

2001 – 2004 Steelhead Monitoring and Incidental Take Report for the Central Valley Project and State Water Project Operations Criteria and Plan (CVP/SWP OCAP) Biological Opinions

The October 2004 CVP/SWP OCAP biological opinion and earlier interim opinions include terms and conditions requiring this report. Term and condition number 1 in the 2004 OCAP BO under the heading Joint Central Valley Project and State Water Project Terms and Conditions states:

Reclamation and DWR shall provide an annual written report to NOAA Fisheries no later than October 1 of each year. This report shall provide the data gathered and summarize the results of Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon and Central Valley steelhead monitoring and incidental take associated with the operation of the Delta pumping plants (including the Rock Slough Pumping Plant). All juvenile mortality must be minimized and reported, including those from special studies conducted during salvage operations. This report should be sent to NOAA Fisheries (Southwest Region, Protected Resources Division, Sacramento Area Office, 650 Capitol Mall, Suite 8-300, Sacramento, California 95814-4706).

The Department of Water Resources completed the reporting requirements for winter-run and spring-run Chinook. Contra Costa Water District provides reports to NOAA on results of their monitoring of incidental take associated with the Rock Slough Pumping Plant. Reclamation previously provided the data summary portions of the steelhead report in August 2004 in an Excel spreadsheet. This report serves to meet the steelhead written report requirement for the water years 2001 through 2004.

Salvage Data

Salvage of steelhead is calculated by the California Department of Fish and Game based on sub-sampling of fish salvaged at the CVP and SWP fish facilities. For a minimum period of 10 minutes within each 2 hour interval throughout the day and night (minimum of 120 minutes per day) all salmon and steelhead are measured (fork length to the nearest millimeter), examined for the presence or absence of the adipose fin and enumerated. The result is a sample averaging 1/12 of the fish salvaged. The subsample data is expanded to account for the entire period over which salvage occurs.

DFG provided the salvage data used for this report to Reclamation in the fall of 2003 (2001 - 2003 salvage data) and in the summer of 2004 (2004 salvage data) for use in the OCAP consultation. The data included sample date, sample time (2001 – 2003 data only), fork length, adipose clip status, length frequency, expansion factor, salvage, study code, facility, and building code. When NOAA requested steelhead loss estimates for the OCAP consultation, we applied a factor based on Chinook salmon loss calculations. The loss factors used, as specified by DFG, are $LOSS = SALVAGE \times 0.579$ for the CVP facility and $LOSS = SALVAGE \times 4.34$ for the SWP facility. These factors are designed to take into account pre-screen losses due primarily to predation, louver efficiency, and trucking losses derived from studies of Chinook salmon.

Other Monitoring Data

We obtained the other steelhead monitoring data from the Bay Delta and Tributaries Web Site on June 3, 2005 (<http://baydelta.ca.gov/>). Projects providing data to this database include the Red Bluff FWS office, Feather River Salmon Emigration Study, Region 2 Juvenile Salmon Monitoring (Butte and Big Chico Creeks), Fall Midwater Trawl, Fish Facility monitoring, Glenn-Colusa Irrigation District Studies, Suisun Marsh Fisheries Monitoring, Yolo Bypass Study, Stanislaus River Emigration Study, Stockton Office Juvenile Salmon Monitoring, and Tuolumne and Merced River Monitoring. The rotary screw trap catches from Deer Creek, Mill Creek and Knights Landing are not provided to this database so they are not included in this report.

Steelhead Incidental Take

The biological opinions use salvage of unclipped steelhead to gauge the amount of incidental take for steelhead. Salvage of unclipped steelhead was 4,603 in 2001, 1,632 in 2002, 2,189 in 2003, and 1,785 in 2004 (Figure 1 and Table 1). No mortalities of salvaged steelhead were reported.

The mean length of unclipped steelhead salvaged over the four year period was 258 mm (SE = 1.5, SD = 59) and ranged from 38 mm to 645 mm. Steelhead were largest in 2002 (mean length = 273 mm) and smallest in 2004 (mean length = 238 mm). Unclipped steelhead size was significantly different between years (ANOVA: $F = 16.2$, $p < 0.01$) Table 2 shows which year pairs had significantly different mean lengths. Figure 2 shows the timing of unclipped and clipped steelhead observed at the facilities throughout the period and Figure 3 shows each year separately. Figure 4 shows the SWP and CVP salvage separately and Figure 5 and Figure 6 show each year at the CVP and each year at the SWP respectively. Figure 7 shows sizes of all steelhead at each facility and Figure 8 is a length frequency distribution comparing unclipped and clipped steelhead. Unclipped steelhead were significantly larger than clipped steelhead ($t = 9.7$, $P < 0.001$).

Table 3 shows steelhead loss calculated using the salmon loss calculation assumptions at the CVP, SWP, and overall. Table 4 shows the number of steelhead observed in the sampling at each facility and Table 5 shows the percentage breakdown in measured steelhead, salvaged steelhead, and steelhead loss between the facilities. Table 6 shows the salvage at each facility and overall broken down by month and year and Table 7 shows the same information for loss. Note that these do not match the yearly totals exactly due to some fish of the same length on the same day being counted once vs twice in the database. Figure 9 and Figure 10 show the timing of salvage throughout the day for the 2001 through 2003 data for unclipped and clipped steelhead. The SWP facility samples primarily on odd hours (eg 1:00, 3:00, etc) and the CVP samples on even numbered hours (eg 12:00, 2:00, etc).

Figure 10 and Figure 12 show captures of unclipped steelhead by date and length in the various monitoring programs from 2001 through 2004. Figure 13 and Figure 14 show captures of clipped steelhead. Many of the steelhead did not have the adipose clip status reported in the data. These fish are probably unclipped fish for those steelhead under 200 mm and may be a mix of clipped and unclipped steelhead for those larger than 200 mm

(Figure 15 and Figure 16). The Stanislaus River steelhead in the unknown clip status charts are all unclipped. No hatchery steelhead are released in the Stanislaus.

Table 8 and 9 show Central Valley hatchery steelhead release data and hatchery returns. Release data is available in Regional Mark Information System (RMIS) database (<http://www.rmis.org/>) for some years for some hatcheries but for steelhead, as for Chinook, much of the release data has not been provided to the database. The hatchery production goal is used for the years and hatcheries when the release data was not in RMIS or was not obtained directly from the hatchery. Total hatchery (clipped) fish in the delta was assumed to include 65% of the total number of Coleman released fish, 75% of Feather River released fish, 80% of Nimbus released fish, and 90% of Mokelumne released fish based on distance from release locations to the delta. No tests of steelhead survival to the delta have been done. The number of hatchery steelhead salvaged each year since 1998 has always been less than 1% of the number of steelhead released even when using the above assumptions for survival to the delta. Without the survival assumptions, the salvage and loss percentage is lower.

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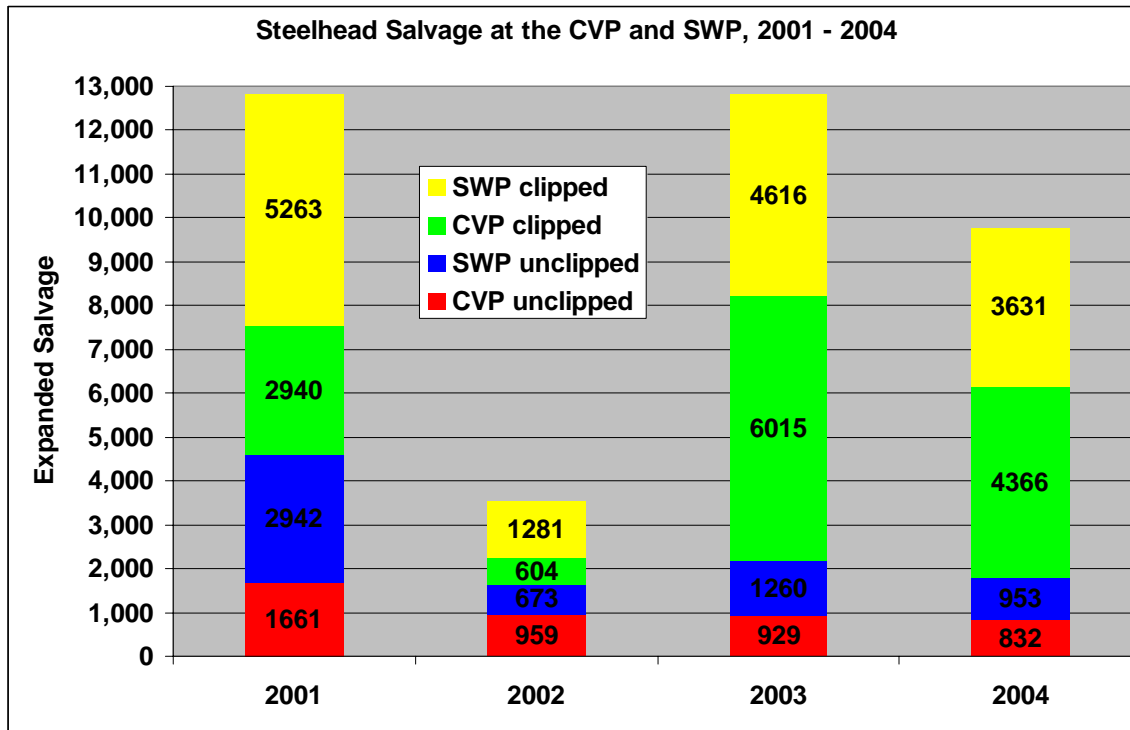


