2008 Fish Salvage at the Tracy Fish Collection Facility

by

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Introduction

The Tracy Fish Collection Facility (TFCF) diverts (salvages) some fish from water exported from the southern portion of the Sacramento-San Joaquin Delta. The fish are loaded into tanker trucks, trucked to release sites away from the immediate influence of the export pumps, and released back into the western Delta. This report summarizes salvage information from the TFCF in 2008. 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 Sacramento splittail (*Pogonichthys macrolepidotus*).

Methods

The daily volume of water exported was reported from gauge readings from the C.W. "Bill" Jones Pumping Plant at Byron. Monthly water exports were plotted and examined for time trends. Annual exports for the Central Valley Project (CVP) from 1982 through 2008 were noted. Data from 1979 or 1982 to 2008 were examined and discussed for analytical convenience and for their relevance to recent conditions.

Fish abundance was reported as 'estimated salvage'. Only fish longer than 20 mm FL were numerated (counts), because salvage efficiency degrades rapidly for fish smaller than this size. Salvage estimates were primarily obtained by expanding the routine sample counts by the duration that water was pumped using the following equation:

$$SALVAGE_{SAMPLE} = COUNT_{SAMPLE} \mathbf{x} (MINUTES\ PUMPING \mathbf{/} MINUTES_{SAMPLE}). \quad (1)$$

Fish collected during predator removals were not expanded:

$$SALVAGE_{PREDATOR\ REMOVAL/SECONDARY\ FLUSH} = COUNT_{PREDATOR\ REMOVAL/SECONDARY\ FLUSH.} \quad (2)$$

Monthly or annual salvage estimates were calculated by the summation of Equations (1) and (2) by month or year. Intra-annual abundances were examined by plotting the monthly salvage totals for selected species and for all taxa combined for 2008.

The annual and daily salvage estimates for Chinook salmon and steelhead were subcategorized as wild or hatchery. Salmonid origin was determined by the presence (wild) or absence (hatchery) of an adipose fin. The race of Chinook salmon was classified by the Delta salmon length-race key using body length and date of capture information.

Chinook salmon loss estimates are presented because its loss model has been widely accepted and has undergone extensive field validation compared to other species. Loss is the estimated number of fish encountered by the facility minus the number of fish that survive salvage operations. Loss was subcategorized by origin and race.

Larval and post-larval (<20 mm FL) fish sampling was started in 2008 in order to sample larval delta smelt. The fish screen used in the routine counts was lined with a 0.5 mm nitex net in order to retain any smaller fish. Larval samples were collected at 0400, 1000, 1600, and 2200 hours. Larval fish samples were identified to species by TFCF personnel and reported by approximately 10 am the next working day.

The dates when the first delta smelt or longfin smelt were salvaged annually were listed and examined during the period of 1979 to 2008 as a possible tool for future water management. The dates of occurrence were converted to Julian days for the period of October 1 to September 30 (the water season). Dry and critical water year types were examined to determine its effect on dates of first salvage. The Sacramento Valley Index was used to determine water year type.

The dates when median salvage (50% of annual salvage) of delta smelt and longfin smelt occurred were also examined from 1982 to 2008 to determine if a pattern in median salvage dates could be identified in a calendar year. Water year types were also recorded for possible effect on median salvage.

Spring water export reductions occurred at the TFCF in 2008 due to reduced water inflow and legal measures to protect delta smelt. To examine what effect the reduction in exports had on delta smelt salvage, the proportion of water exports occurring in April through June were compared with the percentage of delta smelt salvage during the same time period from 2004 through 2008. This time period was selected since exports remained stable and high while delta smelt annual salvage numbers remained relatively stable and low, consequently aiding in isolating the reduced 2008 spring exports as an effect. Water year types were also examined for possible effect on April through June delta smelt salvage.

Water Exports

The CVP exported 1,813,529 acre-feet (AF) of water in 2008 (Figure 1). The annual export in 2008 was reduced from recent stable exports ranging from 2,590,344 to 2,697,077 AF (2004-2007).

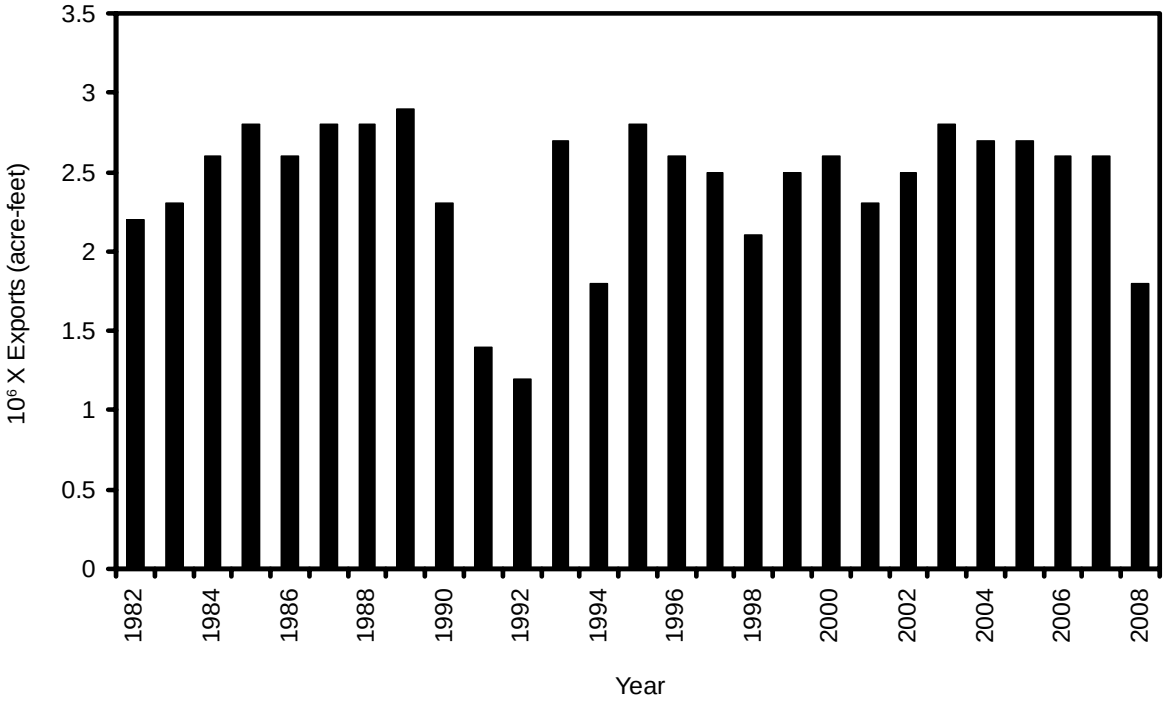

Figure 1 Annual exports (in millions of acre-feet) for the Central Valley Project, 1982 – 2008

The majority of water exports in 2008 occurred from July through November (Figure 2). The monthly exports ranged from 54,657 to 234,418 AF. From July through November, a total of 1,071,879 AF was exported, accounting for 59 % of the 2008 annual export. Combined export during April through June was 174,096 AF which was a reduction from the same period during the previous 4 years (2004-2007: 358,873- 439,833 AF).

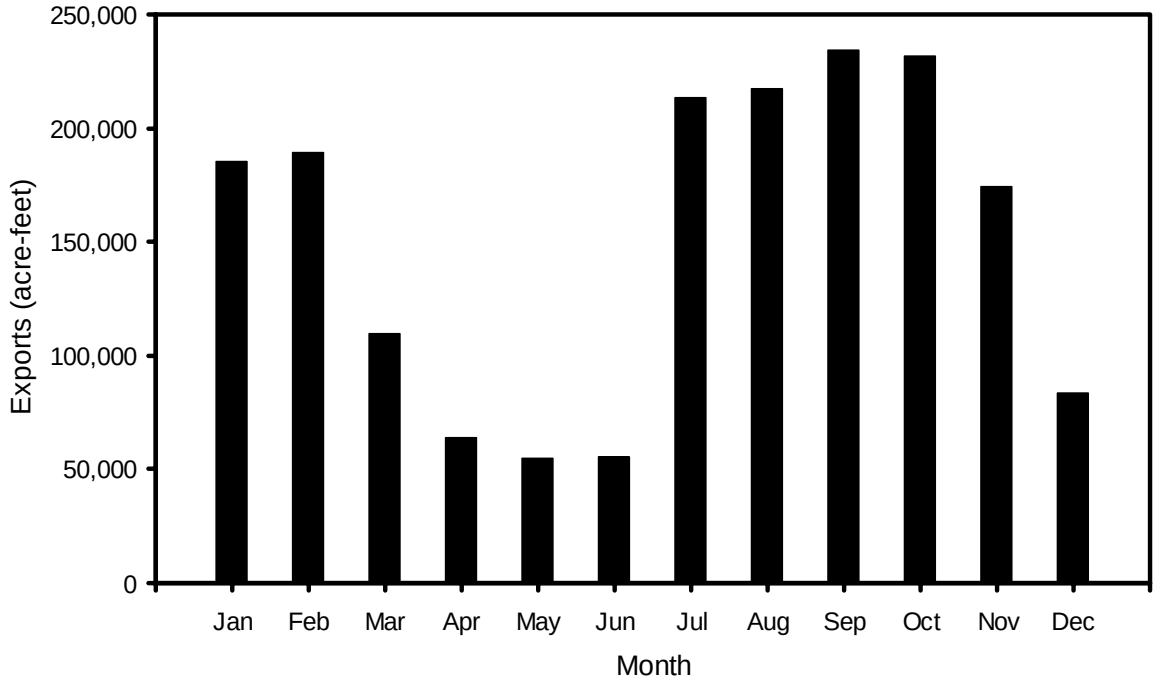

Figure 2 Monthly exports (in acre-feet) for the Central Valley Project, 2008

Total Salvage and Prevalent Species

Annual combined salvage (annual salvage) in 2008 was 5,365,057 (Figure 3). In contrast, the 2006 annual salvage of 37,266,449 was an order of magnitude greater than the annual salvage in 2008 and 2007 (3,164,530).

