■ Interagency Ecological Program for the San Francisco Estuary ■

IEP NEWSLETTER

VOLUME 29, NUMBER 1, 2016

Of Interest to Managers

Steven Slater (CDFW), Steve.Slater@wildlife.ca.gov
Vanessa Tobias (CDFW), Vanessa.Tobias@wildlife.ca.gov

This issue of the Interagency Ecological Program (IEP) Newsletter includes four “Status and Trends” articles. The first two articles describe the distribution and abundance of Delta Smelt in 2015, including adults and the coincident production of young. The third article relates trends in larval Longfin Smelt catch in winter, 2015. The final article reports fish salvage trends for water year 2015, during a fourth year of drought in the San Francisco Estuary.

In the first article, **Lauren Damon** (CDFW) reports the Spring Kodiak Trawl (SKT) Survey catch and gonad maturation patterns of adult Delta Smelt collected January–May, 2015. The number of adult Delta Smelt caught by SKT was a record low in 2015 (n = 104), less than half the next lowest annual catch (n = 271). Low catches resulted in the lowest annual abundance index on record for SKT (13.8) and were consistent with the 2014 Fall Midwater Trawl record low index of the same year class.

In the second article, **Trishelle Morris** (CDFW) reports on the distribution and relative abundance of larval and juvenile Delta Smelt collected by the 20-mm Survey from March–July, 2015. This biweekly sampling effort supplies near real-time catch data, providing information regarding the risk of Delta Smelt entrainment during spring and summer water exports. The 20-mm Survey collected 72,869 larval and juvenile fish, of which 0.1 percent (n = 94) were Delta Smelt. The 2015 Delta Smelt index was 0.3, the lowest on record. Delta Smelt larvae did not appear to be distributed downstream of the confluence in spring, which was likely caused by low flows during the drought.

In the third article, **Trishelle Morris** and **Lauren Damon** (CDFW) report on the Smelt Larva Survey (SLS) catch of larval Longfin Smelt during January–March, 2015. The SLS biweekly catch data provides valuable information to the Smelt Working Group (SWG) to assess entrainment risk of larvae at the water export facilities in the Sacramento-San Joaquin Delta (Delta). The survey also provides catch information for a suite of other larval fishes, including Delta Smelt. The first detection of Delta Smelt larvae can be used to infer the timing of hatching. The SLS collected a total of 81,540 fish, with Longfin Smelt the fourth-most abundant at 1 percent (n = 966) of total catch. The 2015 season had the lowest Longfin Smelt catch in the history of the survey (2009–2015).

In the final article, **Geir Aasen** (CDFW) provides an update on fish salvage at the State Water Project’s (SWP) and Central Valley Project’s (CVP) fish facilities through water year (WY) 2015. This article focuses on several species of management concern, including Chinook Salmon, Steelhead, Striped Bass, Delta Smelt, Longfin Smelt, Splittail, and Threadfin Shad. The SWP exported 1.38 billion m^3 of water, which was a small increase from the record low export in WY 2014, but a substantial decrease from the record high export in WY 2011 (4.90 billion m^3). The CVP exported 0.86 billion m^3 of water, which was a record low and a small decrease from the previous year (1.17 billion m^3), the former record low. Total fish salvage at the SWP Skinner Delta Fish Protection Facility (SDFPF) was a near record low at 347,882, with WY 2014 being the lowest on record (236,846). Total fish salvage (all fish species combined) at the Tracy Fish Collection Facility (TFCF) was low at 295,854, but slightly higher than the record low from the previous WY year (160,681). The low salvage numbers correspond to the low exports that occurred during this period and were similar to the previous year. Bluegill and Threadfin Shad were the most abundant species collected at the salvage facilities; together they made up more than 75 percent of salvaged fish at each location. Few Chinook Salmon, Steelhead, Delta Smelt, and Longfin Smelt were salvaged at the SDFPF (221, 442, 4, and 102, respectively) and TFCF (187, 124, 68, and 28, respectively). These species together made up < 1 percent of total salvage at each location.

Status and Trends

2015 Spring Kodiak Trawl Survey

Lauren Damon (CDFW) Lauren.Damon@wildlife.ca.gov

The Spring Kodiak Trawl Survey (SKT) is conducted January through May by the California Department of Fish and Wildlife (CDFW). The objectives of the SKT are to determine the distribution and relative abundance of adult Delta Smelt (*Hypomesus transpacificus*) in the upper San Francisco Estuary, and to monitor the gonadal maturation of Delta Smelt as an indicator of when and where spawning is likely to occur or is occurring. The SKT conducts a 10-minute surface trawl at 40 stations during each monthly survey in the upper San Francisco Estuary (Figure 1). Each survey runs for four days and samples the lower Napa River through Suisun Bay, the Sacramento-San Joaquin River confluence region, and the Sacramento-San Joaquin River Delta (Delta). All Delta Smelt collected during the SKT are measured, sexed, and gonadal-staged in real-time while in the field. For more information on the SKT's gear descriptions, objectives, methods, and the gonadal-stage, see the previous IEP Newsletter articles by Souza (2002) and Adib-Samii (2010).

SKT completed five routine monthly surveys from January 12 to May 7, 2015. Annual Delta Smelt catch (n = 104) was the lowest on record for the 2002–2015 history of this project, and was less than half of the next lowest annual catch in 2008 (n = 271). During January, February, and March (Surveys 1–3, respectively), Delta Smelt were primarily caught in the low salinity zone, but were also present in Montezuma Slough and in the Sacramento Deep Water Shipping Channel (SDWSC) (Figure 2). In April and May (Surveys 4 and 5), Delta Smelt were caught only upstream in the SDWSC. Three of the individuals caught in May were young-of-the-year. Catches decreased significantly starting in March (n = 6) and remained low in April (n = 1) and May (n = 8).

The 2015 SKT Delta Smelt annual abundance index was 13.8, which was the lowest index on record for the SKT (Figure 3), and was consistent with the 2014 Fall Midwater Trawl (FMWT) record low index for the same-year class (http://www.dfg.ca.gov/delta/data/fmwt/indices.asp). The SKT index is reported annually via interdepartmental memorandum on the SKT website

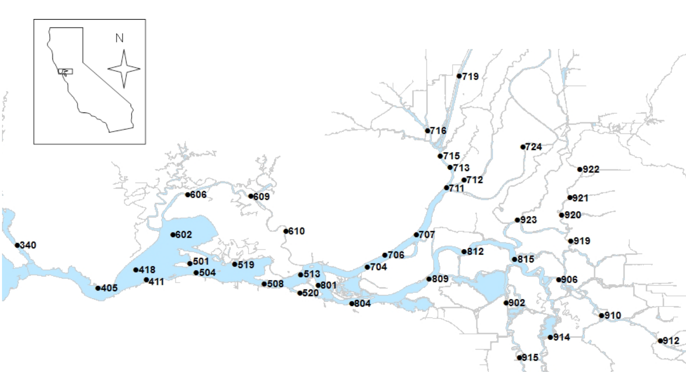

Figure 1 Station locations for the 2015 CDFW Spring Kodiak Trawl Survey in the upper San Francisco Estuary.

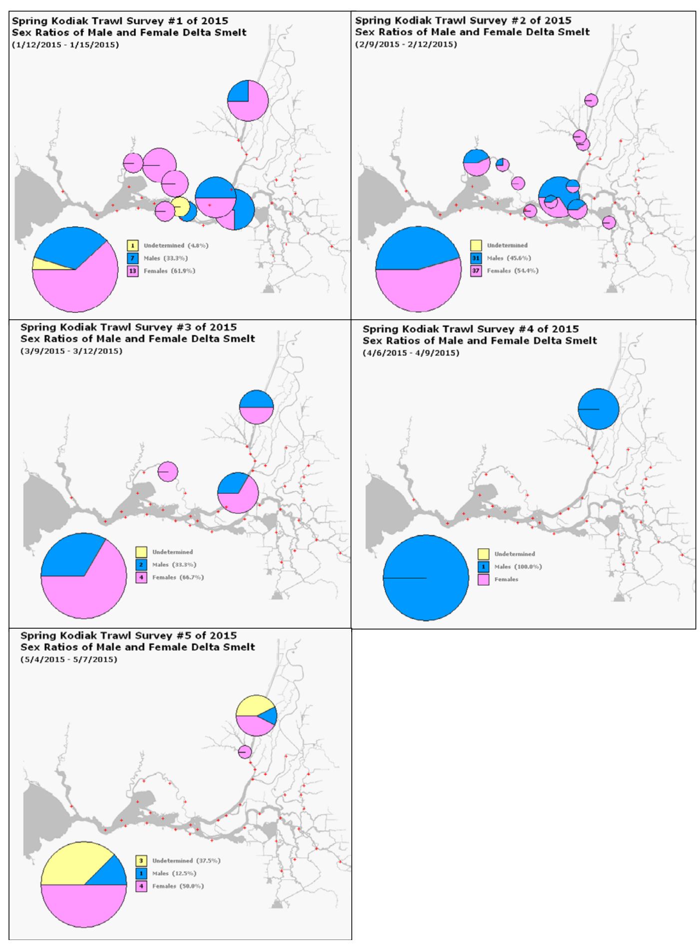

Figure 2 Monthly distribution of Delta Smelt catch and sex ratio for the CDFW Spring Kodiak Trawl Survey in 2015. Pie charts of surveys 1–5 taken from the CDFW Spring Kodiak Trawl webpage.

bibliography (http://www.dfg.ca.gov/delta/data/skt/bibliography.asp). A summary memo of the SKT index methods and calculation is available on the FTP website (ftp://ftp.dfg.ca.gov/Delta%20Smelt/).

Overall, the proportion of females to males caught in 2015 followed the historical pattern, with a few minor exceptions (Figure 4). For all years of SKT (2002–2015), the sex ratio of Delta Smelt is about 1:1 females-to-males in January and February. The ratio skews toward more females caught each month through May, when the ratio becomes 4:1 (Figure 4). This trend is attributed to an increase in male mortality or males becoming less vulnerable to the surface trawl by moving deeper or seeking shoal habitat. Noted exceptions to this pattern were: January, 2015 we observed markedly more females than males, and only one male was caught in April. Females made up 58 percent of the total catch in 2015, which is the average from all previous years. Previous years range from 46 percent to 69 percent female.