Figure 1. Steelhead salvage at the CVP and SWP facilities, 2001 - 2004.

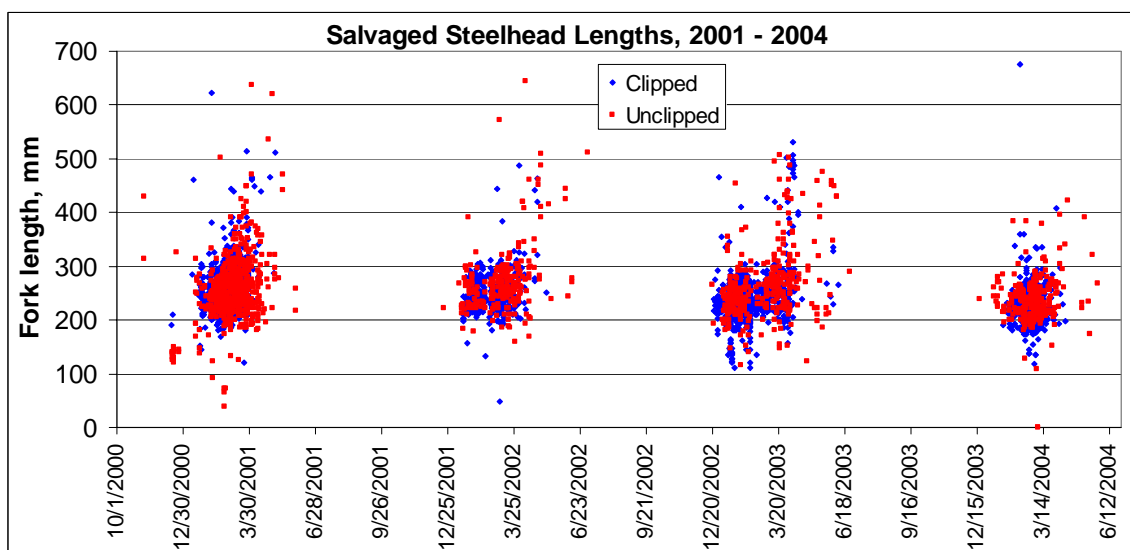


Figure 2. Steelhead salvage timing, 2001 – 2004.

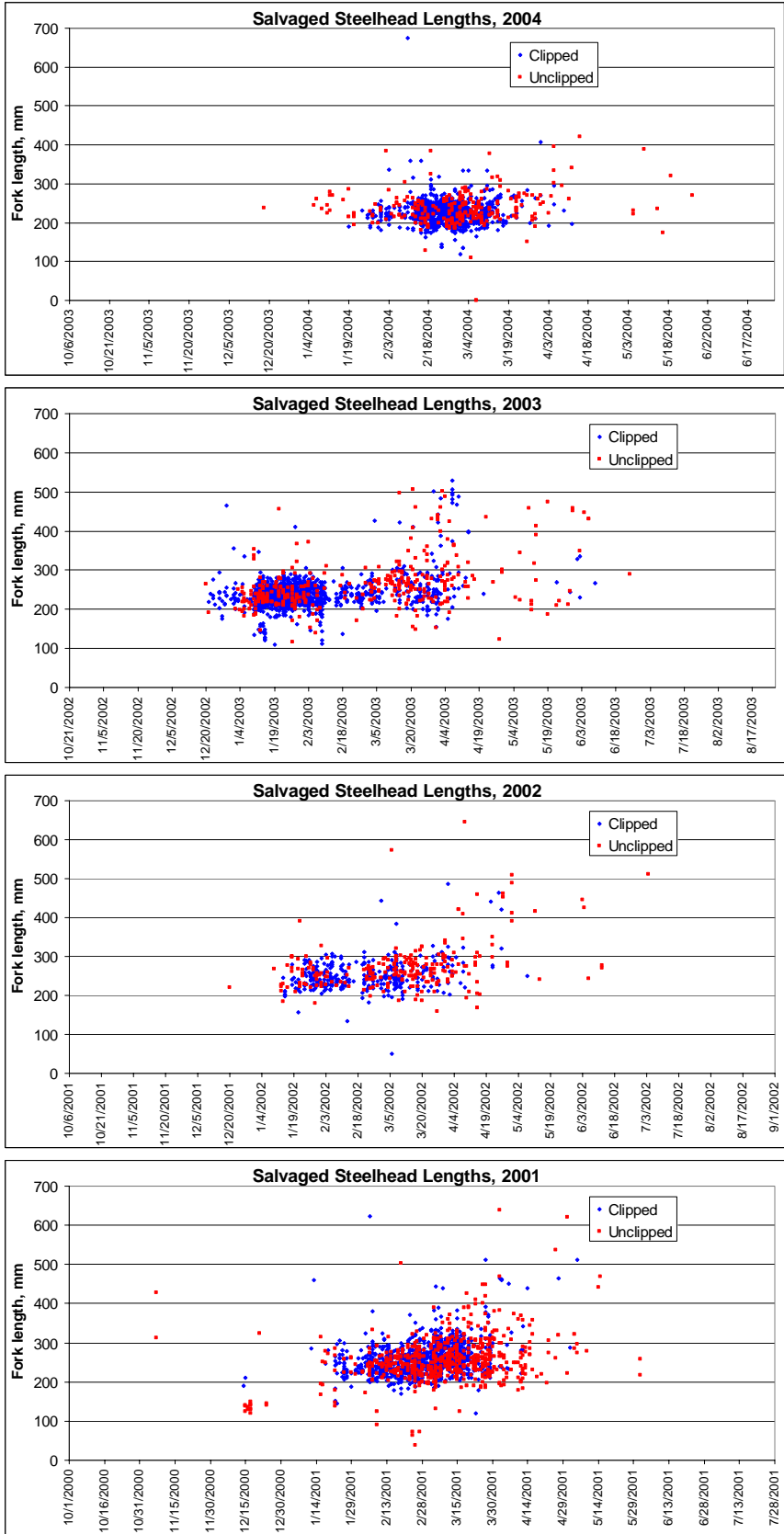


Figure 3. Steelhead salvage timing each year, 2001 - 2004.