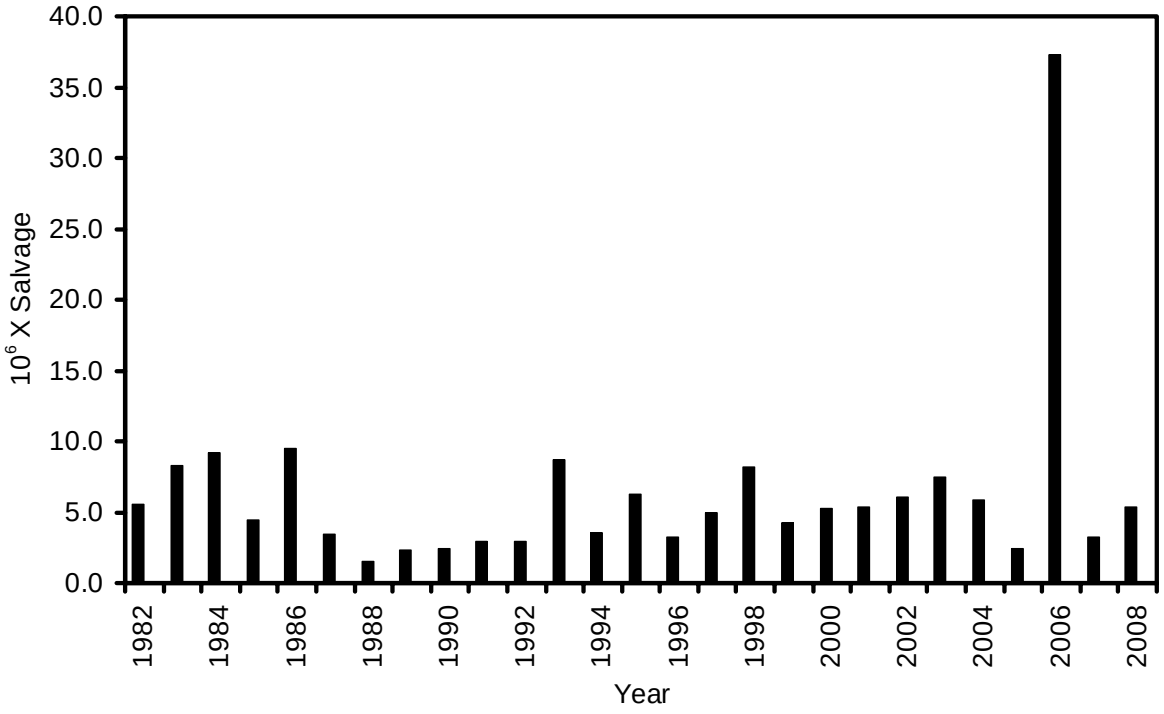

Figure 3 Annual salvage (in millions) of all taxa combined at the TFCF, 1982 – 2008

Threadfin shad accounted for 86.1% of the annual salvage (Figure 4 and Appendix A). Generally, threadfin shad have made up the bulk of salvage, especially in later years. The 2006 salvage was the exception when common carp accounted for 81.8% (30,495,884) and threadfin shad accounted for just 1.9% of salvage. The only other species to be salvaged in substantial numbers in 2008 were striped bass (7.0%) and inland silverside (1.6%). Striped bass salvage decreased in 2008 compared to 2007 (14.2%). White catfish salvage also decreased substantially from 2007 to 2008, accounting for 4.5% and 0.8%, respectively. Relatively few (< 0.3%) Chinook salmon, steelhead, delta smelt, longfin smelt, and Sacramento splittail were salvaged.

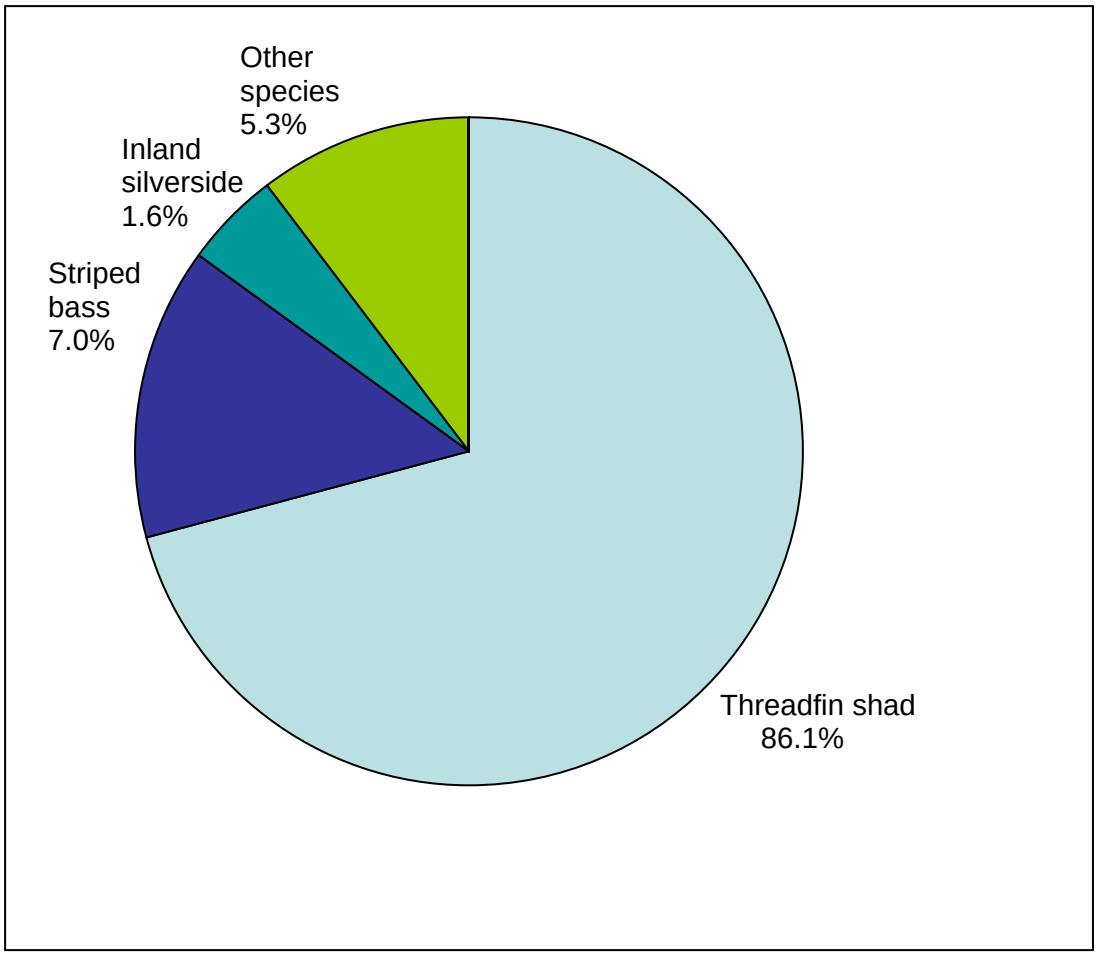

Figure 4 Percentages of annual salvage for the 3 most prevalent species and other species combined at the TFCF, 2008

Chinook Salmon

Annual salvage (all races and origins combined) of 8,786 Chinook salmon in 2008 continued the low salvage trend since 2001 (Figure 5). The annual salvage of salmon in 2008 was similar to the annual salvage of 7,622 observed in 2007, but was a decrease from the annual salvage of 35,319 observed in 2006. Mean annual salvage from 2001 to 2008 was about 6-fold lower than salvage in the 1980's and the late 1990's.

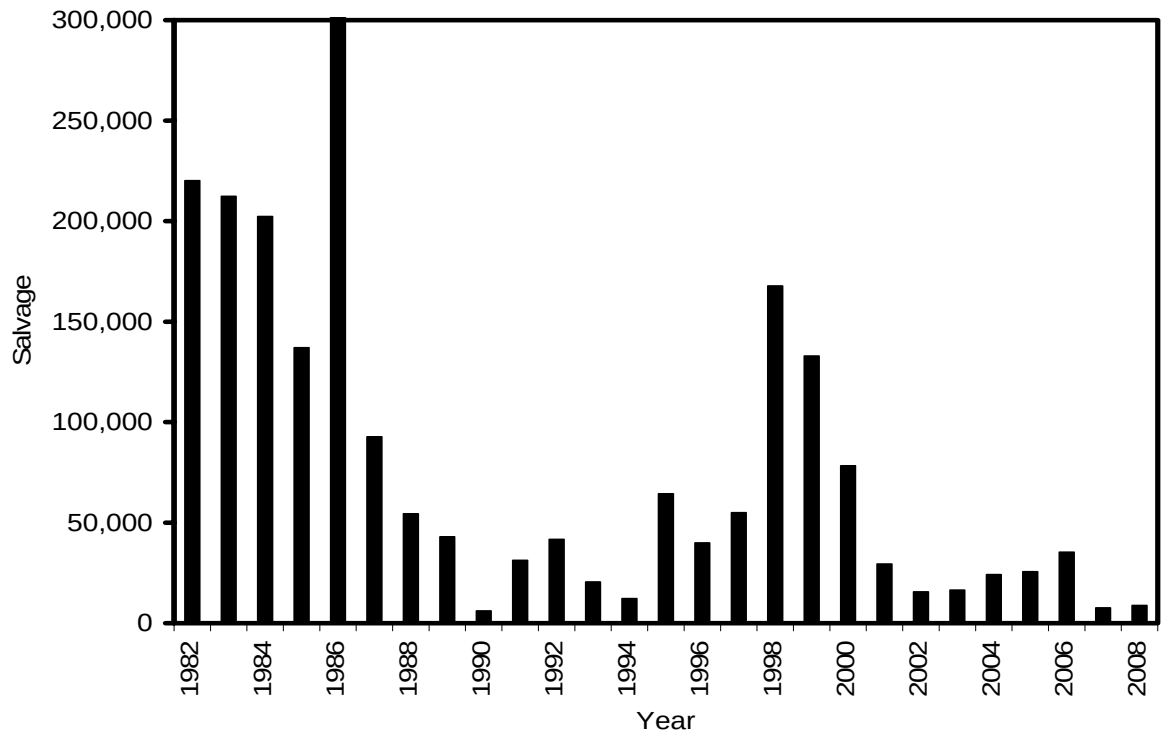

Figure 5 Annual salvage of Chinook salmon (all races and origins combined) at the TFCF, 1982 – 2008. The 1986 salvage of 752,039 was truncated for scale considerations

