Chapter 6

Complimentary Studies Related to the VAMP

Throughout 2005 several fishery studies were conducted that were considered to be important to the overall understanding of the abundance and survival in the San Joaquin River basin. These are presented below to provide the reader with summary information on each study. More information can be obtained from each study manager or report author.

SURVIVAL ESTIMATED FOR CWT RELEASES MADE IN THE SAN JOAQUIN TRIBUTARIES

Contributed by Pat Brandes, U.S. Fish and Wildlife Service

Coded wire tagged salmon from the MRFF were released in the Merced River between April 17 and May 11, 2005 as part of an independent (complimentary to VAMP) fishery investigation. Releases were made in the upper and lower reaches of the Merced River (Merced Hatchery and Hatfield State Park, respectively). One set was also released in the Tuolumne (La Grange) and in the mainstem San Joaquin River just downstream of the confluence with the Tuolumne River (Old Fisherman's Club) (Figure 6-1).

Survival indices to Antioch and Chipps Island of lower Merced releases made at Hatfield State Park and San Joaquin River releases (Old Fisherman's Club) include

Figure 6-1
CWT release sites for releases made in the Merced, Tuolumne and San Joaquin Rivers in 2005

mortality down the mainstem San Joaquin River, as well as through the Delta. Chipps Island survival indices of the lower Merced River and Old Fisherman's Club groups were comparable to survival indices from the 2005 VAMP releases made at Durham Ferry and Dos Reis. Survival indices using Chipps Island recoveries ranged between 0.010 – 0.077 (Table 6-1), while those for VAMP fish released at Dos Reis and Durham Ferry ranged from 0.022 to 0.063 (Table 5-4). No recoveries were made at Antioch.

These data would indicate that the variables that affected the survival of Durham Ferry and Dos Reis released VAMP fish in 2005 also affected survival of the lower Merced River and Old Fisherman's Club release groups. Mortality was not as great for the Jersey Point groups. This same pattern was also detected in 2003 and 2004 (SJRG, 2004).

Survival indices were also generated for the upstream Merced River releases (MRFF) and for those groups released in the upper Tuolumne. Comparison of survival indices to Chipps Island of groups released upstream and downstream provides an estimate of survival through the tributary. This is accomplished by dividing the Chipps Island upstream group survival index by the downstream survival index. For the three sets released on the Merced River, survival was estimated to range from 0.42 to 1.2, indicating survival through the tributary was high (Table 6-2). Survival through the Tuolumne River was also high and was calculated to be 1.2 (Table 6-2). Estimates of over one are likely due to the variance associated with low recoveries of both the upper and lower release groups. These comparisons likely do not provide precise estimates of survival through the Merced and Tuolumne rivers, but may be useful for distinguishing between high and low survival. Ocean recoveries will be available for these groups in future years and will provide an additional means to estimate survival through each tributary.

COMPARISON OF VAMP RELEASES WITH SACRAMENTO RIVER DELTA RELEASES

Contributed by Pat Brandes, U.S. Fish and Wildlife Service

As in previous years, marked fish from the Feather River were released on the Sacramento River near Sacramento (Figure 1-1). Three groups were released to index survival through the Delta for juvenile salmon originating in the Sacramento basin. Comparison of these groups to VAMP releases tell us how survival has varied between basins. The average survival index in 2005 for the three separate groups of Feather River Hatchery smolts released on April 15, April 29 and May 16 was 0.46, similar to that measured in 2003 (0.51) and greater than that measured in 2004 (0.19). VAMP survival for groups released at Durham Ferry, Mossdale and Dos Reis were low for all three years and was estimated to be less than about 0.05. From a relative scale survival was lower through the Sacramento River delta in 2004 than in 2005 or 2003, whereas with the VAMP fish survival was low for all three years. This indicates that perhaps different variables are controlling survival in the two basins since relative survival between years within each of the basins do not follow similar patterns.

Survival indices are typically higher for smolts migrating through the Delta from Sacramento than for smolts migrating from Mossdale. It is unclear why this is the case, although smolts entering the Delta from Mossdale are exposed to lower river flows and higher temperatures than on the Sacramento River. Smolts from the San Joaquin basin migrate in closer proximity to the CVP and SWP pumping plants, and are more subjected to subsequent altered Delta flow patterns. Sacramento stocks also do not have PKD. All of these factors and others probably result in the lower survival through the Delta for juvenile salmon originating from the San Joaquin basin.

2005 MOSSDALE TRAWL SUMMARY

Contributed by Tim Heyne,
California Department of Fish and Game

Introduction

Monitoring for the fall-run Chinook salmon smolt out-migrant population in the San Joaquin drainage is located two miles downstream of Mossdale Landing Country Park (river mile 56), and upstream of the Old River confluence (Figure 6-1). The timing and measurement of out-migrant production (indices and estimates) of fall-run Chinook salmon smolts have been monitored at Mossdale on the San Joaquin River since 1987 to:

1) Determine annual salmon smolt production in the San Joaquin Basin,

2) Develop smolt production trend information,

3) Determine the timing and magnitude of smolt out-migration into the Delta from the San Joaquin tributaries.

