

in verifying daily ring increments in otoliths. After confirmation of daily rings, a broader study using net-penned delta smelt raised in different regions of the estuary could determine if regional differences in growth rate exist.

Acknowledgments

Thanks to Leo Winternitz for initiating this study and the Interagency Ecological Program for funding it. We also thank Zachary Hymanson and Ted Sommer for editorial input and Erin Chappell, Lisa Lynch, and Sally Skelton from DFG Bay-Delta for laboratory assistance.

References

California Department of Water Resources and United States of Bureau of Reclamation. 1994. Effects of the Central Valley Project and the State Water Project on Delta smelt and Sacramento Splittail.

Houde, E.D. 1987. Fish Early Life Dynamics and Recruitment Variability. Transactions of the American Fisheries Society Symposium. 2:17-29.

Lindberg, J., R. Maeger, B. Bridges and S. Doroshov. Summer 1997. Interagency Ecological Program Newsletter. Volume 10, No. 3.

Moyle, P.B. 1976. Inland Fishes of California. University of California Press. Berkeley.

Moyle, P.B., B. Herbold, D.E. Stevens and L.W. Miller. 1992. Life History and Status of Delta Smelt in the Sacramento-San Joaquin Estuary, California. Transactions of the American Fisheries Society 121:67-77.

Neilsen, L.A. and D.L. Johnson. 1983. Fisheries Techniques. Southern Printing Co. Blacksburg, Virginia

Rutherford, E.S., E.D. Houde, R.M. Nyman. 1997. Relationship of Larval-Stage Growth and Mortality of Recruitment of Striped Bass, *Morone saxatilis*, in Chesapeake Bay. Estuaries. Vol. 20, No. 1, p.174-198.

