

Appendix A. Special Status Species Life History Information

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Special Status Fish Species

The mandated fish monitoring is required as one of the permit conditions for maintenance dredging specifically because of the special status of certain fish species, primarily driven by Section 7 of the federal Endangered Species Act (ESA) and the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and also involving the California Endangered Species Act (CESA). The status of a particular species may change with the latest assessments of what are known under the ESA as an evolutionarily significant units (ESU) or distinct population segment (DPS). Given the number of listed fish species that use the monitoring program's action area (at least for a portion of the year), it is likely that a status change could occur annually; potentially with affect to operations of monitoring, the maintenance dredging, and other permitted projects in the area.

The recent changes that affected the 2010 Ship Channel Fish Monitoring Program are highlighted here. Details are provided in following subsections for ESA critical habitat designations, status, and pertinent biology for each fish species - grouped by jurisdictional agency.

The California Fish and Game Commission (CDFG) enacted protections for longfin smelt in 2008, a CESA candidate species at that time. Currently longfin smelt are listed as threatened under CESA (March 4, 2009) and the fish community monitoring is restricted in under a IEP-2081 permit allowing annual incidental take of 150 juvenile and 150 adult longfin smelt for the entire year. Federal protection of the longfin smelt was recently denied by the USFWS (April 9, 2009) finding that the San Francisco Bay-Delta longfin smelt did not qualify as a distinct population segment (DPS). However, the federal status for longfin smelt populations from Alaska to California, remains unresolved. A February 2, 2011 court-approved settlement agreement requires the USFWS to re-evaluate whether ESA protection for longfin smelt is warranted. The decision for longfin smelt is due September 30, 2011 during the upcoming maintenance dredging season. Other key species of interest that are not currently listed under the federal ESA but are present in the action area include: Sacramento splittail, and Pacific lamprey and river lamprey.

Recent state and federal ESA petitions have resulted in decisions to change listing of delta smelt from threatened to endangered. California up-listed delta smelt to endangered status on March 4, 2009 (Final Statement issued on November 10, 2009). The USFWS' five-year status review of delta smelt began March 24, 2009. Most recent is the USFWS 12-month finding reclassifying delta smelt status from threatened to endangered is warranted but precluded by other higher priority listing actions (75 FR 17667, April 7, 2010).

A decision on listing of Sacramento Splittail was due during the period of active period of fish monitoring for 2010 season. On September 29, 2010 a new status review was published with and the 21-month finding listing decision as not warranted for the Sacramento splittail due to new information showing recent abundance increases (Vol. 75 FR 62070); other factors noted were habitat improvements targeted for this species, improved flow conditions, and diminishing threats in the recent past.

Designated Critical Habitat

Critical habitat is established for fish species listed under the federal ESA and habitat areas designated by either the NMFS or USFWS using the latest information and best available science.

The delta smelt is the endangered fish species under USFWS jurisdiction that has designated critical habitat (1994, 59 FR 65256) throughout the project areas waters.

For species under NMFS jurisdiction critical habitat consists of the aquatic habitat below ordinary high water, including navigation channels, for all designated areas. Critical habitat for Sacramento River winter-run Chinook salmon was designated on June 16, 1993 (50 FR 33212) and includes the main Sacramento River channel from Keswick Dam (RM 302) downstream to Chipps Island (RM 0) at the westward margin of the Delta; then most all connected waters from Chipps Island westward through the San Francisco Bay. Rivers and sloughs of the Sacramento above Chipps Island (including the entire San Joaquin River Basin and central Delta) are excluded from critical habitat in the 1993 designation. Designated critical habitat for Central Valley spring-run Chinook salmon borders the northern edge of the San Joaquin River from the confluence of the Mokelumne River west to the boundaries of Suisun Bay and the Delta hydrologic sub units at approximately RM 4 of the San Joaquin River. This includes the waters of Three Mile Slough and New York Slough. Critical habitat for CV spring-run Chinook salmon includes the Sacramento River from Keswick Dam in Shasta County through the San Francisco Bay including Yolo Bypass and associated sloughs; however, the man-made portion of the SRSC is excluded from designation (70 FR 52488). Individuals of both Chinook salmon Evolutionarily Significant Units (ESUs) can occupy waters within the SSC and SRSC action area. Designated critical habitat for the Central Valley steelhead ESU occurs along the entire length of the SSC and SRSC below the ordinary high water mark. The recently listed Southern Distinct Population Segment (DPS) of green sturgeon's critical habitat Final Rule was published in the Federal Register (74 FR 52300) on October 9, 2009 and includes the entire Sacramento and San Joaquin Delta.

Listed Fish Species Under the Jurisdiction of NMFS

Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*)

ESA status: Endangered, critical habitat designated

California status: Endangered

Sources: CDFG 2009, 2010; CalFed 2005; Fry 1961, 1973; Hallock and Fry 1967; Hallock et al. 1970; Miller and Lea 1972; Moyle 1976; Sasaki 1966; Wang 1986

This Chinook salmon ESU listing as endangered was re-affirmed in 1994 (59 FR 440). The winter-run Chinook may use the project area waters primarily for adult spawning migrations and juvenile outmigrations, with some usage overlap for juvenile rearing. Winter-run Chinook adults migrate upstream from December to July and spawn in accessible upper reaches of the Sacramento River basin from April through July. Chinook alevins have been collected from Suisun Bay in January and February. Larger parr juveniles have been found from April to June. Juvenile life stages are commonly found inshore, in shallow water and throughout estuarine habitat. Some Chinook salmon delay their downstream migration until the early smolt stage. Juvenile outmigration peaks from May to June. Juvenile Chinook salmon feed primarily on various aquatic and terrestrial insects, crustaceans, chironomid larvae and pupae, and caddisflies when they are in fresh water. When found in saline waters, the Chinook smolt diet changes to mainly *Gammarids*, *Neomysids*, and *Crangon* shrimp species. Juvenile salmon are prey for many animals, including birds and other fishes.

Central Valley spring-run Chinook salmon (*O. tshawytscha*)

ESA status: Threatened, critical habitat designated

California status: Threatened

Sources: CDFG 2009, 2010; CalFed 2005; Federal Register 2005. Fry 1961, 1973; Hallock and Fry 1967; Hallock et al. 1970; Miller and Lea 1972; Moyle 1976; Sasaki 1966; Skinner 1972; Wang 1986

Uses of the project areas by spring-run Chinook salmon are of the same types as described for the winter-run ESU. Spawning migration timing differs with spring-run Chinook moving upstream from April to October, and spawning from August through October. Juvenile usage in the areas of concern is similar to that described for winter-run Chinook.

Central Valley steelhead (*O. mykiss*)

ESA Status: Threatened, critical habitat designated.

California Status: none

Sources: CDFG 2010; CalFed 2005; Hallock et al. 1970; Hallock and Fry 1967; Moyle 1976; Wang 1986

Residing in the ocean for 2–3 years, anadromous adults of the Central Valley steelhead ESU make their upstream spawning migrations beginning in July (peaking in September and October). Spawning occurs from December through April. Central Valley steelhead primarily use the project areas as a migration corridor, with some juvenile rearing overlapping with their smoltification and outmigration processes. Spawning and incubation, along with the majority of rearing, occurs farther upstream than for Chinook salmon and that of the project area. Freshwater residence of juveniles may be from 1-3 years where they feed on diverse aquatic and terrestrial insects and other small invertebrates. Juveniles primarily occur near the surface and in the water column when over deeper waters. Though juvenile Central Valley steelhead do outmigrate to the ocean from December through August, most are found migrating through the project areas in spring.