Year	Index
2002	N/A
2003	N/A
2004	99.7
2005	52.9
2006	18.2
2007	32.5
2008	24.1
2009	43.8
2010	27.4
2011	18.8
2012	130.2
2013	20.4
2014	30.1
2015	13.8

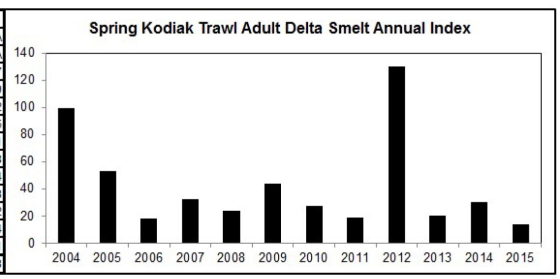

Figure 3 Annual abundance indices for adult Delta Smelt collected from the CDFW Spring Kodiak Trawl Survey during 2004–2015. Incomplete sampling prevents determination of indices for 2002 and 2003.

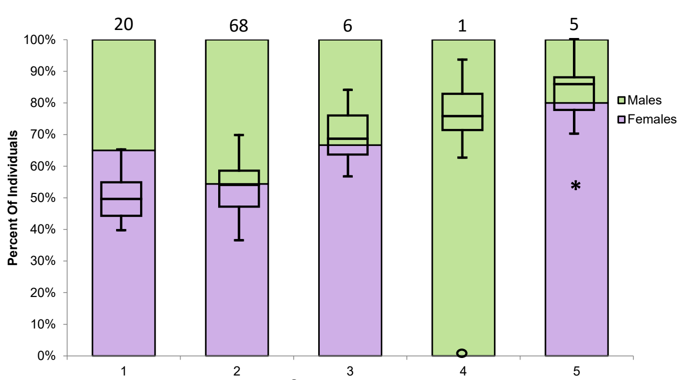

Figure 4 Sex ratios of Delta Smelt by survey during the 2015 CDFW Spring Kodiak Trawl Survey. Sample size is above bars. Females are purple, males are green, unknown or young of year fish were omitted. The ratio of females by survey for the entire period of record (2002–2015) was displayed via box plot.

The first mature female (based on gonadal-stage) was detected in February (Survey 2) after water temperature exceeded 12 °C, suggesting the onset of spawning (Figure 5). Almost all of the females caught in February were still developing (n = 36). In March (Survey 3), the capture of one post-spawn female showed that spawning started sometime in February. Based on incubation and growth rates, this is consistent with the detection of young of the year Delta Smelt in May (26–28 mm) during the 20-mm Survey, which is a larval and juvenile monitoring survey conducted every spring.

Mature females were present in water temperatures ranging from 12.5 °C to 18.5 °C, with an average of 16.1 °C. The first mature male was collected in March, later in the year than the first detection of mature females. Mature males were found in temperatures ranging from 15.9 °C to 18.5 °C, with an average of 17.2 °C. Most of the mature fish, both males and females, were present at low conductivities. All of the mature males were caught at conductivities less than 500 microSiemens per centimeter (µS/cm), and mature females were caught between 363 µS/cm to 1707 µS/cm. Both sexes were caught in narrower conductivity ranges than in previous years. However, these water temperature and conductivity ranges may not be representative of the complete ranges for mature male and female Delta Smelt in 2015, as a result of low catches and patchy distribution. When abundance is low, it becomes increasingly difficult to detect Delta Smelt in the SKT, and therefore it is possible that Delta

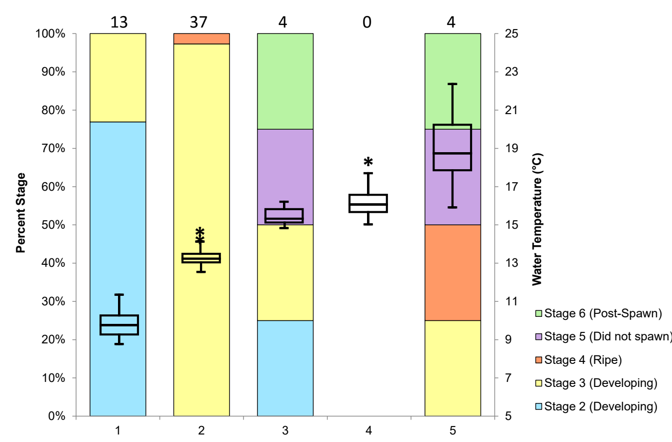

Figure 5 Gonadal-stage percentages of female Delta Smelt, by survey, during the 2015 CDFW Spring Kodiak Trawl Survey, with sample size above each bar. Distribution of water temperatures for all stations sampled during each survey in 2015 was displayed via box plot on the secondary y-axis.

Smelt were not detected in areas where they were present in low abundance.

The 2016 Spring Kodiak Trawl is scheduled to begin in January and run through May. Data, metadata, and protocols are available on the FTP website (ftp://ftp.dfg.ca.gov/Delta%20Smelt/), and interactive geographic distribution maps of Delta Smelt are available on the SKT webpage (https://www.wildlife.ca.gov/Conservation/Delta/Spring-Kodiak-Trawl).

References

Adib-Samii J. 2010. "2010 Spring Kodiak Trawl Survey." Interagency Ecological Program. IEP Newsletter 23(3): 20–24.

Souza K. 2002. "Revision of California Department of Fish and Game's Spring Midwater Trawl and Results of the 2002 Spring Kodiak Trawl." IEP Newsletter 15(3):44–47.

2015 20-mm Survey

Trishelle Morris (CDFW), Trishelle.Morris@wildlife.ca.gov

The California Department of Fish and Wildlife (CDFW) annually conducts the 20-mm Survey to monitor the distribution and relative abundance of larval and juvenile Delta Smelt (*Hypomesus transpacificus*) in the upper San Francisco Bay Estuary. The survey began in 1995, and supplies near real-time catch data to water and fisheries managers as part of an adaptive management strategy to limit the risk of Delta Smelt entrainment during water exports in spring and early summer.

Annually, the 20-mm Survey conducts nine bi-weekly surveys March–July, and visits 47 stations (Figure 1) each survey to measure larval and juvenile fish and zooplankton densities. The 20-mm Survey uses a conical net with 1600-micron mesh for collecting young of the year (YOY) fish. The net is 5.1 meters long with a mouth area of 1.51 square meters and is attached to a rigid steel D-ring frame that is mounted on skis. At each station, the water column was sampled using three stepped-oblique tows. All samples were preserved in 10 percent buffered formalin dyed with Rose Bengal for later identification and enumeration in the laboratory. Fish are measured in millimeters (mm) to the nearest fork length, if the tail is forked, or nearest total length if the tail is not forked.

From March 16 to July 8, 2015, all nine surveys were conducted, but as a result of logistical issues, surveys 1-3 were incomplete[1]. A total of 72,869 fish representing 40 taxa were caught in 2015 (Table 1). Larval gobies of the genus *Tridentiger* spp. were by far the most abundant fish caught, making up about 83 percent of the total catch. Striped Bass (*Morone saxatilis*), Northern Anchovy (*Engraulis mordax*), Threadfin Shad (*Dorosoma petenense*) and Yellowfin Goby (*Acanthogobius flavimanus*) were the next four most abundant species for 2015, together totaling about 14 percent of the total catch. Delta Smelt was the 11th most abundant taxon this year, making up 0.1 percent of the total catch. A total of 94 Delta Smelt were caught, the lowest catch in the history of the Survey (1995–2015). Larval and juvenile Delta Smelt catches were extremely low in March and early April. Catch increased through April and peaked in mid-May. Delta Smelt catch decreased in late May, was variable in June, and was extremely low in late June and July (Figure 2). Overall, this is a normal catch pattern based on the onset and cessation of spawning, in addition to the 20-mm net's limited efficiency at retaining small larvae.

An index of Delta Smelt abundance for the 20-mm Survey is calculated by CDFW using data from four

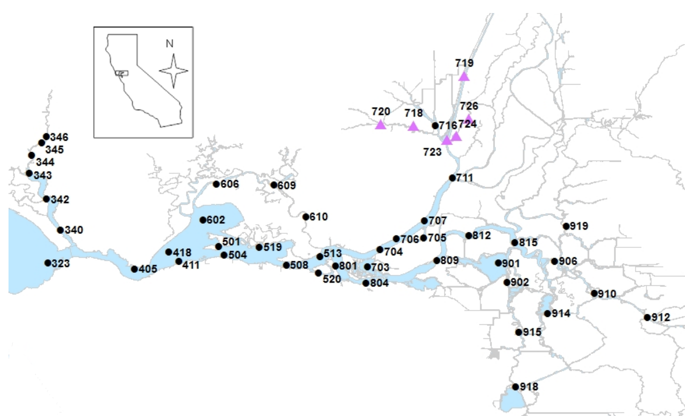

Figure 1 Location of sampling stations for the CDFW 20-mm Survey in the upper San Francisco Estuary. Stations marked with a black dot are core stations. Stations marked with a purple triangle are non-core stations.

[1] Six stations in the Napa River and one station in San Pablo Bay were omitted from Survey 1. Five stations in Cache Slough complex and one station in the south Delta were omitted from Survey 2. Four stations in the Cache Slough complex and six stations in the Napa River were omitted from Survey 3.

Table 1 Total catch by species from the 2015 CDFW 20-mm Survey.