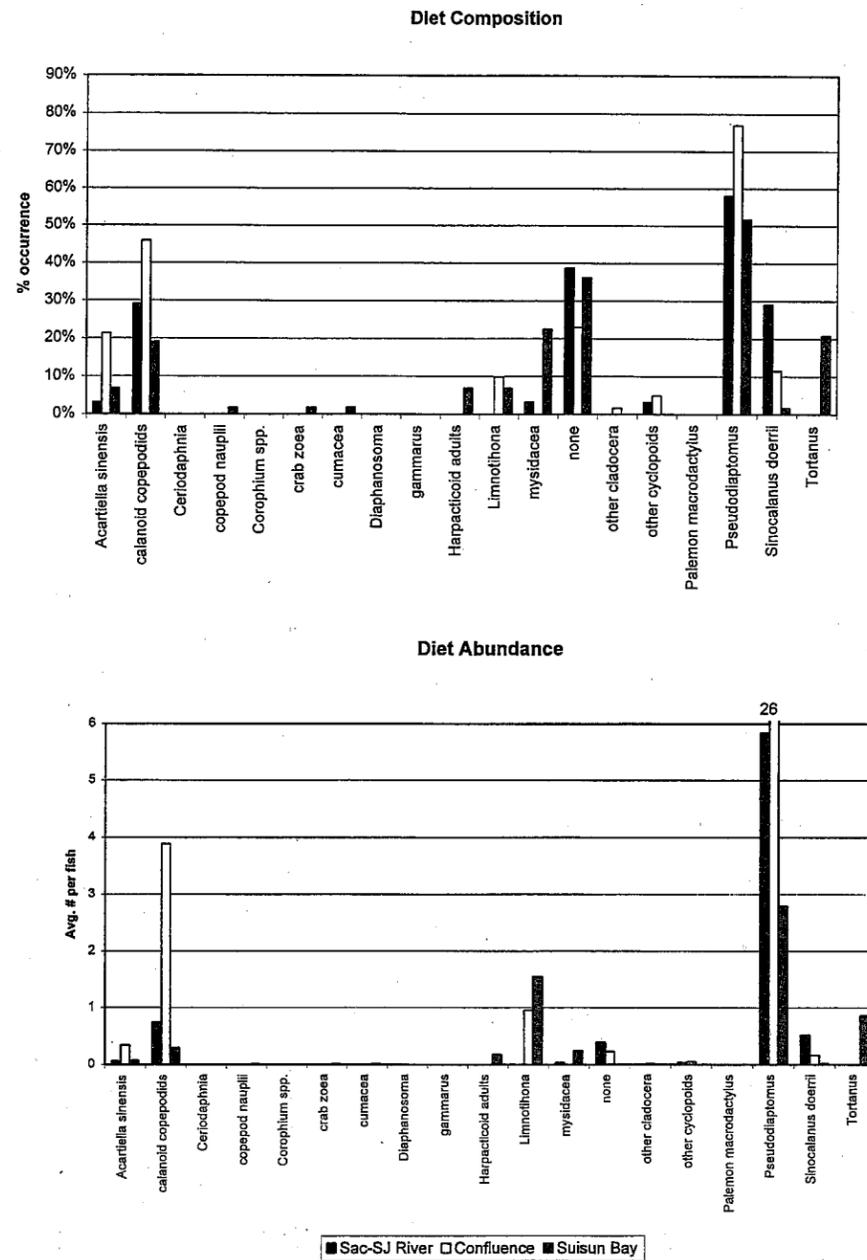


Figure 4
Delta smelt diet composition and abundance by area.

1997 Salmon Smolt Survival Studies in the South Delta

Pat Brandes and Mark Pierce, USFWS

Introduction

Salmon smolt survival studies in the Delta between 1985 and 1990 have shown that survival indices for coded wire tagged (CWT) smolts released at Dos Reis on the mainstem San Joaquin River survive at about twice the rate of smolts released into Upper Old River (Table 1, Figure 1). In response to these findings an attempt was made to test whether a temporary barrier in Upper Old River could improve survival for smolts migrating through the Delta.

A fully closed temporary barrier was installed in Upper Old River during spring 1992, 1994, and 1996. The study design in the first two years of evaluation was to make a series of releases at Mossdale in a four-week period: some releases were made prior to installation and additional releases were after the barrier was in place. Due to logistical considerations, the without barrier scenario was the first experimental condition tested.

In 1992, water temperatures increased after the barrier was installed such that the prebarrier releases survived at a higher rate than those released with the barrier. In 1994, all releases (both with and without the barrier) yielded indices that were too low to differentiate between groups. Neither year of testing was adequate to confirm the benefits of a barrier in Upper Old River.

In 1993 and 1995, San Joaquin River flows were too high for the temporary barrier in Upper Old River to be installed.

In 1996, the study design was changed to measure survival with a barrier in place for all releases and to make comparison with past years to

determine if survival was higher than without a barrier. However, because the barrier was not installed until May 11 due to permitting delays and breached on May 16 because of flooding concerns, smolt survival with a barrier in place was inadequately measured in 1996.

In 1997, a study design similar to that planned for 1996 was used. Although the temporary barrier in Upper Old River was installed as scheduled (April 16 to May 16), it had two 48-inch culverts in it that allowed approximately 300 cfs of water from the San Joaquin River to move through the barrier into Upper Old River. The CWT experiment was then modified to assess the impacts of

the culverts as well as to evaluate the benefits of the barrier on smolt survival through the Delta during spring 1997. This modification consisted of changing the smolts stock used for the Mossdale release (upstream of the barrier) from Merced River Fish Facility (MRFF) to Feather River Hatchery (FRH) stock. The concern was that losses through the culverts of Merced River smolts released at Mossdale would reduce returns back to the hatchery in future years.

