological setting that contributes significantly to the taxon at this time.

(2) Evidence that loss of the discrete population segment would result in a significant gap in the range of a taxon;

The San Pablo population segment is on the western edge of the species range and only constitutes a small portion of the species range. Loss of this population would not create a gap in the remainder of the species range because the San Pablo population does not provide for connectivity with other portions of the range. Therefore, we conclude that loss of this population would not represent a significant gap in the range of the species.

(3) Evidence that the discrete population segment represents the only surviving natural occurrence of a taxon that may be more abundant elsewhere as an introduced population outside its historic range.

This criterion does not apply to the San Pablo splittail population because it is not a population segment representing the only surviving natural occurrence of the taxon that may be more abundant elsewhere as an introduced population outside its historical range.

(4) Evidence that the discrete population segment differs markedly from other

populations of the species in its genetic characteristics.

Under the DPS policy we measure the evidence for potential biological and ecological significance to the species as a whole, as reflected by marked differences in its genetic characteristics. Evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics is provided in the Baerwald *et al* study. (2007, p. 166). These genetically distinct populations may be driven by the strong selective pressure separating out species that are salinity tolerant from those that are susceptible to salinity effects (Baerwald *et al.* 2007, p. 165). We conclude that the San Pablo population of splittail meets this criterion of the DPS policy because it differs markedly from other populations in its genetic characteristics.

Determination of Distinct Population Segment

Based on the best scientific and commercial information available, as described above, we find that under the Service's DPS policy, the San Pablo population segment is discrete and is significant to the taxon to which it belongs. Evidence that the San Pablo splittail is biologically and ecologically significant from other populations of splittail is based on the evidence that the discrete population segment differs markedly from other populations of the species in its genetic characteristics. Because the San Pablo population segment is both discrete and significant, it qualifies as a DPS under the Act.

Distinct Population Segment Five-Factor Analysis

Since the San Pablo population segment qualifies as a DPS, we will now evaluate its status with regard to its potential for listing as endangered or threatened under the five factors listed in section 4(a) of the Act. The majority of the factors affecting the species throughout its range also affect the San Pablo DPS of splittail. These factors can be found in the five factor analysis conducted for the entire range of the splittail found above. Our evaluation of the San Pablo DPS follows.

Factor A. The present or threatened destruction, modification, or curtailment of its habitat or range

Habitat Loss

Rapid development within the San Pablo DPS' range began with the discovery of gold in the Sierra Nevada foothills in the 1850s. Hydraulic mining operations contributed huge amounts of sediment to San Pablo Bay. For the next hundred years, the marshes were filled, diked, or drained to support the bay's development as a major center of commerce. About 85 percent of the historic tidal marshes of San Pablo Bay have been altered, negatively affecting the ability of the remaining tidal marshes to accept winter rainfall and purify water in the bay.

Beneficial Actions Offsetting Adverse Effects

Since the 1960s, State and government agencies, non-profit organizations, and local grassroots organizations have made efforts to protect and restore San Pablo Bay. The San Pablo Bay National Wildlife Refuge was established in 1974 and currently protects over 13, 000 acres of wildlife habitat. Largely comprised of thousands of acres of tidelands leased from the California State Lands Commission, the refuge's ultimate plans include protection and conservation of more than 8,094 ha (20,000 ac) of critical wildlife in northern San Pablo Bay (FWS Brochure 2001, pp. 1-6). Additional efforts are underway to protect and restore the bay. The San Pablo Bay Preservation Society is currently working to acquire land on San Pablo point (http://www.pointsanpablo.org/) and the friends of San Pablo Bay NWR have helped to establish a nursery that is being used to re-vegetate tidal wetlands.

Although the historic loss of floodplains has detrimentally affected the species in the past, current laws and protections including the creation of the San Pablo Bay National Wildlife Refuge have largely eliminated future losses of floodplain to the splittail. Many of the natural floodplains in the Napa and Petaluma rivers are still intact and provide optimal spawning grounds to splittail. The San Pablo DPS is much closer to the ocean than the Delta DPS and is largely influenced by a tidal system. Fresh water input into the system is essential to provide proper salinity levels. Over the past 100 years, fresh water input has been reduced by diversions and water barriers. Although, this reduction in fresh water flow has changed salinity concentrations in the Napa and Petaluma rivers, we have no evidence to suggest that it has had a significant effect on the population level of the species.