Salvaged Chinook salmon consisted primarily of wild fall run fish (49%) followed by wild spring run fish (44%; Table 1). Fall run salmon were salvaged from January through June and spring run salmon were salvaged from March through June (Figure 6). The majority of fall run salmon (82%) were salvaged in May and the majority of spring run salmon (65%) were salvaged in April. The estimated loss of salmon in 2008 was 7,010 (Table 1).

Table 1 Chinook salmon annual salvage, percentage of annual salvage, race and origin (wild or hatchery), and loss at the TFCF, 2008

Origin	Race	Salvage	Percentage	Loss
Wild	Fall	3,285	49	2,675
	Late-fall	4	<1	4
	Spring	2,954	44	2,486
	Winter	462	6	383
Total Wild		**6,705**		**5,548**
Hatchery				
	Fall	4	<1	3
	Late-fall	56	2	41
	Spring	59	3	45
	Winter	1,954	94	1,368
Total Hatchery		**2,073**		**1,457**
Unknown Race		8		5
Grand Total		***8,786***		***7,010***

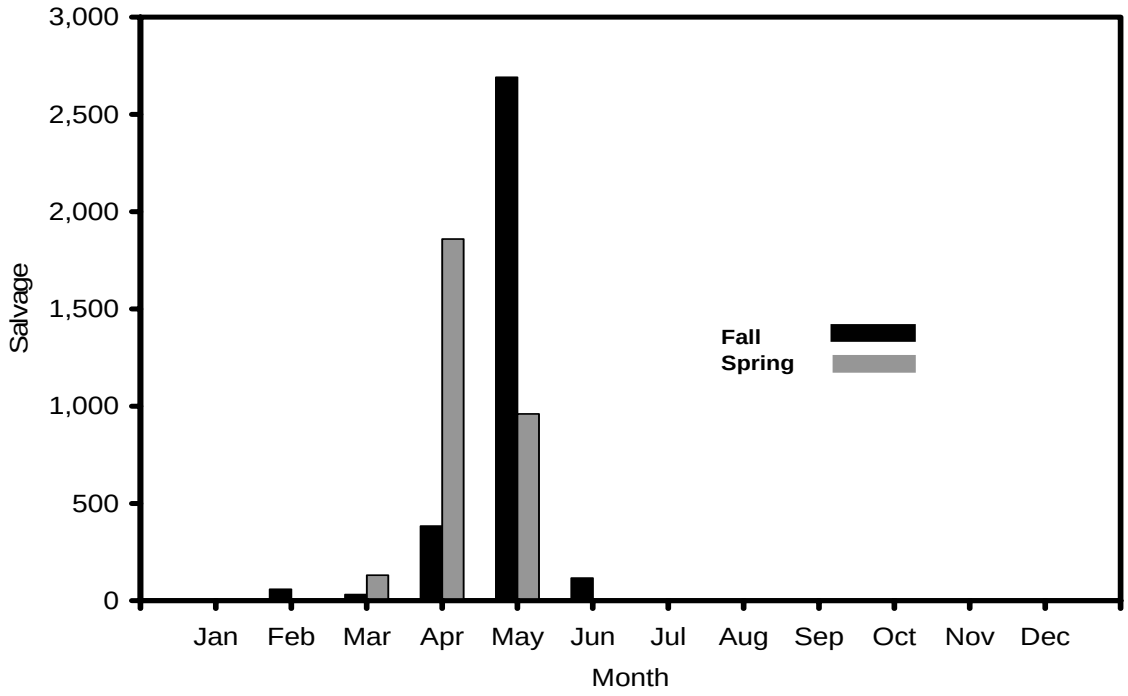

Figure 6 Monthly salvage of wild fall run and wild spring run Chinook salmon at the TFCF, 2008

Steelhead

Annual salvage (all origins combined) of steelhead in 2008 was 1,887 (Figure 7). Salvage decreased in 2008 from 2007 levels. The annual steelhead salvage of 4,068 in 2007 was an increase from annual salvage of 1,347 in 2005 and 2,516 in 2006.

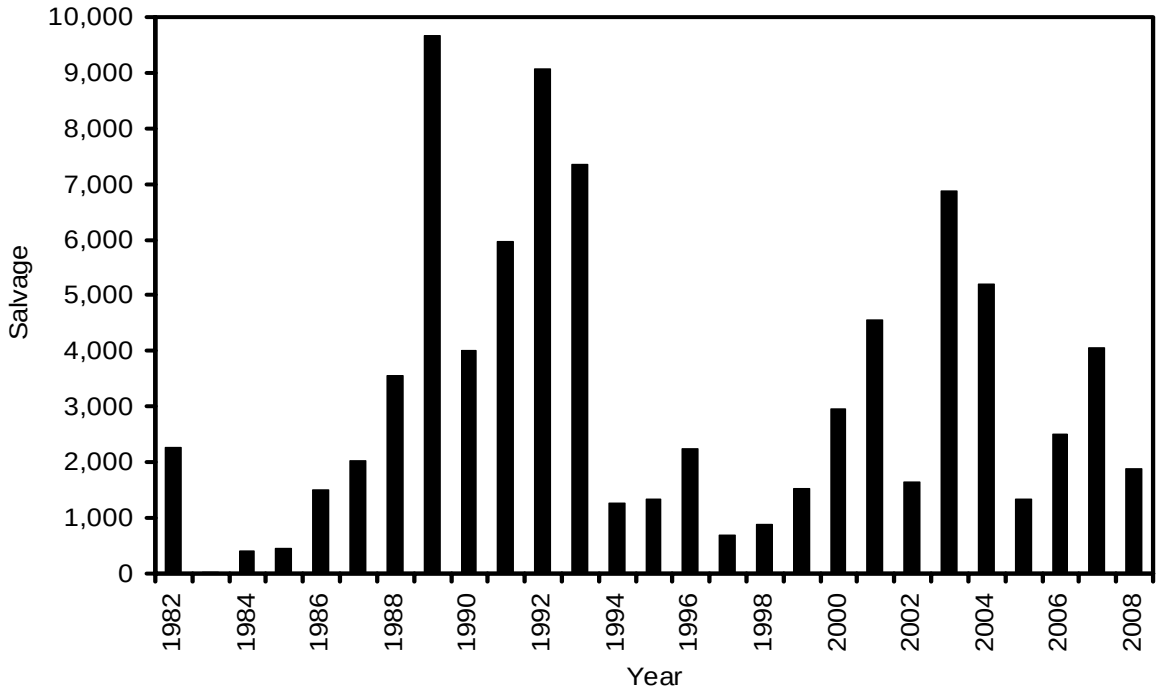

Figure 7 Annual salvage of steelhead (all origins combined) at the TFCF, 1982 – 2008

The majority of steelhead salvaged were of hatchery origin. The salvage composition was 1,578 hatchery and 309 wild fish.

All salvage of hatchery and wild steelhead occurred in the first half of the year. Hatchery steelhead were salvaged from January through April and wild steelhead were salvaged from January through May (Figure 8). Both hatchery and wild steelhead were salvaged most frequently in February.