Common Name	*n*	*% of Catch*
Tridentiger spp.	60,357	82.8%
Striped Bass	4,972	6.8%
Northern Anchovy	2,352	3.2%
Threadfin Shad	2,072	2.8%
Yellowfin Goby	1,173	1.6%
Longfin Smelt	451	0.6%
Prickly Sculpin	331	0.5%
Pacific Herring	326	0.4%
Jacksmelt	189	0.3%
Threespine Stickleback	98	0.1%
Delta Smelt	94	0.1%
American Shad	73	0.1%
Arrow Goby	68	<0.1%
Centrarchids (Unid)	51	<0.1%
Topsmelt	49	<0.1%
Bay Pipefish	43	<0.1%
White Catfish	39	<0.1%
Bigscale Logperch	34	<0.1%
Chinook Salmon	18	<0.1%
Mississippi Silverside	14	<0.1%
Cheekspot Goby	10	<0.1%
Shimofuri Goby	9	<0.1%
Starry Flounder	7	<0.01%
Carp	6	<0.01%
Shokihaze Goby	5	<0.01%
Wakasagi	5	<0.01%
Largemouth Bass	5	<0.01%
Rainwater Killifish	3	<0.01%
Bay Goby	2	<0.01%
Longjaw Mudsucker	2	<0.01%
California Tonguefish	2	<0.01%
Tule Perch	1	<0.01%
Splittail	1	<0.01%
Bluegill Sunfish	1	<0.01%
Channel Catfish	1	<0.01%
Cyprinids (Unid)	1	<0.01%
English Sole	1	<0.01%
River Lamprey	1	<0.01%
Plainfin Midshipman	1	<0.01%
Silversides (Unid)	1	<0.01%

surveys around which the mean length of the Delta Smelt is 20 mm. The index is calculated using only the 41 stations (”core” stations) (Figure 1) which have been sampled consistently since the survey’s inception in 1995. The 2015 index was 0.3, and was calculated using Surveys 3 (April) through 6 (May). The 2015 index is lowest index on record (Figure 3).

The first Delta Smelt larvae was caught on March 16th and had a fork length of 6 mm, indicating that spawning occurred in February, likely as water temperatures began to surpass 12 °C (Smelt Working Group 2015). This was the only newly hatched larvae caught on survey this year.

The first observations of Delta Smelt were in the Lower Sacramento River, and catch in this region continued from March through June (n = 8). YOY Delta Smelt were concentrated in the Sacramento Deep Water Ship Channel (Figure 4), where 85 percent of total catch occurred (n = 79). They were caught in this region from April through July, but Delta Smelt were also detected

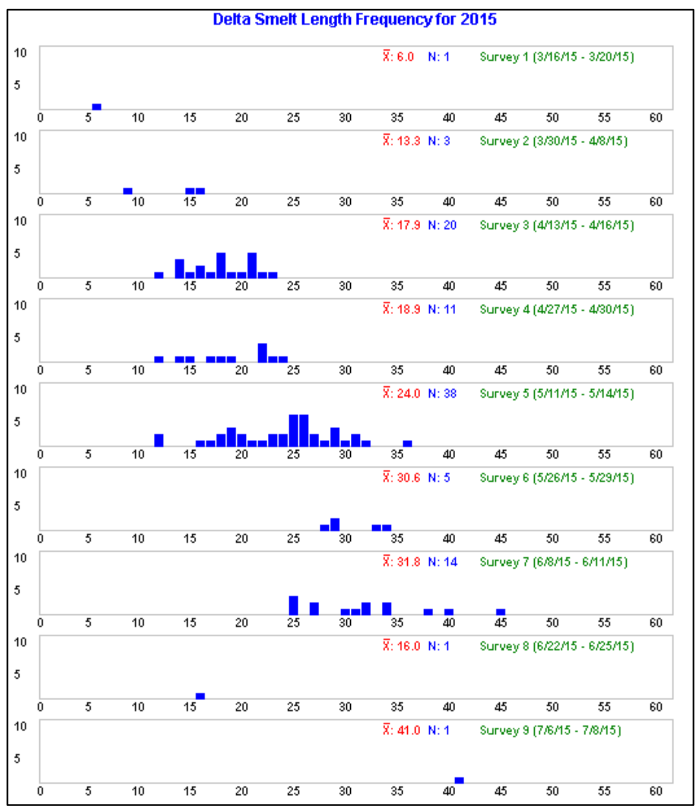

Figure 2 Delta Smelt length frequency distribution from the 2015 CDFW 20-mm Survey (taken from http://dfg.ca.gov/delta/data/20mm/Length_frequency.asp). Length in millimeters is on the X-axis and number of individuals is on the Y-axis.

(n = 5) in the south and central portions of the Sacramento-San Joaquin Delta (Delta) during that time period. Only one Delta Smelt was caught downstream of the confluence in 2015; it was caught in Montezuma Slough in June.

Larvae did not appear to be distributed downstream of the confluence in 2015. This is likely a function of increased salinity in the estuary due to low Delta outflow resulting from minimal precipitation and low reservoir supplies. The low salinity zone was located upstream of the confluence in every survey during the 20-mm season (California Data Exchange Center 2015). Delta Smelt were caught at a specific conductance range from 197 micro-Siemens per centimeter (µS/cm) to 11,210 µS/cm. The mean specific conductance of stations where Delta Smelt were caught in 2015 was 1,289 µS/cm, which is typical in comparison to past years. The mean specific conductance of all stations sampled in 2015 was 8,670 µS/cm, which is the highest recorded average specific conductance for all stations in the history of the Survey (Figure 5). In addition, warm temperatures were observed in areas upstream of the confluence, where Delta Smelt were caught more frequently. The average temperature for all stations sampled east of the confluence was 22.6 °C during Survey 7 (early June), increasing through July (Table 2).

Year	Index
1995	4.4
1996	33.9
1997	19.2
1998	7.7
1999	39.4
2000	23.7
2001	10.9
2002	7.7
2003	13.0
2004	8.2
2005	15.4
2006	9.8
2007	1.0
2008	2.9
2009	2.3
2010	3.8
2011	8.0
2012	11.1
2013	7.8
2014	1.1
2015	0.3

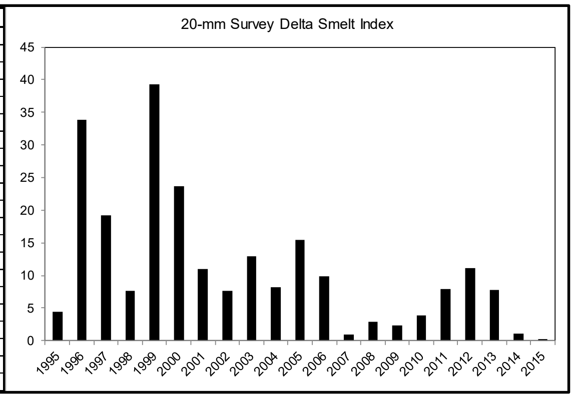

Figure 3 The Delta Smelt indices of relative abundance from the annual CDFW 20-mm Survey for the entire period of record (1995–2015).

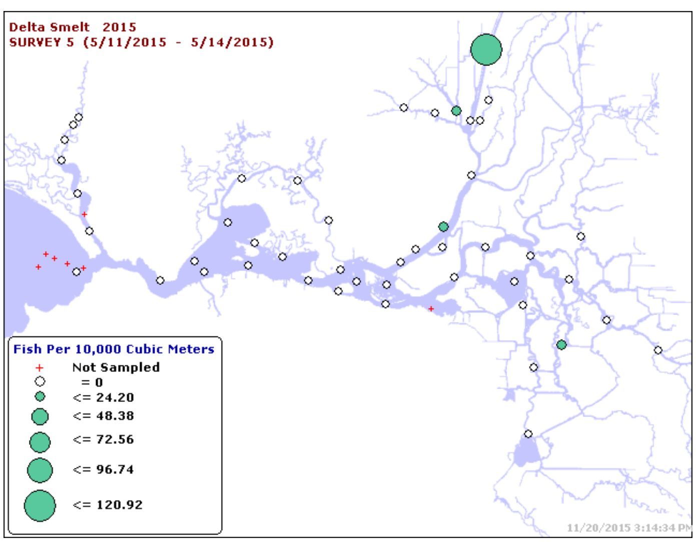

Figure 4 Delta Smelt distribution from Survey 5 of the 2015 CDFW 20-mm Survey (taken from http://dfg.ca.gov/delta/projects.asp?ProjectID=20mm). Green bubbles represent the relative density (fish per 10,000 cubic meters water sampled) of young of the year Delta Smelt at each site. White bubbles are sampled stations with no young of the year Delta Smelt caught. Red crosses indicate the station was not sampled.

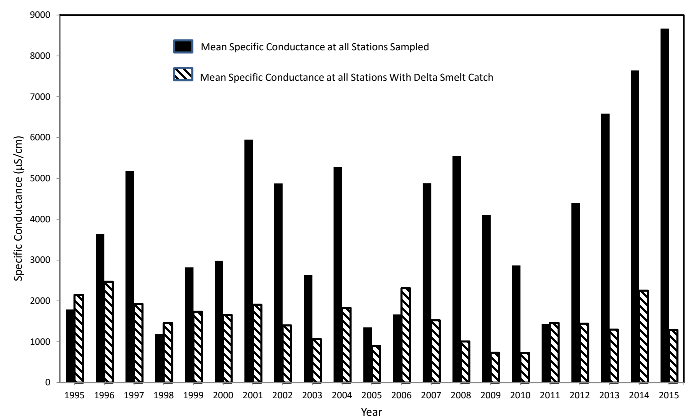

Figure 5 Mean specific conductance from all stations (black bars) and only those stations with positive Delta Smelt catch (hashed bars) that were sampled during the annual 20-mm Survey conducted by the CDFW for the entire period of record (1995–2015).

Table 2 Mean water temperature (in °C) for sampling stations that are east of the confluence, by survey, measured during the 2015 CDFW 20-mm Survey.

Survey	*Mean Temperature (°C)*
1	17.2
2	18.1
3	17.0
4	19.3
5	19.2
6	19.8
7	22.6
8	22.9
9	23.1

The distribution of YOY Delta Smelt in 2015 was likely attributable to consecutive years of drought conditions. The Water Year Type for 2015 was deemed critical for both the Sacramento Valley and San Joaquin Valley (California Data Exchange Center 2015) causing Delta Smelt habitat to be severely truncated due to the lack of freshwater outflow resulting in saltwater intrusion in to the Delta region. As noted above, conductivity in parts of Delta Smelt rearing habitat were high, as were water temperatures in other locations. Delta Smelt tend to spawn and rear upstream in drier water years (Wang 2007), but average water temperatures upstream nearly reached 23 °C in early June and exceeded 24 °C by July, making those habitats unsuitable for Delta Smelt (Gleason et al. 2007; Nobriga et al. 2008; Sommer and Mejia 2013).

Current and past graphical data is available on the 20-mm Survey webpage: http://dfg.ca.gov/delta/projects.asp?ProjectID=20mm. Data and metadata are available through our FTP site: ftp://ftp.dfg.ca.gov/Delta%20Smelt/.

References

CDEC. 2015. Water Year Index from: http://cdec.water.ca.gov/cgi-progs/reports/EXECSUM.

