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Fish Salvage at the State Water Project's and Central Valley Project's Fish Facilities during the 2013 Water Year

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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. 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 summarized the 2013 water year (10/1/2012-9/30/2013) salvage information from the TFCF and the SDFPF, and examined data from water years (WY) 1981 to 2013 for possible relevance to salvage trends in recent years. The following species were given individual consideration: Chinook Salmon (*Oncorhynchus tshawytscha*), Steelhead (*O. mykiss*), Striped Bass¹ (*Morone saxatilis*), Delta Smelt¹ (*Hypomesus transpacificus*), Longfin Smelt¹ (*Spirinchus thaleichthys*), Splittail (*Pogonichthys macrolepidotus*), and Threadfin Shad¹ (*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 subsampled generally once every 1 or 2 hours for 1 to 60 minutes (= 27.1, sd = 7.4) at the SDFPF and once every 2 hours for 10 to 120 minutes (= 27.9, sd = 6.8) at the TFCF. Fish 20 mm fork length (FL) or larger were identified, numerated, and measured. These fish counts were expanded to estimate the total number of fish salvaged in each 1- to 2-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 estimates were presented because the loss model has been widely accepted by regulatory agencies and has undergone extensive review. Loss is the estimated number of Chinook Salmon entrained by the facility minus the number of Chinook Salmon that survive salvage operations (California Dept. 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 of Chinook Salmon was determined solely by the Delta criteria based on length at date of salvage (California Dept. of Fish and Wildlife 2014).

Larval fish were also collected and examined to determine the presence of Delta Smelt and Longfin Smelt < 20 mm FL. Larval sampling ran from March 6 through June 18 at the SDFPF and from March 11 through June 20 at

the TFCF. Larval samples were collected once for every 6 hours of water export. 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 Dept. of Fish and Wildlife personnel.

Water Exports

The SWP exported 2.70 billion m³ of water, which was a decrease from the export in WY 2012 (3.25 billion m³), and well below the record high export in WY 2011 (4.90 billion m³) (Figure 1). The CVP exported 2.27 billion m³ of water, which was comparable to exports in WYs 2008-2010 and 2012, but a decrease in exports from 2011 (3.13 billion m³) and WYs 2002-2007, which ranged from 3.08 billion m³ to 3.35 billion m³.

Exports from the two water projects generally followed a similar seasonal pattern. Exports at the CVP peaked in October-November 2012 and again in July-August 2013 (Figure 2). During these periods, the CVP exported 1.15 billion m³, which represented 50.6% of annual export. Exports at the SWP peaked in December 2012 and again in July-August 2013 (Figure 2). During this period, the SWP exported 1.15 billion m³, which represented 42.5% of annual export. CVP monthly exports ranged from 33.36 to 297.35 million m³. SWP monthly exports ranged from 67.56 to 438.79 million m³.

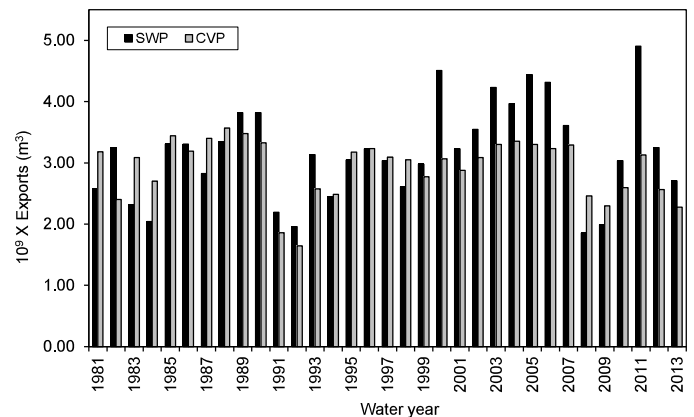


Figure 1 Annual water exports in billions of cubic meters for the SWP and the CVP, water years 1981 to 2013.