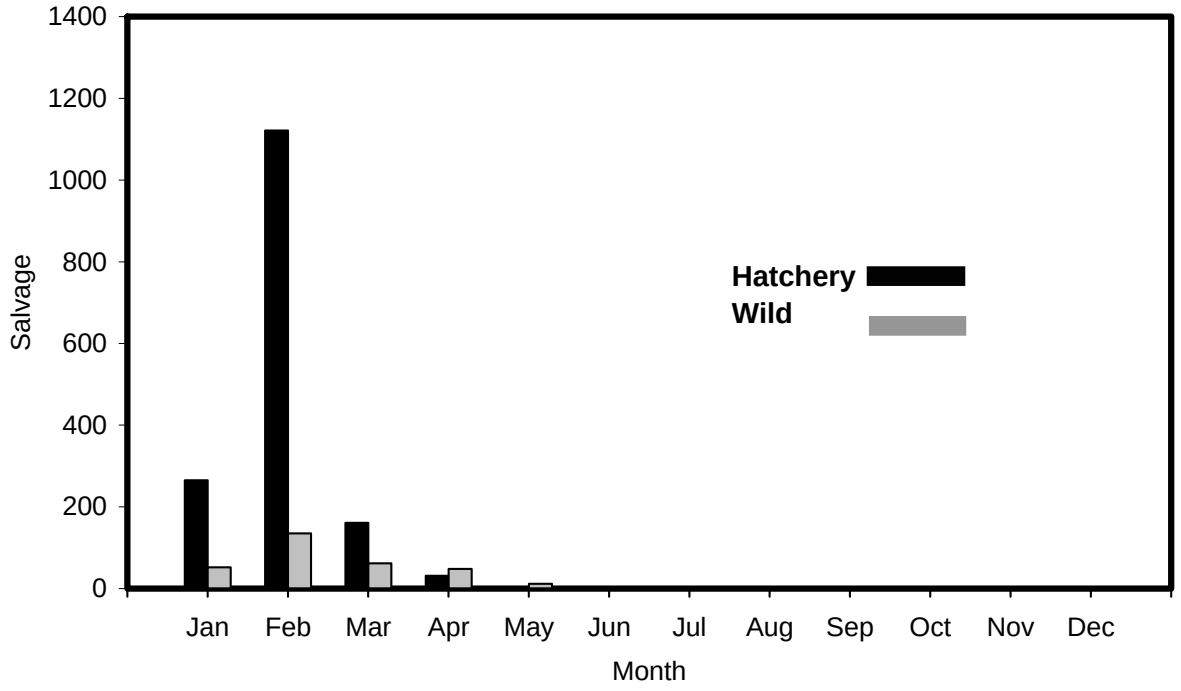

Figure 8 Monthly salvage of hatchery and wild steelhead at the TFCF, 2008

Striped Bass

The annual salvage of 378,916 striped bass in 2008 continued the low trend observed since 1995 (Figure 9). The annual salvage of 1,182,799 in 2001 was a large increase from the 1995 to 2000 salvage but decreased again from the 2002 to 2008 salvage. Prior to 1995, annual striped bass salvage was generally above 1,000,000 except for 1983 and 1988.

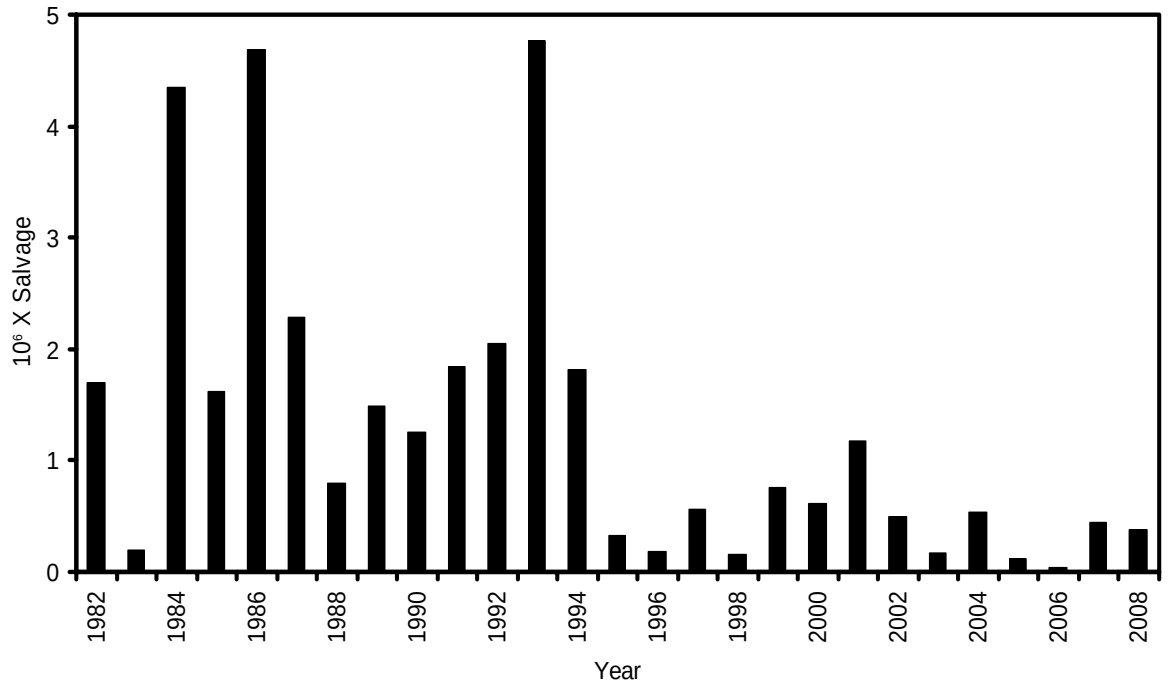

Figure 9 Annual salvage (in millions) of striped bass at the TFCF, 1982 – 2008

Most striped bass were salvaged in June and July (Figure 10). The June salvage of 111,035 and the July salvage of 189,497 accounted for 79% of the annual salvage. Striped bass were salvaged every month and the lowest monthly salvage of 228 occurred in April.

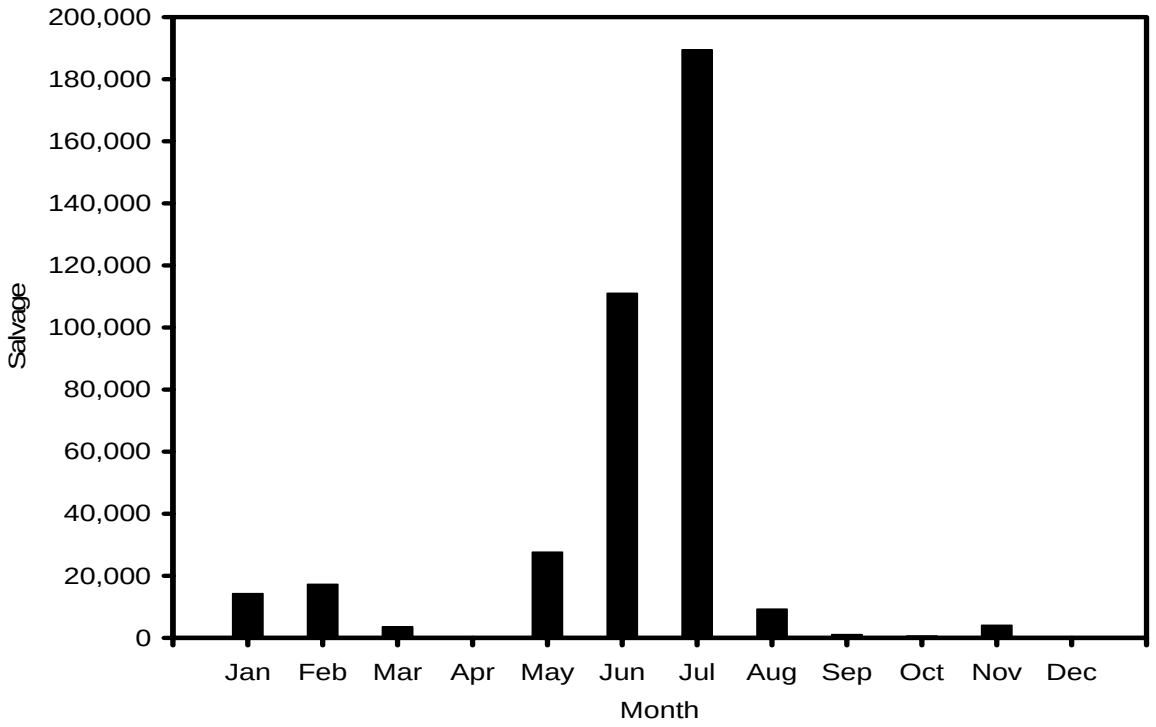

Figure 10 Monthly salvage of striped bass at the TFCF, 2008

Delta Smelt

The annual salvage of 1,009 delta smelt in 2008 continued the low trend observed since 2005 (Figure 11). The annual salvage during 2005 to 2008 (312 - 1,009) was the lowest 4 year period of salvage on record.

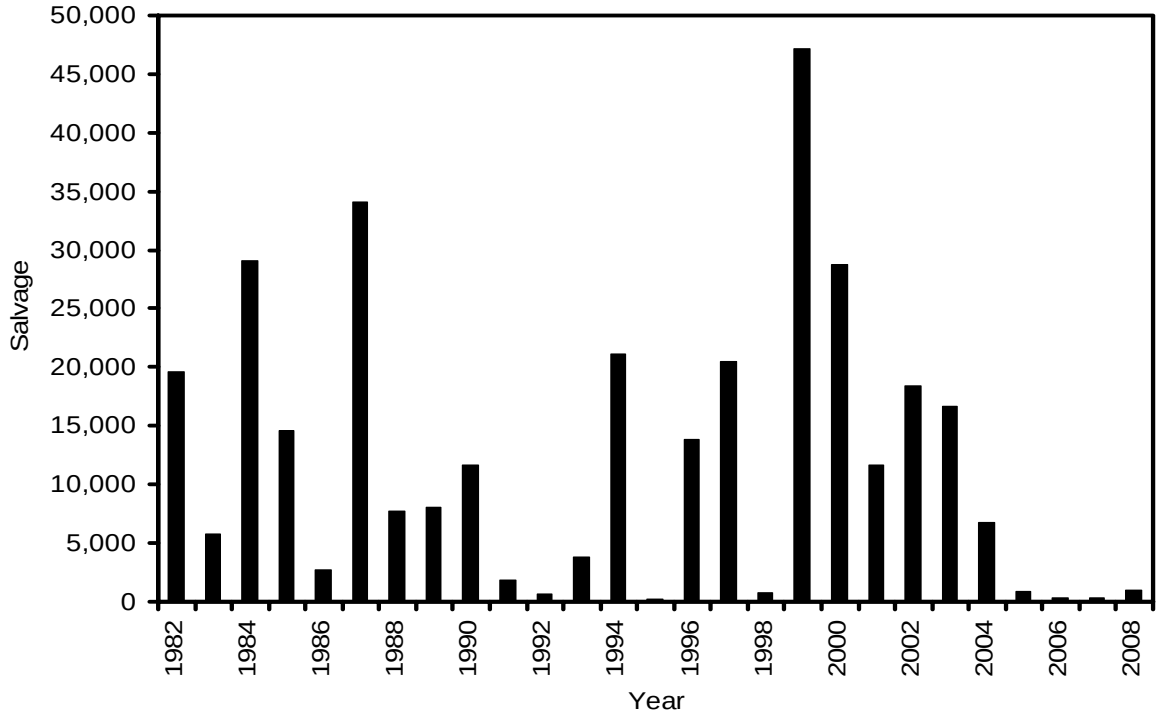

Figure 11 Annual salvage of delta smelt at the TFCF, 1982 – 2008

Delta smelt were salvaged most frequently during the late spring (Figure 12). Most of the delta smelt were salvaged in May and June which accounted for 75% of the annual salvage.