Methods:

Sampling is performed with a 6 x 25 foot (1.87m x 7.6m) Kodiak trawl net. The Kodiak trawl uses two boats to pull a net equipped with spreader bars, wings, and a "belly" in the throat of the net to improve capture vulnerability. The cod end of the trawl net is secured using a rope. The sampling

Table 6-1
Chipps Island VAMP Tag Summary, Survival Calculations and Expanded Fish Facility Recoveries for Tagged Fish

							Antioch				
TagCode	**Release Site/Stock**	**Date**	**Truck Temp (F)**	**Release Temp (F)**	**Number Released**	**Average Size (mm)**	**First Day Recovered**	**Last Day Recovered**	**Number Recovered**	**Minutes Fished**	**Percent Sampled**
06-46-76	Merced Hatchery (MRFF)		N/P	N/P	25,067	N/P	–	–	0	–	–
06-46-77	Merced Hatchery (MRFF)		N/P	N/P	25,141	N/P	–	–	0	–	–
06-46-78	Merced Hatchery (MRFF)		N/P	N/P	24,384	N/P	–	–	0	–	–
06-46-79	Merced Hatchery (MRFF)		N/P	N/P	24,996	N/P	–	–	0	–	–
	Total	**04/17/05**			**99,558**				**0**		
06-46-80	Hatfield (MRFF)		N/P	N/P	24,278	N/P	–	–	0	–	–
06-46-81	Hatfield (MRFF)		N/P	N/P	23,647	N/P	5/8/05	5/8/05	1	471	0.3271
06-46-82	Hatfield (MRFF)		N/P	N/P	23,733	N/P	–	–	0	–	–
	Total	**04/19/05**			**71,658**		**5/8/05**	**5/8/05**	**1**	**471**	**0.327**
05-51-36	La Grange (MRFF)	04/18/05	N/P	N/P	75,696	N/P	5/5/05	5/23/05	5	9,743	0.3561
05-11-69	Old Fisherman's Cl (MRFF)	04/20/05	N/P	N/P	47,376	N/P	5/5/05	5/9/05	2	2,416	0.3356
	Total	**04/20/05**			**123,072**						
06-46-83	Merced Hatchery (MRFF)		N/P	N/P	25,157	N/P	–	–	0	–	–
06-46-84	Merced Hatchery (MRFF)		N/P	N/P	25,029	N/P	–	–	0	–	–
06-46-85	Merced Hatchery (MRFF)		N/P	N/P	25,107	N/P	–	–	0	–	–
06-46-86	Merced Hatchery (MRFF)		N/P	N/P	24,553	N/P	5/21/05	5/21/05	1	560	0.3889
	Total	**04/26/05**			**99,846**		**5/21/05**	**5/21/05**	**1**	**560**	**0.389**
06-46-87	Hatfield (MRFF)		N/P	N/P	23,345	N/P	5/7/05	5/7/05	1	540	0.375
06-46-88	Hatfield (MRFF)		N/P	N/P	24,315	N/P	5/5/05	5/20/05	2	8,163	0.3543
06-46-89	Hatfield (MRFF)		N/P	N/P	23,338	N/P	5/10/05	5/16/05	2	3,453	0.3426
	Total	**04/28/05**			**70,998**		**5/5/05**	**5/20/05**	**5**	**8,163**	**0.3543**
06-46-92	Merced Hatchery (MRFF)		N/P	N/P	25,029	N/P	–	–	0	–	–
06-46-93	Merced Hatchery (MRFF)		N/P	N/P	25,009	N/P	–	–	0	–	–
06-46-96	Merced Hatchery (MRFF)		N/P	N/P	25,312	N/P	–	–	0	–	–
	Total	**05/08/05**			**75,350**				**0**		
06-46-90	Hatfield (MRFF)		N/P	N/P	22,868	N/P	5/18/05	5/18/05	1	560	0.3889
06-46-91	Hatfield (MRFF)		N/P	N/P	22,739	N/P	–	–	0	–	–
	Total	**05/11/05**			**45,607**		**5/18/05**	**5/18/05**	**1**	**560**	**0.389**

Table 6-2
Absolute survival estimates based on survival indices to Chipps Island for survival through the Merced and Tuolumne Rivers in 2005.

Date	**Merced**	**Hatfield**	**Tributary Survival**
4/17-4/19/2005	0.032	0.077	0.42
4/26-4/28/2005	0.024	0.071	0.33
5/8-5/11/2005	0.012	0.010	1.2
Date	**La Grange**	**Old Fishermans Club**	**Tributary Survival**
4/18-4/20/2005	0.047	0.038	1.2

intensity was 5 days a week from April 4 to April 10, and then increased into 7 days a week from April 11 to May 27. The sampling effort was reduced to 5 days a week during May 28 to June 17, and then to 3 days a week during the last 2 weeks. The entire sampling period was from April 4 to July 1, 2005 with a total of 72 sample days out of study period of 89 days. A sampling day usually consisted of 15 tows at 20 minutes per tow, although the first two weeks and last five weeks of sampling had 10 tows per day. Due to hazardous weather conditions, there were only 7 tows on

