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Notes

Dayflow data from water.ca.gov/dayflow/

PDO indices from jisao.washington.edu/pdo/PDO.latest

NPGO indices from www.o3d.org/npgo/data/ NPGO.txt

Upwelling indices and anomalies from www.pfeg.noaa.gov/products/PFEL/modeled/ indices/upwelling/NA/data_download.html

Sea Surface Temperatures from shorestation.ucsd.edu/

Marty Gingras, California Department of Fish and Game, email June 29, 2009.

Jason DuBois, California Department of Fish and Game, email October 3, 2008.

Fish Salvage at the State Water Project's and Central Valley Project's Fish Facilities during 2009

Geir Aasen (CDFG), gaasen@dfg.ca.gov

Introduction

Two facilities reduce the fish loss 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 remove fish from the exported water. The diverted fish are periodically loaded into tanker trucks, transported to fixed release sites, and returned to the western Delta. The TFCF began operations in 1957. Operations at the SDFPF began in 1967.

This report summarizes the 2009 salvage information from the TFCF and the SDFPF, and discusses data from 1982 to 2009 for its relevance to recent conditions. The following species are 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*), threadfin shad[1] (*Dorosoma petenense*), and splittail (*Pogonichthys macrolepidotus*).

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 once every 2 hours for 10 to 30 minutes. Fish 20 mm (fork length: FL) or larger from the sub-sampled bypass flows were identified and numerated. These fish counts were expanded (based on sub-sample duration: sub-sample 10 minutes of 120 minutes = expansion factor of 12) to estimate the total number of fish salvaged in each 2-hour period of water export. These incremental salvage estimates were then summed across time to develop monthly and annual species-salvage totals for each facility.

Chinook salmon loss estimates are presented because the loss model has been widely accepted and has undergone extensive field validation. Loss is the estimated number of fish entrained by the facility minus the number

1. Pelagic Organism Decline (POD) species

of fish that survive salvage operations (California Dept. of Fish and Game 2006). Loss was subcategorized by origin (i.e., hatchery or wild) and race (fall, late-fall, winter, spring).

In 2009, as in the recent past, larval fish (< 20 mm FL) were collected and examined to determine the presence of sub-20mm delta smelt. Larval sampling at TFCF ran from February 25 through June 24, while it ran from March 3 through June 30 at SDFPF. Larval samples were collected once for every 6 hours of water export. To retain these smaller larval fish, the fish screen used in the routine counts was lined with a 0.5 mm Nitex net. Larval fish from TFCF were identified to species by TFCF personnel and larval fish from SDFPF were identified to species by California Dept. of Fish and Game.

Water Exports

Water export was substantially reduced from recent years due to reduced delta inflow and measures to protect delta smelt. The SWP exported roughly 2.2 billion m^3 of water in 2009. Annual SWP exports ranged from 1.5 to 5.0 billion m^3 during the years 2003 through 2008 (Figure 1). The CVP exported roughly 2.4 billion m^3 of water in 2009. CVP exports in 2009 were similar to exports in 2008 (2.2 billion m^3) and exports were reduced in both years compared to exports in recent years, which ranged from 3.2 to 3.4 billion m^3 annually during 2003 through 2007.

The water-export patterns of the two water projects differed seasonally. Exports peaked July-October at the CVP and in July at the SWP (Figure 2). From July-October, 1.2 billion m^3 was exported by the CVP, which represented about 50% of annual export. In July, 471.6 million m^3 was exported by the SWP, which represented about 35% of annual export. SWP monthly exports ranged from 37.5 to 471.6 million m^3. CVP monthly exports ranged from 78.8 to 311.9 million m^3.

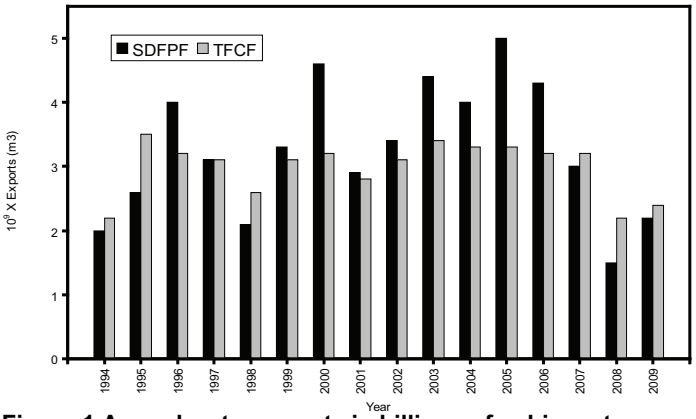

Figure 1 Annual water exports in billions of cubic meters for the SWP and the CVP, 1994 to 2009.