Green sturgeon (*Acipenser medirostrus*)

ESA status: Threatened (July 6, 2006), Southern DPS, critical habitat designated.

California Status: none

Sources: Adams et al. 2002; CDFG 2009, 2010; CalFed 2005; FR 2009. Fry 1973; Gisbert (2006); Klimley 2007; NOAA 2009; Radtke 1966; Van Eenennaam (2005); Wang 1986.

The rare and little studied green sturgeon occurs within the project area the Sacramento and San Joaquin Rivers and the Delta. The Southern DPS consists of fish in the San Francisco Bay and Delta that spawn in the Sacramento River basin. A number of presumed spawning populations of green sturgeon have been lost since the 1960s and 1970s — from the Eel River, South Fork Trinity River, and San Joaquin River. Green sturgeon sub-adults and adults inhabit near shore oceanic waters, bays, and estuaries but also migrate to and from freshwater habitats. Early life-history stages (<4 years old) reside in fresh water, with adults returning to freshwater to spawn (first spawn age range of 10-15 years and > 130 cm in size). Recorded spawning locations are known from the upper Sacramento River and tributaries such as the Feather, Yuba, and American Rivers., with spawning in spring and summer. Recent studies have improved the knowledge of the biology and ecology of this fish, though substantial gaps still exist regarding its habits in the project area and elsewhere in its range. Juveniles of two apparent size groups (fork length range of 20–58 cm) have been collected in the Sacramento and San Joaquin Rivers and Suisun Bay. Green sturgeon can be distributed throughout the freshwater portions of their habitat the entire year (at least the juvenile life stage). The diet of juvenile sturgeon consists mostly of amphipods and mysid shrimps in the Delta. Additional information on green sturgeon is available at NMFS web site (<http://www.nmfs.noaa.gov/pr/species/fish/greensturgeon.htm>).

Listed Fish Species Under the Jurisdiction of USFWS

Delta smelt (*Hypomesus transpacificus*)

ESA status: Endangered (reclassified from threatened but precluded), critical habitat designated

California status: Endangered

Sources: Bennett 2005; CDFG 2010; CalFed 2005; Federal Register 2010; 2008, 1994; Ganssle 1966; Herald 1961; McAllister 1963; Messersmith 1966; Moyle 1976, 2002; Moyle et al. 1995; Radtke 1966; Swanson et al. 2000; Wang 1986

The delta smelt is a euryhaline fish that ranges from the lower reaches of the Sacramento and San Joaquin Rivers, through the Delta, and into Suisun Bay. It is endemic to the Delta and have been found in the SRSC and SSC in low abundance. Delta smelt was listed as threatened under the ESA on March 5, 1993 (FR 58, 12854). Final critical habitat designation for delta smelt (Federal Register 59, 65256; December 19, 1994) includes the Stockton and Sacramento DWSCs. On March 24, 2009, the USFWS initiated a five-year status review of delta smelt. As of April 7, 2010, reclassification status of delta smelt to endangered is warranted but precluded (75 FR 17667; for additional information on why). The state status of delta smelt under CESA was recently elevated from threatened to endangered (March 4, 2009).

The abundance of this fish is closely associated with salinities between 0 and 7 practical salinity units (psu). Delta smelt have an upper salinity tolerance of 19 psu and a significant habitat preference near or upstream of the 2 psu zone. They are not present in waters over 25°C, and are rarely found in water temperatures above 22°C. A similar and introduced smelt the wakasagi (*H. nipponensis*) has a larger temperature and salinity tolerance, as well as stronger swimming ability. Delta smelt spawn in dead-end sloughs, near-inshore areas of the Delta, and shallow fresh water channels of the Delta and Suisun Bay. In the fall, prior to spawning, delta smelt congregate in upper Suisun Bay and the lower reaches of the Delta. The spawning period is estimated to be from February to June. Eggs are demersal and adhesive. Delta smelt may prefer spawning over vegetation, if present, but often deposit their eggs over submerged tree branches and stems, or in open water over sandy and rocky substrate, and may even use the shallower areas of Delta levees. Newly hatched larvae float near the surface of the water column in both inshore and channel areas. Larval movements are variable and follow tides and discharge.

Data from trawl and trap net catches show that larger juveniles and adults are abundant during spring and summer in Suisun Bay and the Delta. Seasonal migrations occur within a short section of the upper estuary. Juvenile smelt move downstream to San Pablo Bay and Carquinez Strait before turning back to Suisun Bay or upstream sloughs for spawning. During average and high outflow years, delta smelt congregate from upper Suisun Bay to the Sacramento River near Decker Island. During low outflow and drought years their pre-spawning congregations are centered in the channel of the Sacramento River and are rarely further downstream in Suisun Bay. Recent spring Kodiak trawl surveys and summer tow-net surveys by the IEP in the DWSC have shown delta smelt to use the Man-made Channel portion up to the Port of Sacramento, are present in the DWSC year-round, and that these smelt they may be genetically distinct from delta smelt occurring in other portions of the Delta.

Juvenile delta smelt primarily eat planktonic crustaceans, small insect larvae, and mysid shrimp. Delta smelt mature quickly, with most adults dying after spawning their first year. The few adults that survive to their second year have vastly higher fecundity.

Estuarine Composite Species with Essential Fish Habitat

The following fishes, though not listed under ESA, are included here as they are part of the estuarine composite species with essential fish habitat (EFH) protections under the Magnuson- Stevens Fishery Conservation and Management Act (MSA). They are administered by the NMFS and are the most likely of their composite to utilize the portions of the Delta within the project area. These species were

included in the EFH assessments for the Sacramento River and Stockton Ship Channel Maintenance Dredging and Levee Stabilization Projects (NMFS 2006a, 2006b).

Starry flounder (*Platyichthys stellatus*)

ESA status: None,

MSA species, estuarine composite EFH

Sources: CalFed 2005; Fry 1973; PFMC 1998; McCain et al. 2005; NMFS 2006; Radtke 1966; Wang 1986; Wydoski and Whitney 2005

The starry flounder is a marine flatfish with both eyes on the same side of its head. Starry flounder are white on the ventral side and have conspicuous ventral black and orange bands on their dorsal and anal fins. They have a tolerance for a variety of salinities and are found along the coast and in estuaries and the lower portions of rivers. Juveniles and adults are demersal and prefer sandy to muddy substrates. Starry flounder have been recorded at a depth of 900 feet. Studies have shown starry flounder can move a considerable distance between estuarine and ocean habitats (440 nautical miles). Juveniles and sub-adult life stages extend the upstream freshwater use to the Bay and lower reaches of the Delta. Adults may reach a length of 3 feet and a weight of 20 pounds. Females grow faster than males and are heavier at a given length. Males mature at 2 years and females at 3 years. They spawn in winter with water temperatures averaging 11°C (51.8°F). Eggs and larvae are epipelagic and occur near the surface over water that ranges from 20 to 70 m (65 to 30 feet) deep. They feed on copepods, amphipods and annelid worms and, as adults, include crabs, mollusks, and echinoderms. Feeding slows in winter as temperatures drop. Starry flounder provide both recreational and commercial fisheries. One juvenile flounder was collected near the Port of Stockton in 2009 and this may represent an extension of its known range in the Delta.