		Chipps Island										
Survival Index	**Group Index**	**First Day Recovered**	**Last Day Recovered**	**Number Recovered**	**Minutes Fished**	**Percent Sampled**	**Survival Index**	**Group Index**	**Salvage CVP**	**Numbers SWP**	**Expanded CVP**	**Expanded SWP**
–		04/26/05	05/28/05	2	11,532	0.243	0.041		11	7	132	27
–		05/10/05	05/10/05	1	400	0.278	0.018		19	6	228	24
–		–	–	0	–	–	–		12	6	144	24
–		04/29/05	04/30/05	3	400	0.139	0.108		9	6	108	27
		04/26/05	**05/28/05**	**6**	**11,532**	**0.243**		**0.032**				
–		04/30/05	05/05/05	3	1,800	0.208	0.073		19	7	228	42
0.009		04/26/05	05/05/05	2	2,600	0.181	0.057		9	5	108	21
–		05/06/05	05/06/05	1	400	0.278	0.019		11	5	132	27
	0.004	**04/26/05**	**05/06/05**	**6**	**3,000**	**0.189**		**0.077**				
0.013		04/27/05	05/26/05	7	10,532	0.244	0.047		29	39	349	210
0.008		05/03/05	05/17/05	4	5,732	0.265	0.038		37	29	444	141
–		–	–	0	–	–	–		5	1	60	3
–		05/03/05	05/23/05	2	8,132	0.269	0.038		5	8	60	36
–		05/06/05	05/25/05	3	7,732	0.268	0.056		1	4	12	24
0.007				0					4	8	48	36
	0.002	**05/03/05**	**05/25/05**	**5**	**8,932**	**0.27**		**0.024**				
0.008		05/07/05	05/07/05	1	400	0.278	0.018		9	1	108	6
0.015		05/02/05	05/26/05	4	9,532	0.265	0.074		11	0	132	0
0.017		05/03/05	05/16/05	3	5,360	0.266	0.058		9	1	108	6
	0.013	**05/02/05**	**05/26/05**	**8**	**9,532**	**0.265**		**0.071**				
–		06/07/05	06/07/05	1	400	0.278	0.018		2	12	24	63
–		06/05/05	06/05/05	1	400	0.278	0.018		5	9	60	48
–		–	–	0	–	–	–		1	16	12	90
		06/05/05	**06/07/05**	**2**	**1,200**	**0.278**		**0.012**				
0.007		05/24/05	05/24/05	1	400	0.278	0.018		7	10	86	54
–		–	–	0	–	–	–		5	6	61	33
	0.004	**05/24/05**	**05/24/05**	**1**	**400**	**0.278**		**0.010**				

April 8, 2005. Sampling is also conducted 3 days per week between July and April by the USFWS in Stockton.

Water temperature, turbidity, weather, beginning tow time and velocity were recorded for each tow. Velocity was recorded by using a digital flow meter model 2030R that is made by General Oceanics Inc. The daily river flow data that is used in this report had been measured by U.S. Geological Survey mean daily stream flow gauge at Vernalis. All fish were identified to species and enumerated. The first 30 per tow of all species, except Chinook salmon, were also measured . Chinook salmon were checked for a clipped adipose fin and/or dye mark. All non-marked Chinook salmon were considered “natural” for the purpose of this study. The first 50 natural and dye mark Chinook salmon, for each tow, were measured (fork length, mm) and the excess tallied without measurement. Every Chinook salmon that had a clipped adipose fin was measured, individually bagged, and labeled and saved for coded wire tag processing.

Flows averaging over 10,000 cfs in the spring of 2005 resulted in the daily operation of the trawl beginning at the upstream end of the sampling area. The weekly vulnerability tests released at the Mossdale boat ramp were done to coincide with the first tow of the day. The first vulnerability test conducted on April 6 was not used in the analysis due to problems with the net.

The 2005 natural smolt production from the San Joaquin drainage was estimated by two different methods. The first method involves taking the actual number of non-marked Chinook salmon and dividing by the actual volume sampled to get Chinook/ac-ft. This number is then expanded by the daily mean flow recorded at Vernalis for a 5-hour index and expanded again for a 24-hour daily estimate. These daily average smolt densities were then expanded by multiplying with the daily mean flow recorded at Vernalis. Production estimates for days not sampled within the study period were assigned by averaging smolt/ac-ft for the days before and after the day not sampled.

The second estimate, which we believe to be a more accurate estimate, due to the uneven distribution of smolts in the channel, was determined using the 8 dye marked vulnerability release groups (Table 6-3 and Figure 6-2). Production estimates for days not sampled within the study period were assigned by averaging smolt caught and minutes towed for the days before and after the day not sampled.

Smolt Production Index Calculation:

The natural smolt index estimates (EI) is calculated as follow:

$$E_I = \sum_{i=1}^{n=89}\left[\left(\frac{C_i}{V_{Ti}}\right)\left(V_{Pi}\right)\left(\frac{24}{5}\right)\right]$$

Where:

n = days in the index period

C = daily non-marked Chinook catch

V_T = daily volume of trawl sampled

V_P = daily 5-hour volume of water passing Mossdale

i = i^{th} Day

The 95% confidence interval around this index was calculated as +1.96 x the Standard Deviation of the mean smolt density (smolt/ac-ft) in the trawl catch over the 89 days.

Table 6-3
Dye marked smolt releases from Merced River Hatchery for vulnerability studies (released 975 meters upstream of the Kodiak trawl) in the San Joaquin River at Mossdale Landing, April through May, 2005.

Release Date/Time	Water Temp. (°C) Truck/River	Effective # Released	Number Recovered	Streamflow (cfs)	Beginning And Ending Recovery Time
*06APR05 08:20	-/-	2,031	3	13,700	09:54 10:41
15APR05 09:15	9.5/14	5,060	71	9,242	09:48 13:10
22APR05 08:11	10.5/14	1,975	47	8,163	09:16 10:04
29APR05 07:59	11/14	4,988	64	6,882	09:41 12:49
06MAY05 08:00	11/14.5	1,997	134	7,847	08:35 09:23
13MAY05 08:20	11/15	4,999	79	8,744	08:53 09:17
20MAY05 07:57	11.5/15	2,001	29	10,190	08:55 09:14
27MAY05 08:07	13/15	1,948	28	14,062	08:37 11:08

*Vulnerability test omitted due to problems with trawl net.

