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Fish Salvage at State Water Project's and Central Valley Project's Fish Facilities during 2010

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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 2010 salvage information from the TFCF and the SDFPF, and discusses data from 1981 to 2010 for its relevance to salvage trends in recent years. 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*), 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. Chinese mitten crab (*Eriocheir sinensis*) were also salvaged. Bypass flows into the fish-collection buildings were subsampled once every 1 to 2 hours for 1 to 45 minutes at the SDFPF and once every 2 hours for 10 to 120 minutes at the TFCF. Fish 20 mm (fork length: FL) or larger were identified and numerated. 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 sub-sample duration of 10 minutes over a 120-minute salvage period equals an expansion factor of 12. 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 under-

1. Pelagic Organism Decline (POD) species

gone extensive field validation. Loss is the estimated number of fish entrained by the facility minus the number of fish that survive salvage operations (California Dept. of Fish and Game 2006). Salmon salvage and loss were summarized by origin (i.e., hatchery or wild) and race (fall, late-fall, winter, spring). Race of Chinook salmon is determined solely by criteria based on length and salvage date.

Larval fish (< 20 mm FL) were also collected and examined to determine the presence of sub-20mm delta smelt. Larval sampling at TFCF ran from February 24 through May 23, while it ran from February 20 through June 30, at SDFPF. Larval samples were collected once for every 6 hours of water export. 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 TFCF were identified to species by TFCF personnel and larval fish from SDFPF were identified to species by California Dept. of Fish and Game personnel.

Water Exports

The SWP exported 3.80 billion m^3 of water in 2010 which was an increase from exports in 2008 (1.45 billion m^3) and 2009 (2.20 billion m^3). Annual SWP exports ranged from 2.96 to 4.97 billion m^3 during the years 2003 through 2007 (Figure 1). The CVP exported 2.86 billion m^3 of water in 2010. CVP exports in 2010 increased from exports in 2009 (2.35 billion m^3) and 2008 (2.24 billion m^3), but were slightly reduced compared to exports in recent years from 2002 to 2007.

The export patterns of the two water projects differed seasonally. Exports reached a maximum in July which was maintained through December at the CVP and in August and December at the SWP (Figure 2). From July-December, 1.85 billion m^3 was exported by the CVP, which represented about 65% of annual export. At SWP, 506 million m^3 was exported in August and 519 million m^3 in December, which represented about 27% of annual export. SWP monthly exports ranged from 50.3 to 519 million m^3. CVP monthly exports ranged from 59.6 to 314 million m^3.

Total Salvage and Prevalent Species

Annual salvage (all species combined including Chinese mitten crab) at the TFCF in 2010 was 1,387,644 (Figure 3). TFCF salvage was an increase from the record-low in 2009 (859,669). Annual salvage at the SDFPF was 2,038,745. SDFPF salvage was an increase from 2009 (837,150) and 2008 (648,797).

Threadfin shad were the most-salvaged species at both facilities (Figure 4 and Table 1). Splittail and American shad were the 2nd and 3rd most-salvaged fish at TFCF. American shad and striped bass were the 2nd and 3rd most-salvaged fish at SDFPF. Relatively few Chinook salmon, steelhead, delta smelt, and longfin smelt were salvaged at the SDFPF (< 0.3% of total annual salvage) and the TFCF (< 0.9% of total annual salvage).

Chinook Salmon

SDFPF salvage (2,624) continued a declining trend which started in 2001 (Figure 5). Salvage of Chinook salmon was similar to 2009 levels (2,463) but was lower than 2008 levels (4,928). Mean 2001-2010 SDFPF salvage was about 9-fold lower than salvage in the 1980's and the late 1990's. Salvage of Chinook salmon at the TFCF (8,119) was higher than in 2009 (4,666) and similar to 2008 (8,786). Mean 2001-2010 TFCF salvage was about 7-fold lower than salvage in the 1980's and the late 1990's.