English sole (*Pleuronectes vetulus*)

ESA status: None

MSA species, estuarine composite EFH

Sources: McCain et al. 2005; NMFS 2006; PFMC 1998; Wang 1986; Wydoski and Whitney 2005

English sole are an inner shelf-mesobenthic flatfish species that ranges from Mexico to Alaska and is abundant in the San Francisco Bay-Estuary system. Adults generally spawn during late fall to early spring in inshore waters over soft mud bottoms to 70 m (230 feet). Epipelagic larvae are carried by wind and near-surface tidal currents into bays and estuaries where they metamorphose to demersal juveniles. Juveniles rear in the inshore areas and in the bays and estuaries moving offshore as they age. Juvenile English sole seek food and shelter in shallow near-shore, inter-tidal, and estuarine waters. Prey items include small crustaceans (e.g., copepods and amphipods) and polychaete worms. English sole provide commercial and recreational fisheries. Bottom-oriented juveniles may occur in the lower portion of the SSC and SRSC. However, none have been encountered during monitoring of dredge operations.

Fish Species Listed under CESA

Longfin smelt (*Spirinchus thaleichthys*)

ESA status: none, Bay-Delta DPS denied petitioned for listing

California status: State Threatened

Sources: CDFG 2010, 2009, 2007, 2000; Moyle 2002; Moyle et al. 1995

Longfin smelt are a small-sized euryhaline and anadromous fish that was historically one of the most abundant fish in the San Francisco estuary and the Delta. Their abundance has declined precipitously throughout its range during the past quarter century. Longfin smelt are distinguished from other

California smelts by their long pectoral fins, which reach or nearly reach the base of their pelvic fins. These fish reach a maximum size of about 150 mm (total length) and mature near the end of their second year. As they mature in the fall, adults found throughout San Francisco Bay migrate to brackish or freshwater in Suisun Bay, Montezuma Slough, and the lower reaches of the Sacramento and San Joaquin Rivers. Adults congregate for spawning at the upper end of Suisun Bay and in the lower and middle Delta, especially in the Sacramento River channel and adjacent sloughs. Juveniles tend to inhabit the middle and lower portions of the water column. In April and May, juveniles are believed to migrate downstream to San Pablo Bay; juvenile longfin smelt are collected throughout the Bay during the late spring, summer, and fall and occasionally venture offshore as far as the Gulf of the Farallones. Their continuing decline in abundance is likely due to multiple factors including: reduction in outflows, entrainment losses to water diversions, shifts in hydrologic regime and climatic variation, toxic substances, predation and introduced species.

Species of Special Concern

The following fishes, though not listed under ESA, nor protected under the MSA, have been listed or petitioned for listing in the recent past, and are presently considered species of special concern by the State of California. Information on these species is being sought by NMFS and USFWS. This background information is provided here because these species were encountered during fish community and or entrainment monitoring.

Lamprey, Pacific (*Entosphenus tridentate*)

Lamprey, river (*Lampetra ayresii*)

ESA status: Not warranted (decision 2005)

California Status: Watch list – river lamprey

Sources: Goodman et al. 2009, Kostow 2002; Moyle 2002; Wydoski and Whitney 2005

Anadromous Pacific and river lamprey co-occur in SSC and SRSC. Little is known about population trends for the river lamprey at the southern end of its distribution. Recorded occurrences of river lamprey in California are primarily from the Feather River and the lower Sacramento-San Joaquin River system, including the area of Ship Channel maintenance dredging. Adult lamprey of both species migrate upstream in early spring and spawn during late spring and early summer in gravel substrates upstream of the Delta and lower Sacramento-San Joaquin river system.

Adult Pacific lamprey generally hibernate in freshwater for up to a year during their upstream spawning migration. During this time they hide in substrates near their spawning area and do not feed prior to spawning the following year. The filter-feeding ammocoetes develop for years (up to six) burrowed into soft substrates in freshwater. River lamprey begin their transformation from ammocoete to adult form at about 120 mm total length; Pacific lamprey at approximately 140 to 160 mm. Metamorphosis lasts from 9 to 10 months in river lamprey, the longest known in this family of fishes. During this time, both lamprey species congregate close to the saltwater-freshwater interface in estuaries. Macrophthalmia is the term applied to the lampreys' transformational stage between filter-feeding ammocoete and parasitic adult. During this period they have large, well-developed eyes, and their body coloration is silvery on the lateral and ventral aspects with blue to dark gray coloration along the dorsal aspect. Adult teeth used to prey on or parasitize other fishes develop and grow in macrophthalmia. Full development of the third, or middle, tooth of the supraoral lamina in Pacific lamprey develops during this stage, previously complicating field identification of the early macrophthalmic stage with that of the two-toothed river lamprey. However, new studies combining DNA analysis with certain morphological characteristics (Goodman et al. 2009) now allow for greater confidence in field differentiation of these two genera.

Fully developed macrophthalmia migrate downstream to the ocean, likely between late fall and spring, when outflows are high. Some river lamprey may spend their entire life history in freshwater. River lamprey appear to be more parasitic in freshwater than Pacific lamprey. Adult river lamprey spend less time in the ocean or estuary migrating back to freshwater in the fall and winter. In general, adult Pacific lamprey migrate from stream to spawning areas in winter and spring.

Sacramento splittail (*Pogonichthys macrolepidotus*)

ESA status: species of concern (2003), formerly listed as threatened (1999)

CESA status: none

Sources: Federal Register 2010. CDFG 2010; Moyle 2002; USFWS 2003; Wang 1986

The Sacramento splittail is found only in California's Sacramento-San Joaquin Delta, streams of the Central Valley, and the Napa and Petaluma rivers. This native minnow (family Cyprinidae) received protection as a threatened species in February 1999 (64 FR 5963). The USFWS delisted the splittail on September 22, 2003 (68 FR 55140). This decision was prompted by a court case challenging the Service on the merits of the prior 2003 ESA not warranted listing determination and alleging improper political influence of the former Deputy Assistant Secretary for Fish Wildlife and Parks, J. MacDonald (Case4:09-cv-03711-PJH). On September 29, 2010 a new status review was published with and the 21-month finding listing decision as not warranted for the Sacramento splittail due to new information showing population increases over the most recent years of study.

The relatively long-lived splittail (up to 9 years) can grow up to 400 mm long. The upper part of the tail is enlarged and appears to be split, hence its common name. Historically, the splittail occurred in the Sacramento River as far north as Redding, as far south in the San Joaquin River as Friant Dam near Fresno, and as far west as the Petaluma River. They are adapted to living in estuarine systems and are tolerant of salinities from 10 to 18 ppt. Young-of-year and yearling splittail are most abundant in shallow water and are able to swim in strong current. Adults exhibit slow upstream movement during winter and spring to forage and spawn in flooded areas. Their small, subterminal mouth with barbels and pharyngeal teeth, along with the large upper tail lobe, reflect their preference for feeding on bottom invertebrates in low to moderate current strength. Splittail reach adulthood at approximately 170 mm in their second year. Splittail populations have declined as dams and diversions have prevented fish from access to upstream areas of large rivers. The Fall Mid-water Trawl Survey (IEP) caught zero splittail in 2010 and only 2 in the last 4 years of study. Reclamation and modification of flood basins also have reduced the species' spawning grounds.