¹ Pelagic Organism Decline (POD) species

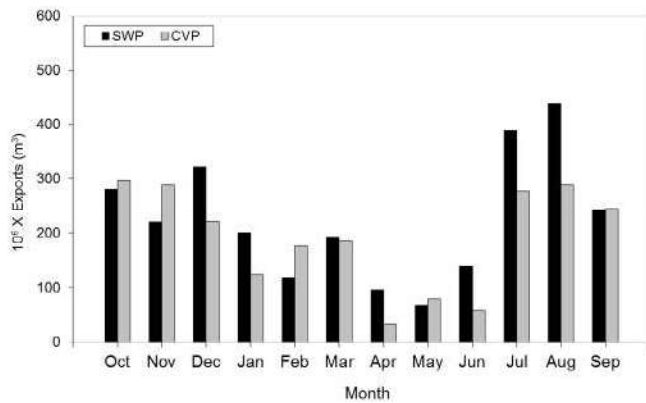


Figure 2 Monthly water exports in millions of cubic meters for the SWP and the CVP, water year 2013.

Total Salvage and Prevalent Species

Total fish salvage (all fish species combined) at the TFCF was low at 2,828,514 (Figure 3). This was an increase from the record low in WY 2012 (475,082) but well below the record high of 37,659,835 in WY 2006 (Figure 3). Total fish salvage at the SDFPF was low at 3,042,176. This was an increase from WY 2012 (1,607,286) and comparable to WY 2011 (3,092,553).

Threadfin Shad was the most-salvaged species at SDFPF and TFCF (Figure 4 and Table 1). American Shad (*Alosa sapidissima*) and Striped Bass were the 2nd and 3rd most-salvaged fishes at SDFPF. Bluegill (*Lepomis macrochirus*) and American Shad were the 2nd and 3rd most-salvaged fishes at TFCF. Native species comprised 1.4% of annual fish salvage at SDFPF and 0.5% of annual fish salvage at TFCF. Relatively few Chinook Salmon, Steelhead, Delta Smelt, and Longfin Smelt were salvaged at the SDFPF (< 0.3% combined of total annual salvage) and at the TFCF (< 0.2% combined of total annual salvage).

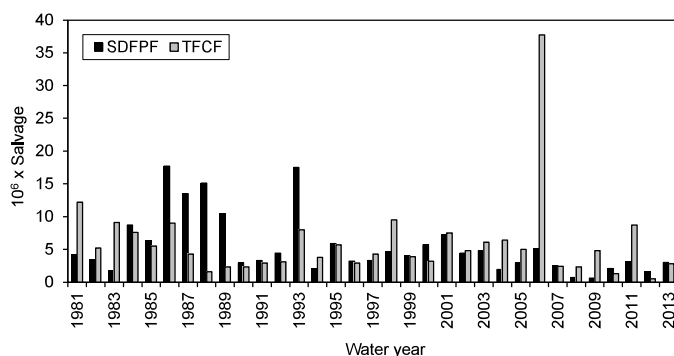


Figure 3 Annual salvages of all fish taxa combined at the SDFPF and the TFCF, water years 1981 to 2013.

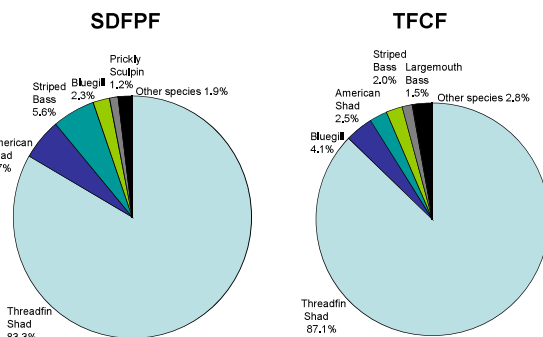


Figure 4 Percentages of annual salvage for the 5 most prevalent fish species and other fish species combined at the SDFPF and TFCF, WY 2013.