Salvaged Chinook salmon at TFCF were primarily wild spring-run fish and wild fall-run fish (Table 2). Salvaged Chinook salmon at SDFPF were primarily wild spring-run fish and hatchery winter-run fish. Hatchery winter-run fish comprised 54% of the salvage of hatchery Chinook salmon at the SDFPF. 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 (11,473) than at the TFCF (6,369; Table 2). Greater entrainment loss at the SDFPF than at the TFCF was attributed to greater pre-screen loss.

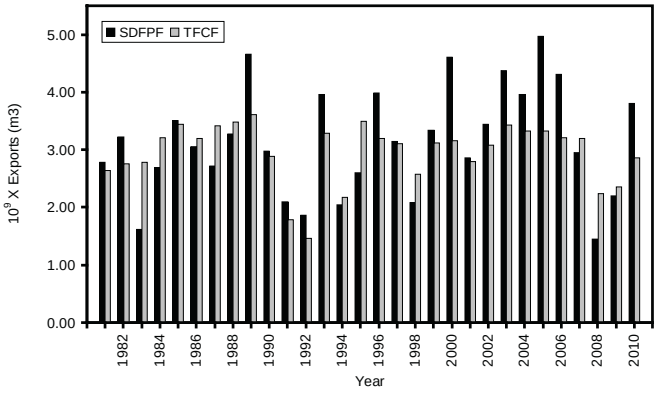

Figure 1 Annual water exports in billions of cubic meters for the SWP and the CVP, 1981 to 2010

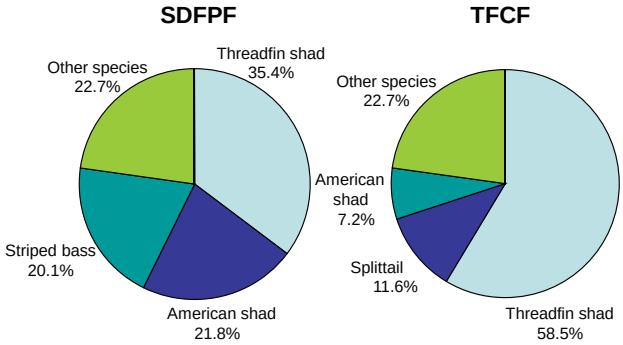

Figure 4 Percentages of annual salvage for the 3 most prevalent species and other species combined including Chinese mitten crab at the TFCF and the SDFPF, 2010

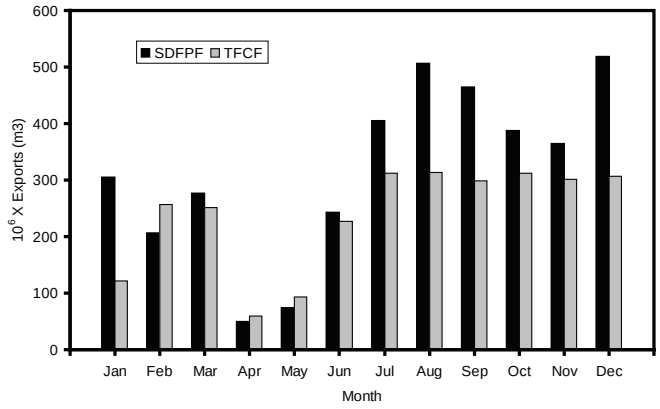

Figure 2 Monthly water exports in millions of cubic meters for the SWP and the CVP, 2010

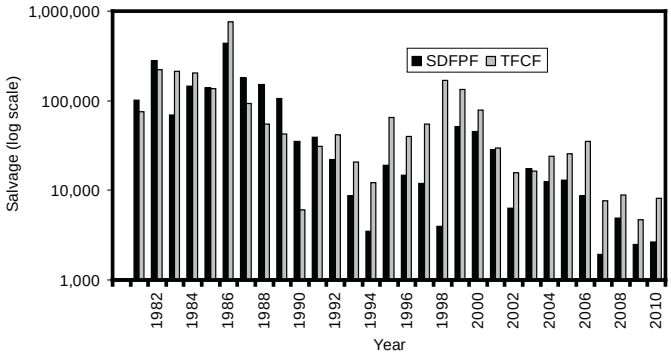

Figure 5 Annual salvage of Chinook salmon (all races and wild and hatchery origins combined) at the SDFPF and the TFCF, 1981 to 2010