Kodiak Trawl Vulnerability Estimates:

The vulnerability expansion production estimates (EV) is calculated as follow:

$$E_V = \sum_{i=1}^{N=89} \left\{ \left[\frac{(C_i/r)}{(T_i/300)} \right] \left(\frac{24}{5} \right) \right\}$$

Where:

r = population ratio

C = Daily non-marked Chinook catch

T = Tow Duration

i = i[th] day

N = number of days sampled

The population ratio (r) is calculated as follow:

$$r = \frac{\sum_{i=1}^{n} y}{\sum_{i=1}^{n} x} = \frac{\overline{y}}{\overline{x}}$$

Where:

n = number of vulnerability test groups

y = number of marked fish captured

x = number of marked fish released (effective release)

i = i[th] day

Estimated variance ($\hat{V}$) of r:

$$\hat{V}(r) = \hat{V}\left(\frac{\sum_{i=1}^{n} y_i}{\sum_{i=1}^{n} x_i} \right) = \left(\frac{N-n}{nN} \right) \left(\frac{1}{\mu_x^2} \right) s.d._r^2$$

Where:

N = number of days sampled

n = number of vulnerability test groups

y = number of marked fish captured

x = number of marked fish released (effective release)

i = i[th] day

_ = average of effective release

s.d. = standard deviation

Standard deviation (s.d.) is calculated as follow:

$$s.d._r = \sqrt{\frac{\sum_{i=1}^{n} (y_i - rx_i)^2}{n-1}}$$

Where:

n = number of vulnerability test groups

y = number of marked fish captured

x = number of marked fish released (effective release)

i = i[th] day

95% Confidence Interval (C.I.) is calculated as follow:

$$C.I. = r \pm 1.96\sqrt{\hat{V}(r)}$$

Where:

r = population ratio of what?

(r) = variance of population ratio

For the purpose of analysis, vulnerability to the trawl calculations was limited to the beginning of the first tow detected to the end of the last tow detected on the day of release. Detection of marked fish subsequent to day of release was not used in the analysis (this was less than 5 fish total in all releases). Travel time (from release point to trawl), time vulnerable to trawl and percent vulnerability as related to flow were determined for each test group.

Results

Between April 4 and July 1, 2005 2,294 non-marked Chinook salmon smolts were captured in the Mossdale trawl. Daily capture of non-marked salmon ranged from 0 – 363 individuals with an average of 32.

Smolt production estimates for the San Joaquin basin ranged between 363,800 using method 1 and 621,403 using method 2 (Table 6-4). The first method used a smolt density index to expand daily catch. The standard deviation using this method was +/-_14,700.

The second method used trawl efficiency (vulnerability) to expand daily catch (Figure 6-3). This method is thought to be more accurate than the smolt density index method because it should account for an uneven distribution of migrating smolts in the river channel. Trawl vulnerabilities were obtained by conducting mark-recapture tests each week. Release groups ranged from 1,948 – 5,060 dye

Figure 6.2
Vulnerability of Test Group vs. Flow

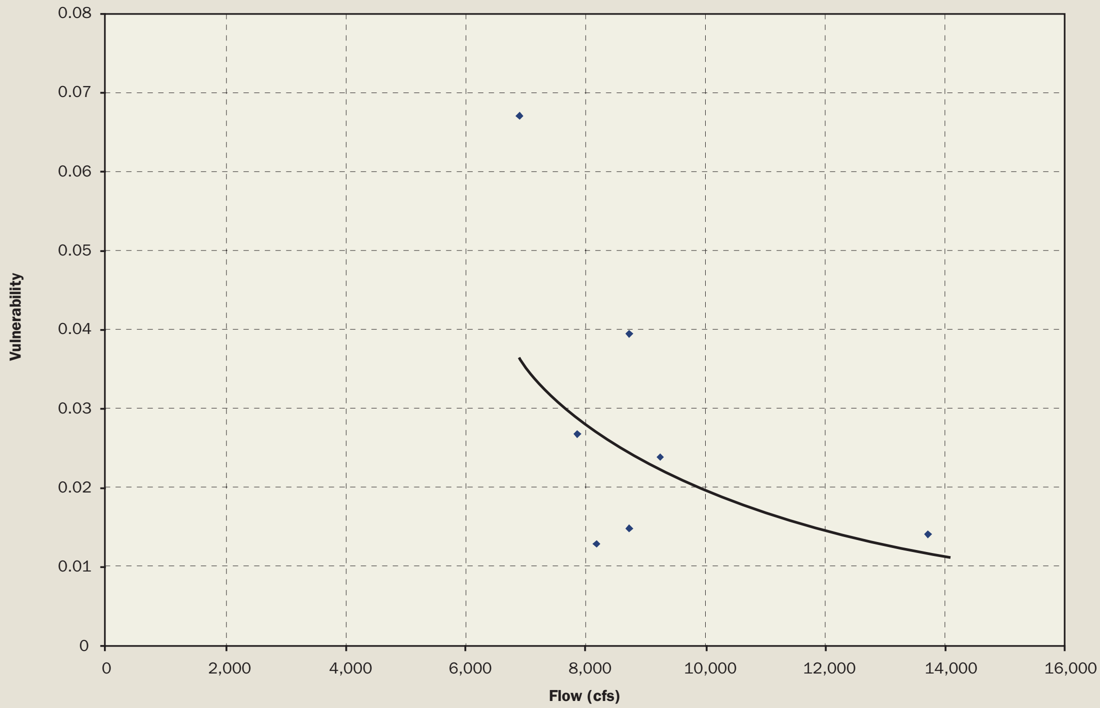
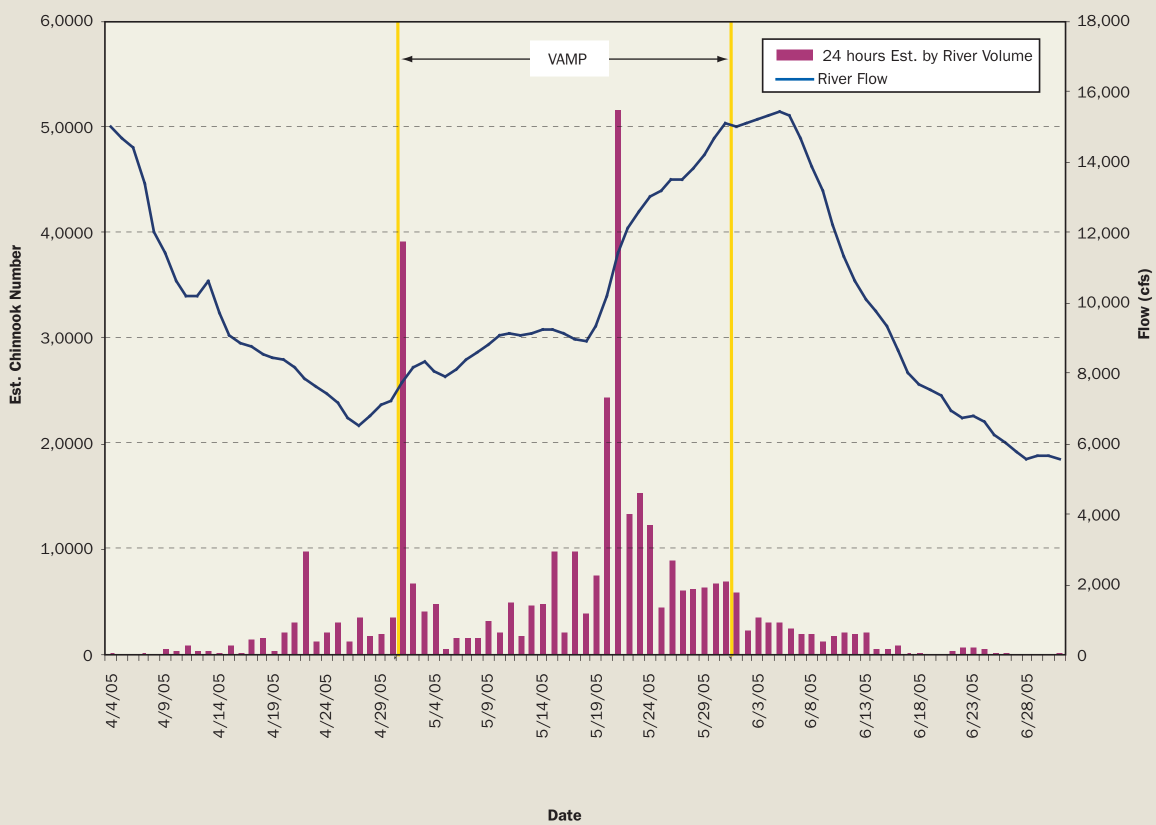