Recent Abundance Data Trends

On June 1, 2010, splittail individuals encompassing both young-of-the-year (less than 1 year in age) and age one were captured in the Petaluma River (Sommer *et al.* unpublished, pp. 1-3). The presence of splittail from two different age classes makes it likely that splittail successfully spawned in the Petaluma River in 2010 (a relatively wet year) and 2009 (a critically dry year). This shows that splittail are persisting in the Petaluma River. In addition, all 10 of the fish captured in the survey belonged to the San Pablo population of splittail. During this survey, fish were collected at two out of three survey sites. During previous surveys in the Petaluma River, splittail were captured at one out of three sites (Feyrer *et al.* 2005, p. 162).

We have no evidence at this time to suggest that the San Pablo population of splittail is in decline. The accepted range of the species in the Napa and Petaluma rivers has increased as new surveys have found presence of splittail in areas where they were previously not believed to be in the mid-1990's (Sommer *et al.* 2007, p. 28).

Summary of Factor A

Although there has been substantial loss of habitat historically, present and future loss of habitat is expected to be minimal due to current land protections including the San Pablo Bay National Wildlife Refuge. Efforts undertaken in the past decade have benefited the species by restoring its habitat. There is presently sufficient habitat to maintain the species, inundation frequency and duration in key areas is sufficient to provide spawning to maintain the species. We conclude that the best scientific and commercial information available indicates that the San Pablo DPS of Sacramento splittail is not now, or in the foreseeable future, threatened by the present or threatened destruction, modification, or curtailment of its habitat or range.

Factor B. Overutilization for commercial, recreational, scientific, or educational purposes

Recreational Fishing

Take of splittail due to fisheries is a potential threat rangewide to the species and this threat is not expected to be any different for the San Pablo DPS. Please refer to *Factor B* in the rangewide analysis for a full discussion of take due to recreational fishing. Take due to recreational fishing is not considered to be a substantial threat to the San Pablo DPS of splittail at this time.

Scientific Collection

Take and fatalities attributed to scientific sampling in areas occupied by the San Pablo population of splittail are far less than the rangewide take of the species. There have only been 10 known surveys of the San Pablo DPS splittail in the last 10 years. These include five U.S. Army Corp of Engineers' surveys (2001 and 2002), three surveys conducted by Feyrer *et al.*(2002, 2003 and 2010) and one study by the Napa Creek Floodplain Project (2007). There were a total of 4 splittail captured in 2001 (USACE 2002), 79 captured in 2002 (USACE 2002), 48 captured in 2003 (USACE 2004), 326 captured in 2004 (USACE 2004), and 305 captured in 2005 (USACE 2006) by the Army Core of Engineers. None of the fish captured by the Corps were kept. The amounts of Yyung-of-the-year captured in the Feyrer *et al*. studies were: 112 in the Napa River and 45 in the Petaluma River in 2002, and 62 in the Napa River and 171 in the Petaluma River in 2003 (Feyrer *2010*, pers. comm.). During a short gill net study in 2003, Feyrer *et. al.* collected 108 adult splittail (Feyrer *2010,* pers. comm.). A total of 13 splittail were captured in 2010. All of the splittail taken in the Feyrer *et al*. studies were preserved for genetic analyisis. There were seven splittail caught in the Napa Creek Floodplain Project study in June of 2007 (Turner 2007). Female splittail can lay up to 100, 000 eggs in a single spawning event and the take of several hundred individuals is not expected to effect the population at the species level. Therefore, scientific take is not considered to be a significant threat to splittail at this time, however, scientific studies regarding the San Pablo population of splittail have been kept to a minimum to be sure not to threaten the limited number of individuals present in this population (Feyrer *et al*. 2010, pers. comm.)

Summary of Factor B

The new CDFG regulation enacted in March 2010 limiting take of splittail to two individuals per day has eliminated any potential threat that fisheries may have posed. There is no indication that the current level of scientific take adversely affects the splittail population, and there is no indication that the level of mortality will increase in the future. We conclude that the best scientific and commercial information available indicates that the San Pablo DPS of the Sacramento splittail is not now, or in the foreseeable future, threatened by overutilization for commercial, recreational, scientific or educational purposes.