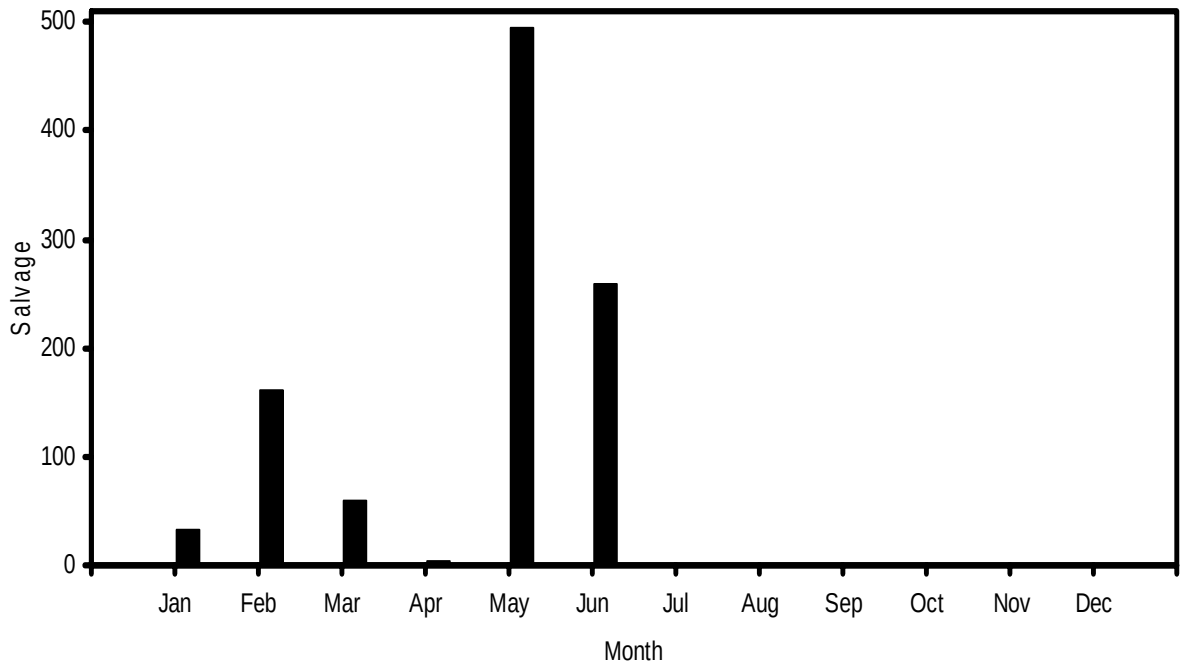

Figure 12 Monthly salvage of delta smelt at the TFCF, 2008

The date of the first occurrence of delta smelt in salvage varied widely among years. Date of first delta smelt salvage during 1979 to 2008 occurred predominantly between October 1 (Julian day 275) and January 8 (Julian day 8) (Figure 13). In 2008, delta smelt were first salvaged on January 11 (Julian day 42) which was somewhat later than the period of October 1 through January 8. From 1979 to 1988, the first observations of delta smelt were most frequently in October. In later years delta smelt were observed most frequently during December through February. There appears to be a weak association between critical and dry water year types and an earlier date of first detection. The date of first delta smelt salvage during critical and dry water year types occurred at a rate of 69% during the period of October 1 through January 8.

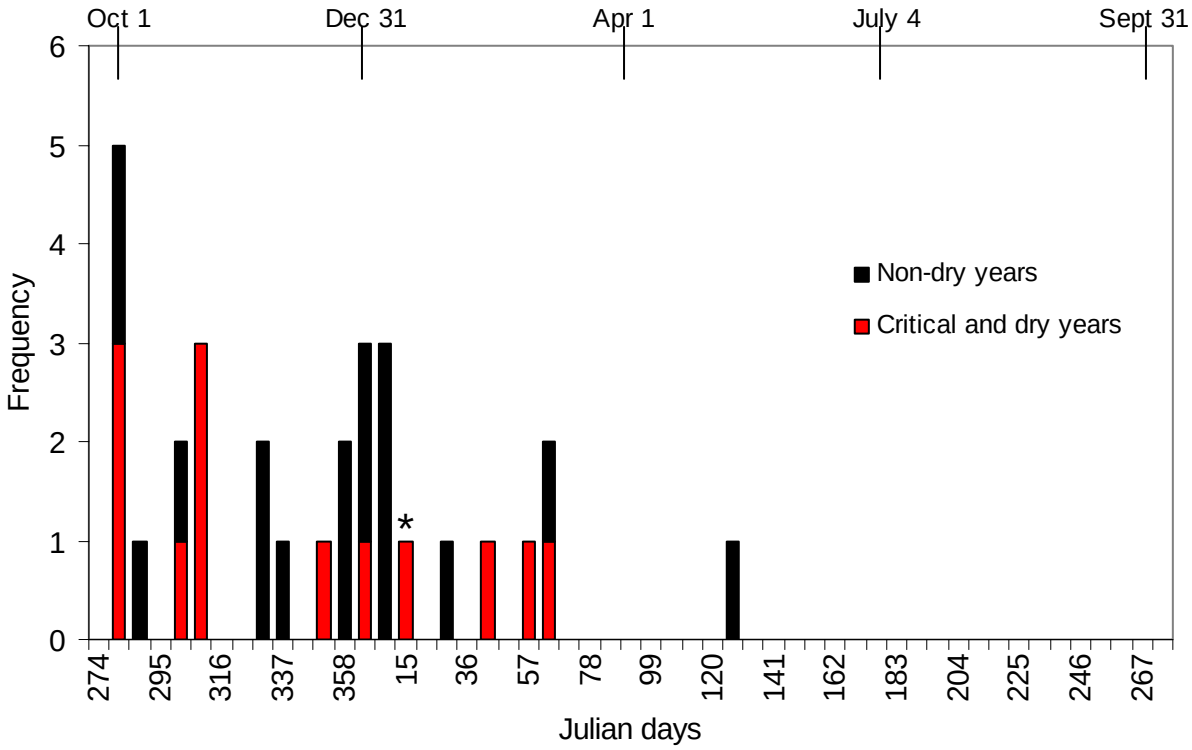

Figure 13 Julian date of first delta smelt salvage at the TFCF, 1979 – 2008. An asterisk marks Julian date of first delta smelt salvage in 2008

Date range when median salvage (50% of annual salvage in a calendar year) of delta smelt occurred during the time period 1982 to 2008 varied between January 24, 1995 to August 6, 1986 (Table 2). The date of median salvage occurred most frequently in May (15 of 27 years). There appears to be a slight association between water year types and the month of May median delta smelt salvage date. The date of median salvage during critical, dry, and below normal water year types occurred at a rate of 77% in May, while the date of median salvage during normal, above normal, and wet water year types occurred at a lower rate of 36%. Date of median salvage during normal, above normal, and wet water year types typically occurred throughout January to June.

Table 2 Date when delta smelt annual (calendar year) median salvage occurred at the TFCF, 1982 – 2008

Year	Annual salvage	Annual median salvage	Date when annual median salvage occurred	Water year type
1982	19,636	9,818	3/5/1982	Wet
1983	5,728	2,864	6/16/1983	Wet
1984	29,094	14,547	5/29/1984	Wet
1985	14,576	7,288	6/13/1985	Dry
1986	2,755	1,378	8/6/1986	Wet
1987	34,097	17,049	4/24/1987	Dry
1988	7,700	3,850	5/21/1988	Critical
1989	8,044	4,022	5/3/1989	Dry
1990	11,700	5,850	5/4/1990	Critical
1991	1,859	930	5/15/1991	Critical
1992	644	322	3/9/1992	Critical
1993	3,804	1,902	6/5/1993	Above Normal
1994	21,164	10,582	5/17/1994	Critical
1995	180	90	1/24/1995	Wet
1996	13,780	6,890	5/14/1996	Wet
1997	20,492	10,246	5/15/1997	Wet
1998	728	364	3/24/1998	Wet
1999	47,180	23,590	6/1/1999	Wet
2000	28,776	14,388	5/25/2000	Above Normal
2001	11,694	5,847	5/13/2001	Dry
2002	18,420	9,210	5/19/2002	Dry
2003	16,662	8,331	5/21/2003	Above Normal
2004	6,769	3,385	5/8/2004	Below Normal
2005	818	409	1/28/2005	Above Normal
2006	312	156	3/7/2006	Wet
2007	348	174	5/24/2007	Dry
2008	1,009	505	5/22/2008	Critical

There does not appear to be any direct relationship between reductions in exports and delta smelt salvage in April through June (Figure 14). The 2005 to 2008 salvages were low while 2004 salvage had a high salvage, possibly due to a combination of a higher 2004 FMWT index (74) than 2005-2008 (23-41) and a below normal year type.