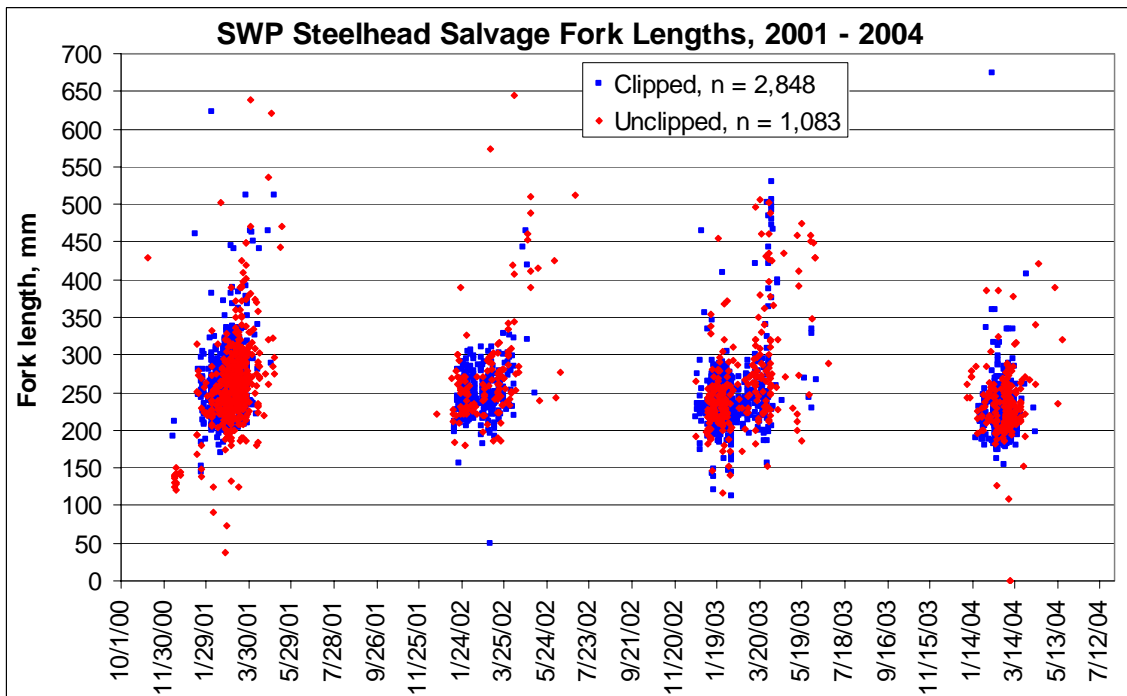
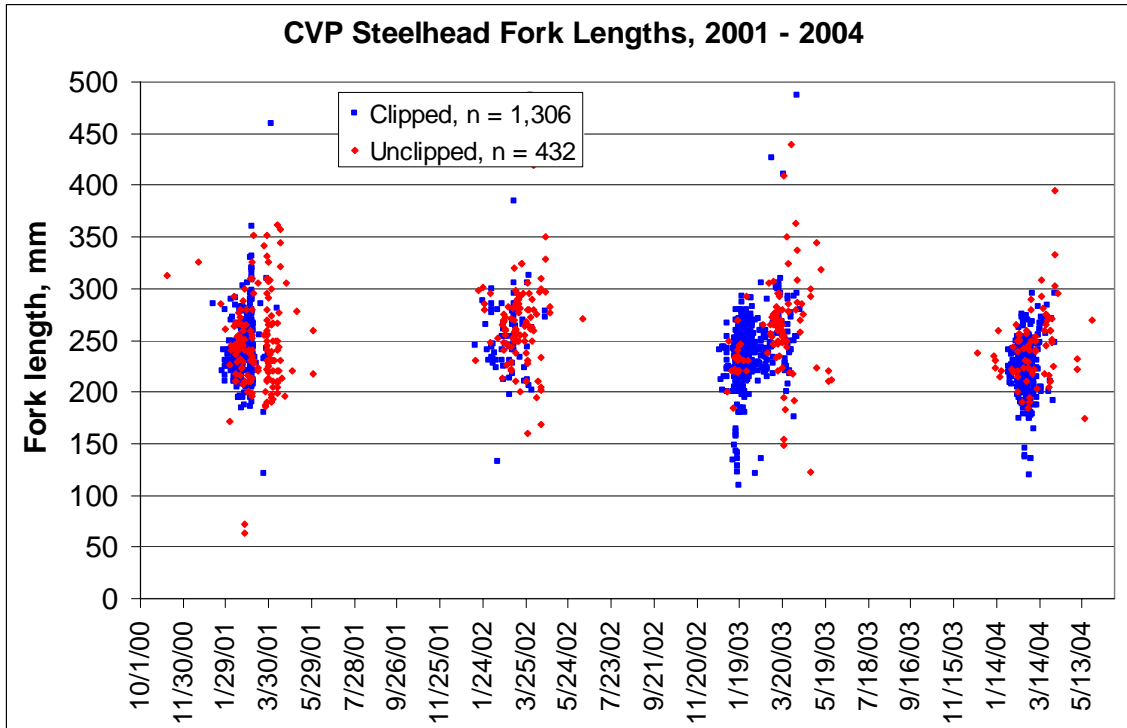


Figure 4. Steelhead salvage at each facility 2001 - 2004.

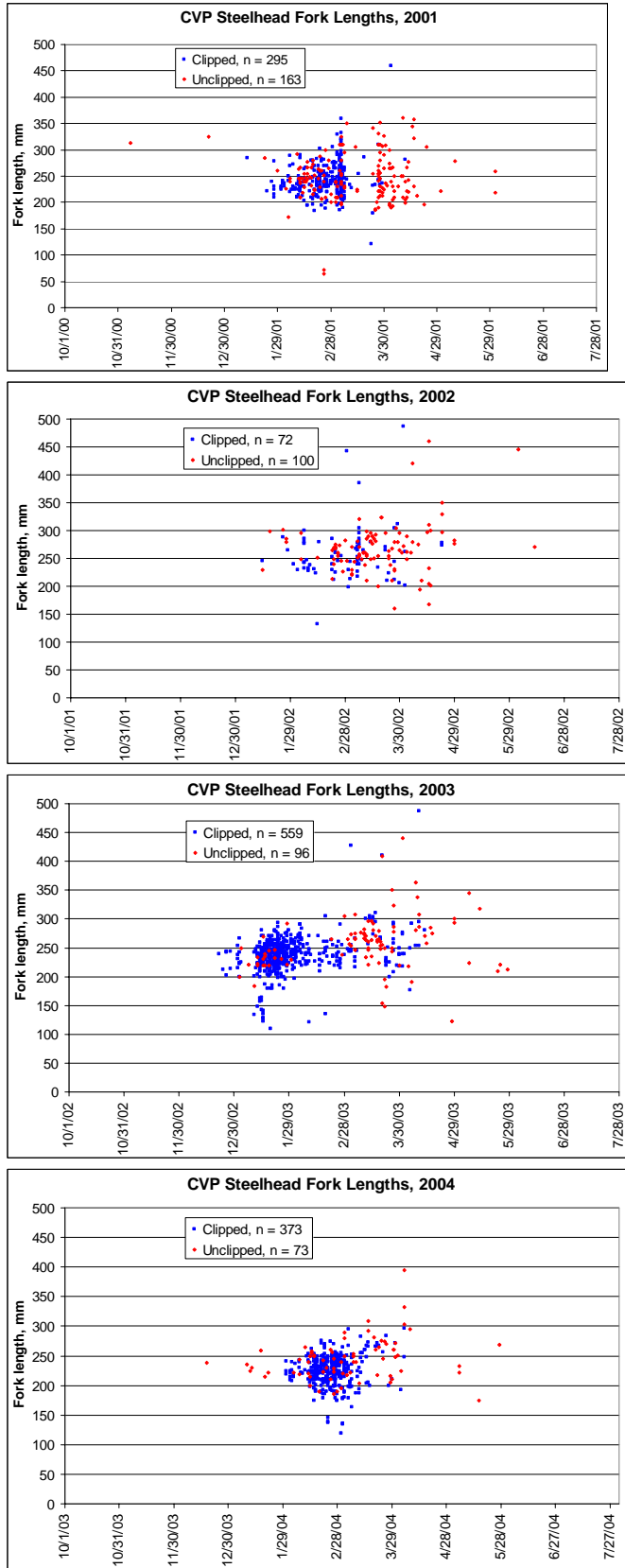


Figure 5. Steelhead salvage timing at the CVP for each year, 2001 - 2004.