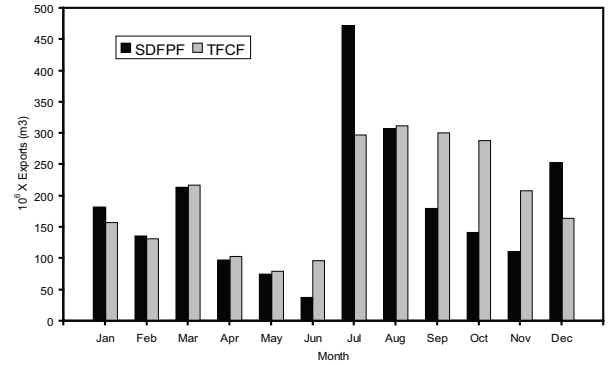

Figure 2 Monthly water exports in millions of cubic meters for the SWP and the CVP in 2009.

Total Salvage and Prevalent Species

Annual salvage (all species combined) at the SDFPF was a near-record low of 837,150 fish (Figure 3). SDFPF salvage in 2009 and 2008 (648,797) decreased substantially in contrast to 2007 (2,239,066) and 2006 (5,138,457). Salvage at the TFCF in 2009 was a record-low (859,501) fish and was substantially lower than in 2008 (5,365,057) or in previous years, which ranged 1.5-37.3 million from 1982 through 2007.

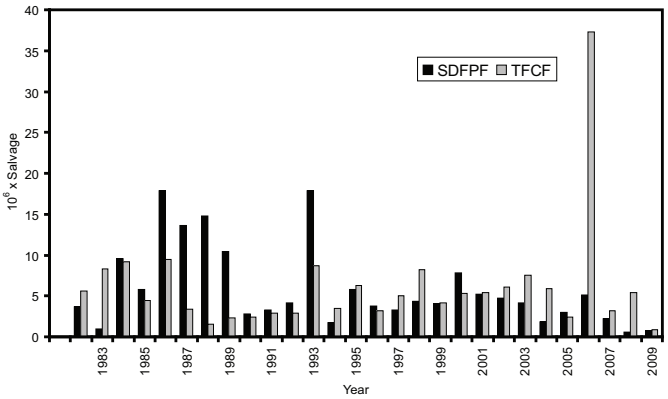

Figure 3 Annual salvage of fishes of all taxa combined at the SDFPF and the TFCF, 1982 to 2009.

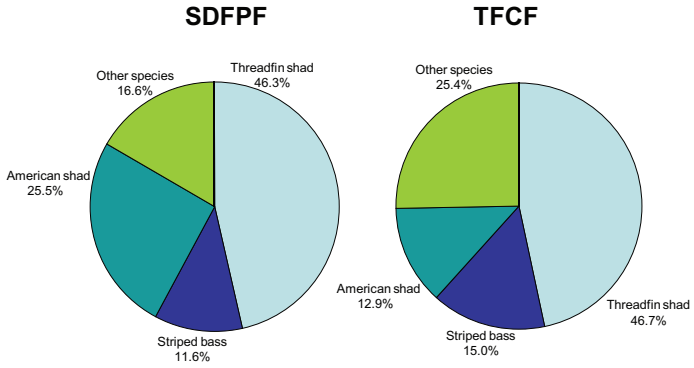

Figure 4 Percentages of annual salvage for the 3 most prevalent species and other species combined at the SDFPF and TFCF, 2009.Chinook Salmon.