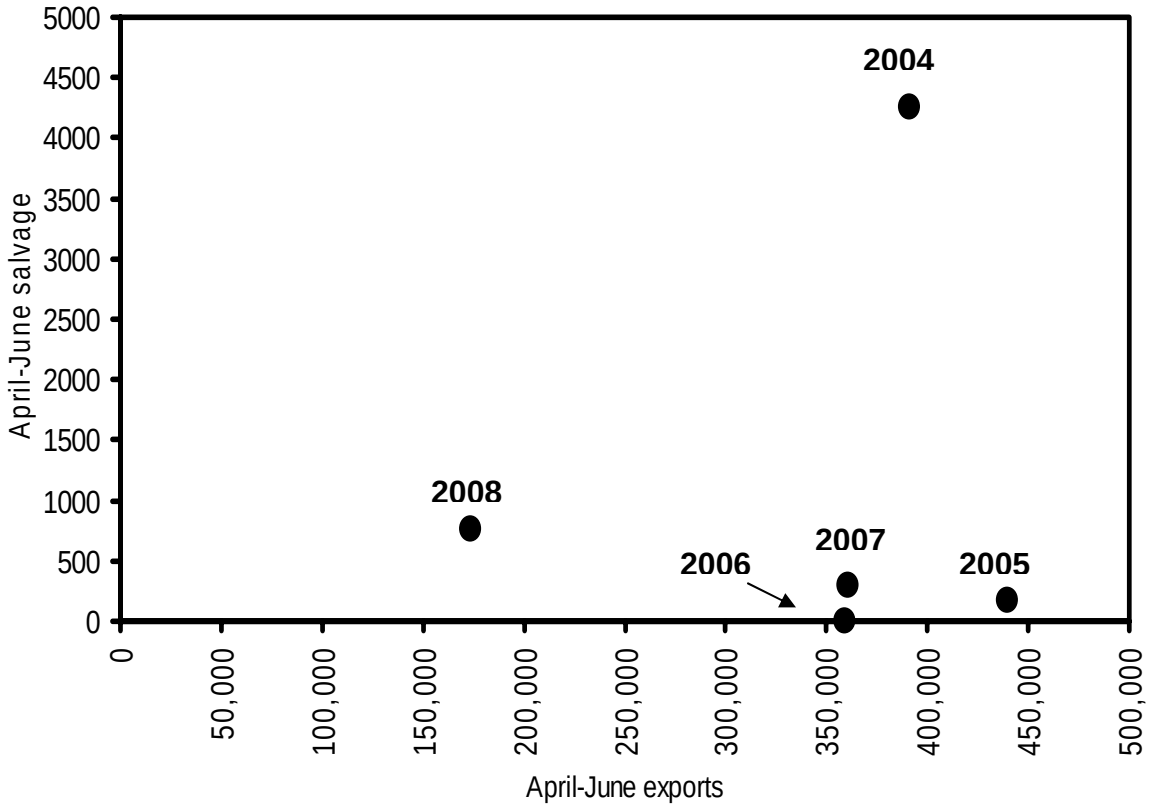

Figure 14 April through June exports and delta smelt salvage at the TFCF, 2004 – 2008

It is important to note that this result does not indicate that the April through June reduction in export did not affect delta smelt salvage since other factors such as water year type, outflow, entrapment zone position, and consequently delta smelt spatial distribution can affect salvage. The spring delta smelt salvages were most likely a function of delta smelt spatial distribution relative to water year type. The lowest April through June delta smelt salvage occurred in 2005 (170) and 2006 (0) which were above normal and wet water year types compared to 2004 (4248), 2007 (300), and 2008 (757) which were below normal, dry, and critical water year types, respectively. In 2005 and 2006, the 20 mm Survey indicated that the delta smelt distributions were located downstream in San Pablo Bay, Napa River, and Suisun Bay which were outside the influence of the pumps at the Central Valley Project. In 2004, 2007, and

2008, the 20 mm Survey indicated that the delta smelt distributions were located upstream in the vicinity of the confluence of the Sacramento and San Joaquin Rivers and the South Delta where they would be vulnerable to entrainment.

Larval and post-larval delta smelt were first detected at the TFCF on April 10 (Table 3). A total of 552 samples were collected. Ten daily detections occurred before the larval sampling commenced on June 15. Only 1 day of sampling detected delta smelt in 2 or more counts per 24 hour period. The longest period of consecutive daily detection was a 3 day period on May 2-4. Larval delta smelt were most frequently detected in May (5 detections).

Table 3 Daily larval fish sampling detections for delta smelt and longfin smelt collected from the TFCF in 2008. A “Y’ indicates that larval fish < 20 mm FL were found while an “N” indicates no detection. If larvae were detected in more than one count per day, number of counts per day with detections were recorded in parenthesis

DATE	Delta smelt larvae Y or N	Longfin smelt larvae Y or N
3/6/2008	N	Y
4/1/2008	N	Y
4/3/2008	N	Y
4/5/2008	N	Y
4/10/2008	Y	N
4/11/2008	N	Y
4/12/2008	N	Y
4/13/2008	N	Y
4/14/2008	N	Y (2)
4/15/2008	N	Y
4/16/2008	N	Y
4/17/2008	N	Y
4/19/2008	N	Y (2)
4/20/2008	N	Y
4/23/2008	Y	Y
4/24/2008	N	Y
4/28/2008	N	Y
4/30/2008	Y (2)	N
5/2/2008	Y	Y
5/3/2008	Y	N
5/4/2008	Y	N
5/25/2008	Y	N
5/29/2008	Y	N
6/1/2008	Y	N
6/4/2008	Y	N

Longfin Smelt

Longfin smelt continued to be salvaged at low levels in 2008. Low annual salvages have been observed since 1991, with the exception of 43,080 salvaged in 2002 (Figure 15). The annual salvage in 2008 was 357.

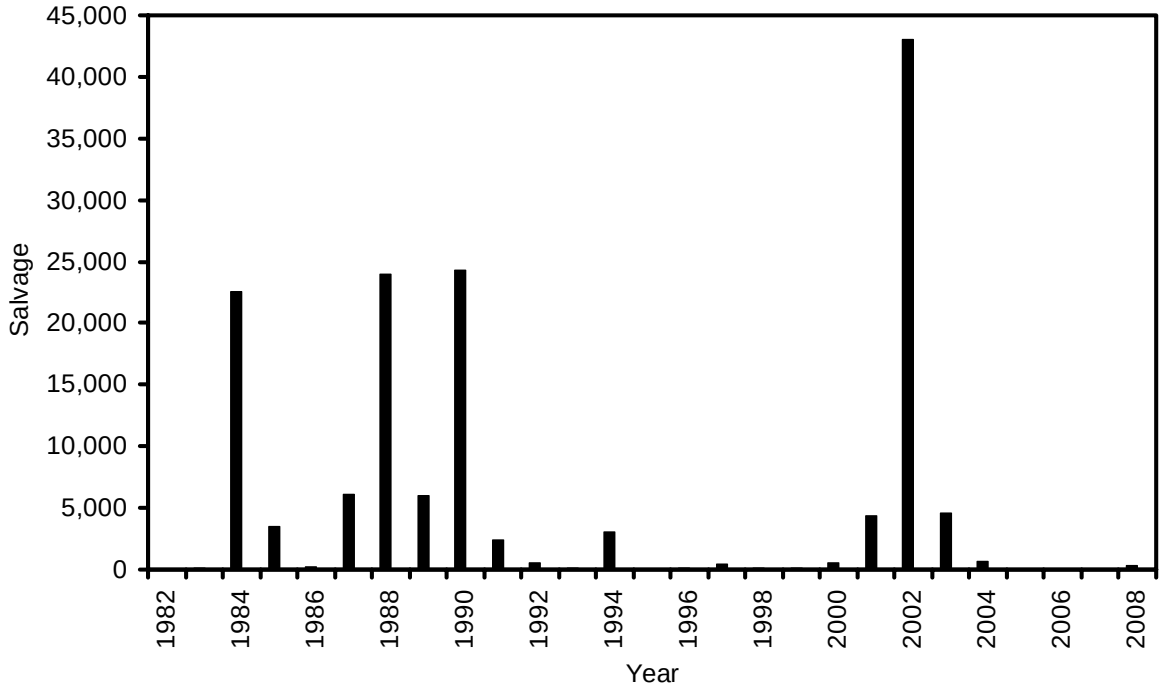

Figure 15 Annual salvage of longfin smelt at the TFCF, 1982 – 2008

Longfin smelt were salvaged in the winter and spring (Figure 16). Most of the longfin smelt were salvaged in April and May which accounted for 89% of the annual salvage.