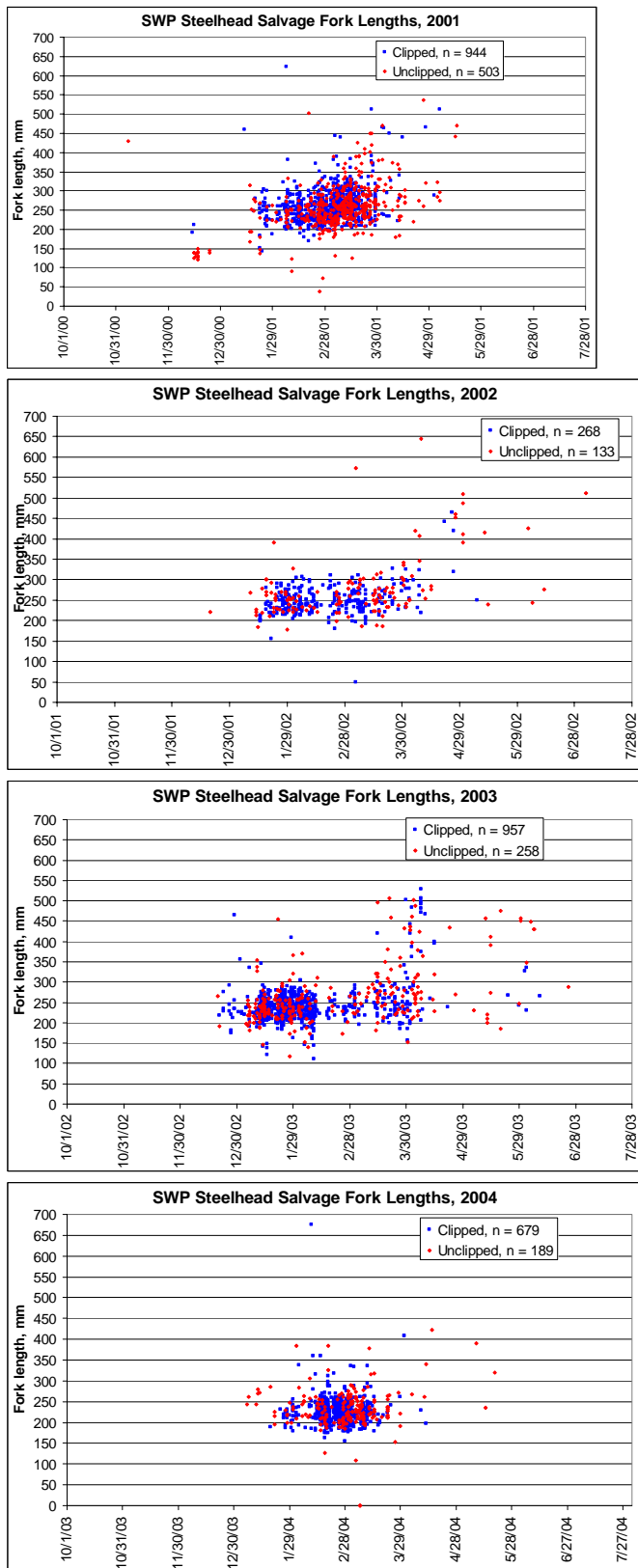


Figure 6. Steelhead salvage for each year at the SWP, 2001 - 2004.

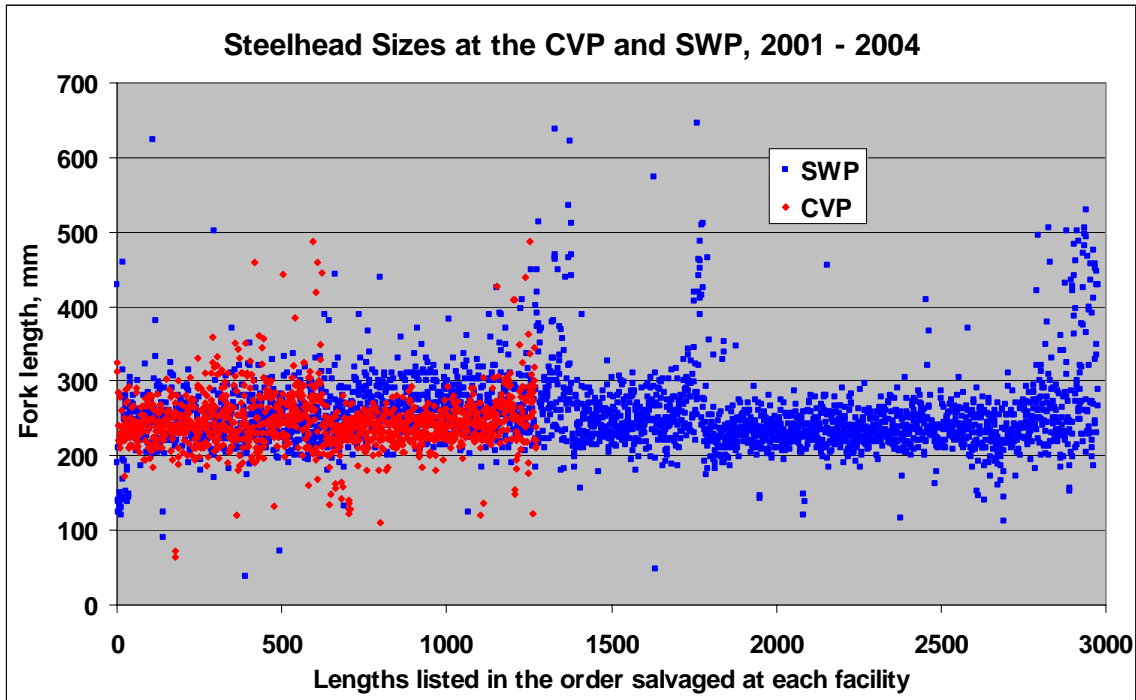


Figure 7. Lengths of steelhead shown consecutively as encountered at the facilities.

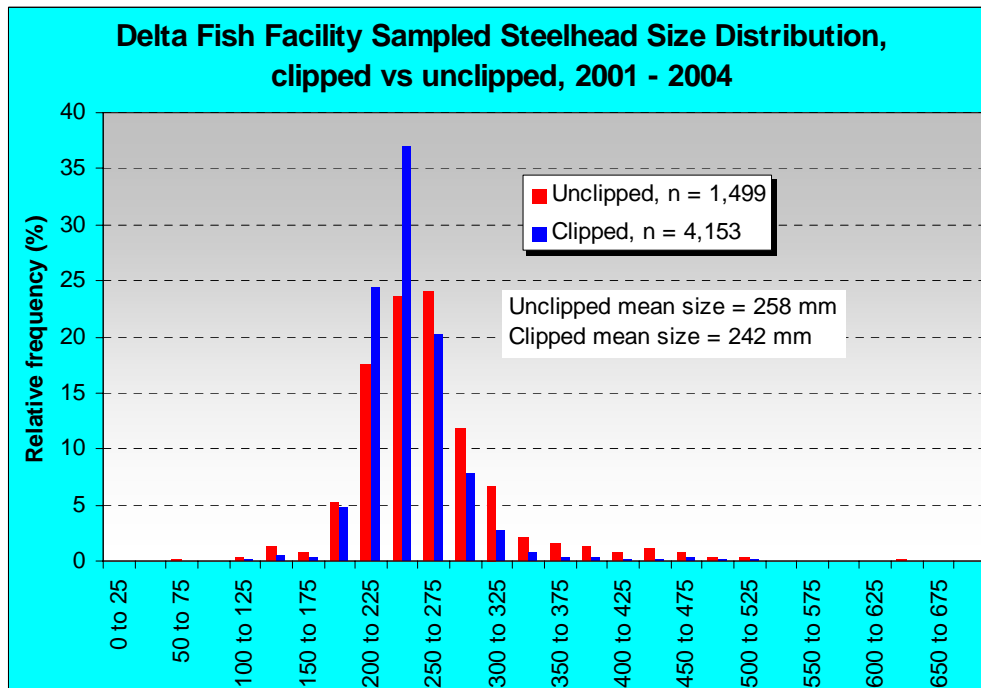


Figure 8. Steelhead length frequency, 2001 - 2004. Unclipped fish were significantly larger than clipped fish ($t=9.7$, $P<0.001$)

Table 1. Steelhead salvage at the CVP and SWP, 2001 – 2004.

CVP				
	Salvaged Fish Calculated			
	Clipped	Unclipped	Total	% unclipped
2001	2,940	1,661	4,601	36%
2002	604	959	1,563	61%
2003	6,015	929	6,944	13%
2004	4,366	832	5,198	16%
SWP				
	Salvaged Fish Calculated			
	Clipped	Unclipped	Total	% unclipped
2001	5,263	2,942	8,205	36%
2002	1,281	673	1,954	34%
2003	4,616	1,260	5,876	21%
2004	3,631	953	4,584	21%
Total CVP + SWP				
	Salvaged Fish Calculated			
	Clipped	Unclipped	Total	% unclipped
2001	8,203	4,603	12,806	36%
2002	1,885	1,632	3,517	46%
2003	10,631	2,189	12,820	17%
2004	7,997	1,785	9,782	18%

Table 2. t-tests comparing unclipped steelhead sizes between year pairs, 2001 - 2004.