References

- Adams, P. B., C. B. Grimes, J. E. Hightower, S. T. Lindley, and M. L. Moser. 2002. Status review for North American green sturgeon, *Acipenser medirostris*. National Marine Fisheries Service, Southwest Fisheries Science Center, Santa Cruz, California.
- Bennett, W. A. 2002. Critical assessment of the delta smelt population in the San Francisco estuary, California. California Bay Delta Authority and John Muir Institute for the Environment, University of California, Davis.
- CalFed (US Bureau of Reclamation and California Department of Water Resources). 2005. South delta improvements program draft environmental impact statement/environmental impact report. October 2005.
- California Department of Fish and Game (CDFG). 2000. Fish species of special concern in California, Bay-Delta monitoring, San Francisco Bay monitoring, fish, longfin smelt. California Department of Fish and Game, Central Valley Bay-Delta Branch, 2000.
- . 2007. Longfin smelt in San Francisco Bay. California Department of Fish and Game, Bay Delta Region. Available: <http://www.delta.dfg.ca.gov/baydelta/monitoring/lf.asp>. (August 10, 2007).
- . 2009. State and Federally Listed Endangered and Threatened Animals of California. Department of Fish and Game. Available: <http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/TEAnimals.pdf>. (January 2010).
- . 2010. State and Federally Listed Endangered and Threatened Animals of California. Department of Fish and Game. July 2010. Available: <http://www.dfg.ca.gov/biogeodata/cnddb/pdfs/TEAnimals.pdf>. (July 2010).
- Federal Register. 1994. Vol. 59 FR 65256. Critical habitat determination for the delta smelt. Final Rule. Final designated. USFWS. December 19. http://ecos.fws.gov/docs/federal_register/fr2751.pdf
- . 2005. Vol. 70. FR 52488. Designation of Critical Habitat for seven Evolutionarily Significant Units of Pacific salmon and steelhead in California. Final Rule. NMFS. September 2. <http://www.gpo.gov:80/fdsys/pkg/FR-2005-09-02/pdf/05-16389.pdf>
- . 2008 Vol. 73 FR 39639. 90-Day Finding on a Petition to reclassify the delta smelt (*Hypomesus transpacificus*) from threatened to endangered
- Notice 90-day Petition Finding of Substantial. USFWS. July 10. <http://www.gpo.gov:80/fdsys/pkg/FR-2008-07-10/pdf/E8-15747.pdf#page=1>
- . 2008. Vol. 73 FR 52084. Proposed Rulemaking to Designate Critical Habitat for the threatened Southern distinct population segment of North American green sturgeon. Proposed Rule. NMFS. September 8. <http://www.gpo.gov:80/fdsys/pkg/FR-2008-09-08/pdf/E8-20632.pdf>

- . 2009. Vol. 74 FR 52300. Final Rulemaking to Designate Critical Habitat for the threatened Southern distinct population segment of North American green sturgeon. Final Rule. NMFS. October 9.
- <http://www.gpo.gov:80/fdsys/pkg/FR-2009-10-09/pdf/E9-24067.pdf#page=1>
- . 2010 Vol. 75 FR 17667. 12-Month Finding on a Petition to reclassify the delta smelt from threatened to endangered throughout its range. Notice 12 month petition finding of warranted but precluded. USFWS. April 7. <http://www.gpo.gov:80/fdsys/pkg/FR-2010-04-07/pdf/2010-7904.pdf#page=1>
- . 2010. Vol. 75 FR 62070. 12-month Finding on a Petition to list the Sacramento splittail as endangered or threatened [Docket No. FWS-R8-ES-2010-0013]. Notice of 12-month petition finding of not warranted. USFWS. October 7. <http://www.gpo.gov:80/fdsys/pkg/FR-2010-10-07/pdf/2010-24871.pdf#page=1>
- Fry, D. H., Jr. 1961. King salmon spawning stocks of the California Central Valley, 1940-1959. California Fish and Game 47(1):55–71.
- . 1973. Anadromous fishes of California. California Department of Fish and Game, Sacramento.
- Ganssle, D. 1966. Fishes and decapods of San Pablo and Suisun bays. Pages 64–94 in
- D. W. Kelley, compiler. Ecological studies of the Sacramento-San Joaquin estuary, part 1. California Department of Fish and Game, Fish Bulletin 133, Sacramento.
- Goodman, D. H., Kinziger, A. P., Reid, S. B., and Docker, M. F. 2009. Morphological diagnosis of *Entosphenus* and *Lampetra ammocoetes* (Petromyzontidae) in Washington, Oregon, and California. American Fisheries Society Symposium. 72: 223-232, 2009.
- Gisbert, E. and S. Doroshov. 2006. Allometric Growth in Green Sturgeon larvae. Journal of Applied Ichthyology. 22 (Suppl.1) (2006), 202-207.
- Hallock, R. J. and D. H. Fry, Jr. 1967. Five species of salmon *Oncorhynchus*, in the Sacramento River, California. California Fish and Game 53(1): 5–22.
- Hallock, R. J., R. F. Elwell, and D. H. Fry, Jr. 1970. Migrations of adult king salmon *Oncorhynchus tshawytscha* in the San Joaquin Delta. California Department of Fish and Game, Fish Bulletin 151, Sacramento.
- Herald, E. S. 1961. Living fishes of the world. Doubleday, New York.
- Kostow, K. 2002. Oregon lampreys: natural history status and problem analysis. Oregon Department of Fish and Wildlife, Portland.
- Klimley, A. P., P. J. Allen, J. A. Israel, and J. T. Kelly. 2007. The green sturgeon and its environment: past, present, and future. Environmental Biology of Fishes (2007) Volume 79, Numbers 3-4 / August, 2007.
- McCain, B. B., Miller, S. D., and W. W. Wakefield II. 2005 life history, geographical distribution, and habitat associations of 82 West Coast groundfish species: a literature review, draft January 2005 in Appendix H of Essential Fish Habitat Designation and Minimization of Adverse Impacts

Draft Environmental Impact Statement, Vol. 4, February 2005. National Marine Fisheries Service, Northwest Fisheries Science Center, Seattle.

McAllister, D. E. 1963. A revision of the smelt family, *Osmeridae*. National Museum of Canada, Bulletin 191, Ottawa.

Messersmith, J. D. 1966. Fishes collected in Carquinez Strait in 1961–1962. Pages 57–63 in D. W. Kelley, compiler. Ecological studies of the Sacramento-San Joaquin estuary, part I. California Department of Fish and Game, Fish Bulletin 133, Sacramento.

Miller, D. J., and R. N. Lea. 1972 (1976). Guide to the coastal marine fishes of California. California Department of Fish and Game, Fish Bulletin 157, Sacramento.

Moyle, P. B. 1976. Inland fishes of California. University of California Press, Berkeley.

———. 2002. Inland fishes of California (revised and expanded). University of California Press, Berkeley.

Moyle, P.B., R. M. Yoshiyama, J. E. Williams, and E. D. Wikramanayake. 1995. Fish species of special concern in California. Final Report for Contract No. 21281F to State of California, Resources Agency, Department of Fish and Game, Inland Fisheries Division, Rancho Cordova, June 1995.

National Marine Fisheries Service (NMFS). 2002. Biological Opinion for the Decker Island Fish Monitoring Program. SWR-00-SA-5820: MEA.

———. 2006a. Biological and conference opinion for the Stockton deep water ship channel maintenance dredging and levee stabilization project. SWR-2004-SA-9121:JSS, April 4, 2006. Prepared for the U.S. Army Corps of Engineers, Sacramento District.

———. 2006b. Biological and conference opinion for the Sacramento River deep water ship channel maintenance dredging and levee stabilization project. ARN 15 1422SWR200600041:JB, August 29, 2006. Prepared for the U.S. Army Corps of Engineers, Sacramento District. http://swr.nmfs.noaa.gov/sac/myweb8/BiOpFiles/2006/SRDWSC_BO.pdf

NOAA 2009. 50 CFR Part 226. [Docket No. 080730953–91263–02] RIN 0648–AX04. Endangered and Threatened Wildlife and Plants: Final Rulemaking To Designate Critical Habitat for the Threatened Southern Distinct Population Segment of North American Green Sturgeon. Federal Register / Vol. 74, No. 195 / Friday, October 9, 2009.