Groups of CWT smolts were released at Mossdale, Dos Reis, and Jersey Point in the South Delta and recovered in sampling at Chipps Island as had been done in past years (Table 2, Figure 1). In 1997, additional inten-

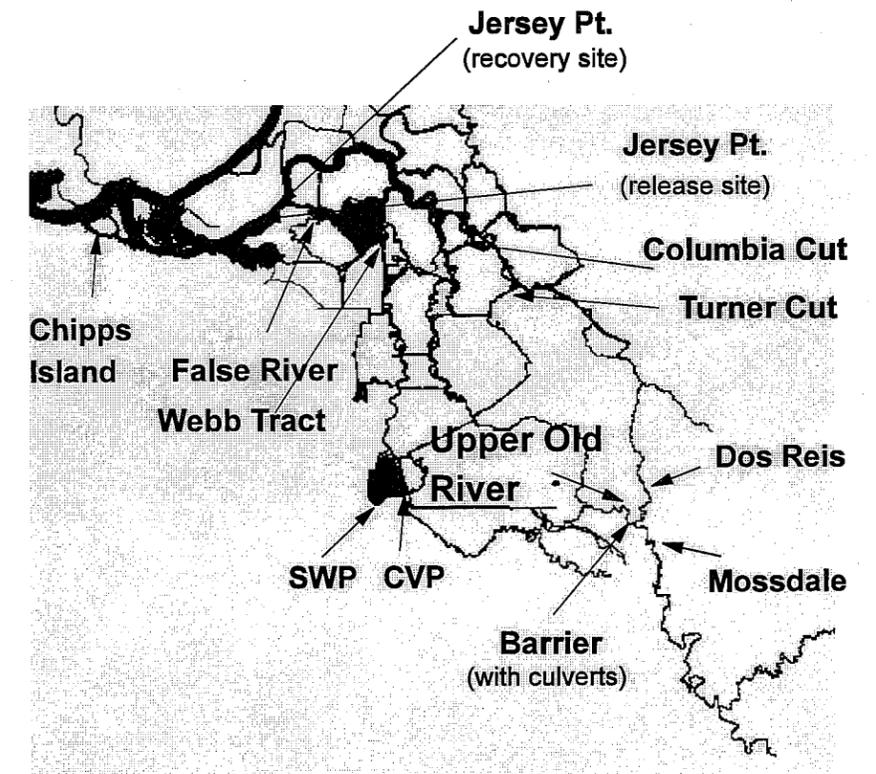


Figure 1
Map of release sites used in the South Delta in 1997 and recovery locations at Chipps Island, Jersey Point, the State Water Project (SWP), and Central Valley Project (CVP) fish salvage facilities and real-time monitoring stations.

sive sampling was conducted for approximately three weeks at Jersey Point to increase the number of recoveries and resulting precision in indexing the survival of the Mossdale and Dos Reis groups. Survival indices to Chipps Island are calculated by dividing the number of recoveries by the number released and the fraction of time and channel width sampled. Survival indices to Jersey Point were calculated in a similar way using recovery information pertinent to that site.

To assess the benefits of the barrier in Upper Old River, the survival index to Chipps Island of the Mossdale release group was compared to the survival indices of past releases made at that location without the barrier. Intensive sampling at Jersey Point has not been conducted in past years, so survival index comparisons to past years could not be made for that recovery location. An additional release at Dos Reis was made to evaluate the impacts of the culverts in the barrier by comparing its survival in-

dex to the Mossdale survival index at Chipps Island and Jersey Point. A separate evaluation of the impact of the culverts was possible from sampling conducted behind the barrier, where the proportion of CWT fish released at Mossdale that moved into Upper Old River via the culverts could be estimated.

Paired CWT releases were made at Dos Reis and Jersey Point using stocks from both FRH and MRFF to evaluate any survival differences through the Delta between stocks. Physiological tests were conducted on a small subset of fish from the two Dos Reis groups after they were held for 48 hours to determine if either stock might have a physiological or health advantage that would explain any observed differences in survival.