Chinook Salmon

Salvages of Chinook Salmon (all races and origins combined) at both facilities continued the low salvage trend since WY 2001 (Figure 5). SDFPF salvage (3,184) increased from the record-low salvage in WY 2012 (1,579) but substantially decreased from WY 2011 levels (18,830). Mean WY 2001-2013 SDFPF salvage was about 10% of the mean salvages in the 1980s and the 1990s. Salvage of Chinook Salmon at the TFCF (4,032) increased from WY 2012 (1,965) but substantially decreased from WY 2011 (18,135). Mean WY 2001-2013 TFCF salvage was about 13% of the mean salvages in the 1980s and the 1990s.

Salvaged Chinook Salmon at the TFCF were primarily wild fall-run fish, which comprised 84.6% of wild fish (Table 2). Salvaged Chinook Salmon at the SDFPF were also primarily wild fall-run fish, which comprised 66.8% of wild fish. The majority of wild fall-run fish at the SDFPF and the TFCF were salvaged in May (Figure 6).

Loss of Chinook Salmon (all origins and races) was higher at the SDFPF (14,171) than at the TFCF (3,069) (Table 2). Greater entrainment loss at the SDFPF than at the TFCF was attributable to greater pre-screen loss (California Dept. of Fish and Game 2006).

Steelhead

Salvage of Steelhead (wild and hatchery origins combined) continued the pattern of low salvage observed since WY 2005 (Figure 7). Salvage at the SDFPF (861) was higher than in WY 2012 (443). Salvage at the TFCF (646) was also higher than in WY 2012 (493).

Table 1 Annual fish salvages and percentages of annual fish salvage (%) collected from the SDFPF and TFCF in water year 2013.

<i>SDFPF</i>			<i>TFCF</i>		
<i>Species</i>	<i>Salvage</i>	<i>%</i>	<i>Species</i>	<i>Salvage</i>	<i>%</i>
Threadfin Shad	2,535,117	83.3	Threadfin Shad	2,463,695	87.1
American Shad	173,480	5.7	Bluegill	115,796	4.1
Striped Bass	170,306	5.6	American Shad	71,619	2.5
Bluegill	70,616	2.3	Striped Bass	57,855	2.0
Prickly Sculpin	36,170	1.2	Largemouth Bass	43,291	1.5
Inland Silverside	15,445	0.5	Inland Silverside	28,747	1.0
Largemouth Bass	11,825	0.4	White Catfish	12,341	0.4
White Catfish	8,601	0.3	Rainwater Killifish	7,444	0.3
Black Crappie	3,881	0.1	Prickly Sculpin	6,621	0.2
Shimofuri Goby	3,539	0.1	Chinook Salmon	4,032	0.1
Chinook Salmon	3,184	0.1	Golden Shiner	3,920	0.1
Delta Smelt	1,701	0.1	Channel Catfish	3,150	0.1
Yellowfin Goby	1,690	0.1	Black Crappie	3,093	0.1
Channel Catfish	1,660	0.1	Yellowfin Goby	1,343	<0.1
Western Mosquitofish	888	<0.1	Lamprey Unknown	1,288	<0.1
Rainbow / Steelhead Trout	861	<0.1	Redear Sunfish	1,078	<0.1
Rainwater Killifish	848	<0.1	Rainbow / Steelhead Trout	646	<0.1
Longfin Smelt	659	<0.1	Shimofuri Goby	601	<0.1
Bigscale Logperch	643	<0.1	Delta Smelt	300	<0.1
Splittail	329	<0.1	Longfin Smelt	241	<0.1
Lamprey Unknown	161	<0.1	Tule Perch	232	<0.1
Golden Shiner	111	<0.1	Western Mosquitofish	222	<0.1
Redear Sunfish	92	<0.1	Black Bullhead	166	<0.1
Wakasagi	88	<0.1	Warmouth	159	<0.1
Tule Perch	71	<0.1	Bigscale Logperch	141	<0.1
Common Carp	66	<0.1	Splittail	125	<0.1
Starry Flounder	57	<0.1	Threespine Stickleback	97	<0.1
Threespine Stickleback	22	<0.1	Brown Bullhead	47	<0.1
White Sturgeon	12	<0.1	Green Sunfish	46	<0.1
Red Shiner	12	<0.1	Wakasagi	42	<0.1
Shokihaze Goby	10	<0.1	Common Carp	26	<0.1
Brown Bullhead	9	<0.1	Pacific Lamprey	24	<0.1
Rifle Sculpin	6	<0.1	White Crappie	23	<0.1
Goldfish	4	<0.1	Sacramento Blackfish	16	<0.1
Hitch	4	<0.1	Pacific Brook Lamprey	16	<0.1
Sacramento Sucker	4	<0.1	Shokihaze Goby	11	<0.1
Blue Catfish	4	<0.1	Pacific Staghorn Sculpin	8	<0.1
			White Sturgeon	4	<0.1
			Starry Flounder	4	<0.1
			Fathead Minnow	4	<0.1