Pacific Fishery Management Council (PFMC). 1998. Essential Fish Habitat – West Coast Groundfish. Modified from: Final Environmental Assessment/Regulatory Impact Review for Amendment 11 to the Pacific Coast Groundfish Fishery Management Plan. October 1998. Portland. 46 pp. <http://www.pcouncil.org>.

Radtko, L. D. 1966. Distribution of smelt, juvenile sturgeon, and starry flounder in the Sacramento-San Joaquin Delta with observations on food of sturgeon. Pages 115–129 in J. L. Turner and D. W. Kelley, compilers. Ecological studies of the Sacramento-San Joaquin delta, part II. California Department of Fish and Game, Fish Bulletin 136, Sacramento.

- Sasaki, S. 1966. Distribution and food habits of king salmon, *Oncorhynchus tshawytscha*, and steelhead rainbow trout, *Salmo gairdnerii*, in the Sacramento-San Joaquin Delta. Pages 108–114 in J. L. Turner and D. W. Kelley, compilers. Ecological studies of the Sacramento-San Joaquin delta, part II. California Department of Fish and Game, Fish Bulletin 136, Sacramento.
- Skinner, J. E. 1972. Ecological studies of the Sacramento-San Joaquin Estuary. California Department of Fish and Game, Delta Fish Wildlife Protection Study Report 8, Sacramento. United States Fish and Wildlife Service (USFWS). 2001. Annual progress report: abundance and survival of juvenile Chinook salmon in the Sacramento-San Joaquin estuary. Stockton, California.
- Swanson, C., T. Reid, P. S. Young and J.J. Cech Jr. 2000. Comparative environmental tolerances of threatened delta smelt (*Hypomesus transpacificus*) and introduced wakasagi (*H. nipponensis*) in an altered California estuary. *Oecologia* Vol. 123, Number 3, 384-390.
- U.S. Fish and Wildlife Service (USFWS). 2009. Delta smelt spotlight species action plan 2010-2014. Aug. 27. http://ecos.fws.gov/docs/action_plans/doc3168.pdf
- Van Eenennaam, J. P., J. Linares-Casenave, X. Deng, and S.I. Doroshov. 2005. Effect of incubation temperature on green sturgeon embryos, *Acipenser medirostris*. *Environmental Biology of Fishes*. Volume 72, Number 2 / February, 2005
- Wang, J. C. S. 1986. Fishes of the Sacramento-San Joaquin estuary and adjacent waters, California: a guide to the early life histories. Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary, Technical Report 9 (FS/B10-4ATR 86-9), Sacramento.
- Wydoski R., and R. Whitney. 2003. Inland fishes of Washington. University of Washington Press, Seattle.

Appendix B. Water Quality Data

Bottom Water Quality Readings

Survey ID	Dredge Reach	Date (m/d/year)	Time (hh:mm)	Depth (ft)	Temp (°C)	DO (ppm)	DO (%)	pH	ORP (mV)	Cond (uS)	Sal (ppt)	Turb (ntu)
WQ1001	MM Channel 1	9/20/2010	14:35	-28	21.2	10.55	117	8.68	157	780	0.4	83.6
WQ1002	MM Channel 1	9/22/2010	16:26	-32	20.78	9.92	106	8.88	167	753	0.4	84.5
WQ1003	MM Channel 1	9/22/2010	18:53	-25	21.01	8.93	99	9.08	182	746	0.4	78
WQ1004	MM Channel 1	9/24/2010	11:55	-29	20.95	8.76	97	8.97	152	858	0.4	89.2
WQ1005	MM Channel 1	9/24/2010	14:46	-32	21.01	8.82	98	9	178	850	0.4	177
WQ1006	MM Channel 1	9/26/2010	12:56	-33	21.39			9.09	839	839	0.44	110
WQ1007	MM Channel 1	9/26/2010	15:20	-30	21.5	9.53	105	9.2	141	832	0.4	132
WQ1008	MM Channel 1	9/28/2010	11:34	-34	21.62	8.5	95	8.32	170	772	0.4	107
WQ1009	MM Channel 1	9/28/2010	14:32	-30	21.68	8.9	99	8.09	178	780	0.4	97.5
WQ1010	MM Channel 2	9/30/2010	16:09	-33	21.79	9.31	104	7.91	198	633	0.3	85.5
WQ1011	MM Channel 2	9/30/2010	18:43	-35	21.76	9.91	110	8.32	165	633	0.3	89.1
WQ1012	MM Channel 2	10/2/2010	14:39	-33	21.59	8.81	98	8.01	173	551	0.3	117
WQ1013	MM Channel 2	10/2/2010	17:40	-33	21.46	9.33	103	7.94	153	634	0.3	103
WQ1014	MM Channel 2	10/4/2010	13:09	-26	20.69	8.26	90	7.85	154	561	0.3	127
WQ1015	MM Channel 2	10/4/2010	15:58	-30	20.77	8.89	97	8.05	141	532	0.3	133
WQ1016	MM Channel 2	10/6/2010	13:35	-26	20.41	8.85	96	7.86	143	556	0.3	169
WQ1017	MM Channel 2	10/6/2010	15:47	-28	20.56	9.37	102	7.7	151	489	0.2	168
WQ1018	MM Channel 2	10/8/2010	11:59	-31	19.76	8.58	92	7.95	151	628	0.3	121
WQ1019	MM Channel 2	10/8/2010	14:34	-30	19.93	8.74	96	7.64	176	550	0.3	169
WQ1020	MM Channel 2	10/10/2010	15:41	-28	20.06	9.08	98	7.93	144	535	0.3	177
WQ1021	MM Channel 2	10/10/2010	17:51	-35	20.3	9.81	106	7.59	173	442	0.2	192
WQ1022	MM Channel 2	10/12/2010	14:04	-28	19.74	8.89	96	8.13	133	559	0.3	143
WQ1023	MM Channel 2	10/12/2010	17:02	-30	19.86	9.29	100	7.86	147	576	0.3	161
WQ1024	MM Channel 2	10/14/2010	14:46	-30	20.3			7.79	155	489	0.2	144
WQ1025	MM Channel 2	10/14/2010	16:53	-30	20.17	8.22	91	7.88	154	559	0.3	143
WQ1026	MM Channel 2	10/16/2010	12:07	-30	20	8.62	94	7.97	138	462	0.2	146
WQ1027	Rio Vista Bridge	10/19/2010	14:01	-30	18.42	8.81	93	7.32	152	147	0.1	13.2
WQ1028	Rio Vista Bridge	10/19/2010	15:57	-32	18.58	8.8	94	6.97	183	187	0.1	6.5
WQ1029	Rio Vista South	10/21/2010	14:49	-25	18.22				153	220	0.1	30.9
WQ1030	Rio Vista South	10/21/2010	17:01	-30	18.31	9.58	100	7.71	139	991	0.5	40.3
WQ1031	Rio Vista South	10/23/2010	11:40	-31	17.75	9.48	98	7.22	160	143	0.1	10.1
WQ1032	Rio Vista South	10/23/2010	13:44	-32	17.95	9.69	100	7.54	144	224	0.1	22
WQ1033	Scour Pond	10/25/2010	15:29	-35	17.54	9.86	101	7.62	146	5240	2.8	12.2