Factor C. Disease or predation

Disease

Disease is a potential threat to splittail rangewide including in the San Pablo Bay and the potential threat of disease is expected to be the same in scope and intensity as it is in the overall range of the population. Please refer to *Factor C* in the range wide analysis for a full discussion of the effects of disease on splittail. Based on a review of the best scientific information available, we find that disease is not a significant threat to the San Pablo Bay population of splittail now or in the foreseeable future.

Predation

The salinity level in San Pablo Bay and the Napa and Petaluma rivers serves as a barrier to potential predators of the San Pablo DPS of splittail. Predators such as largemouth bass and catfish are not able to tolerate the high salinity environment present in the area of the San Pablo Bay population. The only substantial predator of splittail that is able to reside in this environment is the striped bass (Nobriga 2010, pers. comm.). Based on a review of the best scientific information available, we find that predation is not a significant threat to the San Pablo Bay population of splittail now or in the foreseeable future.

Summary of Factor C

We found disease occurs at low levels in the population, but does not constitute a significant threat to the species. Because the potential threat of predation on the San Pablo DPS of splittail is expected to be less than the potential threat on the overall population due to a salinity barrier, we conclude that predation is not a significant threat to the San Pablo population now or in the foreseeable future. We conclude that the best scientific and commercial information available indicates that the San Pablo Bay DPS of the Sacramento splittail is not now, or in the foreseeable future, threatened by disease or predation.

Factor D. The inadequacy of existing regulatory mechanisms

State Laws

State laws acting as existing regulatory mechanisms are expected to provide the same protections to the San Pablo Bay DPS of splittail as they do to the entire range of the species because the laws are uniform throughout the State of California. Please refer to *Factor D* in the rangewide analysis for a full discussion of the State laws acting as existing regulatory mechanisms to provide protections to the splittail.

Federal Laws

Federal laws acting as existing regulatory mechanisms are expected to provide the same protections to the San Pablo Bay DPS of splittail as they do to the entire range of the species because the laws are uniform throughout the United States. Please refer to *Factor D* in the rangewide analysis for a full discussion of the Federal laws acting as existing regulatory mechanisms to provide protections to the splittail.

Summary of Factor D

Federal and State regulations described in the analysis of the entire species range provide protection for the splittail and its habitat by limiting adverse affects from new projects, restoring habitat and limiting contaminants discharged into the Estuary.

Although the Act does not directly regulate actions in splittail habitat, the provisions in the Act that apply to other listed species benefit the splittail. We conclude that the best scientific and commercial information available indicates that the San Pablo DPS of the Sacramento splittail is not now, nor in the foreseeable future, threatened by inadequate regulatory mechanisms.

Factor E. Other natural or manmade factors affecting its continued existence

We have identified the risk of water export facilities, agricultural and power plant diversions, poor water quality, environmental contaminants, climate change, or introduced species as potential threats to the San Pablo DPS of splittail.

Water export facilities

Water export facilities (CVP and SWP pumps) and power plant diversions which were analyzed in the range wide splittail finding are not located within the range of the San Pablo DPS and therefore do not represent potential threats to the San Pablo DPS. Water export facilities do not exist in the area of the San Pablo DPs and therefore are not considered to be a substantial threat to splittail now or in the foreseeable future.

Agricultural Diversions for Irrigation

Agricultural diversions are a potential threat range wide to splittail including in the area occupied by the San Pablo DPS. The majority of agricultural diversions in the Napa River are utilized by wineries for the production of grapes. Wine production in the

Napa Valley is a multimillion dollar industry. There are a total of 1200 agricultural diversions in Napa County. Of these, there are 99 active diversions in the Napa River itself and they are primarily attributed to wine production (California integrated water quality systems 2010, p. 1). Splittail populations are persisting in the Napa and Petaluma Rivers and we have no data to show that agricultural diversions are a significant threat to the continued existence of the species at the population level now or in the foreseeable future.

Power Plant Diversions

There are no power plant diversions within the range of the San Pablo DPS of splittail. The Contra Costa Power Plant and the Pittsburg Power Plant (discussed in the rangewide analysis) are not a factor because they are located outside of the range of the San Pablo DPS of splittail. Power plant diversions are not expected to be a threat to the San Pablo population of splittail now or in the foreseeable future.

Water Quality and Environmental Contaminants

The Napa River exhibits a high eutrophication rate and has been placed on California List of Impaired Water Bodies (303(d) list) because nutrients, pathogens and sedimentation. The Petaluma River is on the California List of Impaired Water Bodies (303(d) list) for possessing high elevations of diazinon, nutrients, and sedimentation. The primary symptom of excessive nutrient loading in this watershed is dense algae growth.