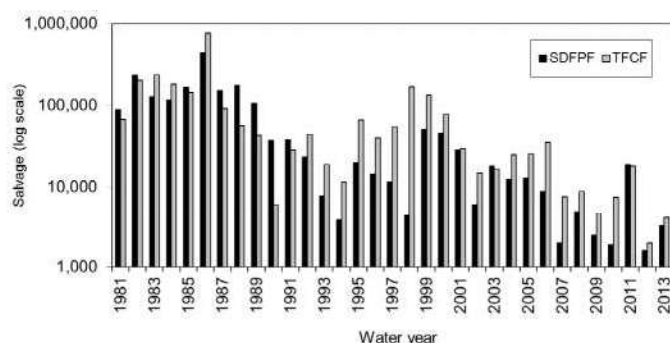


Figure 5 Annual salvages of Chinook Salmon (all races and wild and hatchery origins combined) at the SDFPF and the TFCF, water years 1981 to 2013. The logarithmic scale is \log_{10} .

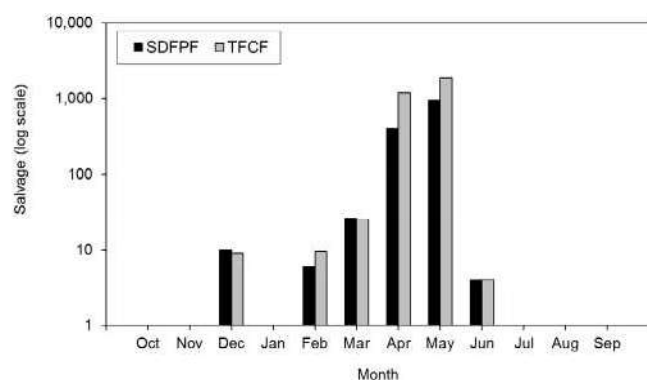


Figure 6 Monthly salvages of wild, fall-run Chinook Salmon at the SDFPF and the TFCF, WY 2013. The logarithmic scale is \log_{10} .

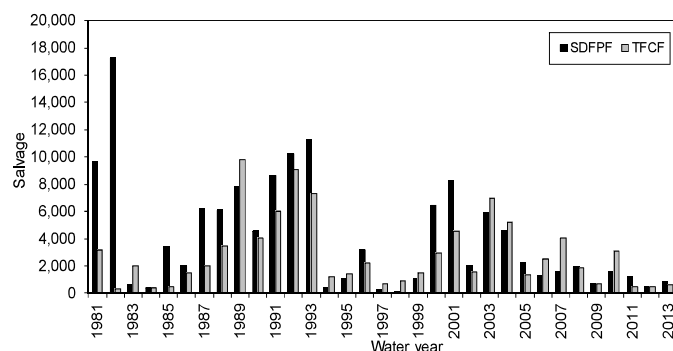


Figure 7 Annual salvages of Steelhead (wild and hatchery origins combined) at the SDFPF and the TFCF, water years 1981 to 2013.

Table 2 Chinook Salmon annual salvages, percentages of annual salvage, race and origin (wild or hatchery), and losses at the SDFPF and the TFCF, water year 2013.