CDEC. 2015. X2 data from: http://cdec.water.ca.gov/cgi-progs/stationInfo?station_id=CX2.

Gleason E, Adib-Samii J, Fleming K. 2007. "Relating Water Quality and Fish Occurrence: Spring and Summer Patterns of Distribution for Three Species in the San Francisco Estuary." Poster presented at Eighth Biennial State of the Estuary Conference, Oakland, CA, October 16–18, 2007.

Nobriga ML, Sommer TR, Feyrer F, Fleming K. 2008. "Long-term Trends in Summertime Habitat Suitability for Delta Smelt (*Hypomesus transpacificus*)." San Francisco Estuary and Watershed Science. 6(1). Viewed online at: http://escholarship.org/uc/item/5xd3q8tx.

SWG (Smelt Working Group) Meeting Notes [Internet], 2015. United States Fish and Wildlife Service. Viewed online at: http://www.fws.gov/sfbaydelta/cvp-swp/smelt_working_group.cfm.

Sommer, T., F. Mejia. 2013. "A Place to Call Home: A Synthesis of Delta Smelt Habitat in the Upper San Francisco Estuary." San Francisco Estuary and Watershed Science. 11(2). Viewed online at: http://www.escholarship.org/uc/item/32c8t244#page-1.

Wang, J. 2007. *Spawning, early life stages, and early life histories of the Osmerids found in the Sacramento-San Joaquin Delta of California.* U.S. Department of Interior, Bureau of Reclamation, Tracy Series Volume 38.

2015 Smelt Larva Survey

Trishelle Morris (CDFW), Trishelle.Morris@wildlife.ca.gov
Lauren Damon (CDFW), Lauren.Damon@wildlife.ca.gov

The California Department of Fish and Wildlife (CDFW) conducts the Smelt Larva Survey (SLS) annually, monitoring the distribution and relative abundance of larval Longfin Smelt (*Spirinchus thaleichthys*) in the upper San Francisco Estuary (SFE). This data is reported in near-real-time to resources managers in order for them to assess the entrainment risk to Longfin Smelt at water export facilities. The survey also collects data on other larval fishes in the upper San Francisco Estuary.

The SLS conducts six biweekly surveys January–March, and 44 locations in the upper SFE are sampled each survey (Figure 1). Surveys are conducted every two weeks when larval Longfin Smelt are most likely to be present in the system. At each station, an oblique tow is conducted using a rigid-framed, plankton-style net with 500-micron mesh. All samples are preserved in 10 percent buffered formalin dyed with Rose Bengal for later identification and enumeration in the laboratory. Fish are measured in millimeters (mm) to the nearest fork length (FL) if the tail is forked, or nearest total length if the tail is not forked. For additional information on SLS methods and sampling design, see the previous IEP Newsletter articles by Adib-Samii (2012) and Damon (2016).

From January 5th to March 26th, 2015, all six surveys were conducted, but as a result of logistical issues, not all stations were sampled in the Napa River during Surveys 1

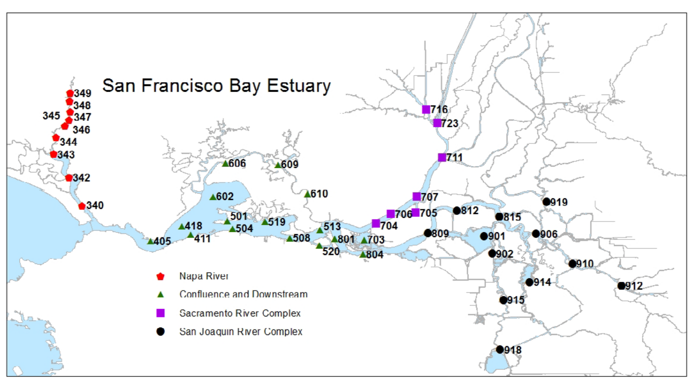

Figure 1 Station locations and geographical regions sampled by the California Department of Fish and Wildlife's (CDFW) Smelt Larva Survey.

and 6, and far western stations during survey 1. A total of 81,540 fish representing 26 taxa (Table 1) were collected during the 2015 field season. Pacific Herring (*Clupea pallasii*) was by far the most abundant species caught, comprising about 74 percent of total catch. Longfin Smelt was the fourth most abundant species, making up about 1 percent of total catch. A total of 966 Longfin Smelt were caught, which is the lowest catch in the history of the survey (2009–2015). Although their abundance was relatively low, Longfin Smelt were broadly distributed through each survey and were collected in 57.6 percent of all samples taken (Figure 2).

Mean (±SE) fork length of Longfin Smelt increased 2 mm from January to March (Surveys 1 and 6; Figure 3), and was significantly different between those two surveys (Mann-Whitney U: U = 1946.5, df = 1, $P < 0.0001$). FL was slightly higher west of the confluence than it was upstream, with the largest individuals found in the Napa River (Figure 3). This may indicate downstream transport of larvae from their hatching site to a rearing site, although this has been more strongly indicated in previous years (Damon 2016). This could also be an indication of more suitable rearing habitat west of the confluence and in the Napa River.

Eight Delta Smelt (*Hypomesus transpacificus*) were collected, making up less than 0.1 percent of the total

Table 1 Total species catch for the 2015 CDFW Smelt Larva Survey.

Common Name	n	% of Catch
Pacific Herring	60,382	74.1%
Yellowfin Goby	11,227	13.8%
Prickly Sculpin	8,611	10.6%
Longfin Smelt	966	1.2%
Northern Anchovy	96	0.1%
Longjaw Mudsucker	69	0.1%
Arrow Goby	57	<0.1%
Striped Bass	41	<0.1%
Three Spine Stickleback	26	<0.1%
Jacksmelt	23	<0.1%
Delta Smelt	8	<0.01%
White Catfish	8	<0.01%
Bigscale Logperch	6	<0.01%
Shimofuri Goby	4	<0.01%
Pacific Staghorn Sculpin	3	<0.01%
Centrarchids (Unid)	2	<0.01%
Cheekspot Goby	2	<0.01%
Bay Goby	1	<0.01%
California Tonguefish	1	<0.01%
White Croaker	1	<0.01%
Cyprinids (Unid)	1	<0.01%
Topsmelt	1	<0.01%
Sacramento Sucker	1	<0.01%
Rainwater Killifish	1	<0.01%
Wakasagi	1	<0.01%
Chinook Salmon	1	<0.01%

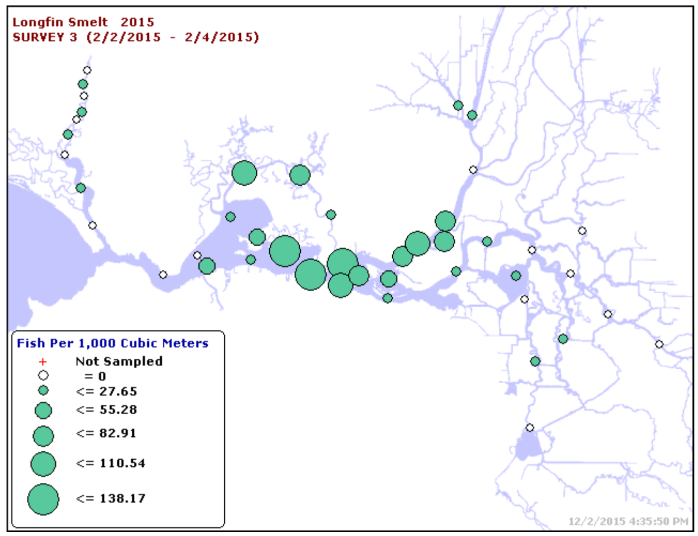

Figure 2 Distribution and catch per unit effort of Longfin Smelt for Survey 3 of the 2015 CDFW Smelt Larva Survey. Taken from SLS webpage https://www.wildlife.ca.gov/Conservation/Delta/Smelt-Larva-Survey.

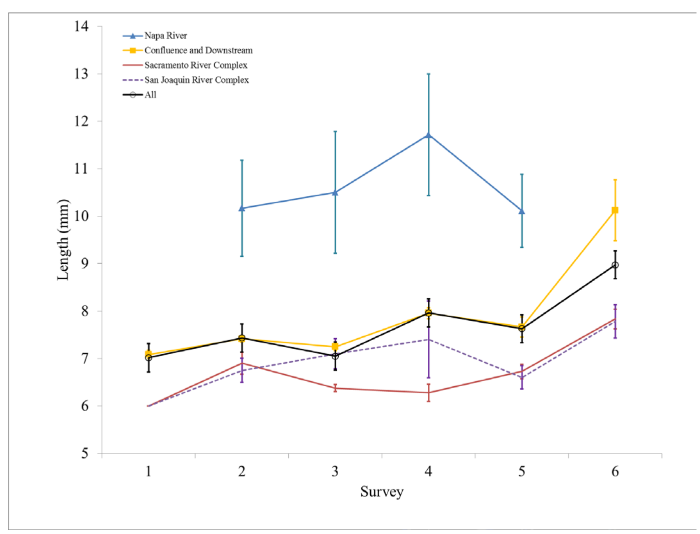

Figure 3 Mean (±SE) fork lengths of Longfin Smelt collected during the 2015 CDFW Smelt Larva Survey grouped by survey number and geographic regions. The black line is all regions combined.

catch in 2015. Most of the Delta Smelt were caught in late March, which is typical for most years. Two of the eight individuals collected were adults; they were caught in the Lower Sacramento River in early February. Only one newly hatched larva was caught in early March, and it was caught in Cache Slough. This indicates that some spawning began in February, as was also indicated by larva captured during the 20-mm Survey (Morris 2016). However, most of the spawning likely took place in March, just prior to the collection of the other five larvae (Figure 4).

The total catches and distribution of Pacific Herring were lower than the exceptional catches of Pacific Herring caught in 2014 (Damon 2016). In 2015, there were 60,382 Pacific Herring caught from all stations; with 80 percent being caught in the Napa River. Pacific Herring catch in the Napa River was highest in mid-February (Survey 4; Figure 5), where we saw single-station catches as high as 10,197. This was a pattern similar to 2014 (Damon 2016). The abundance and distribution of Pacific Herring outside of the Napa River was also more similar to years prior to 2014 (Figure 6). Catches of Pacific Herring in the western-most stations dropped off considerably compared with 2014, and their presence in the Delta was minimal (Figure 6).