Multiple comparisons

Method: LSD

Significance (p): 0.008

Least Significant Difference

Critical differences in mean between group pairs (upper right)
and calculation of significances (lower left):

	(Mean)	2004	2001	2003	2002
2004	238.2	----	11.3	12.6	14.0
2001	256.9	yes	----	10.2	11.8
2003	262.6	yes	no	----	13.0
2002	273.5	yes	yes	no	----

Subsets that are significantly different from each other

Subset 1: 2001

Subset 2: 2003
2002

Subset 3: 2004

Table 3. Steelhead loss at the CVP and SWP, 2001 - 2004.

CVP				
	Loss Calculated			
	Clipped	Unclipped	Total	% unclipped
2001	1,702	962	2,664	36%
2002	350	555	905	61%
2003	3,483	538	4,021	13%
2004	2,528	482	3,010	16%
SWP				
	Loss Calculated			
	Clipped	Unclipped	Total	% unclipped
2001	22,841	12,768	35,610	36%
2002	5,560	2,921	8,480	34%
2003	20,033	5,468	25,502	21%
2004	15,759	4,136	19,895	21%
Total CVP + SWP				
	Loss Calculated			
	Clipped	Unclipped	Total	% unclipped
2001	24,544	13,730	38,274	36%
2002	5,909	3,476	9,385	37%
2003	23,516	6,006	29,522	20%
2004	18,286	4,618	22,904	20%

Table 4. Steelhead observed at the CVP and SWP, 2001 - 2004.

CVP				
Measured fish				
	Clipped	Unclipped	Total	% unclipped
2001	297	163	460	35%
2002	72	100	172	58%
2003	564	96	660	15%
2004	373	73	446	16%
SWP				
Measured fish				
	Clipped	Unclipped	Total	% unclipped
2001	944	503	1,447	35%
2002	268	133	401	33%
2003	957	258	1,215	21%
2004	679	189	868	22%
Total CVP + SWP				
Measured fish				
	Clipped	Unclipped	Total	% unclipped
2001	1,241	666	1,907	35%
2002	340	233	573	41%
2003	1,521	354	1,875	19%
2004	1,052	262	1,314	20%

Table 5. Percent of steelhead observed, salvaged, and lost that occurred at the CVP, 2001 - 2004.

Percent of SWP + CVP total that came from the CVP												
% CVP	Measured fish, % from CVP			Salvaged Fish Calculated, % from CVP				Loss Calculated, % at CVP				
	Clipped	Unclipped	Total	Clipped	Unclipped	Total	% unclipped	Clipped	Unclipped	Total		
2001	24%	24%	24%	36%	36%	36%		7%	7%	7%		
2002	21%	43%	30%	32%	59%	44%		6%	16%	10%		
2003	37%	27%	35%	57%	42%	54%		15%	9%	14%		
2004	35%	28%	34%	55%	47%	53%		14%	10%	13%		

Table 6. Monthly steelhead salvage at the CVP and SWP, 2001 - 2004.

Clipped Salvage at CVP

Sum of SALVAGE		Month						Grand Total
Year		1	2	3	4	12		
2001		132	1,764	1,020	24		2,940	
2002		36	198	355	15	84	688	
2003		4,315	1,152	356	108		5,931	
2004		36	3,312	982	36		4,366	
Grand Total		4,519	6,426	2,713	183	84	13,925	

Unclipped Salvage at CVP

Sum of SALVAGE		Month										Grand Total
Year		1	2	3	4	5	6	11	12			
2001		24	648	497	444	12	12	12	12		1,661	
2002		60	204	483	188		24				959	
2003		240	36	461	132	60					929	
2004		72	300	339	61	48			12		832	
Grand Total		396	1,188	1,780	825	120	36	12	24		4,381	

Clipped Salvage at SWP

Sum of SALVAGE		Month								Grand Total
Year		1	2	3	4	5	6	12 (blank)		
2001		240	2,218	2,709	72	12		12		5,263
2002		412	421	374	68	6				1,281
2003		3,076	906	359	104	12	9	150		4,616
2004		153	2,410	1,064	4					3,631
(blank)										
Grand Total		3,881	5,955	4,506	248	30	9	162		14,791

Unclipped Salvage at SWP

Sum of SALVAGE		Month										Grand Total
Year		1	2	3	4	5	6	7	11	12		
2001		147	711	1740	186	45			48	65	2942	
2002		196	116	233	80	16	18	12		2	673	
2003		577	206	232	152	50	28			27	1272	
2004		108	362	429	24	18					941	
Grand Total		1028	1395	2634	442	129	46	12	48	94	5828	

Total Clipped Steelhead Salvage

Sum of SALVAGE		Month								Grand Total
Year (water)		1	2	3	4	5	6	12		
2001		372	3,982	3,729	96	12		12	8,203	
2002		448	619	729	83	6		84	1,969	
2003		7,391	2,058	715	212	12	9	150	10,547	
2004		189	5,722	2,046	40				7,997	
Grand Total		8,247	9,971	6,155	427	30	9	246	28,716	

Total Unclipped Steelhead Salvage

Sum of SALVAGE		Month										Grand Total
Year (water)		1	2	3	4	5	6	7	11	12		
2001		171	1,359	2,237	630	57	12		60	77	4,603	
2002		256	320	716	268	16	42	12		2	1,632	
2003		817	242	693	284	110	28			27	2,201	
2004		180	662	768	85	66				12	1,773	
Grand Total		1,244	1,921	3,646	1,182	183	82	12	60	118	10,209	

Table 7. Monthly steelhead loss at the CVP and SWP, 2001 - 2004.

Clipped Loss at CVP

Sum of Loss = salvage X 0.579		Month						Grand Total
Year		1	2	3	4	12		
2001		76	1,021	591	14		1,702	
2002		21	115	206	9	49	398	
2003		2,498	667	206	63		3,434	
2004		21	1,918	569	21		2,528	
Grand Total		2,617	3,721	1,571	106	49	8,063	

Unclipped Loss at CVP

Sum of Loss = salvage X 0.579		Month								Grand Total
Year		1	2	3	4	5	6	11	12	
2001		14	375	288	257	7	7	7	7	962
2002		35	118	280	109		14			555
2003		139	21	267	76	35				538
2004		42	174	196	35	28			7	482
Grand Total		229	688	1,031	478	69	21	7	14	2,537

Clipped Loss at SWP

Sum of Loss = salvage X 4.34		Month							Grand Total
Year		1	2	3	4	5	6	12 (blank)	
2001		1,042	9,626	11,757	312	52		52	22,841
2002		1,788	1,827	1,623	295	26			5,560
2003		13,350	3,932	1,558	451	52	39	651	20,033
2004		664	10,459	4,618	17				15,759
(blank)									
Grand Total		16,844	25,845	19,556	1,076	130	39	703	64,193

Unclipped Loss at SWP

Sum of Loss = salvage X 4.34		Month										Grand Total
Year		1	2	3	4	5	6	7	11	12		
2001		638	3,086	7,552	807	195			208	282	12,768	
2002		851	503	1,011	347	69	78	52		9	2,921	
2003		2,504	894	1,007	660	217	122			117	5,520	
2004		469	1,571	1,862	104	78					4,084	
Grand Total		4,462	6,054	11,432	1,918	560	200	52	208	408	25,294	

Total Clipped Steelhead Loss

Sum of Loss		Month								Grand Total
Year (water)		1	2	3	4	5	6	12		
2001		1,118	10,647	12,348	326	52		52	24,544	
2002		1,809	1,942	1,829	304	26		49	5,958	
2003		15,848	4,599	1,764	514	52	39	651	23,467	
2004		685	12,377	5,187	38				18,287	
Grand Total		19,460	29,565	21,128	1,182	130	39	752	72,256	

Total Unclipped Steelhead Loss

Sum of Loss		Month										Grand Total
Year (water)		1	2	3	4	5	6	7	11	12		
2001		652	3,461	7,839	1,064	202	7		215	289	13,730	
2002		885	622	1,291	456	69	92	52		9	3,476	
2003		2,643	915	1,274	736	252	122			117	6,058	
2004		510	1,745	2,058	139	106				7	4,565	
Grand Total		4,690	6,742	12,462	2,395	629	220	52	215	422	27,829	