Threadfin shad was the most-salvaged species at both facilities (Figure 4). Threadfin shad dominated salvage at the TFCF (Figure 4). Striped bass and American shad were the only other species to be salvaged in substantial numbers at each facility. Threadfin shad dominated salvage at the SDFPF. Relatively few Chinook salmon, steelhead, delta smelt, longfin smelt, and splittail were salvaged at the SDFPF (< 0.6% of total annual salvage) or the TFCF (< 0.8% of total annual salvage).Salvage of Chinook salmon (all races and origins combined) continued to be low at both facilities in 2009 (Figure 5). SDFPF salvage (2,463) continued a declining trend which started in 2001 (Figure 5). Salvage of Chinook salmon in 2009 decreased from 2008 levels (4,928) but was greater than 2007 levels (1,941). Mean 2001-2009 SDFPF salvage was about 8-fold lower than salvage in the 1980's and the late 1990's. Salvage of Chinook salmon in 2009 at the TFCF (4,666) was lower than in 2008 (8,786) or 2007 (7,622). Mean 2001-2009 TFCF salvage was about 6-fold lower than salvage in the 1980s and the late 1990s.

Salvaged Chinook salmon at both facilities were primarily wild spring-run fish and wild fall-run fish (Table 1). Wild spring-run fish comprised 61% and 72% of the salvage of wild Chinook salmon at the SDFPF and the TFCF, respectively. Wild fall-run fish were 27% of the salvage of wild salmon at the SDFPF and about 22% of the wild salmon salvaged at the TFCF. The majority of wild fall-run fish at the SDFPF and TFCF were salvaged in May (Figure 6).

Loss of Chinook salmon (all origins and races) was higher at the SDFPF (10,620) than at the TFCF (3,682; Table 1). Relatively-greater entrainment loss at the SWP was attributable to loss within Clifton Court Forebay.

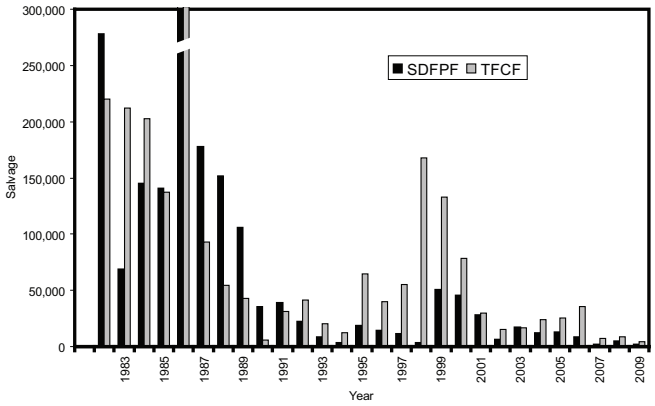

Figure 5 Annual salvage of Chinook salmon (all races and origins combined) at the SDFPF and the TFCF, 1982 to 2009. The SDFPF 1986 salvage of 435,233 and the TFCF 1986 salvage of 752,039 have been truncated.

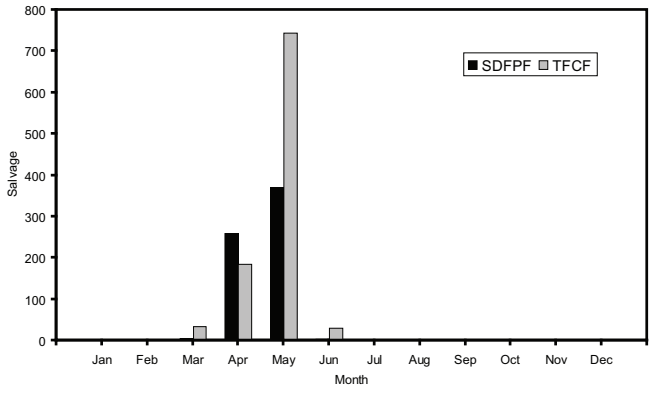

Figure 6 Monthly salvage of wild, fall-run Chinook salmon at the SDFPF and the TFCF, 2009

Table 1 Chinook salmon annual salvage, percentage of annual salvage, race and origin (wild or hatchery), and loss at the SDFPF and the TFCF, 2009

Facility	Origin	Race	Salvage	Percentage	Loss
SDFPF					
	Wild				
		Fall	633	27	2,723
		Late-fall	0	0	0
		Spring	1,459	61	6,256
		Winter	287	12	1,291
	Total Wild		**2,379**		**10,270**
	Unknown Race		**6**		**NA**
	Hatchery				
		Fall	0	0	0
		Late-fall	0	0	0
		Spring	0	0	0
		Winter	78	100	350
	Total Hatchery		**78**		**350**
	Grand Total		**2,463**		**10,620**
TFCF					
	Wild	*Fall*	986	22	778
		Late-fall	*0*	*0*	*0*
		Spring	*3,270*	*72*	*2,585*
		Winter	*290*	*6*	*219*
	Total Wild		***4,546***		***3,582***
	Hatchery				
		Fall	*0*	*0*	*0*
		Late-fall	*4*	*3*	*4*
		Spring	*15*	*13*	*12*
		Winter	*101*	*84*	*84*
	Total Hatchery		***120***		***100***
	Grand Total		***4,666***		***3,682***