Bottom Water Quality Readings

Survey ID	Dredge Reach	Date (m/d/year)	Time (hh:mm)	Depth (ft)	Temp (°C)	DO (ppm)	DO (%)	pH	ORP (mV)	Cond (uS)	Sal (ppt)	Turb (ntu)
WQ1034	Scour Pond	10/25/2010	17:14	-32	17.56	10.43	107	7.76	130	8340	4.6	15.5
WQ1035	Scour Pond	10/27/2010	15:13	-40	16.99	9.08	98	7.57	147	4400	2.3	24.2
WQ1036	Scour Pond	10/27/2010	17:14	-38	16.99	9.92	103	7.71	147	6540	3.6	12.9
WQ1037	Scour Pond	10/29/2010	10:00	-32	16.71	9.89	102	7.68	136	3990	2.1	19.1
WQ1038	Scour Pond	10/29/2010	12:30	-34	16.7	9.02	92	7.65	127	4420	2.3	13.7
WQ1039	Scour Pond	10/31/2010	11:15	-36	16.52	10.81	106	7.68	135	3520	1.8	13.4
WQ1040	Scour Pond	10/31/2010	13:35	-37	16.51	9.52	96	7.7	143	5810	3.1	14.9
WQ1041	Antioch Bridge W.	11/3/2010	14:21	-39	16.75	9.18	94	7.59	172	3420	1.8	23.7
WQ1042	Antioch Bridge W.	11/3/2010	16:47	-35	16.87	9.5	97	7.61	142	4220	2.2	22.5
WQ1043	Antioch Bridge E.	11/5/2010	10:42	-32	17.03	9.8	99	7.8	129	1540	0.8	9.4
WQ1044	Antioch Bridge E.	11/5/2010	17:20	-30	17.15	10.11	103	7.82	121	2360	1.2	16.6
WQ1045	Light 19	11/9/2010	10:47	-38	15.8	10.78	107	7.66	127	1660	0.8	10.8
WQ1046	Light 19	11/9/2010	13:43	-32	15.89			7.64	142	1410	0.7	9.4
WQ1047	Light 19	11/11/2010	14:59	-35	15.4	13.19	136.8	7.82	149	1320	0.7	11
WQ1048	Light 19	11/11/2010	17:12	-36	15.44	14.91	154.9	7.87	145	1840	0.9	12
WQ1049	Upper Bradford	11/14/2010	10:05	-45	14.85	12.52	128.2	7.69	179	957	0.5	11.9
WQ1050	Upper Bradford	11/14/2010	12:35	-38	14.99	12.87	132.2	7.8	3	1110	0.5	12
WQ1051	Upper Bradford	11/16/2010	14:39	-38	15.3	14.61	151.3	7.84	217	1610	0.8	18.5
WQ1052	Upper Bradford	11/16/2010	17:11	-30	15.23	12.26	126.5	7.74	162	1070	0.5	18.4
WQ1053	Upper Roberts 1	11/20/2010	10:24	-35	14.79	9.95	101.6	7.56	140	530	0.3	10.4
WQ1054	Upper Roberts 1	11/20/2010	14:01	-36	14.62	10.2	103.7	7.61	144	467	0.2	6.1
WQ1055	Turning Basin	11/23/2010	10:28	-35	13.44	8.76	86.8	7.42	161	600	0.3	36.7
WQ1056	Turning Basin	11/23/2010	13:59	-36	13.62	9.36	93.2	7.62	142	590	9.3	26.5
WQ1057	Turning Basin	11/27/2010	13:33	-36	11.69	9.74	92.9	7.42	124	624	0.3	11.9
WQ1058	Turning Basin	11/27/2010	16:39	-35	11.82	11.32	108.3	7.48	117	611	0.3	16.9
WQ1059	Turning Basin	12/1/2010	10:50	-37	10.17	10.15	93.4	7.54	116	667	0.3	15.6
WQ1060	Turning Basin	12/1/2010	14:24	-34	10.77	10.51	98.2	7.51	172	632	0.3	8.2
WQ1061	Turning Basin	12/3/2010	12:45	-35	10.2	9.22	84.9	7.39	152	637	0.3	72.1
WQ1062	Turning Basin	12/3/2010	15:31	-36	10.36	8.92	82.5	7.62	133	630	0.3	39.8
WQ1063	Spud Island	12/6/2010	15:23	-35	10.51	11.79	109.3	7.44	189	255	0.1	3.9
WQ1064	Spud Island	12/6/2010	17:34	-34	10.49	12.04	111.3	7.44	196	246	0.1	3

Surface Water Quality Readings

Survey ID	Dredge Reach	Date (m/d/year)	Time (hh:mm)	Depth (ft)	Temp (°C)	DO (ppm)	DO (%)	pH	ORP (mV)	Cond (uS)	Sal (ppt)	Turb (ntu)
WQ1001	MM Channel 1	9/20/2010	14:28	-1	22	10.26	112	8.73	154	794	0.4	63.9
WQ1002	MM Channel 1	9/22/2010	16:22	-2	21.07	11.8	130	8.76	177	700	0.3	67.5
WQ1003	MM Channel 1	9/22/2010	18:49	-1	20.97	8.3	92	9.02	167	726	0.4	74.7
WQ1004	MM Channel 1	9/24/2010	11:47	-2	21.31	8.08	93	8.88	166	863	0.4	75.5
WQ1005	MM Channel 1	9/24/2010	14:42	-2	21.68	8.49	95	8.93	187	830	0.4	76.3
WQ1006	MM Channel 1	9/26/2010	12:52	-2	22.16	--	--	8.99	146	856	0.4	76.9
WQ1007	MM Channel 1	9/26/2010	15:17	-2	22.49	9.8	110	9.08	150	830	0.4	89.6
WQ1008	MM Channel 1	9/28/2010	11:24	-2	21.96	8.31	93	7.94	195	777	0.4	98.2
WQ1009	MM Channel 1	9/28/2010	14:22	-2	22.61	8.53	97	8.24	185	810	0.4	78.8
WQ1010	MM Channel 2	9/30/2010	16:05	-1	22.77	9.22	105	8.08	191	591	0.3	72.4
WQ1011	MM Channel 2	9/30/2010	18:39	-2	22.25	9.45	107	7.99	186	583	0.3	81.1
WQ1012	MM Channel 2	10/2/2010	14:34	-2	22.12	9.36	106	7.73	194	536	0.3	91.2
WQ1013	MM Channel 2	10/2/2010	17:38	-2	22.55	8.74	99	8.1	147	658	0.3	78
WQ1014	MM Channel 2	10/4/2010	13:02	-2	20.69	8	89	7.8	153	154	0.3	124
WQ1015	MM Channel 2	10/4/2010	15:55	-2	20.97	9.77	106	7.93	148	526	0.3	117
WQ1016	MM Channel 2	10/6/2010	13:30	-2	20.55	7.94	88	7.8	143	556	0.3	153
WQ1017	MM Channel 2	10/6/2010	15:41	-2	20.58	8.09	89	7.56	175	488	0.2	121
WQ1018	MM Channel 2	10/8/2010	11:52	-2	20.12	8.07	88	7.9	152	632	0.3	111
WQ1019	MM Channel 2	10/8/2010	14:32	-2	21.29	8.31	93	8.01	156	518	0.2	125
WQ1020	MM Channel 2	10/10/2010	15:37	-1	21.29	9.94	109	7.66	159	507	0.2	122
WQ1021	MM Channel 2	10/10/2010	17:48	-2	20.4	8.29	92	7.63	169	448	0.2	123
WQ1022	MM Channel 2	10/12/2010	13:56	-2	20.32	8.32	93	7.69	156	537	0.3	136
WQ1023	MM Channel 2	10/12/2010	16:59	-2	20.28	8.4	93	7.71	155	580	0.3	116
WQ1024	MM Channel 2	10/14/2010	14:39	-2	20.97	10.42	118	7.54	167	481	0.2	118
WQ1025	MM Channel 2	10/14/2010	16:50	-2	21.23	7.98	88	7.8	163	570	0.3	109
WQ1026	MM Channel 2	10/16/2010	12:01	-2	20.05	7.56	82	7.48	163	450	0.2	142
WQ1027	Rio Vista Bridge	10/19/2010	13:54	-2	18.51	8.21	87	6.7	183	147	0.1	8.2
WQ1028	Rio Vista Bridge	10/19/2010	15:54	-2	18.54	8.69	92	7.24	167	187	0.1	8.7
WQ1029	Rio Vista South	10/21/2010	14:42	-2	18.23	10.22	108	6.9	172	220	0.1	30.7
WQ1030	Rio Vista South	10/21/2010	16:54	-1	18.27	8.62	92	7.56	144	786	0.4	37.2
WQ1031	Rio Vista South	10/23/2010	11:36	-2	17.8	8.1	85	7.11	165	145	0.1	7.5
WQ1032	Rio Vista South	10/23/2010	13:39	-2	17.94	8.46	88	7.35	153	252	0.1	11.3
WQ1033	Scour Pond	10/25/2010	14:44	-2	17.79	9.49	99	7.57	151	5300	2.8	7.2