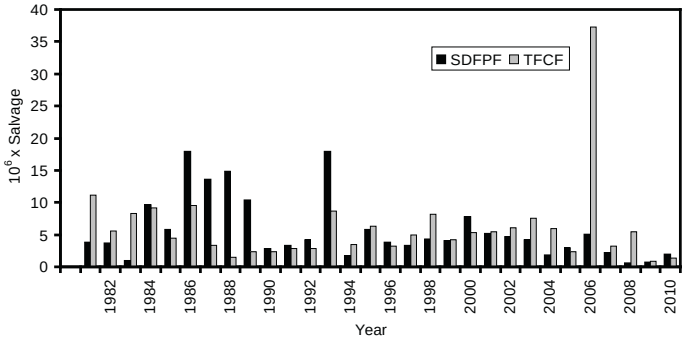

Figure 3 Annual salvage of all taxa combined including Chinese mitten crab at the TFCF and the SDFPF, 1981 to 2010

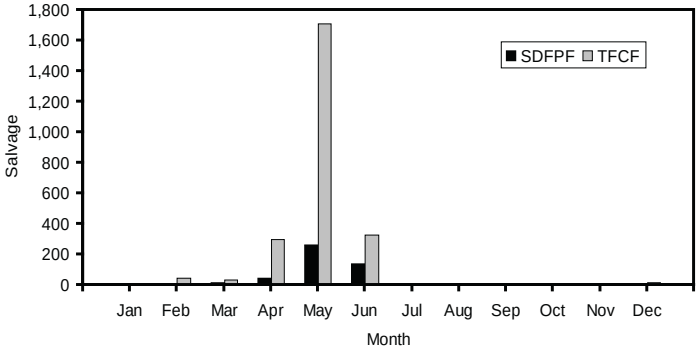

Figure 6 Monthly salvage of wild, fall-run Chinook salmon at the SDFPF and the TFCF, 2010

Table 1 Annual salvage (salvage) and percentage of annual salvage (%) by species including Chinese mitten crab (common name) collected from the SDFPF and TFCF in 2010