NA: loss cannot be calculated since lengths were missing

Steelhead

In 2009, salvage of steelhead (all origins combined) declined at both facilities, continuing the pattern of mostly low salvage observed since 2005 (Figure 7). Salvage at the SDFPF (658) in 2009 was lower than in 2008 (1,944). Similarly, TFCF salvage (712) in 2009 was lower than in 2008 (1,887).

Hatchery fish made up the majority of steelhead salvaged at both facilities. The TFCF salvaged 511 hatchery steelhead and 201 wild steelhead. The SDFPF salvaged 483 hatchery steelhead and 175 wild steelhead.

Salvage of wild steelhead at both facilities occurred predominantly in the first half of the year (Figure 8). Wild steelhead were salvaged January-May and in July and December at the SDFPF and February-June at the TFCF. Wild steelhead at both facilities were salvaged most frequently February-April.

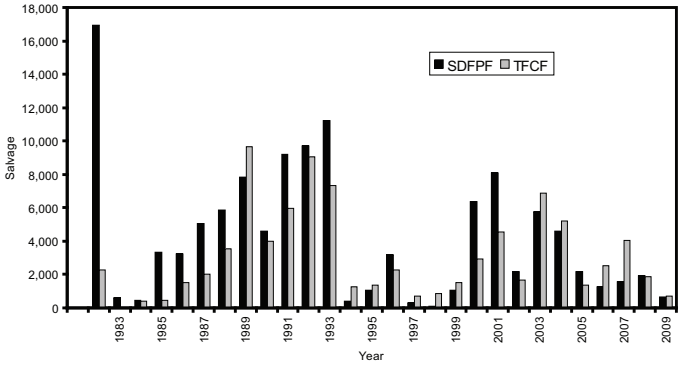

Figure 7 Annual salvage of steelhead (all origins combined) at the SDFPF and the TFCF, 1982 to 2009.

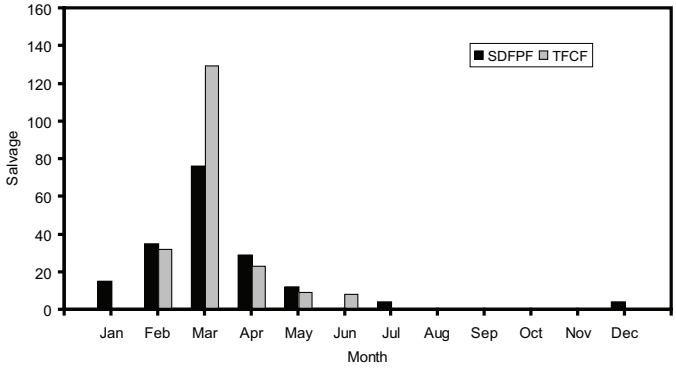

Figure 8 Monthly salvage of wild steelhead at the SDFPF and the TFCF, 2009

Striped Bass

Salvage at the SDFPF (97,208) in 2009 was a record-low. Salvage at the SDFPF and TFCF (128,622) continued the generally-low trend observed since the mid-1990's (Figure 9). Prior to 1995, annual striped bass salvage was generally above 1,000,000 fish.

Most striped bass salvage at the SDFPF happened in October and November 2009, whereas most striped bass salvage at the TFCF happened in June and July (Figure 10). At the SDFPF, October salvage (30,974) and November salvage (22,307) accounted for 55% of annual salvage. At the TFCF, salvage during June (62,084) and July (48,825) accounted for 86% of annual salvage. Striped bass were salvaged every month at both facilities, with the lowest monthly salvage occurring in April at the SDFPF (442) and in January at the TFCF (294).