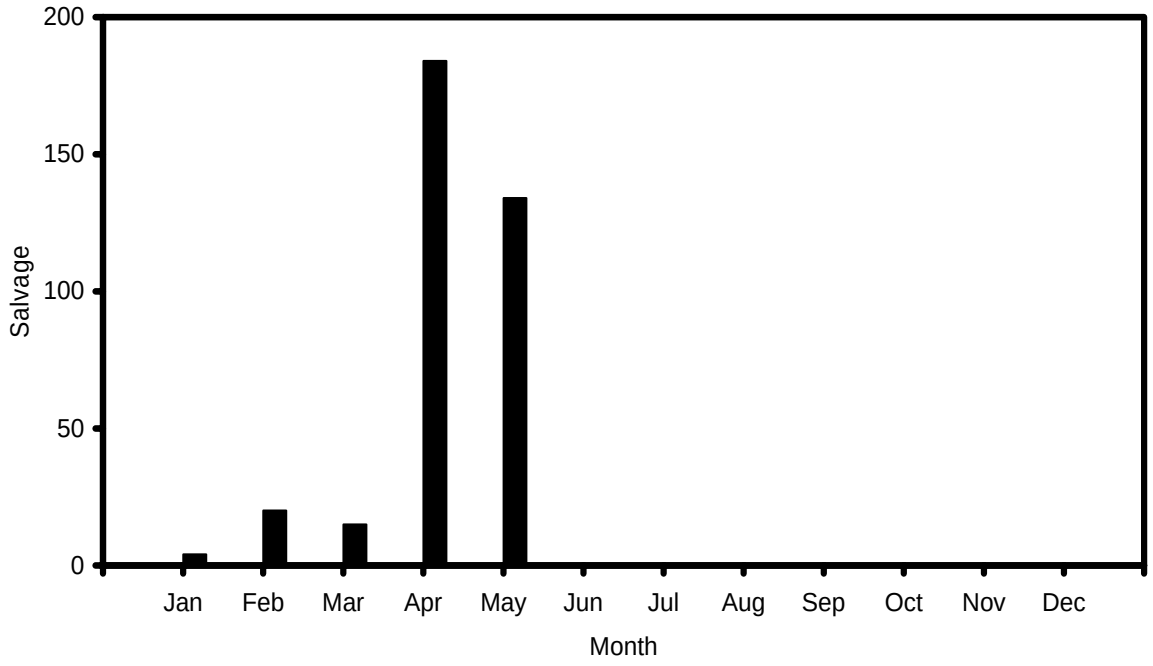

Figure 16 Monthly salvage of longfin smelt at the TFCF, 2008

Date of first occurrence of longfin smelt in salvage occurred predominantly between December 18 (Julian day 352) to February 4 (Julian day 35) during 1979 to 2008 (Figure 17). For water year 2008, longfin smelt were first observed on December 18, 2007 (Julian day 352). The date of first longfin smelt salvage occurred most frequently in December and January. There does not appear to be any obvious association between critical and dry water year types and date of first longfin smelt salvage. The date of first longfin smelt salvage during critical and dry water year types occurred at a rate of 54% during the period of December 18 to February 4.

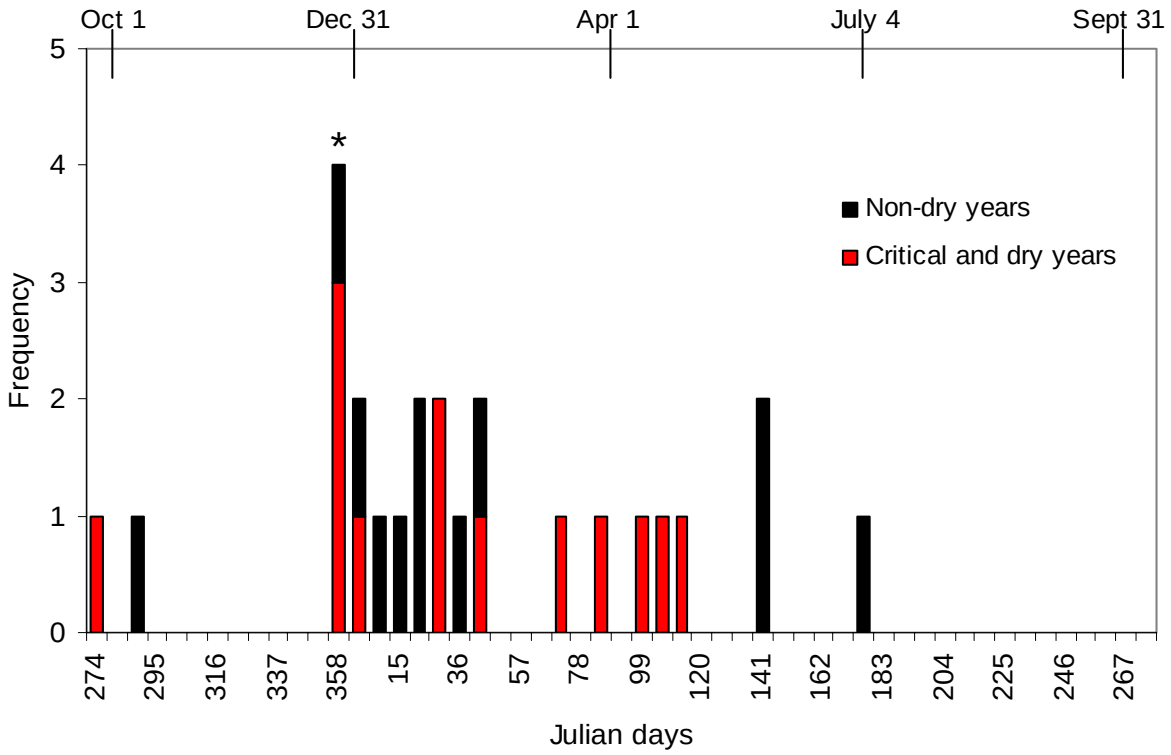

Figure 17 Julian date of first longfin smelt salvage at the TFCF, 1979 – 2008. An asterisk marks Julian date of first longfin smelt salvage in 2008

Dates when median salvage (50% of annual salvage in a calendar year) of longfin smelt occurred during the time period 1982 to 2008 varied between January 9, 1998 to July 29, 1986 (Table 4). The date of median salvage occurred most frequently in May (12 of 24 years). There does not appear to be any association between water year types and date of median salvage. The date of median salvage during critical, dry, and below normal water year types occurred at a rate of 46 % in May, while the date of median salvage during normal, above normal, and wet water year types occurred at a slightly higher rate of 55%.

Table 4 Date when longfin smelt annual (calendar year) median salvage occurred at the TFCF, 1982 – 2008

Year	Annual salvage	Annual median salvage	Date when annual median salvage occurred	Water year type
1982	0	0	NA	Wet
1983	57	29	6/23/1983	Wet
1984	22,535	11,268	5/30/1984	Wet
1985	3,512	1,756	5/14/1985	Dry
1986	168	84	7/29/1986	Wet
1987	6,094	3,047	5/6/1987	Dry
1988	24,005	12,003	5/5/1988	Critical
1989	6,036	3,018	4/15/1989	Dry
1990	24,308	12,154	6/10/1990	Critical
1991	2,405	1,203	4/22/1991	Critical
1992	528	264	5/16/1992	Critical
1993	132	66	5/19/1993	Above Normal
1994	3,015	1,508	5/8/1994	Critical
1995	0	0	NA	Wet
1996	156	78	5/11/1996	Wet
1997	444	222	5/5/1997	Wet
1998	60	30	1/9/1998	Wet
1999	132	66	5/5/1999	Wet
2000	528	264	4/20/2000	Above Normal
2001	4,404	2,202	4/28/2001	Dry
2002	43,080	21,540	4/26/2002	Dry
2003	4,562	2,281	5/4/2003	Above Normal
2004	648	324	5/1/2004	Below Normal
2005	36	18	1/25/2005	Above Normal
2006	0	0	NA	Wet
2007	48	24	2/4/2007	Dry
2008	357	179	4/27/2008	Critical

Larval and post-larval longfin smelt were first detected at the TFCF on March 6 (Table 3). A total of 552 samples were collected in 2008. Seventeen daily detections occurred before the larval sampling commenced on June 15. But, only 2 days of sampling detected longfin smelt in 2 or more counts per 24 hour period. The longest period of consecutive daily

detection was a 7 day period on April 11-17. Larval longfin smelt were most frequently detected in April (15 detections).

Sacramento Splittail

The annual salvage of Sacramento splittail was 1,439 in 2008 which was a small increase from 2007 (Figure 18). The salvage of 780 in 2007 was the lowest in recent record and a marked decrease from the record-high salvage of 5.0 million in 2006. Since 1982, Sacramento splittail have typically followed a boom or bust salvage scenario with salvage in some years in the millions to be followed by low salvage the following year.