For replication purposes a second set of releases using smolts from MRFF was made at Dos Reis and Jersey Point about 10 days later at similar flow and export conditions. A third release of MRFF smolts was made later in May at Dos Reis after flow and export conditions had changed, largely because the fish were too small to release earlier. There was no corresponding release at Jersey Point.

To determine if any differential, immediate or short-term mortality was present and associated with handling, trucking, or temperature shock (temperature differences between the hatchery truck and release site), subsets of approximately 200 fish from each release were held in live pens at the release site for 48 hours.

An additional release of CWT smolts was made at Port Chicago to factor out the ocean influences on the recovery rates of the various CWT groups. These recoveries in the ocean fishery will allow additional information on South Delta survival to be generated.

Additional juvenile recoveries were made in the real-time monitoring (RTM) sampling conducted between April 1 and June 30, 5 days per week in Turner and Columbia Cuts and at False River and Webb Tract (Figure 1). Jersey Point sampling was also conducted on this schedule after the intensive pilot effort had concluded. Sampling consisted of five, 20-minute tows per sample day. In addition, recoveries were made in sampling conducted at the State Water Project (SWP) and Central Valley Project (CVP) fish salvage facilities in the South Delta. Unexpanded salvage numbers from both facilities have been expanded by sample time to obtain "expanded" salvage numbers.

Results

Assessment of the culverts in the barrier. The survival indices to Chipps Island of Feather River smolts released at Dos Reis and Mossdale were similar, indicating that no difference in survival attributable to the culverts was detected (Table 3). This was also observed at Jersey Point, where recoveries from both groups were similar (Table 3). In addition, the sampling behind the barrier estimated that less than 0.05% of the Mossdale release group went into Upper Old River via the culverts (Mike Healy, personal communication). These three independent pieces of information seem to indicate that the impact of the culverts was minimal to smolts passing between Mossdale and Dos Reis.

Net Pen Mortality Evaluations. For all releases, subsamples of the 200 fish held in live pens (25 fish) were closely evaluated immediately after each release and again after they had been held for 48 hours to assess their relative condition. Fish were evaluated based on eye condition, body color, fin condition, scale loss, and gill color. All fish in both cases looked

healthy with the exception of an occasional case of slightly pale gills. Eyes also were found to be normal with the exception of a couple of cases where a slight bulge may have been present. Color contrasts were generally distinct (normal) and no fin hemorrhaging was observed. Scale loss was estimated within a range of 1% to 25%, and generally fell between 3% and 15%. Greater than 10% loss may be of significant concern during transition to salt water,

although it was later determined that the scale loss estimations may have been high.

After 48 hours, the remainder of the 200 fish were counted and evaluated on the vigorousness of their activity. Six fish were observed dead from the eight releases and included one fish that sustained obvious injuries during handling. Four of the dead fish observed were from the Jersey Point release using Merced River smolts

Table 1. Results of Studies Comparing Survival Indices of CWT Juvenile Chinook Salmon from Dos Reis and Old River to Chipps Island

Release at Dos Reis		Release at Old River		
Date	Survival Index	Date	Survival Index	Dos Reis/Old River Survival Index
30 April 1985	0.59	29 April 1985	0.62	0.95
29 May 1986	0.34	30 May 1986	0.20	1.7
27 April 1987	0.38 ^a	27 April 1987	0.16	2.4
20 April 1989	0.14	21 April 1989	0.09	1.5
2 May 1989	0.14	3 May 1989	0.05	2.8
16 April 1990	0.04	17 April 1990	0.02	2.0
2 May 1990	0.04	13 May 1990	0.01	4.0
Mean	0.24		0.16	2.2

^a Original survival estimate (0.82) was modified based on the ratio of ocean recovery rates between the Dos Reis and Old River releases.