Facility	Origin	Race	Salvage	Percentage	Loss
SDFPF					
	Wild	Fall	1,419	66.8	6,285
		Late-fall	57	2.7	259
		Spring	505	23.8	2,199
		Winter	142	6.7	633
		Total Wild	2,123		9,376
	Hatchery	Fall	322	30.3	1,460
		Late-fall	616	58.1	2,780
		Spring	3	0.3	13
		Winter	120	11.3	542
Total Hatchery		1,061		4,795	
Grand Total		3,184		14,171	
TFCF					
	Wild	Fall	3,134	84.6	2,416
		Late-fall	28	0.8	18
		Spring	404	10.9	297
		Winter	129	3.5	98
		Unknown Race	8	0.2	5
		Total Wild	3,703		2,834
	Hatchery	Fall	93	28.3	62
		Late-fall	165	50.1	118
		Spring	4	1.2	2
		Winter	67	20.4	53
		Total Hatchery	329		235
		Grand Total		4,032	

The TFCF salvaged 320 hatchery Steelhead and 326 wild Steelhead. The SDFPF salvaged 389 hatchery Steelhead and 472 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 March at the TFCF and in April at the SDFPF.

Striped Bass

Salvage at the TFCF (57,855) was a near-record low. Salvage at the TFCF and the SDFPF (170,306) continued the generally-low trend observed since the mid-1990s (Figure 9). Prior to WY 1995, annual Striped Bass salvages were generally above 1,000,000 fish.

Most Striped Bass salvage at the SDFPF occurred in December and from June-July. Most Striped Bass salvage at the TFCF occurred from May-July (Figure 10). At the SDFPF, December salvage (34,934), June salvage (39,733), and July salvage (45,532) accounted for 70.6% of annual salvage. At the TFCF, May salvage (14,445), June salvage (16,812), and July salvage (19,878) accounted for 88.4% of annual salvage. Striped Bass was salvaged every month at both facilities, with the lowest monthly salvage occurring in September at the SDFPF (307) and in April at the TFCF (56).

Delta Smelt

Salvage of Delta Smelt continued the pattern of mostly low salvage observed since WY 2005 (Figure 11). Salvage at the SDFPF (1,701) decreased slightly from WY 2012 (1,999) and increased markedly from WY 2011 (0). Similarly, salvage at the TFCF (300) decreased slightly from WY 2012 (355) and increased noticeably from WY 2011 (51).

Salvage of Delta Smelt at both facilities occurred in the middle of the water year (Figure 12). Adult Delta Smelt were salvaged from December-March at the SDFPF. Juvenile Delta Smelt were salvaged from April-June, where June salvage (785) accounted for 46.1% of the total annual salvage. Adult Delta Smelt were salvaged from December-March at the TFCF. Juvenile Delta Smelt were salvaged from April-June, where May salvage (72) accounted for 24.0% of the total annual salvage.

Delta Smelt less than 20 mm FL were first detected at the SDFPF on April 4 and were observed on 14 days of monitoring (Table 3). The longest period of consecutive

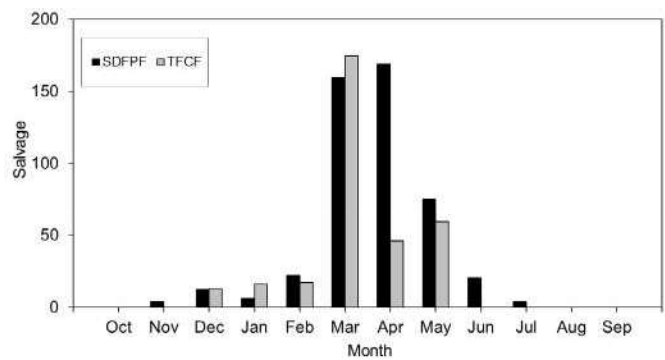


Figure 8 Monthly salvages of wild Steelhead at the SDFPF and the TFCF, WY 2013.