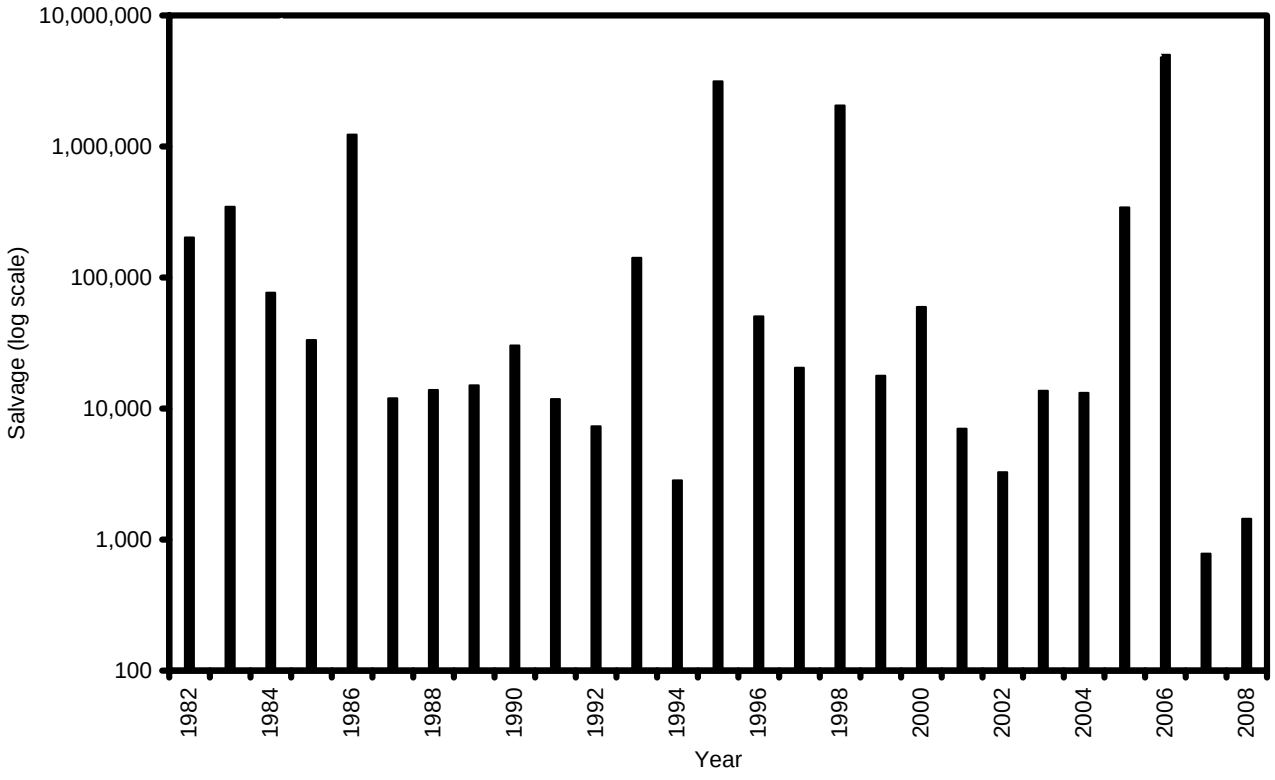

Figure 18 Annual salvage of Sacramento splittail at the TFCF, 1982 – 2008.

Threadfin Shad

Annual salvage of threadfin shad was markedly higher in 2008 than in 2007 and 2006 (Figure 19).

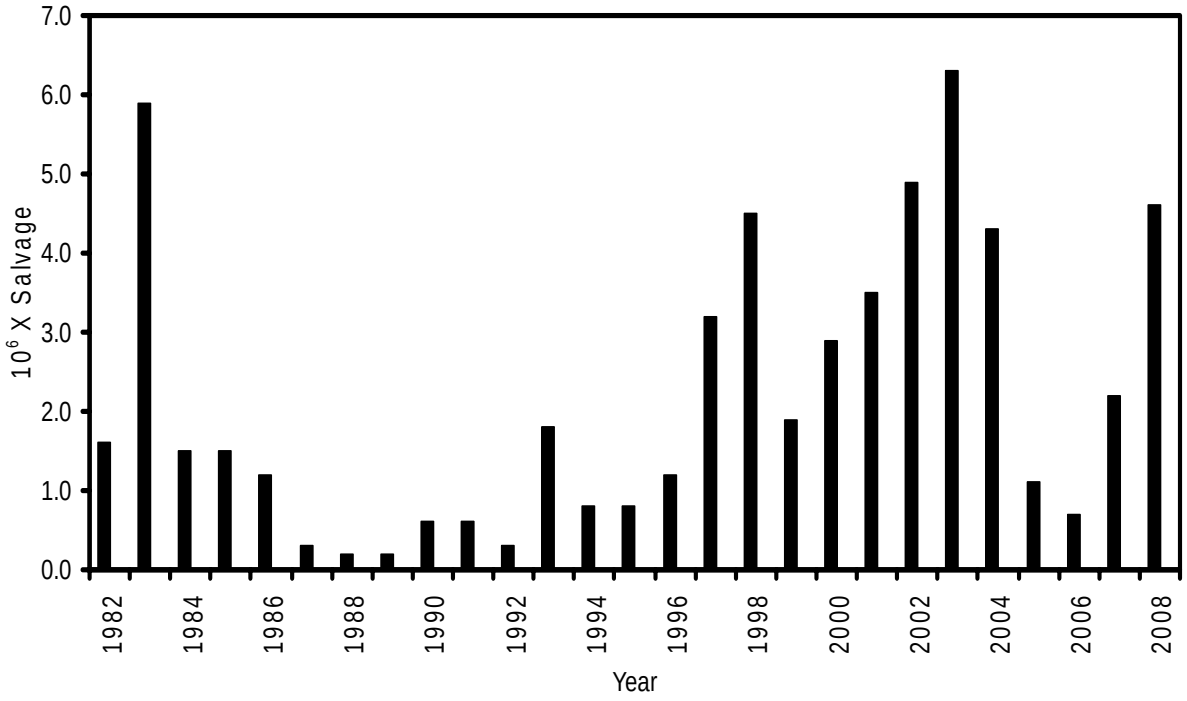

Figure 19 Annual salvage (in millions) of threadfin shad at the TFCF, 1982 – 2008

The salvage of 4,617,313 in 2008 was greater than the salvage of 2,242,577 in 2007 and 717,112 in 2006 which ended the salvage decline since 2005. Prior to 2005, the annual salvage during 2000 to 2004 (2.9 - 6.3 million) was the highest 5 year period of salvage on record.

Conclusion

The annual water export decreased in 2008 compared to years since 1995. The reduced exports occurred predominantly in April through June and was primarily aimed to reduce delta smelt salvage.

Salvage of Chinook salmon, striped bass, delta smelt, and longfin smelt has declined in recent years. The Fall Midwater Trawl indices indicated that striped bass, delta smelt, and longfin smelt have also drastically declined in recent years which may be reflected in the low salvage. The reduced spring export rate in 2008 may also have reduced salvage of delta smelt although a clear relationship would depend on other variables such as outflow and entrapment zone position not considered in this analysis. Both hatchery and wild fall run Chinook salmon escapement in the Sacramento River system has also decreased in recent years which may be a factor in low salvage.

Seasonally, delta smelt occurred in the salvage earlier than longfin smelt in most years. In contrast, delta smelt and longfin smelt median salvage both occurred most frequently during May.

FOOTNOTES

1. Pelagic Organism Decline (POD) species

Appendix A Annual salvage (salvage) and percentage of annual salvage (%) for fish collected from the TFCF in 2007 and 2008

	2008		2007	
Species	Salvage	%	Salvage	%
Threadfin shad	4,617,313	86.1	2,242,577	70.9
Striped bass	378,916	7.0	447,971	14.2
Inland silverside	86,295	1.6	24,157	0.8
Bluegill	67,387	1.3	84,035	2.6
American shad	45,795	0.9	65,574	2.1
White catfish	44,621	0.8	143,918	4.5
Yellowfin goby	25,375	0.5	22,276	0.7
Largemouth bass	22,710	0.4	45,159	1.4
Channel catfish	21,574	0.4	28,587	0.9
Golden shiner	14,754	0.3	3,564	0.1
Prickly sculpin	8,991	0.2	21,318	0.7
Chinook salmon	8,786	0.2	7,622	0.2
Black crappie	7,570	0.1	5,707	0.2
Shimofuri goby	4,056	0.1	626	< 0.1
Steelhead	1,887	< 0.1	4,068	0.1
Unknown lamprey	1,495	< 0.1	168	< 0.1
Sacramento splittail	1,439	< 0.1	780	< 0.1
Redear sunfish	1,326	< 0.1	1,492	< 0.1
Rainwater killifish	1,084	< 0.1	1,300	< 0.1
Delta smelt	1,009	< 0.1	348	< 0.1
Fathead minnow	485	< 0.1	1,164	< 0.1
Bigscale logperch	418	< 0.1	702	< 0.1
Longfin smelt	357	< 0.1	48	< 0.1
Pacific staghorn sculpin	328	< 0.1	12	< 0.1
Warmouth	317	< 0.1	420	< 0.1
Sacramento sucker	148	< 0.1	8,345	0.3
Western mosquitofish	112	< 0.1	554	< 0.1
Common carp	88	< 0.1	746	< 0.1
Brown bullhead	84	< 0.1	358	< 0.1
Threespine stickleback	51	< 0.1	28	< 0.1
Wakasagi	44	< 0.1	144	< 0.1
Starry flounder	36	< 0.1	220	< 0.1
Black bullhead	36	< 0.1	205	< 0.1
Spotted bass	34	< 0.1	0	0.0
Tule perch	24	< 0.1	48	< 0.1
Shokihaze Goby	20	< 0.1	0	0.0
Goldfish	18	< 0.1	24	< 0.1
Green sunfish	16	< 0.1	0	0.0
Blue catfish	16	< 0.1	1	< 0.1
Sacramento squawfish	12	< 0.1	0	0.0
Green sturgeon	8	< 0.1	12	< 0.1
Hitch	4	< 0.1	0	0.0
Smallmouth bass	4	< 0.1	0	0.0
Riffle sculpin	4	< 0.1	0	0.0
White crappie	4	< 0.1	0	0.0

Appendix A (Cont) Annual salvage (salvage) and percentage of annual salvage (%) for fish collected from the TFCF in 2007 and 2008

	2008		2007	
Species	Salvage	%	Salvage	%
Pumpkinseed	4	< 0.1	0	0.0
Red shiner	4	< 0.1	72	< 0.1
Sacramento blackfish	0	0.0	60	< 0.1
Sacramento pikeminnow	0	0.0	36	< 0.1
White sturgeon	0	0.0	72	< 0.1