Surface Water Quality Readings

Survey ID	Dredge Reach	Date (m/d/year)	Time (hh:mm)	Depth (ft)	Temp (°C)	DO (ppm)	DO (%)	pH	ORP (mV)	Cond (uS)	Sal (ppt)	Turb (ntu)
WQ1034	Scour Pond	10/25/2010	17:09	-2	17.6	8.87	92	7.71	131	7730	4.3	11.8
WQ1035	Scour Pond	10/27/2010	15:10	-2	17.11	8.45	87	7.6	145	3010	1.6	7
WQ1036	Scour Pond	10/27/2010	17:10	-1.5	17.01	9.01	92	7.66	151	5590	3	10.6
WQ1037	Scour Pond	10/29/2010	9:51	-2	16.71	8.88	90	7.53	142	3830	2	12.7
WQ1038	Scour Pond	10/29/2010	12:22	-1	16.95	8.8	91	7.64	128	3660	1.9	9.8
WQ1039	Scour Pond	10/31/2010	11:01	-2	16.72	9.49	98	7.5	139	3180	1.7	12.4
WQ1040	Scour Pond	10/31/2010	13:29	-2	16.8	8.8	90	16.8	146	4920	2.6	15
WQ1041	Antioch Bridge W.	11/3/2010	14:12	-1	16.65	8.86	89	7.56	176	2190	1.1	23.2
WQ1042	Antioch Bridge W.	11/3/2010	16:43	-2	16.88	8.52	87	7.52	146	2940	1.5	19.2
WQ1043	Antioch Bridge E.	11/5/2010	10:33	-2	17.05	9.41	92	7.42	145	1490	0.7	6.9
WQ1044	Antioch Bridge E.	11/5/2010	13:12	-2	17.13	9.11	93	7.61	129	2480	1.3	14.6
WQ1045	Light 19	11/9/2010	11:35	-2	15.92	9.41	94	7.45	132	1670	0.8	10.8
WQ1046	Light 19	11/9/2010	13:39	-2	16.08	10.61	106	7.56	146	1370	0.7	7.2
WQ1047	Light 19	11/11/2010	14:46	-2	15.45	11.96	124	7.24	182	1210	0.6	10.8
WQ1048	Light 19	11/11/2010	17:07	-1	15.36	11.8	122.3	7.78	150	1690	0.9	9.8
WQ1049	Upper Bradford	11/14/2010	9:51	-2	14.88	11.61	118.9	7.63	183	972	0.5	11.4
WQ1050	Upper Bradford	11/14/2010	12:17	-1	14.97	11.5	118	7.53	169	840	0.4	12.4
WQ1051	Upper Bradford	11/16/2010	14:32	-1	15.19	12.17	125.4	7.66	223	698	0.3	15.4
WQ1052	Upper Bradford	11/16/2010	16:57	-2	15.2	11.57	119.3	7.49	174	1030	0.5	12.8
WQ1053	Upper Roberts 1	11/20/2010	10:20	-2	14.79	8.4	85.7	7.09	167	529	0.3	12.7
WQ1054	Upper Roberts 1	11/20/2010	13:58	-2	14.63	8.75	89	7.52	150	471	0.2	9
WQ1055	Turning Basin	11/23/2010	10:24	-2	13.72	8.04	80.2	7.42	161	576	0.3	10.2
WQ1056	Turning Basin	11/23/2010	13:54	-2	13.75	8.49	84.8	7.56	148	581	0.3	14.2
WQ1057	Turning Basin	11/27/2010	13:40	-2	12.12	8.34	80.4	7.73	109	590	0.3	12.7
WQ1058	Turning Basin	11/27/2010	16:37	-1	12.02	11.68	112.2	7.47	117	589	0.3	11.8
WQ1059	Turning Basin	12/1/2010	11:56	-2	10.8	8.58	80.2	7.65	110	631	0.3	7.8
WQ1060	Turning Basin	12/1/2010	14:21	-1	11.07	8.72	82	7.25	188	612	0.3	5.7
WQ1061	Turning Basin	12/3/2010	12:51	-2	10.55	8.82	81.9	7.6	139	620	0.3	37.9
WQ1062	Turning Basin	12/3/2010	15:27	-1	10.4	8.84	81.8	7.31	151	627	0.3	36.1
WQ1063	Spud Island	12/6/2010	15:28	-2	10.59	9.82	91.2	7.76	171	154	0.1	5.3
WQ1064	Spud Island	12/6/2010	17:37	-2	10.53	10.24	94.9	7.72	182	247	0.1	2.4

Appendix C. Field Data Collection and Database Forms

Appendix C. Database and Paper Data Entry Forms

Paper Data Entry Forms

Fish Community Survey Data Sheet 2010

Sampling Method	trawl / beach s. / purse s.
Survey Number:	
Survey Date:	
Survey Waterbody:	
Survey County:	
DMP Site:	
Dredge Reach:	
Daylight Conditions:	
Sampling Staff	JG / SN

Survey Replicate Data Sheet 2010

Survey Replicate Number:		Subsample?	yes / no
Start Time:		* Subsample percent (estimate):	
End Time:			
Total Survey Time* [hh:mm:ss]:		Gear Status:	good / bad
Start GPS Track Num:		Gear Comments*:	
End GPS Track Num:			
Replicate Data Recorder:	JG / SN / other:		
Weather:		* (Comments for use only when Gear Status is Bad)	
Substrate Description:			
Tidal Phase:	ebb / flood / slack	Piscivorous Bird Activity:	
Flow Direction:	upstream / downstream		
Current Direction [° True North]:			
Current Speed [kts]:			
Ground Speed [kts]:			
Boat Speed (kts)		Other Survey Notes:	
Boat Power [rpms]:			
Survey Depth_Lower [ft]:			
Survey Depth_Upper [ft]:			
Tow distance [m]:			

Entrainment Sampling Data Sheet (Screen)