TFCF			*SDFPF*		
Species	**Salvage**	**%**	**Species**	**Salvage**	**%**
Threadfin shad	811,164	58.5	Threadfin shad	720,945	35.4
Splittail	161,050	11.6	American shad	445,278	21.8
American shad	99,847	7.2	Striped bass	409,248	20.1
Striped bass	90,328	6.5	Bluegill	336,543	16.5
White catfish	*62,071*	*4.5*	*Inland silverside*	*28,332*	*1.4*
Bluegill	58,410	4.2	Splittail	28,278	1.4
Yellowfin goby	26,404	1.9	White catfish	15,219	0.7
Channel catfish	24,190	1.7	Yellowfin goby	12,488	0.6
Largemouth bass	14,956	1.1	Prickly sculpin	11,234	0.6
Inland silverside	11,753	0.8	Largemouth bass	9,004	0.4
Chinook salmon	8,119	0.6	Channel catfish	5,578	0.3
Shimofuri goby	5,726	0.4	Common carp	3,616	0.2
Prickly sculpin	3,241	0.2	Bigscale logperch	3,146	0.2
Steelhead	3,088	0.2	Chinook salmon	2,624	0.1
Golden shiner	1,556	0.1	Shimofuri goby	2,283	0.1
Unknown lamprey	1,545	0.1	Steelhead	1,545	<0.1
Rainwater killifish	1,125	0.1	Rainwater killifish	774	<0.1
Redear sunfish	882	0.1	Black crappie	769	<0.1
Black crappie	801	0.1	Western mosquitofish	734	<0.1
Western mosquitofish	304	<0.1	Red shiner	297	<0.1
Warmouth	186	<0.1	Lamprey unknown	276	<0.1
Threespine stickleback	171	<0.1	Golden shiner	203	<0.1
Brown bullhead	150	<0.1	Starry flounder	56	<0.1
Delta smelt	95	<0.1	Goldfish	50	<0.1
Common carp	95	<0.1	Riffle sculpin	38	<0.1
Bigscale logperch	87	<0.1	Warmouth	33	<0.1
Tule perch	52	<0.1	Blue catfish	28	<0.1
Black bullhead	41	<0.1	Pacific staghorn sculpin	24	<0.1
Longfin smelt	31	<0.1	Hitch	22	<0.1
Western brook lamprey	28	<0.1	Delta smelt	22	<0.1
Pacific staghorn sculpin	24	<0.1	Redear sunfish	10	<0.1
Sacramento sucker	20	<0.1	Threespine stickleback	9	<0.1
White crappie	20	<0.1	Pumpkinseed	8	<0.1
Starry flounder	16	<0.1	Smallmouth bass	6	<0.1
Red shiner	12	<0.1	Tule perch	5	<0.1
Fathead minnow	8	<0.1	Brown bullhead	4	<0.1
Wakasagi	8	<0.1	Longfin smelt	4	<0.1
Blue catfish	8	<0.1	White sturgeon	4	<0.1
Hitch	5	<0.1	Black bullhead	4	<0.1
Shokihaze goby	4	<0.1	Unknown species	4	<0.1
Green sunfish	4	<0.1	Spotted bass	1	<0.1
Sacramento pikeminnow	4	<0.1			
Goldfish	4	<0.1			
Smallmouth bass	4	<0.1			
Sacramento blackfish	4	<0.1			
Chinese mitten crab	3	<0.1			

Table 2 Chinook salmon annual salvage, percentage of annual salvage, race and origin (wild or hatchery), and loss at the SDFPF and the TFCF, 2010

Facility	Origin	Race	Salvage	Percentage	Loss
SDFPF					
	Wild				
		Fall	454	30	*2,057*
		Late-fall	32	2	*135*
		Spring	733	49	*3,234*
		Winter	279	19	*1,218*
	Total Wild		1,498		*6,644*
	Unknown Race		4		*16-17**
	Hatchery				
		Fall	82	7	*351*
		Late-fall	427	38	*1,831*
		Spring	12	1	*51*
		Winter	601	54	*2596*
	Total Hatchery		1,122		*4,829*
	Grand Total		2,624		*11,473*
TFCF					
	Wild	Fall	2,417	35	*1,855*
		Late-fall	172	3	*115*
		Spring	3,335	48	*2,848*
		Winter	969	14	*679*
	Total Wild		6,893		*5,497*
	Hatchery				
		Fall	56	5	*40*
		Late-fall	239	20	*167*
		Spring	30	2	*23*
		Winter	889	73	*634*
	Total Hatchery		1,214		*864*
	Unknown Race		12		*8*
	Grand Total		8,119		*6,369*

** loss range is listed since actual loss could not be calculated due to a missing length (not included in grand total of loss)*

Steelhead

Salvage of steelhead (wild and hatchery origins combined) continued the pattern of mostly low salvage observed since 2005 (Figure 7). Salvage at the SDFPF (1,545) was higher than in 2009 (658). Similarly, TFCF salvage (3,088) was higher than in 2009 (712).

The TFCF salvaged 2,460 hatchery steelhead and 628 wild steelhead. The SDFPF salvaged 1,126 hatchery steelhead and 419 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-June and in October and December (2) at the SDFPF and January-June at the TFCF. Wild steelhead at both facilities were salvaged most frequently February-March.

Striped Bass

Salvage at the TFCF (90,328) was a near record-low. Salvage at the TFCF and SDFPF (409,248) 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 occurred in June and July, whereas most striped bass salvage at the TFCF was observed in March and June (Figure 10). At the SDFPF, June salvage (175,033) and July salvage (122,493) accounted for 73% of annual salvage. At the TFCF, salvage during March (20,639) and June (20,669) accounted for 46% of annual salvage. Striped bass were salvaged every month at both facilities, with the lowest monthly salvage occurring in May at both the SDFPF (71) and the TFCF (253).