Table 2. Release Sites, Numbers, and Dates for CWT Merced River Fish Facility and Feather River Hatchery Smolts Released in the South Delta in 1997

Barrier Status	Release Sites (Hatchery Stock)	Number Released	Release Date
Barrier in with culverts	First set of Releases:		
	Mossdale (FRH)	50,000	4/28
	Dos Reis (MRFF)	100,000	4/29
	Dos Reis (FRH)	50,000	4/29
	Jersey Point (FRH & MRFF)	50,000 each	5/2
	Port Chicago (FRH)	50,000	5/5
	Second Set of Releases:		
	Dos Reis (MRFF)	50,000	5/8
	Jersey Point (MRFF)	50,000	5/12
	Third Set of Releases:		
	Dos Reis (MRFF)	50,000	5/27

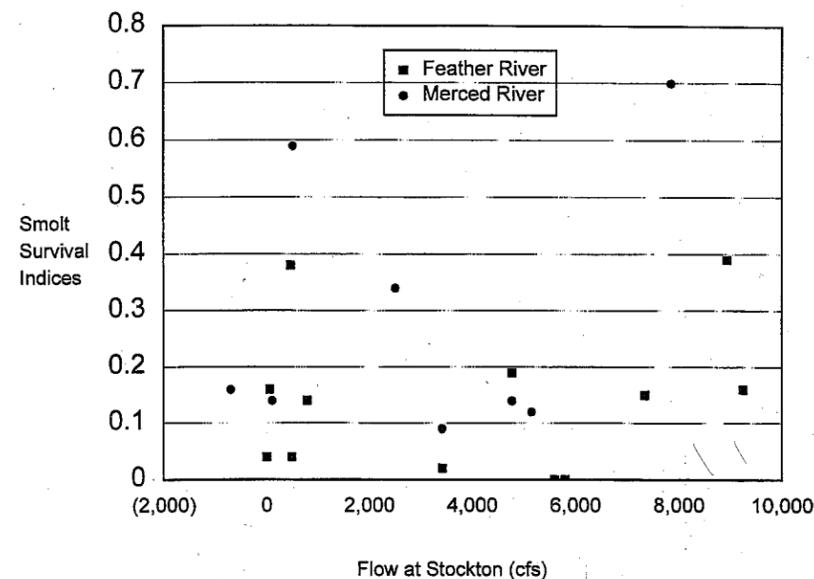


Figure 2
Survival indices for smolts released at Dos Reis between 1982; 1985-87, 1989-91, and 1995; 1996 and 1997.

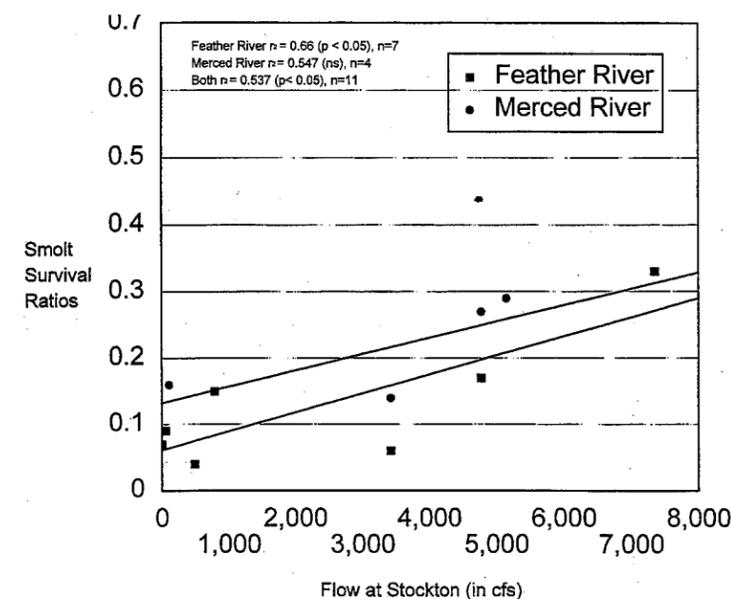


Figure 3
Smolt survival for smolts released at Dos Reis in relation to those released at Jersey Point versus flow at Stockton (in cfs).