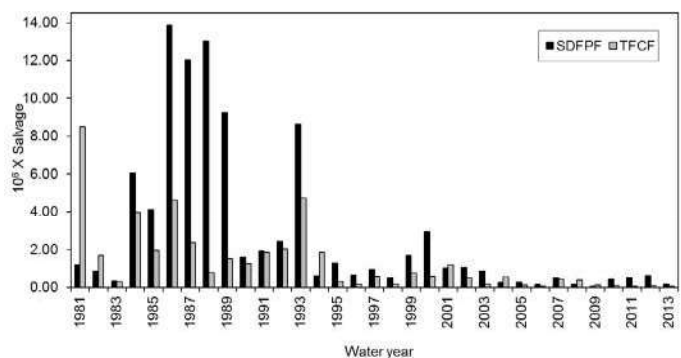


Figure 9 Annual salvages of Striped Bass at the SDFPF and the TFCF, water years 1981 to 2013.

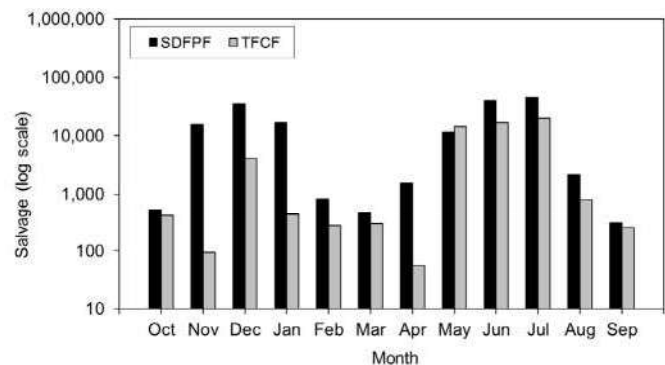


Figure 10 Monthly salvages of Striped Bass at the SDFPF and the TFCF, WY 2013. The logarithmic scale is \log_{10} .

daily detections was April 21-24. April also recorded the most daily detections (12 days).

Delta Smelt less than 20 mm FL were first detected at the TFCF on March 18 and were observed on 8 days of monitoring (Table 3). The longest period of consecutive daily detections was March 22-23. March also recorded the most daily detections (4 days).

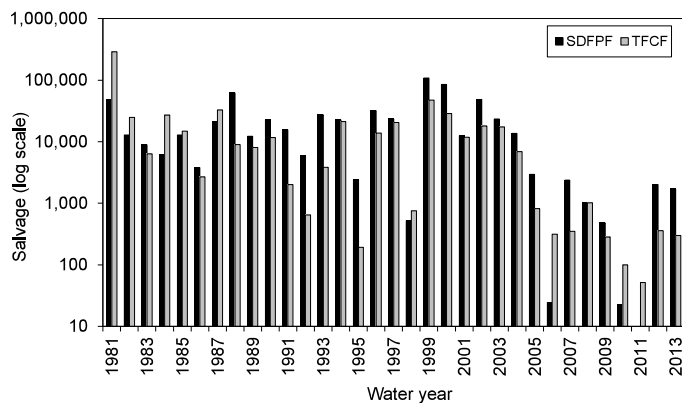


Figure 11 Annual salvages of Delta Smelt at the SDFPF and the TFCF, water years 1981 to 2013. The logarithmic scale is \log_{10} .

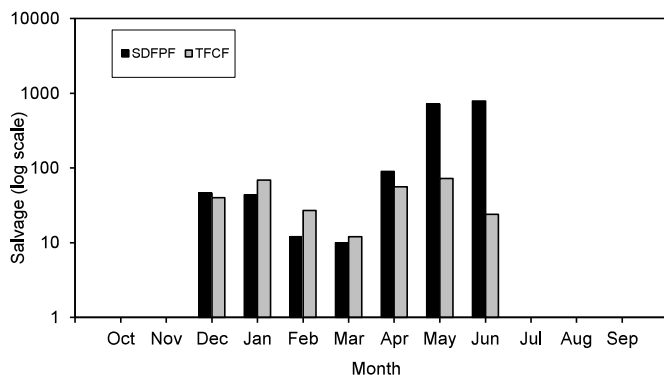


Figure 12 Monthly salvages of Delta Smelt at the SDFPF and the TFCF, WY 2013. The logarithmic scale is \log_{10} .