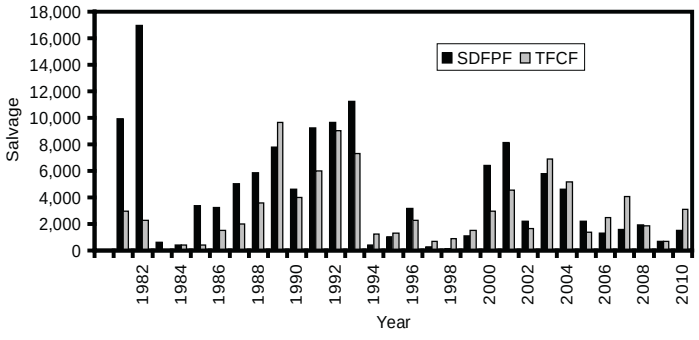

Figure 7 Annual salvage of steelhead (wild and hatchery origins combined) at the SDFPF and the TFCF, 1981 to 2010

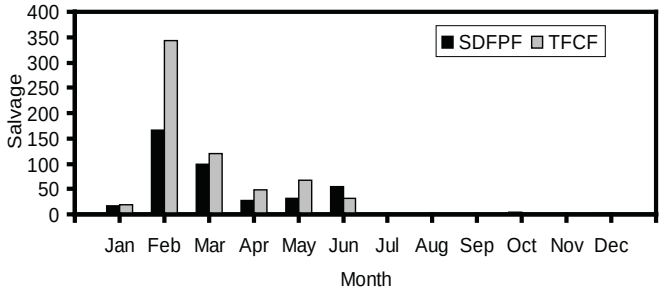

Figure 8 Monthly salvage of wild steelhead at the SDFPF and the TFCF, 2010

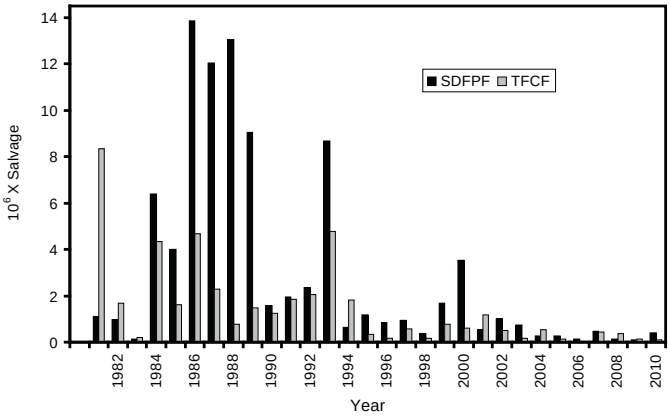

Figure 9 Annual salvage of striped bass at the SDFPF and the TFCF, 1981 to 2010

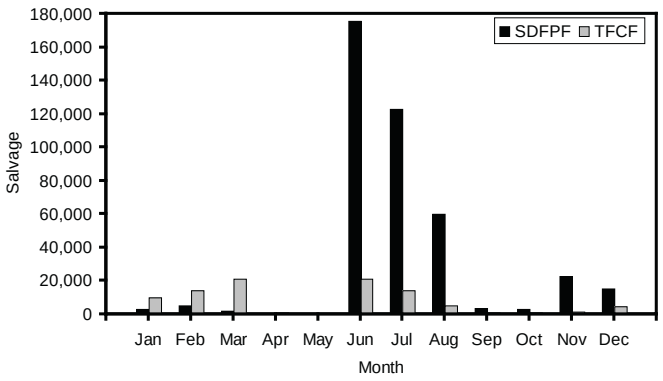

Figure 10 Monthly salvage of striped bass at the SDFPF and the TFCF, 2010

Delta Smelt

Record-low numbers of delta smelt were salvaged at both facilities (Figure 11). Salvage at the SDFPF (22) was lower than in 2009 (479). Salvage at the TFCF (95) was also lower than in 2009 (286).