For CPUE values, survey data, and data visualization, please see the SLS webpage and FTP site (https://www.wildlife.ca.gov/Conservation/Delta/Smelt-Larva-Survey; ftp://ftp.dfg.ca.gov/Delta%20Smelt/).

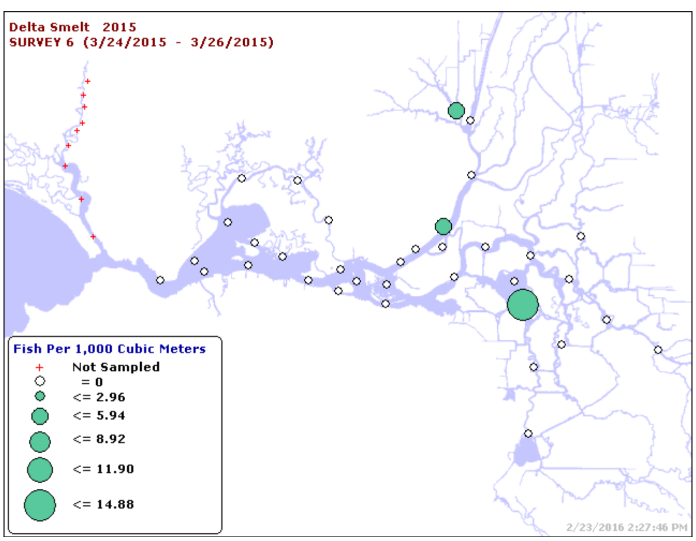

Figure 4 Distribution and catch per unit effort of Delta Smelt for Survey 6 of the 2015 CDFW Smelt Larva Survey. Taken from SLS webpage https://www.wildlife.ca.gov/Conservation/Delta/Smelt-Larva-Survey.

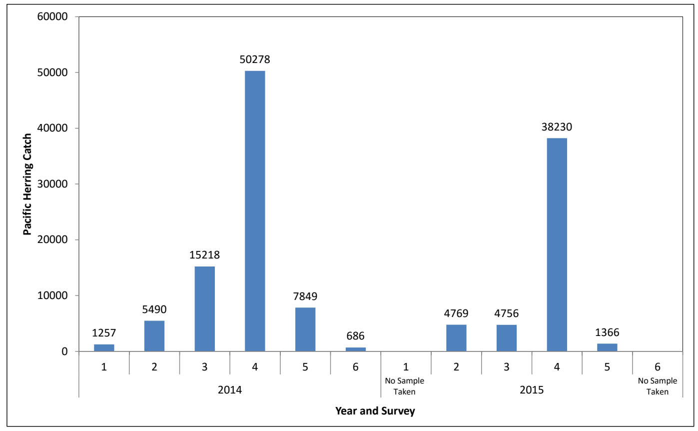

Figure 5 Pacific Herring catch in the Napa River by year and survey for the CDFW Smelt Larva Survey for 2014 and 2015.

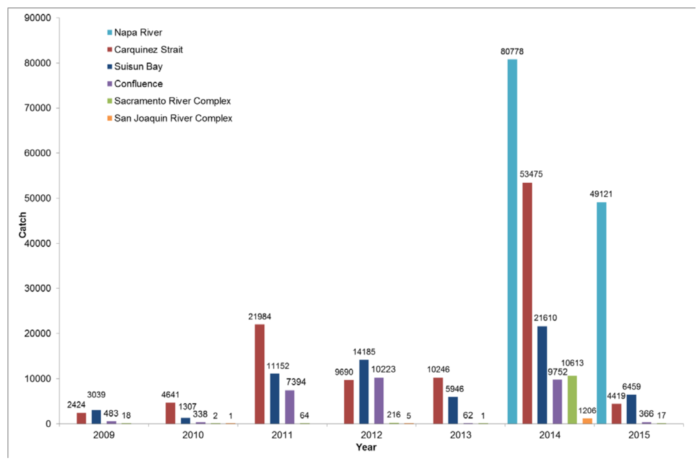

Figure 6 Annual Pacific Herring catch for the CDFW Smelt Larva Survey by region during the period of record (2009–2015). Stations in the Napa River were added in 2014. Not all stations and surveys were sampled in all years.

References

Adib-Samii, J. 2012. “2011 Smelt Larva Survey.” Interagency Ecological Program Newsletter. 25(1):16-19.

Damon, L. 2016. “2014 Smelt Larva Survey.” Interagency Ecological Program Newsletter. In press.

Morris, T. 2016. “2015 20-mm Survey Summary.” Interagency Ecological Program Newsletter. In press. Current issue.

Fish Salvage at the State Water Project's and Central Valley Project's Fish Facilities during the 2015 Water Year

Geir Aasen (CDFW), Geir.Aasen@wildlife.ca.gov

Introduction

Two facilities mitigate fish losses associated with water export by the federal Central Valley Project (CVP) and California's State Water Project (SWP). The CVP's Tracy Fish Collection Facility (TFCF) and the SWP's Skinner Delta Fish Protective Facility (SDFPF) divert (salvage) fish from water exported from the southern end of the Sacramento-San Joaquin Delta (Delta). Both facilities use louver-bypass systems to divert fish from the exported water. The diverted fish are periodically loaded into tanker trucks and transported to fixed release sites in the western Delta. Operations began in 1957 at the TFCF and in 1968 at the SDFPF.

Methods

This report summarizes the 2015 water year (WY) (WY 2015 was 10/1/2014–9/30/2015) salvage information from the TFCF and the SDFPF, and examines data from water years 1981–2015 for possible relevance to salvage trends in recent years. The following species were given individual consideration: Chinook Salmon (*Oncorhynchus tshawytscha*), Steelhead (*O. mykiss*), Striped Bass[1] (*Morone saxatilis*), Delta Smelt[1] (*Hypomesus transpacificus*), Longfin Smelt[1] (*Spirinchus thaleichthys*), Splittail (*Pogonichthys macrolepidotus*), and Threadfin Shad[1] (*Dorosoma petenense*).

Systematic sampling was used to estimate the numbers and species of fish salvaged at both facilities. Bypass flows into the fish-collection buildings were sub-sampled generally once every one or two hours for 5–60 minutes ($\bar{x}$ = 29.05 minutes, standard deviation (sd) = 4.48) at the SDFPF and once every two hours for 10–45 minutes ($\bar{x}$ = 27.47, sd = 6.65) at the TFCF. Fish with 20 millimeter (mm) fork length (FL) or larger were identified, counted, and measured. These fish counts were expanded to estimate the total number of fish salvaged in each one- to two-hour period of water export. For example, a subsample duration of 30 minutes over a 120-minute export period equals an expansion factor of 4, which was multiplied by the number of fish per species collected from the fish count. These incremental salvage estimates were then summed across time to develop monthly and annual species-salvage totals for each facility.

Chinook Salmon loss is the estimated number of juvenile Chinook Salmon entrained by the facility, minus the number of Chinook Salmon that survive salvage operations (California Department of Fish and Game 2006). Salmon salvage and loss were summarized by origin (i.e., hatchery fish defined as adipose fin clipped or wild fish defined as non-adipose fin clipped) and race (fall, late-fall, winter, or spring). Race classification of wild and hatchery Chinook Salmon was determined solely by the Delta Model length-at-date table, which is based on length at date of salvage (California Department of Fish and Wildlife 2014). It was created by the U.S. Fish and Wildlife Service who further modified the California Department of Water Resources modified version of the Fisher Model by changing the upper and lower boundaries for winter-run Chinook Salmon (Matt Dekar, personal communication, see "Notes"). However, apparent growth rates and size ranges among races are variable, leading to potential misclassification with the Delta Model (Harvey and Stroble 2013).

Larval fish were also collected and examined to determine the presence of Delta Smelt and Longfin Smelt < 20 mm FL. Larval sampling at the SDFPF ran from March 2–June 26 and from February 24–June 12 at the TFCF. Larval samples were collected once for every six hours of water export. The duration of larval samples was the same as the duration for counts. To retain these smaller fish, the fish screen used in the routine counts was lined with a 0.5 mm Nitex net. Larval fish from the TFCF were identified to species by TFCF personnel, and larval fish from the SDFPF were identified to the lowest taxa possible by California Department of Fish and Wildlife personnel.

[1] Pelagic Organism Decline (POD) species

Water Exports

The SWP exported 1.38 billion cubic meters (m^3) of water, which was a small increase from the record low exports in WY 2014 (1.12 billion m^3), but a marked decrease from WY 2013 (2.70 billion m^3) and the record high in WY 2011 (4.90 billion m^3) (Figure 1). The CVP exported 0.86 billion m^3 of water, which was a record low and a small decrease in exports from the previous record low in WY 2014 (1.17 billion m^3), and substantially lower than WY 2013 (2.27 billion m^3). The low exports at both facilities coincided with 2015 being a critical water year and the 4th straight year of drought conditions in California. Exports in WY 2015 at both facilities were well below the WYs 1981–2013 average (3.18 billion m^3 at SWP and 2.92 billion m^3 at CVP).

Exports at the SWP peaked from December 2014 through February 2015 (Figure 2). During this period, the SWP exported 887.03 million m^3, which represented 64.2 percent of annual export. Exports at the CVP were markedly higher in the months of December, 2014; March, 2015; and September, 2015. The cumulative water export for those months was 397.37 million m^3, which represented 46.3 percent of the annual export. CVP monthly exports ranged from 23.19 to 168.00 million m^3. SWP monthly exports ranged from 20.90 to 320.58 million m^3.

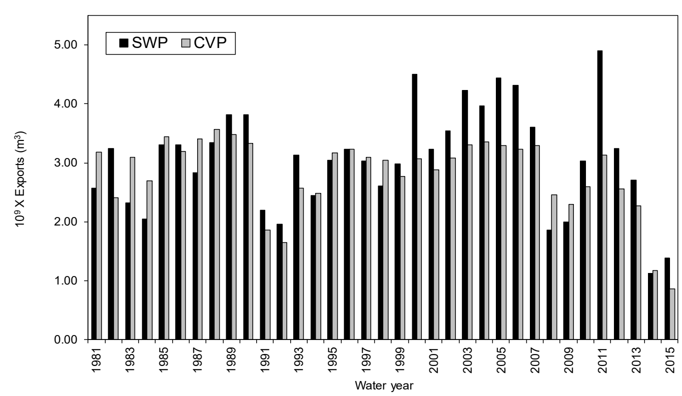

Figure 1 Annual water exports in billions of cubic meters for the SWP and the CVP, WYs 1981 to 2015.