Eutrophication occurs when high nutrient levels increase growth of plant and algal matter resulting in dissolved oxygen removal from the system when the plants die and begin to decompose (Wang *et al.* 2004, p. 10).

Efforts are underway by State water resource staff to address many nutrient sources including faulty septic systems, agricultural and urban runoff, and livestock through regulatory programs. These programs will address multiple pollutants, including pathogens, nutrients, and sediment. The Napa County resource conservation district has ongoing restoration efforts including native plant re-vegetation, road improvements, fish barrier removal, upland habitat improvements, and stream and wetland restoration. A Napa sustainable winegrowing group is active in educating wine growers on the benefits of reducing pesticide use and promoting soil health through erosion control.

Although the Napa and Petaluma rivers do exhibit a high amount of nutrients, we have no evidence at this time to suggest that nutrient loading is causing a decline in the San Pablo DPS of splittail at the population level now or that it will in the foreseeable future. The known range of the species in the Napa and Petaluma rivers has increased as new surveys have found presence of splittail in areas where they were previously not believed to be found in the mid 1990's (Sommer *et al.* 2007, p. 28).

Effects from selenium, mercury, organophosphates, pyrethroids and bioaccumulation on the San Pablo DPS are expected to be comparable to the effects that these potential threats are having on the overall population of splittail. These contaminants are dispersed throughout the estuary and we have no evidence to suggest that there is a higher concentration of these contaminants in the range of the San Pablo DPS than in the entire range of the species. Please refer to *Factor E* in the range wide analysis for a full discussion of the effects of contaminants on splittail. Based on a review of the best available scientific and commercial data, we conclude that contaminants are not a significant threat to splittail at the population level now or in the foreseeable future.

Climate Change

Climate change is a potential threat to splittail range wide including in the San Pablo Bay and the potential threat of climate change is expected to be the same in scope and intensity as it is in the overall range of the species. Please refer to *Factor E* in the range wide analysis for a full discussion of the effects of climate change on splittail. Based on a review of the best scientific information available, we find that climate change is not a significant threat to the San Pablo Bay population of splittail now or in the foreseeable future.

Introduced Species

Introduced species are a potential threat to the splittail rangewide and the effects of introduced species on the San Pablo DPS are expected to be similar to the effects on the species range-wide. However, several introduced species mentioned in the range-wide analysis will not be present in the San Pablo Bay. The invasive *Corbula amurensis* has become established in San Pablo Bay (USGS 2010); no records exist for *Corbicula fluminea*, which is physiologically capable of becoming established in the freshwater portions of the Petaluma and Napa rivers. *Corbicula fluminea* is not expected to be present in the San Pablo Bay because it is a freshwater clam. Largemouth bass are not expected to be present in San Pablo Bay because they are a freshwater species.

Brazilian pondweed and water hyacinth are also not expected to be present in this brackish environment because they are freshwater plants. We are lacking any studies on introduced species present in the Napa and Petaluma rivers. Although the non-native copepods and bivalves discussed in the rangewide analysis have altered the food web in the Delta ecosystem, we have no compelling evidence to suggest that this has led to a decline in the splittail population. Therefore, we do not consider introduced species to be a significant threat to splittail now or in the foreseeable future.

We conclude that the best scientific and commercial information available indicates that the San Pablo DPS of the Sacramento splittail is not now, nor in the foreseeable future, threatened by other natural or manmade factors affecting its continued existence.

Finding

As required by the Act, we considered the five factors in assessing whether the San Pablo DPS of Sacramento splittail is endangered or threatened. We examined the best scientific and commercial information available regarding the past, present, and future threats faced by the San Pablo DPS.

The rate of habitat loss in San Pablo Bay that occurred the 1900's is no longer occurring today and efforts undertaken in the past decade have benefited the species by restoring its habitat. There is presently sufficient habitat to maintain the species: inundation frequency and duration in key areas is sufficient to provide spawning to maintain the species. Based on a review of the best scientific information available, we find that the present or threatened destruction, modification, or curtailment of splittail habitat or range (*Factor A*) is not a significant threat to the San Pablo DPS throughout all or a part of its range.