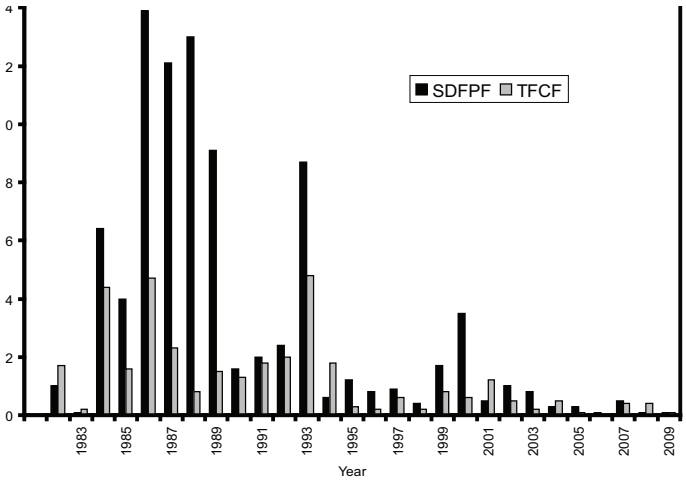

Figure 9 Annual salvage of striped bass at the SDFPF and the TFCF, 1982 to 2009

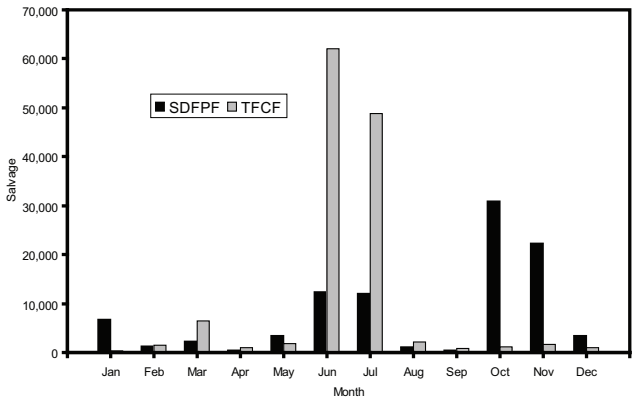

Figure 10 Monthly salvage of striped bass at the SDFPF and the TFCF, 2009

Delta Smelt

Compared to the historical levels, very few delta smelt were salvaged (Figure 11). Salvage in 2009 at the SDFPF (479) was lower than in 2008 (1,029). Salvage at the TFCF (286; a near-record low) was lower than in 2008 (1,009).

Most delta smelt were salvaged in a few months during the first half of the year (Figure 12). Juvenile delta smelt were most-frequently salvaged in May (211) and June (256) at the SDFPF, which together accounted for 97% of the total annual salvage. Delta smelt (juveniles) were also most-frequently salvaged in May (212) and June (58) at the TFCF, which accounted for 94% of the total annual salvage.

Delta smelt less than 20 mm were first detected at the TFCF on April 10 in 2009 (Table 2). Larval delta smelt were observed on 19 days of monitoring at the TFCF. The longest period of consecutive daily detections was May 5-8. Larval delta smelt were most-frequently detected in May (14 days).

Delta smelt less than 20 mm were first detected at the SDFPF on April 20 in 2009. Delta smelt larvae or post-larvae were observed on 12 days of monitoring at the SDFPF. The longest periods of consecutive daily detections were May 15-16 and June 5-6. Larval delta smelt were most-frequently detected in May (8 days).