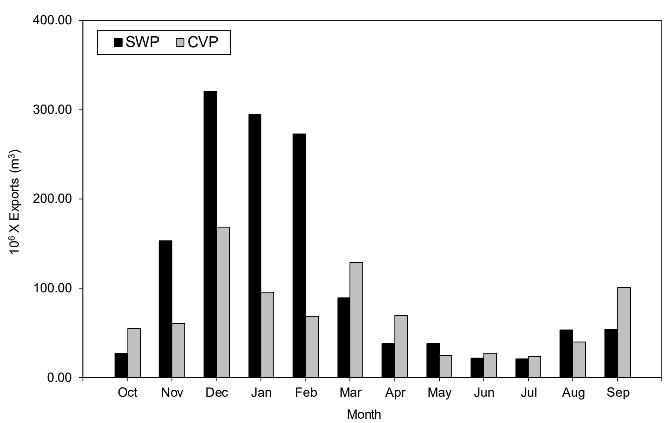

Figure 2 Monthly water exports in millions of cubic meters for the SWP and the CVP, WY 2015.

Total Salvage and Prevalent Species

Total fish salvage (all fish species combined) at the SDFPF was a near-record low at 347,882 (Figure 3). This was a marked increase from the record low in WY 2014 (236,846), but well below WY 2013 (3,042,176) and WY 2012 (1,607,286). Total fish salvage at the TFCF was low at 295,854. This was an increase from the record low in WY 2014 (160,681), but well below WY 2013 (2,828,514) and WY 2012 (475,082) (Figure 3). The low and near-record low total fish salvage at both facilities in WY 2014–2015 were most likely affected by low or near-record low exports, as salvage in recent years has been influenced by exports (i.e., lower salvage at low exports).

Threadfin Shad was the most-salvaged species at both the SDFPF and TFCF (Figure 4 and Table 1). Bluegill (*Lepomis macrochirus*) and Striped Bass were the 2nd and 3rd most-salvaged fish at SDFPF, respectively. Bluegill and Striped Bass were also the 2nd and 3rd most-salvaged fish at TFCF, respectively. Native species comprised 1.1 percent of total fish salvage at SDFPF and 1.3 percent of total fish salvage at TFCF. Relatively few Chinook Salmon, Steelhead, Delta Smelt, and Longfin Smelt were

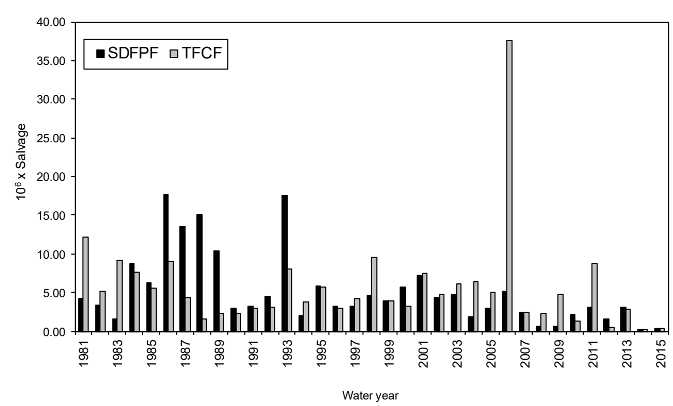

Figure 3 Annual salvage of all fish taxa combined at the SDFPF and the TFCF, WYs 1981 to 2015.

Table 1 Annual fish salvage and percentage of annual fish salvage (%) collected from the SDFPF and TFCF in WY 2015.

SDFPF			*TFCF*		
Species	***Salvage***	***%***	***Species***	***Salvage***	***%***
Threadfin Shad	186,368	53.6	Threadfin Shad	114,804	38.8
Bluegill	78,532	22.6	Bluegill	107,883	36.5
Striped Bass	35,070	10.1	Striped Bass	21,398	7.2
Inland Silverside	18,349	5.3	Shimofuri Goby	11,467	3.9
American Shad	15,299	4.4	Largemouth Bass	11,278	3.8
Largemouth Bass	2,953	0.8	White Catfish	7,979	2.7
Shimofuri Goby	2,371	0.7	Inland Silverside	4,187	1.4
Prickly Sculpin	2,298	0.7	American Shad	3,384	1.1
Rainwater Killifish	1,773	0.5	Prickly Sculpin	2,836	1
Bigscale Logperch	937	0.3	Rainwater Killifish	2,240	0.8
Black Crappie	777	0.2	Yellowfin Goby	1,545	0.5
Yellowfin Goby	674	0.2	Channel Catfish	1,276	0.4
Splittail	656	0.2	Golden Shiner	1,232	0.4
Steelhead	442	0.1	Redear Sunfish	949	0.3
White Catfish	298	<0.1	Western Mosquitofish	837	0.3
Golden Shiner	286	<0.1	Black Crappie	808	0.3
Chinook Salmon	221	<0.1	Black Bullhead	324	0.1
Western Mosquitofish	151	<0.1	Pacific Lamprey	265	<0.1
Longfin Smelt	102	<0.1	Chinook Salmon	187	<0.1
Channel Catfish	84	<0.1	Brown Bullhead	172	<0.1
Lamprey Unknown	82	<0.1	Threespine Stickleback	164	<0.1
Common Carp	77	<0.1	Bigscale Logperch	148	<0.1
Redear Sunfish	34	<0.1	Steelhead	124	<0.1
Green Sunfish	15	<0.1	Striped Mullet	88	<0.1
Sacramento Blackfish	15	<0.1	Delta Smelt	68	<0.1
Threespine Stickleback	7	<0.1	Warmouth	48	<0.1
Shokihaze Goby	4	<0.1	Green Sunfish	32	<0.1
Delta Smelt	4	<0.1	Lamprey Unknown	31	<0.1
Tule Perch	2	<0.1	Longfin Smelt	28	<0.1
Riffle Sculpin	1	<0.1	Red Shiner	24	<0.1
			Pacific Staghorn Sculpin	12	<0.1
			Splittail	12	<0.1
			Starry Flounder	12	<0.1
			River Lamprey	4	<0.1
			Tule Perch	4	<0.1
			White Crappie	4	<0.1

salvaged at the SDFPF (0.22 percent of combined total fish salvage), which was an increase from WY 2014 (0.10 percent) and approximately equal to WY 2013 (0.21 percent). Relatively few Chinook Salmon, Steelhead, Delta Smelt, and Longfin Smelt were salvaged at the TFCF (0.14 percent of combined total fish salvage), which was a decrease from WY 2014 (0.95 percent) and WY 2013 (0.18 percent).

Chinook Salmon

Annual salvage estimates of Chinook Salmon (all races and origins combined) at both facilities continued the low salvage trend since WY 2001 (Figure 5). SDFPF salvage of juvenile and sub-adult Chinook Salmon (221) increased considerably from the record low in WY 2014 (64), but was a marked decrease from WY 2013 (3,184). Mean salvage for Chinook Salmon in WYs 2001–2015 at SDFPF was only 8.7 percent of the mean salvage in WYs 1981–2000. Salvage of juvenile Chinook Salmon was a record low at the TFCF (187) and markedly decreased from the previous record low in WY 2014 (1,177) and WY 2013 (4,032). Mean WYs 2001–2015 TFCF salvage was only 11.0 percent of the mean salvage in WYs 1981–2000.

Salvaged Chinook Salmon at the SDFPF were primarily hatchery late-fall-run sized fish, which comprised 39.3 percent of hatchery fish. Salvaged Chinook Salmon at the TFCF were also primarily hatchery late-fall-run sized fish, which comprised 75.0 percent of hatchery fish (Table 2). The majority of hatchery late-fall-run fish at the SDFPF and the TFCF were salvaged in December (Figure 6).

Annual loss of Chinook Salmon (all origins and races) was higher at the SDFPF (822) than at the TFCF (148) (Table 2). Greater entrainment loss at the SDFPF than at the TFCF was attributable to greater pre-screen loss.

Steelhead

Salvage of juvenile and sub-adult Steelhead (wild and hatchery origins combined) continued the pattern of low salvage observed since WY 2005 (Figure 7). WY 2015 salvage at the SDFPF (442)

Table 2 Chinook Salmon annual salvage, percentage of annual salvage, race and origin (wild or hatchery), and loss at the SDFPF and the TFCF, WY 2015.

Facility	*Origin*	*Race*	*Salvage*	*Percentage*	*Loss*
SDFPF					
	Wild				
		Fall	4	6.9	17
		Late-fall	6	10.3	27
		Spring	7	12.1	34
		Winter	17	29.3	75
		Unknown race	24	41.4	*
	Total Wild		58		153
	Hatchery				
		Fall	41	25.2	181
		Late-fall	64	39.3	285
		Spring	0	0.0	0
		Winter	46	28.2	203
		Unknown race	12	7.4	*
	Total Hatchery		163		669
	Grand Total		221		822
TFCF					
	Wild	Fall	12	13.2	9
		Late-fall	0	0.0	0
		Spring	43	47.3	36
		Winter	36	39.6	31
	Total Wild		91		76
	Hatchery				
		Fall	0	0.0	0
		Late-fall	72	75.0	54
		Spring	8	8.3	7
		Winter	16	16.7	11
	Total Hatchery		96		72
	Grand Total		187		148

*No loss was calculated for sub-adult unknown run Chinook Salmon (n=3), since they were too large to fit the loss calculation.

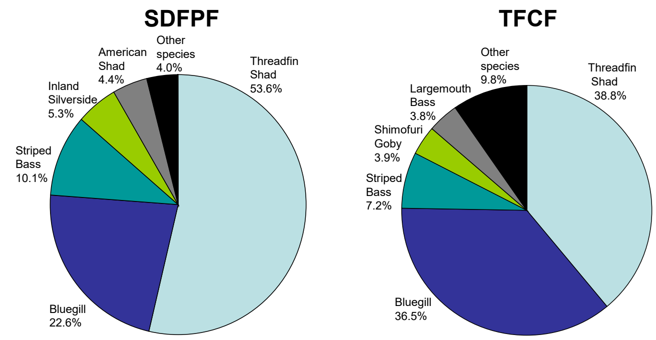

Figure 4 Percentages of annual salvage for the five most prevalent fish species and other fish species combined at the SDFPF and TFCF, WY 2015.