EntScreen Number: _____

EntScreen Date: _____

Survey Waterbody: _____

Survey County: _____

DMP Site: _____

Dredge Reach: _____

Daylight Conditions: _____

All Field Staff: _____ JG / SN / other: _____

Field Recorder: _____ JG / SN / other : _____

Weather: _____

Water Temperature: _____

Substrate Desc: _____

GPS Track ID Num: _____

Gear Status: _____ good / bad

Gear Comments*: _____

EntScreen Start Time: _____

EntScreen End Time: _____

Total Survey Time [hh:mm:ss]: _____

Dredge Pumping Rate [gpm]: _____

Sampled Volume [gallons]: _____

Bird Activity at Survey Site: _____

Other Survey Notes: _____

* (Comments for use only when Gear Status is Bad)

SPECIMEN COLLECTION DATASHEET (2010)

Associated Sample Type and
Sample Number:

Page _____
of _____[illegible]

General Notes:

Water Quality Monitoring Datasheet (2010)

Associated Survey Number: _____

WQ Sample Number: _____

WQ Field Recorder: _____

JG / SN / other: _____

Starting WQ Reading

Associated Replicate Number: _____

<i>Measurements Taken</i>	Near Surface	
Secchi Depth [cm]:		Near Bottom
WQ Time:		
WQ Depth:		
Temp [°C]:		
DO [ppm]:		
DO [% saturation]:		
pH:		
Conductivity [µm]:		
Salinity:		
ORP [mV]:		
TDS [g/L]:		
Turbidity [ntu]:		
Gear Status:	good / bad	good / bad
Gear Comments*:		

Ending WQ Reading

Associated Replicate Number: _____

<i>Measurements Taken</i>	Near Surface	
Secchi Depth [cm]:		Near Bottom
WQ Time:		
WQ Depth:		
Temp [°C]:		
DO [ppm]:		
DO [% saturation]:		
pH:		
Conductivity [µm]:		
Salinity:		
ORP [mV]:		
TDS [g/L]:		
Turbidity [ntu]:		
Gear Status:	good / bad	good / bad
Gear Comments*:		

* (Comments for use only when Gear Status is Bad)

Microsoft Access

Home Create External Data Database Tools Add-Ins Acrobat

Navigation Pane

frm_MainMenu

2010 Fish Monitoring Data California Delta Dredging Operation

Choose a Survey Type below:

Trawl	Water Quality	Entrainment Screen
Purse Seine	Beach Seine	Entrainment Cell
Quit Application		

Form View Num Lock

frm_Entrainment_Screen

Entrainment Screen

EntScreen Number
Date mm/dd/yyyy
Waterbody
Survey County
DMP Location
Dredge Reach
Day Period
Field Recorder

Additional staff are allowed but not necessary

Weather
Water Temperature °C
Substrate

Gear Status

Gear Comments are
required ONLY if Gear
Status is set to "Bad".

Gear Comments

Survey Start Time hh:mm:ss
Survey End Time hh:mm:ss
Elapsed Survey Time hh:mm:ss
Dredge Pumping
Rate gpm
Sampled Volume gallons

Bird Activity Survey Notes

Number of related
specimens

#Error

View or Add
Specimens

New
Entrainment
Screen

Return to
Main Menu

Record: 33 of 33

No Filter

Search

Entrainment Screen Specimen

Entrainment Screen Specimen

Entrainment Number

ES1032

Species

CLM-ASI

15 char. max

Number of
Specimens

0

☐

Actual Count

☐

Approximate Count

Disposition at
Time of CaptureDisposition at
Time of Release

Lifestage

Sex

Anomalies

Comments

Return to
Entrainment
Screen Form

Record: 9 of 9

Filtered

Search

Entrainment Screen Specimen

Entrainment Screen Specimen

Entrainment Number

ES1032

Species

AMERSHAD

15 char. max

Disposition at
Time of CaptureNumber of
Specimens

0

Disposition at
Time of Release☐

Actual Count

☐

Approximate Count

Anomalies

Lifestage

Sex

Comments

Fish Specimen Details

	Fork Length	Total Length	Standard Length	Fin Clip
*				

Return to
Entrainment
Screen Form

Record: 9 of 9

Filtered

Search

Number of specimens caught that meet the other criteria

Num Lock



Navigation Pane

frm_WaterQuality

Assoc Survey Number

WQ Number:

WQ Field Recorder:

WQ Reading Sequence

Secchi Depth:

Surface Time

Surface Depth

Surface Temp

Surface DO

Surface DO %

Surface PH

Surface ORP

Surface Cond

Surface Salinity

Surface Turbidity

Assoc Replicate Number:

Bottom Time

Bottom Depth

Bottom Temp

Bottom DO

Bottom DO %

Bottom PH

Bottom ORP

Bottom Cond

Bottom Salinity

Bottom Turbidity

Gear Status

Gear Comments are required ONLY if Gear Status is set to "Bad".

Gear Comments

Return to Main Menu

Record: 65 of 65

No Filter

Search

Microsoft Access

Home Create External Data Database Tools Add-Ins Acrobat

frm_Survey

Survey Number TR1033 Survey number and type will concatenate here

Survey Date

Survey County

Waterbody

Dredge Reach

DMP Location

Day Period

Field Staff

Additional staff are allowed but not necessary

Enter Replicate Information

Return to Main Menu

Record: 33 of 33 No Filter Search

Form View Num Lock

frm_Survey

Survey Number: TR1033

Replicate Number:

Start Time: hh:mm:ss

End Time: hh:mm:ss

Duration*: hh:mm:ss

Field Recorder:

GPS Start:

GPS End:

Weather:

Riverbed:

Tide:

Flow:

Current Direction: degrees (°)

Current Speed: knots

Ground Speed: 0 knots

Boat Speed: 0 knots

Boat Power: 0 rpm

Lower Depth: 0 feet

Upper Depth: 0 feet

Tow Distance: 0 m

Gear Status:

Gear Comments are
required ONLY if Gear
Status is set to "Bad".

Gear Comments:

Bird Activity:

Survey Notes:

Number of related
specimens: #Error

*As recorded / calculated by the Nobelltech Software

View or Add
Specimens

New Survey

Return to Main
Menu

Record: 6 of 6 No Filter Search

Record: 33 of 33 No Filter Search

frm_Survey

Replicate Specimen

Survey and
Replicate Number

TR1033 Replicate5

Disposition at
Time of Capture

Start

Species Code

CLM-ASI

15 char. max

Disposition at
Time of Release

End

Number of
Specimens

Anomalies

Dura

☒ Actual Count☐ Approximate Count

Field

Lifestage

Comments

GPS

Sex

GPS

Wea

Rive

Tide

Flow

Curr

Curr

Grou

Boat

Boat

*As

Return to
Replicate Form

Record: 1 5 of 5 Filtered Search

Record: 1 5 of 5 No Filter Search

Record: 1 33 of 33 No Filter Search

frm_Survey

Replicate Specimen

Survey and
Replicate Number

TR1033 Replicate5

Disposition at
Time of Capture

Start

Species Code

AMERSHAD

15 char. max

Disposition at
Time of Release

End

Number of
Specimens

Anomalies

Dura

Field



Actual Count



Approximate Count

GPS

Lifestage

Comments

GPS

Sex

Wea

River

Tide

Flow

Curr

Curr

Grou

Boat

Boat

*As

Fish Specimen Details

	Fork Leng	Total Leng	Standard Leng	Fin Cl
*				

Return to
Replicate Form

Record: 1 5 of 5 Filtered Search

Record: 1 5 of 5 No Filter Search

Record: 1 33 of 33 No Filter Search