Table 3: 1997 Chipps Island (CI) and Jersey Point (JP) coded wire tagged chinook recovery summary, survival indices, expanded CVP and SWP recoveries, and Real Time site recoveries.

Tag Code	Release Site	Date	Number Released	Chipps Island		Jersey Point		Expanded Facility		Real Time Site Recoveries						
				Release Size (mm)	Survival Index	Number Recovered	Survival Index	Group Survival Index	Group Survival Index	SWP	CVP	Jersey	False	Webb	Columbia	Turner
San Joaquin Delta																
06-01-06-03-02	Mossdale FRH	04/28/97	23701	100	0.0792	21	0.1347	*May-11	10	96	0	0	0	0	0	0
06-01-06-03-03	Mossdale FRH	04/28/97	25073	100	0.3022	28	0.2015	*May-12	24	108	0	0	0	0	0	4
	Total		48774		0.1939	49		0.1810								
06-01-06-03-04	Dos Reis FRH	04/29/97	25084	97	0.2619	25	0.1489	*May-12	19	60	1	1	0	0	3	3
06-01-06-03-05	Dos Reis FRH	04/29/97	24746	97	0.1138	26	0.1836	*May-13	12	36	0	1	1	0	3	3
	Total		49830		0.1883	51		0.1789								
06-25-45	Dos Reis MRH	04/29/97	49005	74	0.1719	69	0.2421	*May-15	72	108	4	2	1	1	10	12
06-25-46	Dos Reis MRH	04/29/97	53475	74	0.1225	58	0.1940	*May-15	58	180	1	0	0	2	12	12
	Total		102480		0.1461	127		0.2116								
06-01-06-02-07	Jersey Point FRH	05/02/97	24815	99	1.0204	74			0	12	2	0	0	0	0	0
06-01-06-02-08	Jersey Point FRH	05/02/97	25049	99	1.0483	77			0	0	1	1	0	0	0	0
	Total		49864		1.0342	151										
06-25-47	Jersey Point MRH	05/02/97	51588	75	0.4950	383			12	12	15	5	1	0	0	0
06-25-48	Dos Reis MRH	05/08/97	46728	75	0.1170	10		*May-15	78	36	0	0	1	1	2	2
06-25-49	Jersey Point MRH	05/12/97	47254	74	0.3982	138			4	12	18	1	1	0	0	0
06-25-50	Dos Reis MRH	05/27/97	49139	77	0.1652	0			2	24	14	0	0	0	8	8

Survival indices were not generated for releases made at Jersey Point and recovered at Jersey Point since the release was actually made downstream of the sampling location. The sampling at Jersey Point was only conducted until May 16. The last day of recovery at Jersey Point for the various groups is included in the table.

Table 3: 1997 Chipps Island (CI) and Jersey Point (JP) coded wire tagged chinook recovery summary, survival indices, expanded CVP and SWP recoveries, and Real Time site recoveries.