Figure 6.3
Daily Production Estimates (expanded using vulnerability testing) vs. Flow



marked juveniles. Juveniles were obtained from the Merced River Hatchery and were selected by size to match as closely as possible the size of wild fish being observed in the river at that time. The production estimate had a 95% confidence range of 388,884 – 1,119,550). Production of San Joaquin River basin smolts in 2005 was roughly twice that of the production in 2004.

This doubling in production occurred in spite of the number of spawning salmon the fall before being roughly equivalent in both years (~10,000). The main difference between the two years was a more than doubled spring outflow.

REVIEW OF JUVENILE SALMON DATA FROM THE SAN JOAQUIN RIVER TRIBUTARIES TO THE SOUTH DELTA DURING JANUARY TO JUNE, 2005

Contributed by Tim Ford, Turlock and Modesto Irrigation Districts, and Andrea Fuller, S. P. Cramer and Associates

The VAMP includes protective measures for San Joaquin River (SJR) smolts during a 31 day window in April and May, and evaluations are conducted annually to determine how these measures (i.e., river flow and exports) relate to delta survival. However, juvenile salmon from the spawning areas of the Stanislaus, Tuolumne, and Merced rivers (referred

Table 6-4
Smolt production seasonal estimates with corresponding smolt/ac-ft. estimates and sampling period for the duration of the study.

Year	Sampling Period (Days)	Smolt/ac-ft Estimate 1=1,000	Vulnerability Smolt Production Seasonal Estimate (95% confidence range)
2005	89	363,800 + 14,700	621,403 : (388,884-1,119,550)**
2004	61	92,500 + 66,500	333,080
2003	88	107,500 + 60,300	550,446
2002	75	229,100. + 557,100	733,839
2001	*	*	848,488
2000	72	211,100 + 181,900	484,703
1999	86	*	438,979
1998	80	*	2,844,637
1997	67	*	635,517
1996	75	*	1,155,319
1995	46	*	3,361,384
1994	48	*	453,245
1993	51	*	269,035
1992	33	*	280,395
1991	39	*	538,005
1990	55	*	263,932
1989	50	*	4,241,862

Note: Data from 1989 – 2004 is cited from Annual Performance Report Federal Aid in Sport Fish Restoration Act. Project No. 26, Job No. 4, Table 1.

*Estimates are currently being analyzed.

**Analysis of 2005 production estimate was performed by the method described in the body of the report. All previous years have a production estimate that is based on a regressive relation of flow and vulnerability that uses data from all test years except 2005. Confidence limits are currently being developed for those estimates.

to here as tributaries) can migrate to the SJR and delta over a longer season that may range from January to June. Their migration and rearing patterns vary among tributaries and among years in response to flow releases, runoff events, turbidity, and other factors. During 2005, rotary screw trapping was conducted on the Stanislaus River to document juvenile outmigration throughout the season; on the Tuolumne River during roughly half of the outmigration season; and no monitoring occurred on the Merced River. This review briefly presents data from the rotary screw traps fished in the Stanislaus and Tuolumne rivers during 2005 to identify the movement of juvenile salmon from the tributaries into the mainstem San Joaquin River relative to observations at the Mossdale Trawl and in salvage.