Unclipped Steelhead Salvage by Time of Day, 2001 - 2003

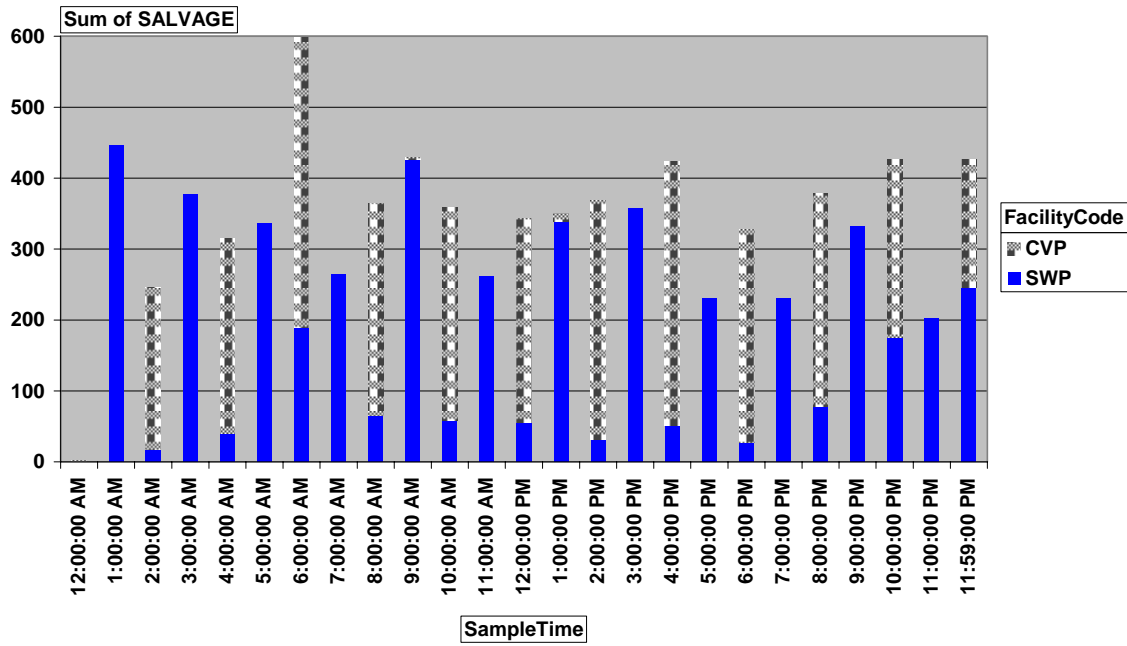


Figure 9. Unclipped steelhead salvage by time of day at the CVP and SWP, 2001 - 2003 data.

Clipped Steelhead Salvage by Time of Day, 2001 - 2003

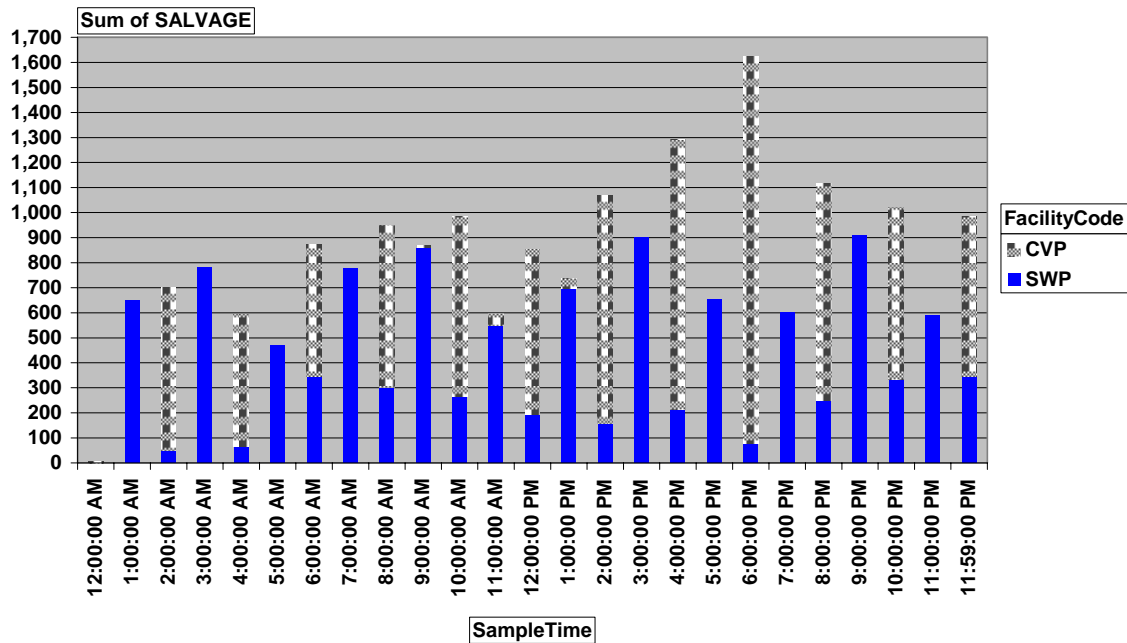
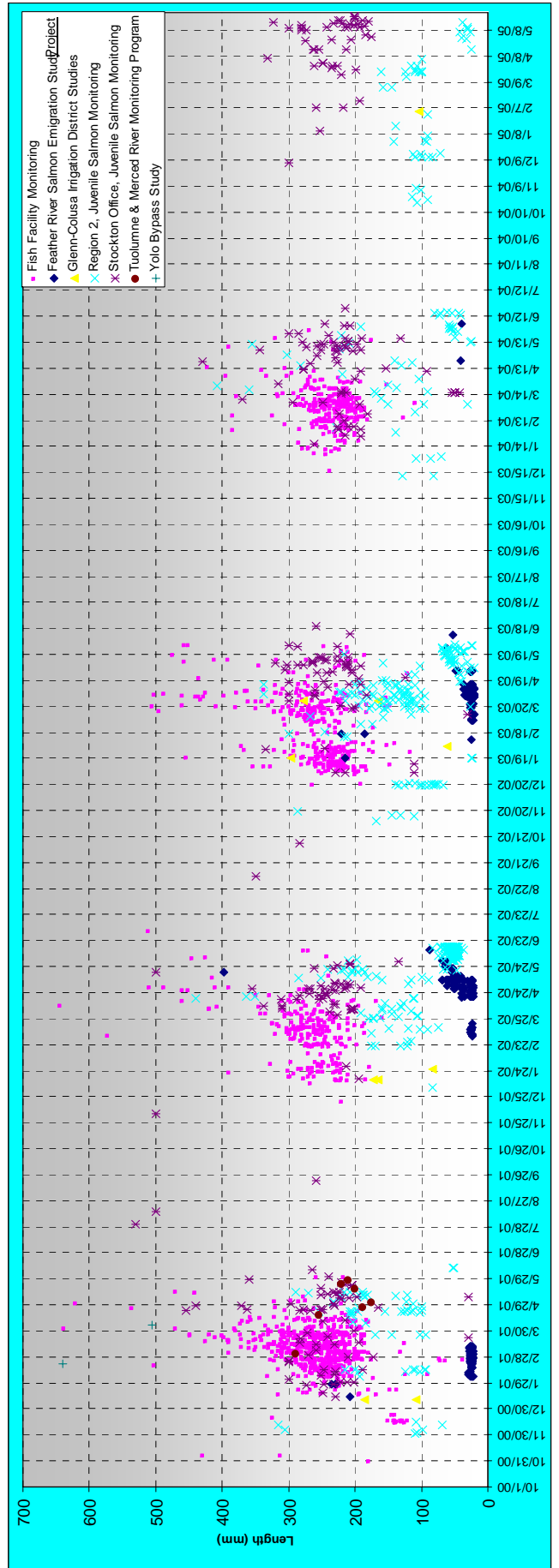


Figure 10. Clipped steelhead salvage by time of day at the CVP and SWP, 2001 - 2003 data.

Figure 11. Unclipped steelhead captured in various Central Valley monitoring programs, 2001 - 2004.