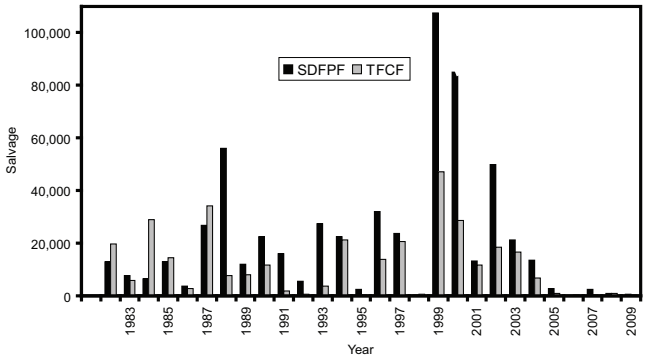

Figure 11 Annual salvage of delta smelt at the SDFPF and the TFCF, 1982 to 2009

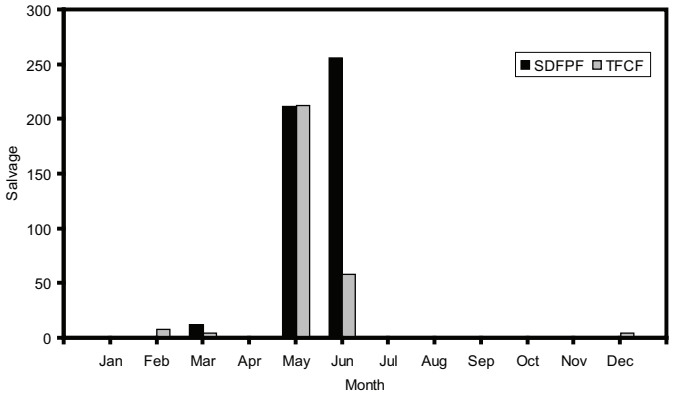

Figure 12 Monthly salvage of delta smelt at the SDFPF and the TFCF, 2009

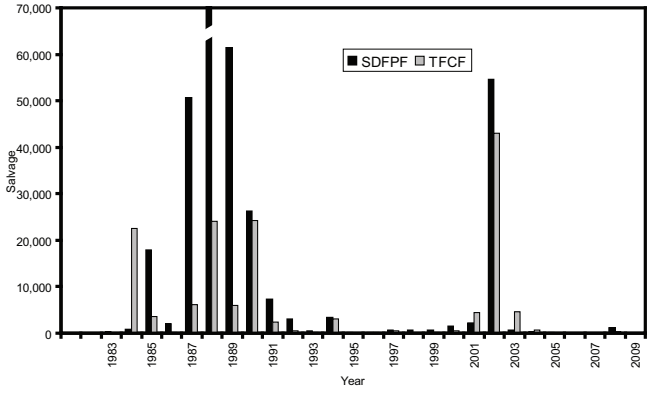

Figure 13 Annual salvage of longfin smelt at the SDFPF and the TFCF, 1982 to 2009. The annual salvage at the SDFPF for 1988 has been truncated for scale considerations (140,040).

Longfin Smelt

Longfin smelt at both facilities continued to be salvaged at very low levels compared to the early 2000s and the late 1980s (Figure 13). In 2009, salvage at the SDFPF (22) was lower than at the TFCF (66). Longfin smelt were salvaged in winter and spring at both facilities (Figure 14). Juvenile longfin smelt were most-frequently salvaged in April (8) and June (6) at the SDFPF, which accounted for 64% of salvage. The salvage of longfin smelt peaked in March (28) at the TFCF, which accounted for 42% of salvage.

Larval longfin smelt were collected on 10 occasions at the TFCF, mostly in March (Table 2). Only 3 longfin smelt larvae were collected (March 4, April 7, and May 8) at the SDFPF. Longfin smelt larvae or post-larvae were first collected at the TFCF on February 25. The longest-period of consecutive daily detections was February 25-26.

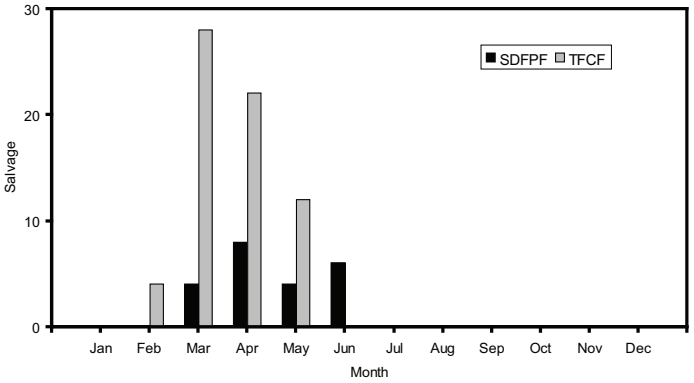

Figure 14 Monthly salvage of longfin smelt at the SDFPF and the TFCF, 2009.

Table 2 Occurrence of delta smelt and longfin smelt larvae among larval fish collected from the SDFPF and TFCF in 2009 based on sampling from March 3 through June 30 at SDFPF and from February 25 through June 24 at TFCF. A "Y' indicates that larval delta or longfin smelt < 20 mm FL were found while an "N" indicates no detection. Number of counts per day with larval smelt were recorded in parenthesis.