Stanislaus River rotary screw trap (RST) monitoring was conducted at River Mile (RM) 9 (Caswell site) during 05 Jan - 16 Jun; and Tuolumne River RST monitoring was conducted at RM 5 (Grayson site) during 01 Apr - 16 Jun. Trawling was conducted in the San Joaquin River at Mossdale near RM 54 (downstream of the tributaries, and upstream of the Head of Old River) during 03 Jan – 29 June (daily, except only 3 days/week prior to April). Although salvage data of unmarked salmon does not distinguish which salmon originate from the San Joaquin tributaries, they can be compared to timing, abundance, and size of salmon collected in the San Joaquin basin monitoring.

Several local runoff events between January and March were associated with significant rainfall periods (Figure 6-4). The seasonal peak catch of fry in the Stanislaus River RST (Figure 6-5) followed a late January storm event. However, relatively few early fish were observed at the Mossdale trawl (Figure 6-6), and SWP (Figure 5-24) salvage operations; more were found in the CVP salvage (Figures 5-23 and 5-26). Figure 6-7 shows that most fish observed prior to mid-February averaged <40 mm fork length (FL). Average size increased by mid- April to >80 mm FL in all areas (Figure 6-7), coincident to increased daily catch on the Tuolumne River (Figure 6-8) and also the highest densities observed at Mossdale (Figure 6-6) and the CVP/SWP (Figure 5-26). By mid-June, all sampling indicated very low abundance of juvenile salmon marking the end of the 2005 outmigration season.

It appears from the Stanislaus data that in 2005, much of juvenile salmon population migrated into the SJR, as fry and pre-smolts, between January to April. These early migrants were not captured in high densities at Mossdale but appear to have arrived in the CVP salvage, indicating that at least some fry moved into the Delta; relative efficiency of the trawl and salvage facilities for fry size salmon may be less than for the RST. However, even though fry were not observed at Mossdale in high densities during 2005, high densities have been recorded early in the season at this site in other years (SJRGA, 2005); and differences in density at Mossdale between years may also be influenced by the overall abundance of juveniles migrating from the tributaries as a result of fluctuating escapement.

To obtain more information on fry movement into the Delta, additional monitoring at the lower end of each of the three San Joaquin tributaries for the entire season (January through June) would be a high priority. Further evaluation of the trawl efficiency on different sized juvenile salmon might also be useful. These data would help to refine existing protective measures, if warranted, and to identify potential needs for additional protective measures targeting a larger proportion of the juvenile salmon population migrating from the San Joaquin tributaries.

FLORIDONE EXPOSURE TO EMIGRATING JUVENILE FALL RUN CHINOOK SALMON

Contributed by Jeff Stuart, National Marine Fisheries Service

In April 2005, the California Department of Boating and Waterways (DBW) in conjunction with the U.S. Department of Agriculture-Agricultural Research Service (USDA-ARS) applied the herbicide fluridone to waters of the Delta for the control of the non-native invasive weed *Egeria densa*. The National Marine Fisheries Service (NMFS) permitted this early season application of herbicide to the waters of Franks Tract, Sandmound Slough, and Disappointment Slough under the authority of their Section 7 Biological Opinion for the *Egeria densa* Control Program. Applications to these restricted areas were determined by NMFS to present a reduced level of exposure to juvenile salmonids during their spring emigration through the Delta. As part of the terms and conditions for this early season application, NMFS required DBW and the USDA-ARS to examine the level of fluridone exposure to emigrating juvenile fall-run Chinook salmon through the levels of fluridone found in their body tissues.

NMFS, in cooperation with the U.S. Fish and Wildlife Service (USFWS), the California Department of Fish and Game (DFG), and the Vernalis Adaptive Management Plan (VAMP) stakeholders, gathered coded wire tagged (CWT) fall-run Chinook salmon from monitoring trawls at Chipps Island, Antioch, Mossdale, and Sherwood Harbor to look for exposure to the fluridone herbicide during their downstream migration. The reading of the CWTs allow for the direct measurement of time spent in the water since release, the location of release, and the origins of these fish. These fish

Figure 6-4
San Joaquin Basin Flows and Rainfall

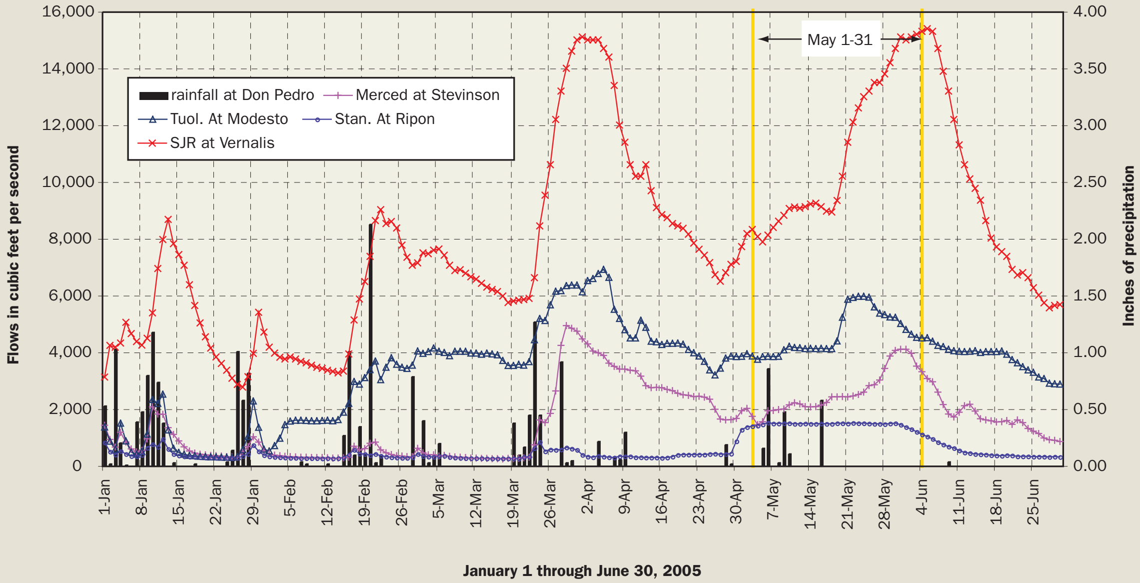


Figure 6-5
Stanislaus rotary screw trap daily catch of all unmarked juvenile Chinook salmon.