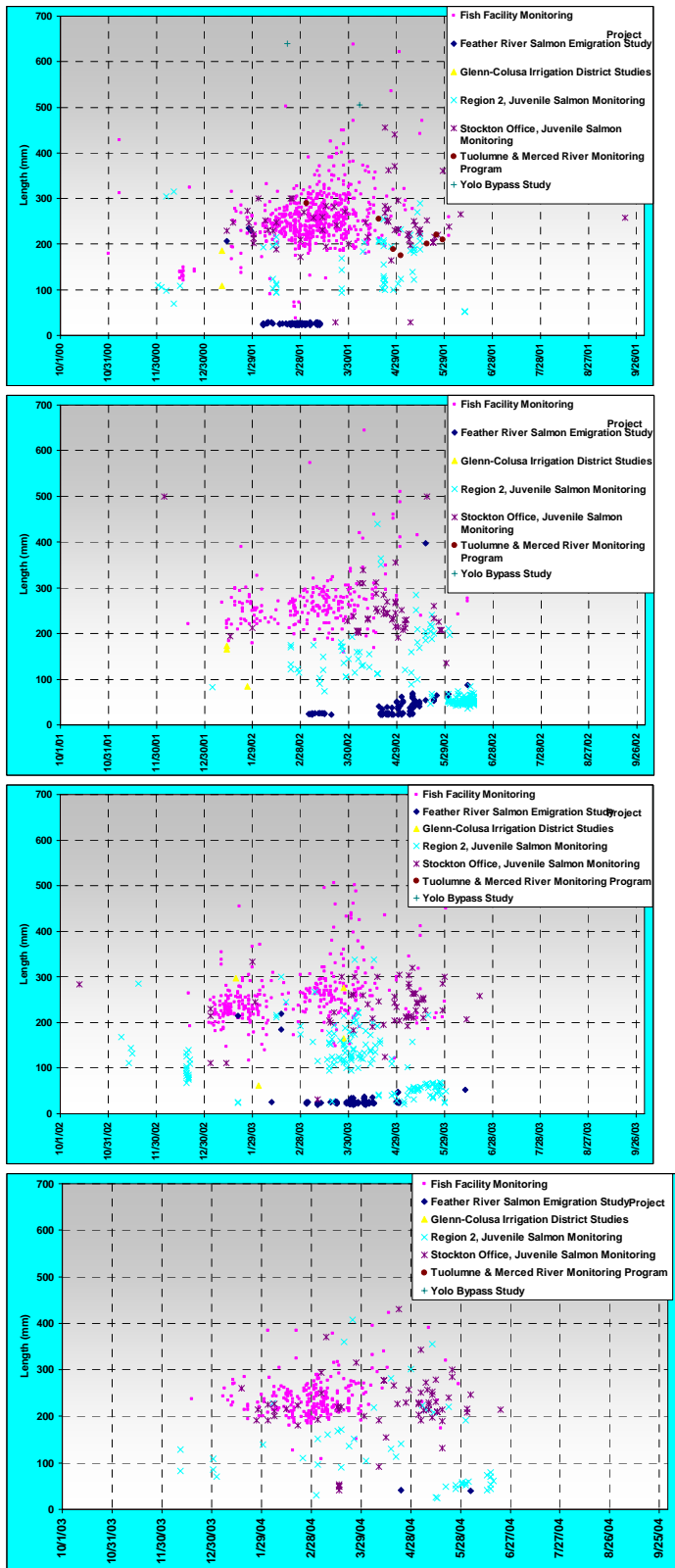
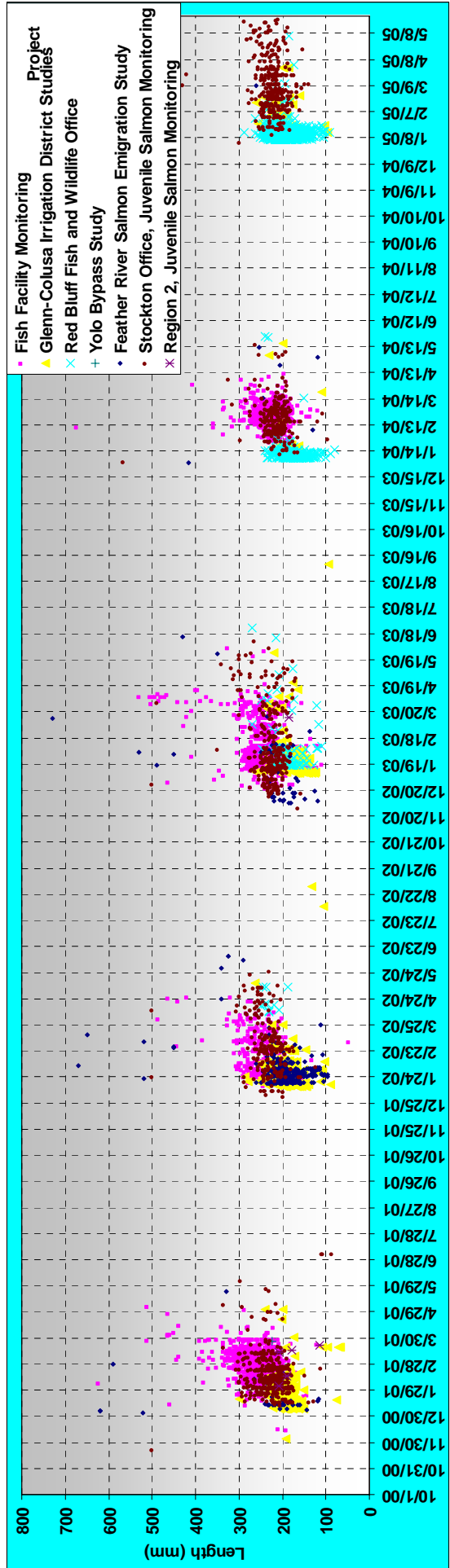


Figure 12. Unclipped steelhead captured in various Central Valley monitoring programs each year, 2001 - 2004.

Figure 13. Clipped steelhead captured in various central valley monitoring programs.