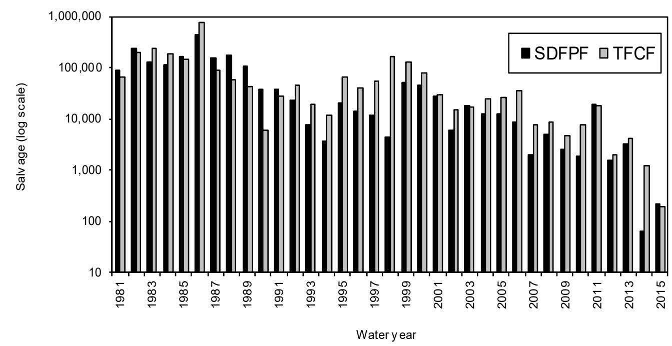

Figure 5 Annual salvage of Chinook Salmon (all races and wild and hatchery origins combined) at the SDFPF and the TFCF, WYs 1981 to 2015. The logarithmic scale is $\log_{10}$.

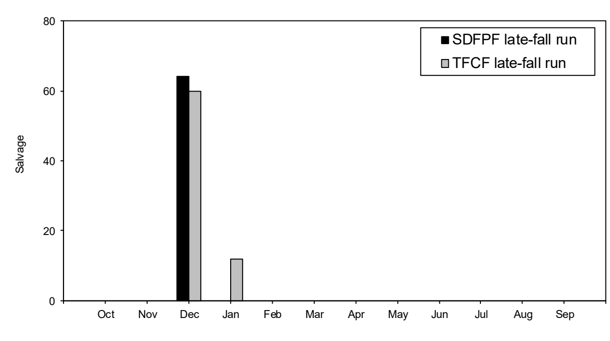

Figure 6 Monthly salvage of hatchery late fall-run Chinook Salmon at the SDFPF and the TFCF, WY 2015.

was a five-fold increase from the record low in WY 2014 (84), but substantially lower than in WY 2013 (861). Salvage at the TFCF (124) was a record low and a marked decrease from WY 2014 (330) and 2013 (646).

The SDFPF salvaged 407 hatchery Steelhead and 35 wild Steelhead. The TFCF salvaged 116 hatchery Steelhead and eight wild Steelhead. Salvage of wild Steelhead at both facilities peaked around the middle of the water year (Figure 8). Wild Steelhead were salvaged most frequently in February at the SDFPF and in April–May at the TFCF.

Striped Bass

Salvage of juvenile and sub-adult Striped Bass at the SDFPF (35,070) was a record low, while salvage at the TFCF (21,398) was a near-record low. Salvage at the SDFPF and the TFCF continued a declining trend observed since the mid-1990s (Figure 9). Prior to WY 1995, annual Striped Bass salvage estimates were generally above 1,000,000 fish.

Most Striped Bass salvage at the SDFPF occurred in December, February, and May–June (Figure 10). Most Striped Bass salvage at the TFCF occurred in December and May–June. Salvage at the SDFPF in December (11,105), February (11,024), May (6,482), and June (3,007) accounted for 90.2 percent of total WY salvage. At the TFCF, salvage in December (3,286), May (9,265), and June (5,443) accounted for 84.1 percent of total WY salvage. Striped Bass were salvaged every month except for October at the SDFPF. Striped Bass were salvaged every month at the TFCF, with the lowest monthly salvage occurring in October (2).

Delta Smelt

Salvage of Delta Smelt continued the pattern of mostly low salvage observed since WY 2005 (Figure 11). Salvage at the TFCF (68) was a four-fold increase from

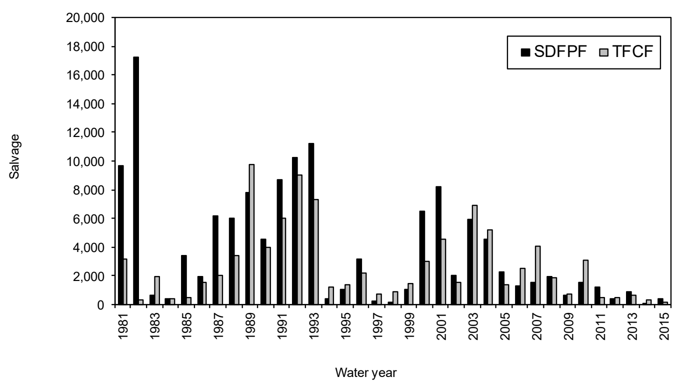

Figure 7 Annual salvage of Steelhead (wild and hatchery origins combined) at the SDFPF and the TFCF, WYs 1981 to 2015.

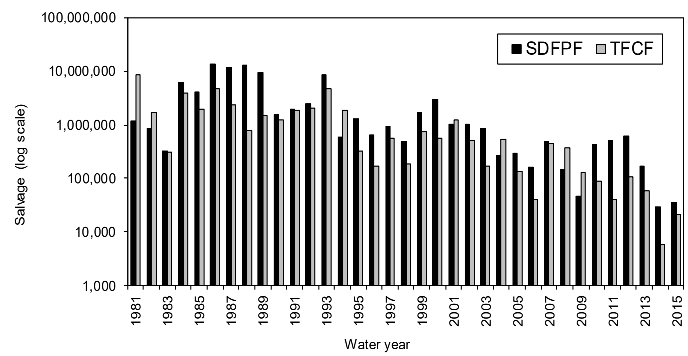

Figure 9 Annual salvage of Striped Bass at the SDFPF and the TFCF, WYs 1981 to 2015. The logarithmic scale is $\log_{10}$.

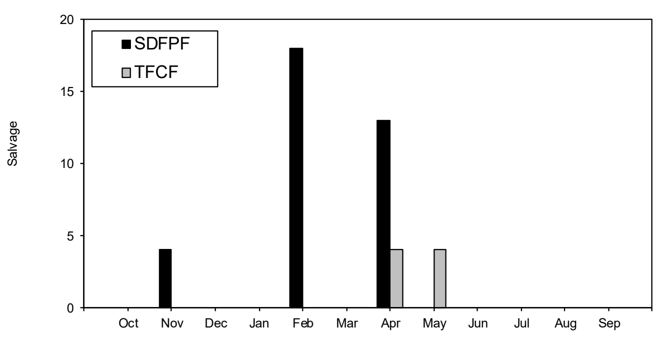

Figure 8 Monthly salvage of wild Steelhead at the SDFPF and the TFCF, WY 2015.

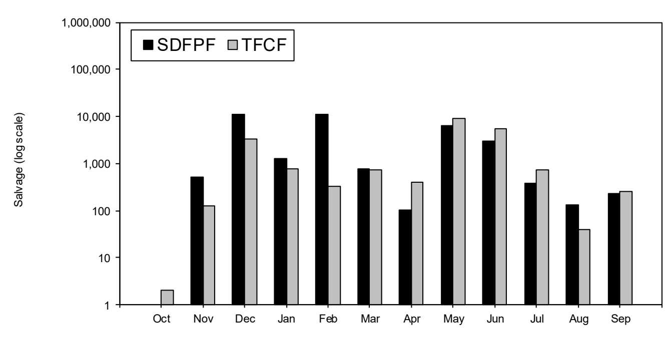

Figure 10 Monthly salvage of Striped Bass at the SDFPF and the TFCF, WY 2015. The logarithmic scale is $\log_{10}$.

the record low in WY 2014 (16), but a marked decrease from WY 2013 (300). Salvage at the SDFPF (4) decreased markedly from WY 2014 (62) and WY 2013 (1,701), but increased from the record low in WY 2011 (0).

Salvage of Delta Smelt at both facilities occurred predominantly in the winter (Figure 12). Adult Delta Smelt at SDFPF were only salvaged in January. No juvenile Delta Smelt was salvaged at SDFPF. Adult Delta Smelt at TFCF were salvaged in January–February, where January salvage (52) accounted for 76.0 percent of the total WY salvage. Juvenile Delta Smelt at TFCF were only salvaged in May (4).

Delta Smelt less than 20 mm FL were only detected at the SDFPF on April 23 (Table 3).

No Delta Smelt less than 20 mm FL were detected at the TFCF in WY 2015, which was a decrease from WY 2014 (6) and WY 2013 (9).

Longfin Smelt

Salvage of juvenile Longfin Smelt at the SDFPF in WY 2015 (102) increased from WY 2014 (32), but markedly decreased from WY 2013 (659) (Figure 13). The record low salvage of Longfin Smelt occurred in WY 2011 (0). Salvage at the TFCF (28) also increased from WY 2014 (8), but markedly decreased from WY 2013 (241). Salvage in WY 2015 increased slightly from WY 2011 (4).

Juvenile Longfin Smelt were salvaged in April–May at the SDFPF (Figure 14). April salvage (60) accounted for 59.0 percent of the total WY salvage. Longfin Smelt were salvaged in March–May at the TFCF. April salvage (12) accounted for 43.0 percent of the total WY salvage.

Table 3 Delta Smelt and Longfin Smelt less than 20 mm fork length (FL) observed in larval samples collected from the SDFPF and the TFCF in WY 2015. Daily numbers of smelt < 20 mm FL are recorded, while an "N" indicates no detection. An "NS" indicates no sampling.

	SDFPF		*TFCF*	
DATE	*Delta Smelt larvae*	*Longfin Smelt larvae*	*Delta Smelt larvae*	*Longfin Smelt larvae*
2/27/2015	NS	NS	N	1
3/3/2015	N	1	N	N
3/30/2015	N	N	N	1
4/5/2015	N	1	N	N
4/8/2015	N	N	N	1
4/13/2015	N	1	N	N
4/14/2015	N	2	N	1
4/15/2015	N	1	N	N
4/19/2015	N	1	N	N
4/21/2015	N	5	N	N
4/23/2015	1	1	N	1

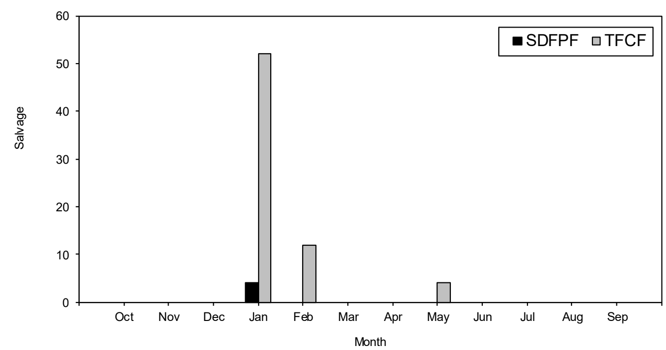

Figure 12 Monthly salvage of Delta Smelt at the SDFPF and the TFCF, WY 2015.