The new CDFG regulation enacted in March 2010 limiting take of splittail to two individuals per day has eliminated any potential threat that fisheries may have posed. There is no indication that the current level of scientific take adversely affects the San Pablo DPS, and there is no indication that the level of mortality will increase in the future. Based on a review of the best scientific information available, we find that overutilization for commercial, recreational, scientific, or educational purposes (*Factor B*) is not a significant threat to the San Pablo DPS now or in the foreseeable future.

We found disease occurs at low levels in the population, but does not constitute a significant threat to the species (*Factor C*). Predation by striped bass appears to be unchanged from past levels and is currently not a significant threat to the San Pablo DPS. Other freshwater predators are absent from the San Pablo Bay due to elevated salinity levels. Based on a review of the best scientific information available, we find that disease and predation (*Factor C*) are not significant threats to the San Pablo DPS in all or a significant portion of its range, now or in the foreseeable future.

Federal and State regulations provide protection for the San Pablo DPS and its habitat by limiting adverse effects from new projects, restoring habitat and limiting contaminants discharged into the Estuary. Based on a review of the best scientific information, we find that a lack of regulatory mechanisms (*Factor D*) does not constitute a significant threat to the San Pablo DPS.

Based on the best available science, we find that other natural or manmade factors affecting the continued existence of the San Pablo DPS described in *Factor E* have not been shown to be significant threats to the San Pablo DPS at this time. Furthermore, there is no compelling evidence to suggest that these factors will increase and become threats to the San Pablo DPS in the foreseeable future. The San Pablo DPS is not threatened by water export facilities, agricultural and power plant diversions, poor water quality, environmental contaminants, climate change, or introduced species (*Factor E*).

The existing data fails to show a significant long-term decline of the San Pablo DPS. The accepted range of the species in the Napa and Petaluma rivers has increased as new surveys have found presence of splittail in areas where they were previously not believed to be in the mid-1990's (Sommer *et al.* 2007, p. 28).Therefore, based on the best available data, we do not find an overall declining trend in the species' population.

Based on our review of the best available scientific and commercial information pertaining to the five factors, we find that the threats are not of sufficient imminence, intensity, or magnitude to indicate that the San Pablo DPS is in danger of extinction (endangered)**,** or likely to become endangered within the foreseeable future (threatened). Therefore, we find that listing the San Pablo DPS as an endangered or threatened species is not warranted at this time.

Significant Portion of the Range Analysis

Having determined that the splittail does not meet the definition of an endangered or threatened species, we must next consider whether there are any significant portions of the range where the splittail is in danger of extinction or is likely to become endangered in the foreseeable future.

We have analyzed the potential for the San Pablo DPS to make up a significant portion of the species range by looking at areas where there may be a significant concentration of threats. We evaluated the San Pablo DPS in the context of whether any potential threats are concentrated in one or more areas of the projected range, such that if there were concentrated impacts, those splittail populations might be threatened, and further, whether any such population or complex might constitute a significant portion of the species range. In the case of the San Pablo DPS, we conclude that the potential threats to the species are uniform throughout the DPS. After reviewing the range of the species, we find that no areas have a significant concentration of threats such that a significant portion of the range analysis on them would be necessary.

We do not find that the Sacramento splittail is in danger of extinction now, or is it likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Therefore, listing the Sacramento splittail as endangered or threatened under the Act is not warranted at this time.

We request that you submit any new information concerning the status of, or threats to, the Sacramento splittail or the markedly separate San Pablo DPS to our San Francisco Bay Delta Fish and Wildlife Office (see **ADDRESSES**) whenever it becomes available. New information will help us monitor the Sacramento splittail and encourage its conservation. If an emergency situation develops for the splittail or any other species, we will act to provide immediate protection.

References Cited

A complete list of references cited in this finding is available on the Internet at *http://www.regulations.gov* and upon request from the San Francisco Bay Delta Fish and Wildlife Office (see **ADDRESSES**).

Author(s)

The primary authors of this notice are the staff members of the San Francisco Bay Delta Fish and Wildlife Office, Sacramento, California.

Authority

The authority for this section is section 4 of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.).

Dated: September 24, 2010

/s/ Daniel M. Ashe

Acting Director, Fish and Wildlife Service

[~~**Endangered and Threatened Wildlife and Plants; 12-month Finding on a Petition to list the Sacramento Splittail as Endangered or Threatened**~~]

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