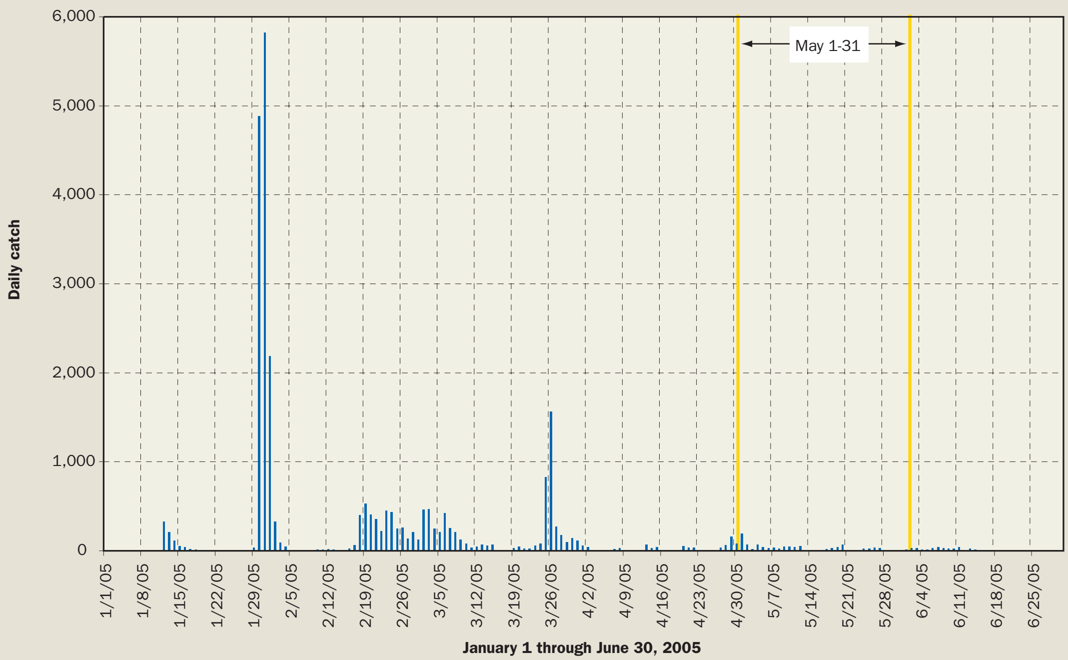


Figure 6-6
Mossdale Kodiak trawl mean daily catch per minute of all unmarked juvenile Chinook salmon.

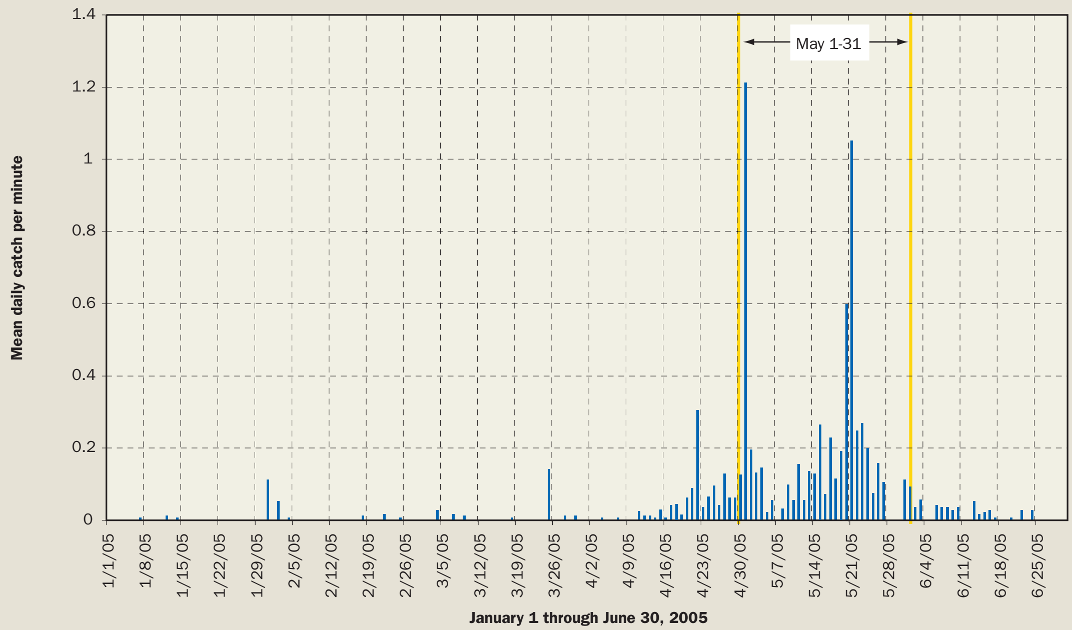


Figure 6-7
Daily average forklength of unmarked juvenile Chinook salmon.