DATE	SDFPF Delta smelt larvae Y or N	SDFPF Longfin smelt larvae Y or N	TFCF Delta smelt larvae Y or N	TFCF Longfin smelt larvae Y or N
2/25/2009	N	N	N	Y
2/26/2009	N	N	N	Y
3/3/2009	N	N	N	Y
3/4/2009	N	Y	N	N
3/8/2009	N	N	N	Y (2)
3/10/2009	N	N	N	Y
3/16/2009	N	N	N	Y
3/24/2009	N	N	N	Y
4/7/2009	N	Y	N	N
4/10/2009	N	N	Y	N
4/20/2009	Y	N	Y	Y
4/22/2009	Y	N	Y	N
4/25/2009	N	N	Y	N
4/29/2009	N	N	N	Y
5/3/2009	N	N	N	Y
5/4/2009	Y	N	N	N
5/5/2009	N	N	Y	N
5/6/2009	Y	N	Y (2)	N
5/7/2009	N	N	Y	N
5/8/2009	N	Y	Y	N
5/11/2009	N	N	Y	N
5/13/2009	N	N	Y	N
5/14/2009	N	N	Y	N
5/15/2009	Y	N	N	N
5/16/2009	Y	N	N	N
5/17/2009	N	N	Y	N
5/18/2009	Y	N	Y	N
5/19/2009	N	N	Y	N
5/21/2009	Y	N	Y	N
5/22/2009	N	N	Y	N
5/23/2009	Y	N	N	N
5/26/2009	N	N	Y (2)	N
5/28/2009	Y	N	N	N
5/30/2009	N	N	Y (2)	N
6/1/2009	N	N	Y	N
6/5/2009	Y	N	N	N
6/6/2009	Y (2)	N	N	N

Splittail

Salvage of splittail in 2009 at both facilities was lower than in 2008 and low compared to recent years (Figure 15). Salvage at the SDFPF (1,418) was lower than in 2008 (4,979). Salvage at the TFCF (1,405) was slightly lower than in 2008 (1,439). TFCF salvage in 2007 (780) was the lowest since 1982 and a marked decrease from the record-high salvage in 2006 (5.0 million). Splittail salvage has followed a boom-or-bust pattern, often varying year to year by several orders of magnitude.

Threadfin Shad

In 2009, annual salvage at the SDFPF (387,940) was lower than at the TFCF (401,911) and both were near record low levels (Figure 16). Salvage, particularly that of TFCF, differed markedly from recent years (Figure 16). Similar to splittail, annual salvage of threadfin shad has varied greatly through time.

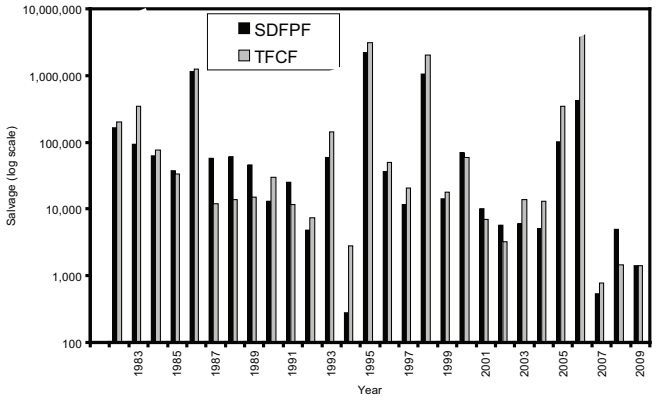

Figure 15 Annual salvage of splittail at the SDFPF and the TFCF, 1982 to 2009.

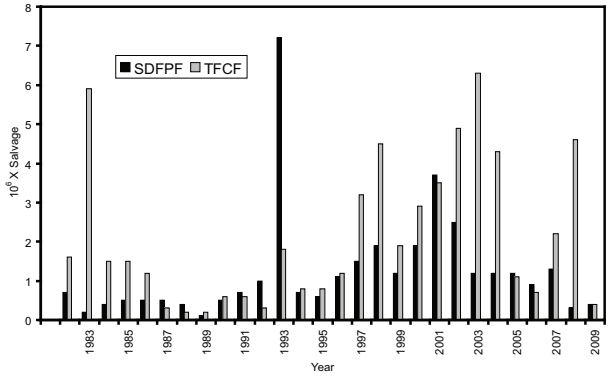

Figure 16 Annual salvage of threadfin shad at the SDFPF and the TFCF, 1982 to 2009.

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