Longfin Smelt

Salvage at the SDFPF (659) decreased from WY 2012 (2,842) but increased from WY 2011 (0) (Figure 13). Salvage at the TFCF (241) also decreased from WY 2012 (898) but increased from WY 2011 (4).

Longfin Smelt was salvaged in January and from March-June at the SDFPF (Figure 14). May salvage (483) accounted for 73.3% of the total annual salvage. Longfin Smelt was salvaged from March-May at the TFCF. March salvage (111) accounted for 46.1% of the total annual salvage.

Longfin Smelt less than 20 mm FL were first detected at the SDFPF on March 9 and were observed on 13 days of monitoring (Table 3). The longest period of consecutive daily detections was from April 4-10. April also recorded the most daily detections (11 days).

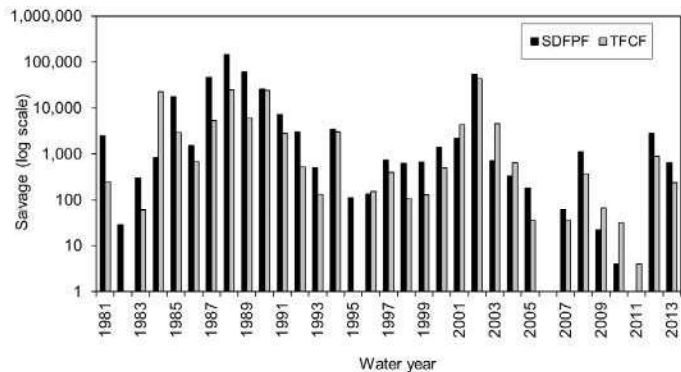


Figure 13 Annual salvages of Longfin Smelt at the SDFPF and the TFCF, water years 1981 to 2013. The logarithmic scale is \log_{10} .

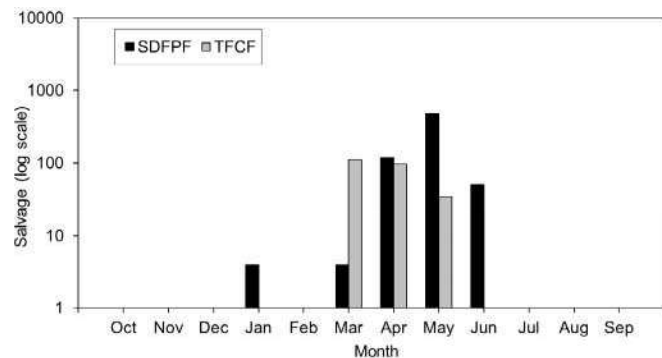


Figure 14 Monthly salvages of Longfin Smelt at the SDFPF and the TFCF, water year 2013. The logarithmic scale is \log_{10} .

Longfin Smelt less than 20 mm FL were first detected at the TFCF on March 13 and were observed on 17 days of monitoring (Table 3). The longest period of consecutive daily detections was from March 16-19. March also recorded the most daily detections (11 days).

Splittail

Annual salvages of Splittail at both facilities were lower than in WY 2012 (Figure 15). Salvage at the SDFPF (329) was much lower than in WY 2012 (4,057). Salvage at the TFCF was a record low (125), which was substantially lower than in WY 2012 (929) and the record-high in WY 2011 (7,660,024). Annual Splittail salvages have followed a boom-or-bust pattern, often varying year to year by several orders of magnitude.

Table 3 Smelt less than 20 mm fork length (FL) observed in larval samples collected from the SDFPF and the TFCF in WY 2013. Daily numbers of Delta Smelt and Longfin Smelt < 20 mm FL are recorded while an “N” indicates no detection and an “NS” indicates no sampling.