Most delta smelt were salvaged in a few months during the first half of the year (Figure 12). Adult delta smelt were only salvaged in March (16) at the SDFPF, which accounted for 73% of the total annual salvage. Juvenile delta smelt were only salvaged in June (6) at the SDFPF. Adult delta smelt were most-frequently salvaged in February (44) at the TFCF, which accounted for 46% of the total annual salvage. Juvenile delta smelt were only salvaged in May (23) at the TFCF.

Only 1 delta smelt less than 20 mm was detected at the TFCF. Delta smelt less than 20 mm were first detected on June 3 at the SDFPF and were observed 9 days there.

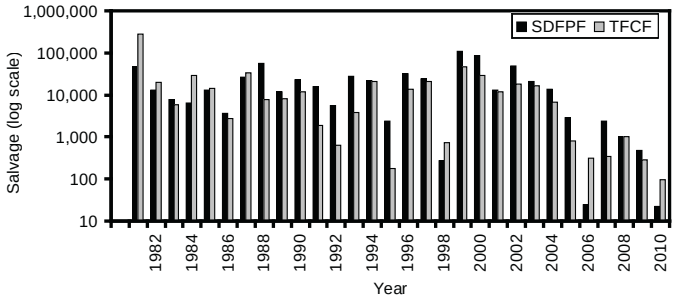

Figure 11 Annual salvage of delta smelt at the SDFPF and the TFCF, 1981 to 2010

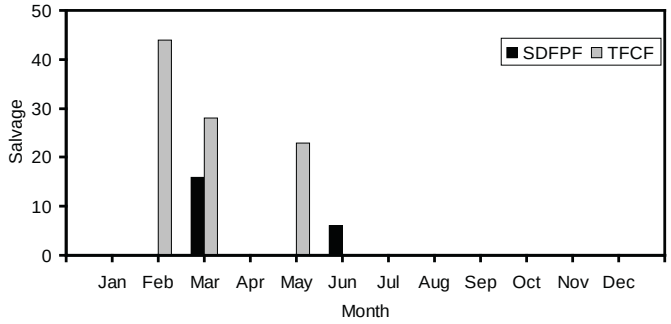

Figure 12 Monthly salvage of delta smelt at the SDFPF and the TFCF, 2010

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). Salvage at the SDFPF (4) was lower than at the TFCF (31).

No adult longfin smelt were salvaged at either facility. Juvenile longfin smelt were only salvaged in May (4) at the SDFPF. Juvenile longfin smelt were salvaged in April (3) and May at the TFCF. The salvage of juvenile longfin smelt peaked in May (28) at the TFCF, which accounted for 90% of salvage. Only 1 longfin smelt less than 20 mm was detected at the TFCF. No longfin smelt less than 20 mm were detected at the SDFPF.

Splittail

Salvage of splittail at both facilities was higher than in 2009 (Figure 14). Salvage at the SDFPF (28,279) was higher than in 2009 (1,418). Salvage at the TFCF (161,050) was substantially higher than in 2009 (1,405). Splittail salvage has followed a boom-or-bust pattern, often varying year to year by several orders of magnitude.

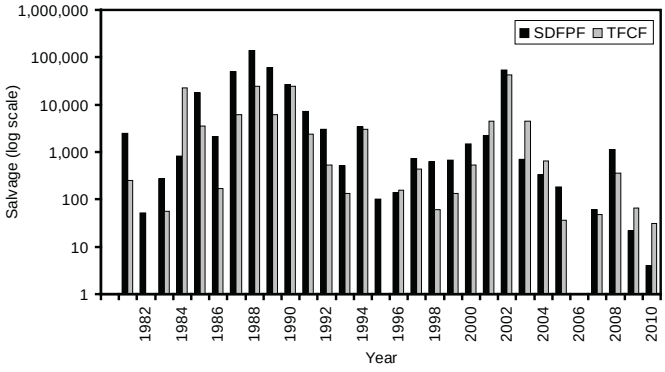

Figure 13 Annual salvage of longfin smelt at the SDFPF and the TFCF, 1981 to 2010

Threadfin Shad

Annual salvage at the SDFPF (720,945) was lower than at the TFCF (811,164) (Figure 15). Salvage at the SDFPF was higher than in 2009 (387,940). Similarly, TFCF salvage was higher than in 2009 (401,911). Similar to splittail, annual salvage of threadfin shad has varied greatly through time.