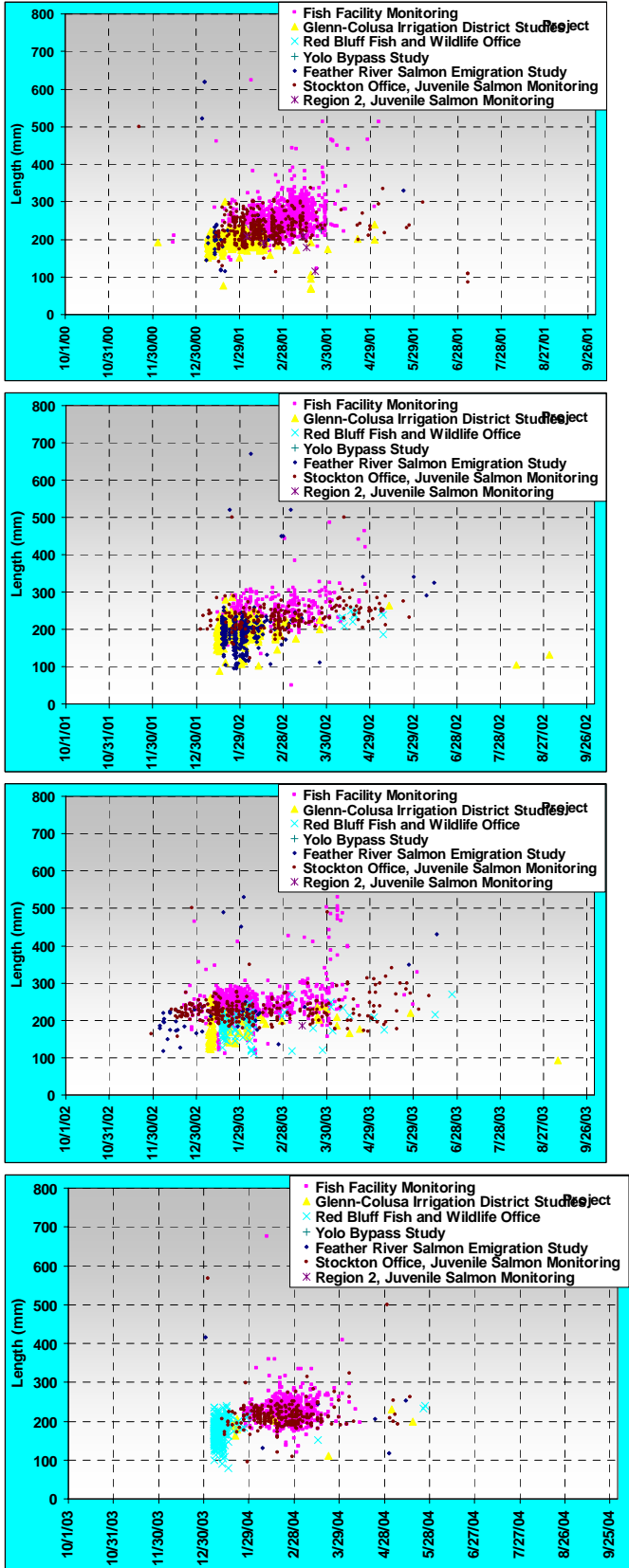
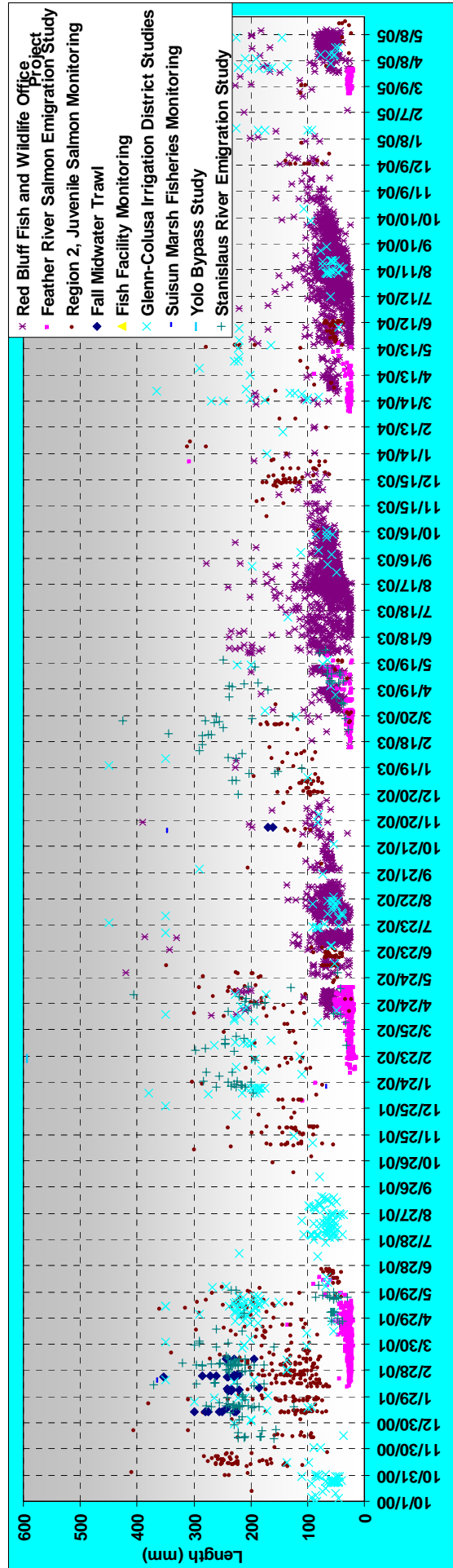


Figure 14. Clipped steelhead captured in Central Valley monitoring programs each year.

Figure 15. Steelhead with adipose clip status unspecified captured in various Central Valley monitoring programs, 2001 - 2004.



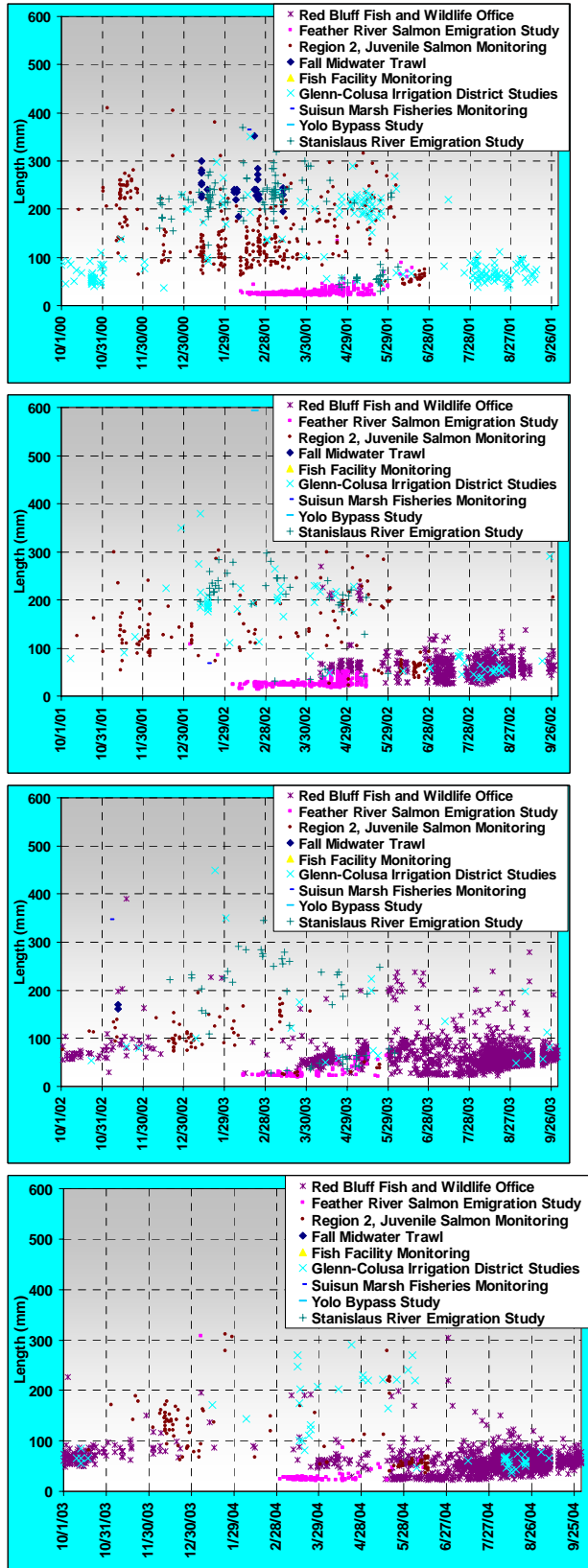


Figure 16. Steelhead with adipose clip status unspecified captured in various Central Valley monitoring programs each year.

	Total Released	total hatchery fish in delta	1% actual number salvaged	% of pop	number lost	% of pop
1995	2,253,633	1,599,361	15,994			
1996	2,794,264	2,057,100	20,571			
1997	1,692,573	1,281,659	12,817			
1998	1,863,503	1,377,464	13,775	372	0.03%	351
1999	1,406,073	1,035,712	10,357	187	0.02%	548
2000	1,232,688	920,636	9,206	5,442	0.59%	18,763
2001	1,574,590	1,161,350	11,613	8,203	0.71%	24,544
2002	1,618,353	1,187,432	11,874	1,885	0.16%	5,909
2003	1,633,544	1,228,262	12,283	10,631	0.87%	23,516
2004	1,605,140	1,181,612	11,816	7,997	0.68%	18,286

Table 8 and 9. Steelhead hatchery release data and comparisons of steelhead salvage and loss to the estimated number of hatchery steelhead passing through the delta.

		fish released from prior year brood		fish released from prior year brood		fish released from prior year brood		fish released from prior year brood	
	Adult steelhead hatchery returns	Feather	Nimbus	% natural	fish released from prior year brood	Nimbus	% natural	fish released from prior year brood	Mokelumne
1995	2,185	1,273,633	1,594		450,000	3,805		430,000	25
1996	3,106	1,105,407	877		450,000	2,257		1,138,857	39
1997	2,529	399,328	1,058		450,000	1,309		743,245	46
1998	1,409	544,579	2,113		833,037	509		385,887	5
1999	1,755	546,453	1,023		343,560	1,056		416,060	0
2000	1,976	389,953	633		340,435	1,506		402,300	32
2001	2,294	596,957	1,742	6%	398,930	2,877	50	467,023	32
2002	3,824	620,736	1,431	11%	482,798	1,253	69	414,819	43
2003	2,688	530,045	2,942	16%	450,000	873	27	419,160	52
2004	1,823	600,000	1,483	12%	450,000	1,741	17	455,140	61
									289,939