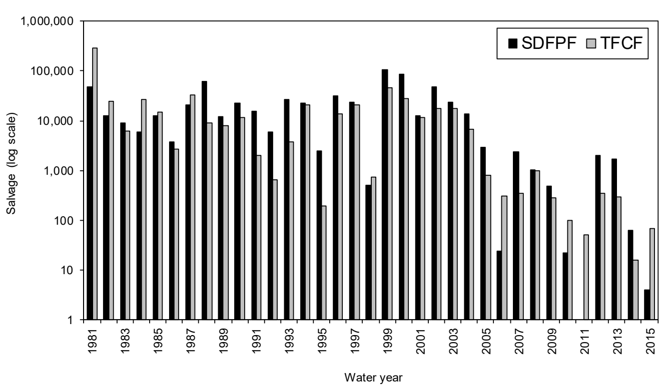

Figure 11 Annual salvage of Delta Smelt at the SDFPF and the TFCF, WYs 1981 to 2015. The logarithmic scale is $\log_{10}$.

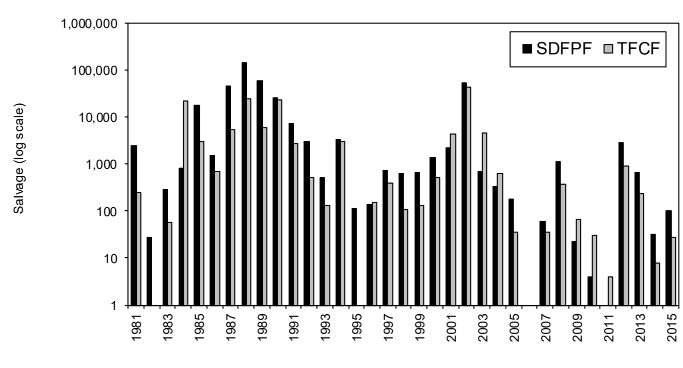

Figure 13 Annual salvage of Longfin Smelt at the SDFPF and the TFCF, WYs 1981 to 2015. The logarithmic scale is $\log_{10}$.

Longfin Smelt less than 20 mm FL were first detected at the SDFPF on March 3, and were observed on eight days of monitoring (Table 3). The longest period of consecutive daily detections was April 13–15. April recorded the most daily detections (7 days).

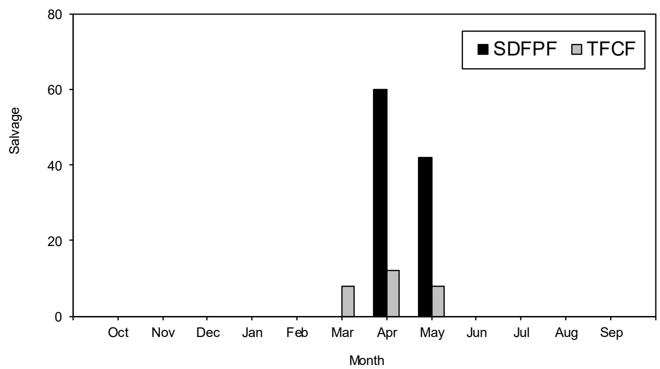

Figure 14 Monthly salvage of Longfin Smelt at the SDFPF and the TFCF, WY 2015.

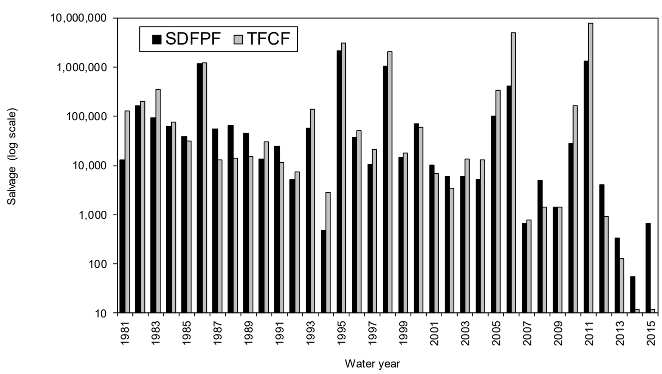

Figure 15 Annual salvage of Splittail at the SDFPF and the TFCF, WYs 1981 to 2015. The logarithmic scale is $\log_{10}$.

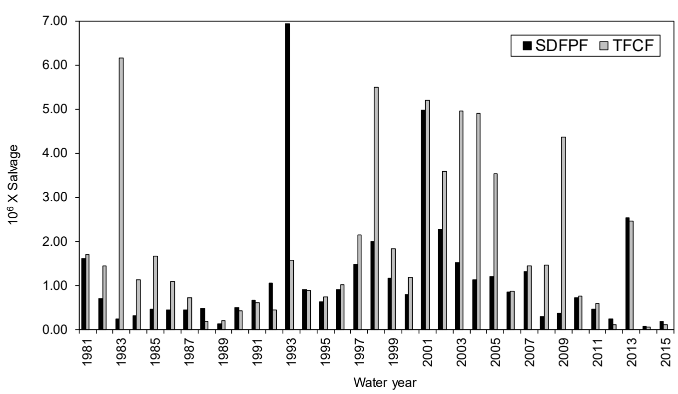

Figure 16 Annual salvage of Threadfin Shad at the SDFPF and the TFCF, WYs 1981 to 2015.

Longfin Smelt less than 20 mm FL were first detected at the TFCF on February 27 and were observed on five days of monitoring (Table 3). April recorded the most daily detections (3 days).

Splittail

Annual salvage estimates of Splittail at both facilities were markedly different from each other (Figure 15). Salvage at the TFCF was a record tying low (12), which was equal to the record low in WY 2014 (12). Conversely, salvage at the SDFPF was 12 times higher (656) than the record-low in WY 2014 (55). Annual Splittail salvage estimates have followed a boom-or-bust pattern, often varying year to year by several orders of magnitude.

Threadfin Shad

Annual salvage of juvenile and adult Threadfin Shad was higher at the SDFPF (186,368) than at the TFCF (114,804), and both were near record lows (Figure 16). Salvage at the SDFPF was higher than the record low in WY 2014 (63,237) but substantially lower than WY 2013 (2,535,117). Similarly, TFCF salvage was higher than the record low in WY 2014 (47,603) but substantially lower than WY 2013 (2,463,695). Similar to Splittail, annual salvage estimates of Threadfin Shad have varied greatly through time.

Notes

Dekar, M. 2015. U.S. Fish and Wildlife Service. 850 South Guild Ave, Suite 105 Lodi, CA 95240.

References

California Dept. of Fish and Game. 2006. *Chinook salmon loss estimation for Skinner Delta Fish Protective Facility and Tracy Fish Collection Facility*. Available at: ftp://ftp.dfg.ca.gov/salvage/.

California Dept. of Fish and Wildlife. 2014. "Delta Model length at date table." Available at: ftp://ftp.dfg.ca.gov/salvage/.

Harvey BN, and Stroble C. 2013. "Comparison of genetic versus Delta Model length-at-date race assignments for juvenile Chinook Salmon at State and Federal South Delta salvage facilities." Interagency Ecological Program for the San Francisco Estuary Technical Report 88: 48 pages plus appendices.

The IEP Newsletter is a quarterly publication that provides IEP program and science highlights as well as in-depth articles on important scientific topics for resource managers, scientists, and the public. The spring issue of the IEP Newsletter provides an annual overview of important results from all IEP monitoring programs and associated studies. Articles in the IEP newsletter are intended for rapid communication and do not undergo external peer review; all primary research results should be interpreted with caution.

If you would like to be notified about new issues of the quarterly IEP newsletter, please send an e-mail to Shaun Philippart (DWR), shaun.philippart@water.ca.gov, with the following information:

- Name
- Agency
- E-mail address

Article Submission Deadlines for Calendar Year 2016

Issue	*Article Submission Deadline*
Issue 1 (Winter)	January 15, 2016
Issue 2 (Spring)	April 15, 2016
Issue 3 (Summer)	July 15, 2016
Issue 4 (Fall)	October 15, 2016

Submit articles to Shaun Philippart.

Did you know that quarterly highlights about current IEP science can be found on the IEP webpage along with a new calendar that displays IEP Project Work Team and other IEP-related public meetings? To view these features, click the following links:

http://www.water.ca.gov/iep/activities/calendar.cfm

http://www.water.ca.gov/iep/highlights/index.cfm

■ Interagency Ecological Program for the San Francisco Estuary ■

IEP NEWSLETTER

3500 Industrial Blvd.
West Sacramento, CA 95691

For information about the Interagency Ecological Program, log on to our Web site at http://www.water.ca.gov/iep/. Readers are encouraged to submit brief articles or ideas for articles. Correspondence—including submissions for publication, requests for copies, and mailing list changes—should be addressed to Frank Keeley, California Department of Water Resources, P.O. Box 942836, Sacramento, CA, 94236-0001. Questions and submissions can also be sent by e-mail to: frank.keeley@water.ca.gov.

■ Interagency Ecological Program for the San Francisco Estuary ■

IEP NEWSLETTER

Steven Slater, California Department of Fish and Wildlife, Lead Editor
Vanessa Tobias, California Department of Fish and Wildlife, Contributing Editor
Shaun Philippart, California Department of Water Resources, Managing Editor
Frank Keeley, California Department of Water Resources, Editor

The Interagency Ecological Program for the San Francisco Estuary
is a cooperative effort of the following agencies:

California Department of Water Resources
State Water Resources Control Board
U.S. Bureau of Reclamation
U.S. Army Corps of Engineers
California Department of Fish and Wildlife
U.S. Fish and Wildlife Service
U.S. Geological Survey
U.S. Environmental Protection Agency
National Marine Fisheries Service

BEFORE CITING INFORMATION HEREIN,
CONSIDER THAT ARTICLES HAVE NOT RECEIVED PEER REVIEW.