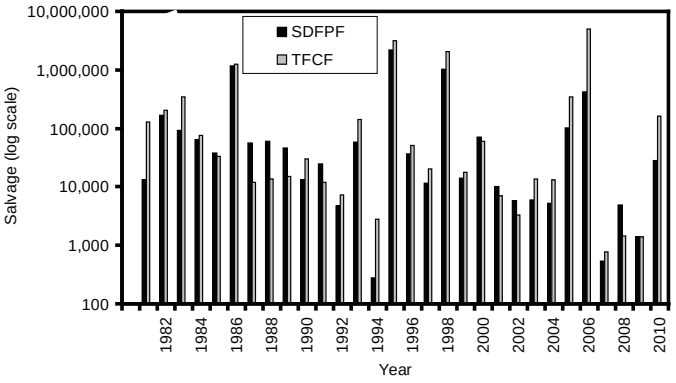

Figure 14 Annual salvage of splittail at the SDFPF and the TFCF, 1981 to 2010

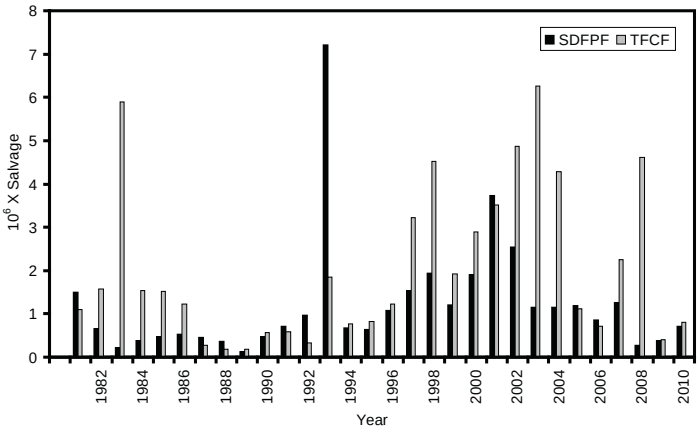

Figure 15 Annual salvage of threadfin shad at the SDFPF and the TFCF, 1981 to 2010

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Status and Trends of San Francisco Estuary White Sturgeon

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Introduction

The California Department of Fish and Game's (CDFG) sturgeon population study (study) develops data and collects information to assess the suitability of fishing regulations, to determine progress towards management objectives, and to contribute to the understanding of how sturgeon populations respond to changes in environmental conditions.

The study uses mark-recapture methods to develop information on the absolute abundance, harvest rate, and survival rate of white sturgeon (*Acipenser transmontanus*) and — to a much lesser extent due to scarcity of individuals — of green sturgeon (*A. medirostris*). The metrics require a minimum of 1-3 years to develop and broad confidence intervals around most of the estimates are attributable in large part to relatively small sampling effort. We do not know the degree to which these estimates violate pertinent assumptions for mark-recapture studies (Ricker 1975), but the metrics have critical management utility.

The study also uses the reported catch and catch per unit effort (CPUE) of sturgeon by the Commercial Passenger Fishing Vessel (CPFV) fleet, an index of age-0 white sturgeon year class strength from the San Francisco Bay Study, length data from Sturgeon Fishing Report Cards and during tagging, and CPUE during tagging. Taking just 1-2 years to develop and speaking to a large fraction of the sturgeon age distribution, these are important and complementary metrics.

With green sturgeon listed under the federal Endangered Species Act and San Francisco Estuary white sturgeon the object of an important sport fishery while