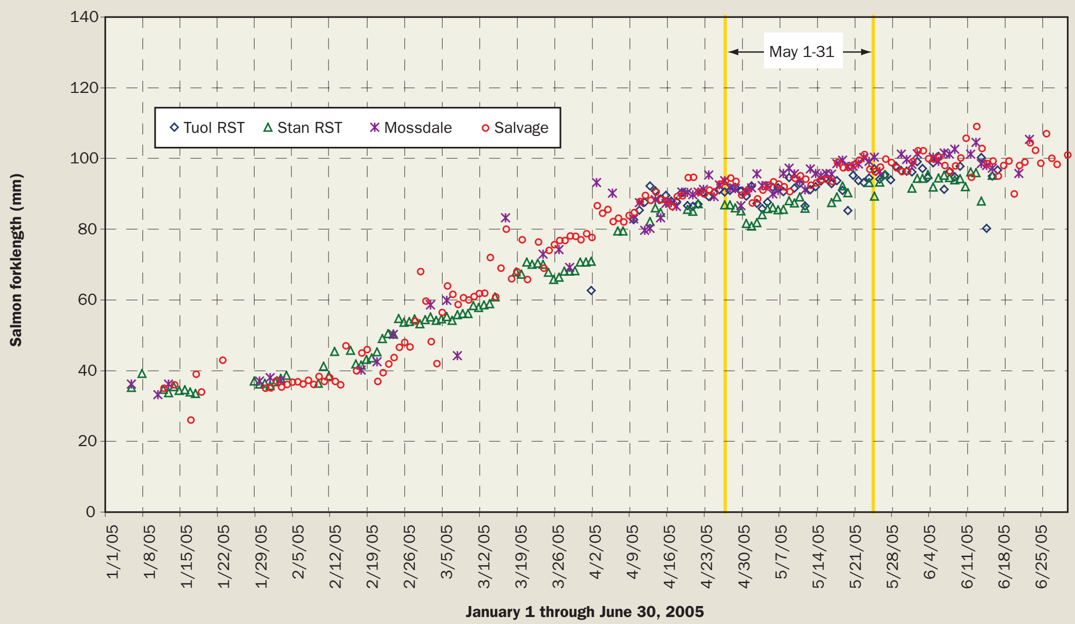
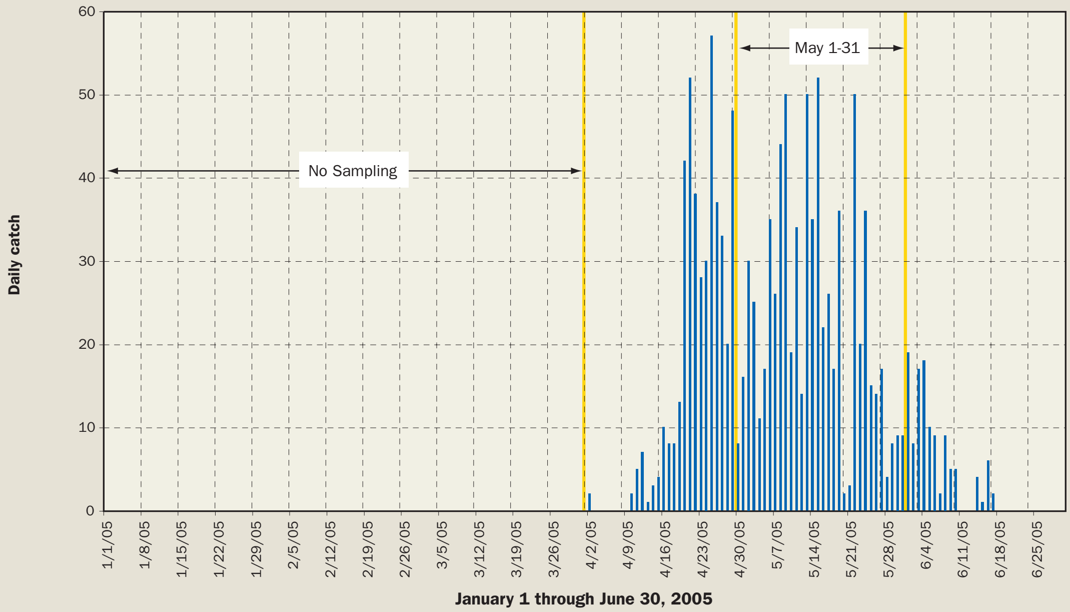


Figure 6-8
Tuolumne rotary screw trap daily catch of all unmarked juvenile Chinook salmon.



will be processed and whole body homogenates analyzed by DFG staff at the Water Pollution Control Laboratory for residues of the parent fluridone compound and the daughter metabolite compound, hydroxyl-fluridone. NMFS hypothesizes that fish migrating through the San Joaquin River system have a higher likelihood of encountering the fluridone compound than those which migrate down the Sacramento River system. Prior to entrance into the Delta from the San Joaquin River, fish should not have had any exposure history to the fluridone compound. Fish sampled at Mossdale should therefore not have any fluridone residues in their body, while those fish from the Merced Hatchery recovered at Antioch and Chipps Island should at least have the potential to have fluridone residues in their body, based on their predicted migration path through the Delta. Samples which are found to have residues of fluridone or its daughter metabolite indicate that the fish have moved through areas being treated for *Egeria densa*. Chinook salmon recovered at Sherwood Harbor on the Sacramento River have not yet entered the Delta, and like fish from Mossdale, should not have any fluridone residues in their body tissues. Fish recovered at Chipps Island were predominantly from the Sacramento River basin (Feather River hatchery). NMFS hypothesizes that most of these fish should migrate down the Sacramento River channel to Chipps Island before capture in the monitoring trawls and should therefore not have any fluridone or its metabolite in their body tissues. Should these Sacramento River origin fish show fluridone residues, then their migration path would necessitate that they moved through the Central Delta and into the San Joaquin River system prior to their capture at Chipps Island.

NMFS will use the fluridone body tissue burdens in their future analysis of exposure risks to emigrating salmonids in the Delta. The results of the data will facilitate developing future application windows to reduce or eliminate exposure risk to listed salmonids in the Delta from weed control programs.