DATE	SDFPF		TFCF	
	Delta Smelt larvae	Longfin Smelt larvae	Delta Smelt larvae	Longfin Smelt larvae
3/9	N	1	NS	NS
3/13	N	N	N	4
3/14	N	N	N	5
3/16	N	N	N	3
3/17	N	N	N	5
3/18	N	N	1	6
3/19	N	N	N	3
3/22	N	N	1	1
3/23	N	N	2	N
3/24	N	N	N	1
3/25	N	2	N	1
3/26	N	N	1	N
3/28	N	N	N	1
3/31	N	N	N	4
4/4	1	1	NS*	NS*
4/5	2	3	NS*	NS*
4/6	N	1	NS*	NS*
4/7	N	3	NS*	NS*
4/8	2	3	NS*	NS*
4/9	N	2	NS*	NS*
4/10	N	1	NS*	NS*
4/12	1	N	NS*	NS*
4/13	1	N	NS*	NS*
4/15	N	N	N	1
4/16	N	N	N	1
4/18	1	1	N	1
4/20	N	N	N	1
4/21	16	3	N	N
4/22	7	3	N	1
4/23	8	N	N	N
4/24	1	N	N	N
4/29	1	1	N	N
4/30	1	N	1	N
5/7	NS**	NS**	N	1
5/13	N	N	1	N
5/19	N	N	1	N
5/21	N	N	1	N
6/1	1	N	N	N
6/3	1	N	N	N

NS* The TFCF was non-operational during April 2-14 due to installation of a new hoist trolley beam

NS** The SDFPF was non-operational due to inspections and replacing pumps

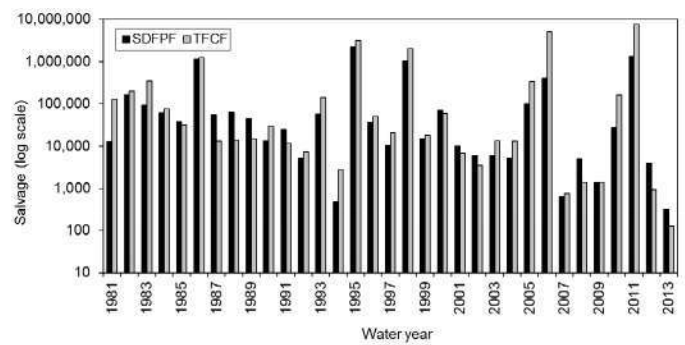


Figure 15 Annual salvages of Splittail at the SDFPF and the TFCF, water years 1981 to 2013. The logarithmic scale is \log_{10} .

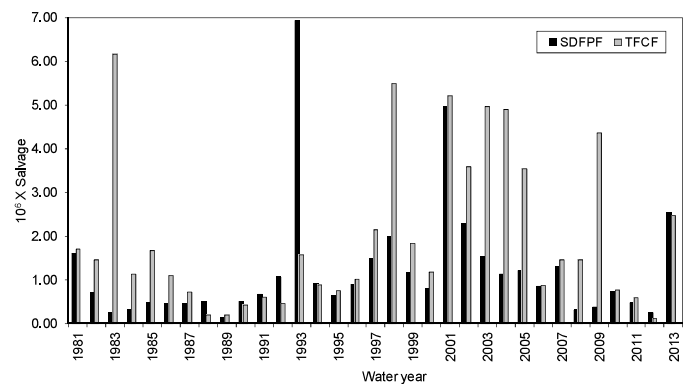


Figure 16 Annual salvages of Threadfin Shad at the SDFPF and the TFCF, water years 1981 to 2013.

Threadfin Shad

Annual salvage of Threadfin Shad at the SDFPF (2,535,117) was slightly higher than at the TFCF (2,463,695) (Figure 16). Salvage at the SDFPF was higher than in WY 2012 (238,135). Similarly, TFCF salvage was much higher than in WY 2012 (109,610), which was a record low. Similar to Splittail, annual salvages of Threadfin Shad have varied greatly through time.

References

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