Tag Code	Release Site	Date	Number Released	Release Size (mm)	Chipps Island		Jersey Point		Expanded Facility		Real Time Site Recoveries					
					Survival Index	Number Recovered	Survival Index	Number Recovered	Group Survival Index	Group Survival Index	SWP	CVP	Jersey	False	Webb	Columbia
San Joaquin Tributaries																
06-01-11-05-11	Merced Hatchery	04/20/97	26045	77	0.0365	10	0.0586	*May-07	18	0	0	1	0	0	1	1
06-01-11-05-12	Merced Hatchery	04/20/97	27683	77	0.1019	4	0.0225	*May-06	3	24	0	0	0	0	1	1
06-01-11-05-13	Merced Hatchery	04/20/97	31930	77	0.0293	8	0.0378	*May-13	0	36	0	0	0	0	0	0
06-01-11-05-14	Merced Hatchery	04/20/97	24880	77	0.0000	7	0.0406	*May-11	0	0	0	1	0	1	1	1
	Total		110538		0.0425	29		0.0385								
06-01-11-05-15	Hatfield St. Park	04/22/97	24398	75	0.2305	23	0.1406	*May-13	18	24	1	1	0	0	0	0
06-01-11-06-01	Hatfield St. Park	04/22/97	29011	75	0.0970	26	0.1533	*May-15	12	72	0	1	0	0	2	2
06-01-11-06-02	Hatfield St. Park	04/22/97	25761	75	0.2547	11	0.0613	*May-09	2	24	2	1	1	1	0	0
06-01-11-06-03	Hatfield St. Park	04/22/97	25317	75	0.0000	17	0.1085	*May-12	4	36	0	0	0	0	0	5
	Total		104487		0.1435	77		0.1261								
06-01-11-06-07	LaGrange	04/22/97	31112	71	0.0354	1	0.0767	*May-08	12	84	0	0	0	0	0	0
06-01-11-06-08	LaGrange	04/22/97	29947	71	0.0000	2	0.0094	*May-14	16	204	0	0	1	0	0	0
06-01-11-06-09	LaGrange	04/22/97	24551	71	0.0381	3	0.0191	*May-12	8	96	0	0	0	1	0	0
06-01-11-06-10	LaGrange	04/22/97	7897	71	0.1394	0	0.0000		0	12	0	0	0	0	0	0
	Total		93507		0.0359	6		0.0107								
06-01-11-06-04	Lower Tuolumne	04/23/97	25241	75	0.2268	19	0.1444	*May-13	28	48	1	1	0	0	2	2
06-01-11-06-05	Lower Tuolumne	04/23/97	25692	75	0.0743	13	0.0768	*May-13	14	72	2	1	0	0	1	1
06-01-11-06-06	Lower Tuolumne	04/23/97	21531	75	0.1895	7	0.0545	*May-15	6	84	0	0	0	0	0	3
	Total		72464		0.1689	39		0.1079								
06-01-11-06-11	Merced Hatchery	05/12/97	28031			0			0	12	0	0	0	0	0	0
06-01-11-06-12	Merced Hatchery	05/12/97	27915	76		0			0	0	0	0	0	0	0	0
06-01-11-06-13	Merced Hatchery	05/12/97	10561	76		0			0	0	0	0	0	0	0	0
	Total		66507			0										
06-01-11-06-14	Hatfield St. Park	05/14/97	33064		0.0000	0			8	180	0	0	0	0	0	0
06-01-11-06-15	Hatfield St. Park	05/14/97	28294	67	0.0331	0			18	168	0	0	0	0	0	0
06-01-11-07-01	Hatfield St. Park	05/14/97	24943	67	0.0000	0			0	84	1	0	0	0	0	0
06-01-11-07-02	Hatfield St. Park	05/14/97	5856	67	0.0000	0			0	24	0	0	0	0	0	0
	Total		92157		0.0102	1										

Survival indices were not generated for releases made at Jersey Point and recovered at Jersey Point since the release was actually made downstream of the sampling location. The sampling at Jersey Point was only conducted until May 16. The last day of recovery at Jersey Point for the various groups is included in the table.

where relatively high mortality (300 – 400 fish) was observed immediately following the release. The remaining fish among all releases were vigorously active and appeared generally healthy both immediately after release and after the 48 hour holding period.

Temperature differences between the hatchery truck and receiving waters were as great as 15°F for some releases. Based on the low mortality observed, it does not appear that these temperature differences affected

the immediate or short-term mortality of any CWT fish released in 1997. Increased predation as a result of reduced avoidance due to temperature stress can not be assessed holding fish in live cars.

Merced River versus Feather River stocks. The survival index to Chipps Island was higher for the Feather River stock released at both Dos Reis and Jersey Point than for the corresponding Merced River stock. It is likely that the increased survival for the Feather River groups is due to the

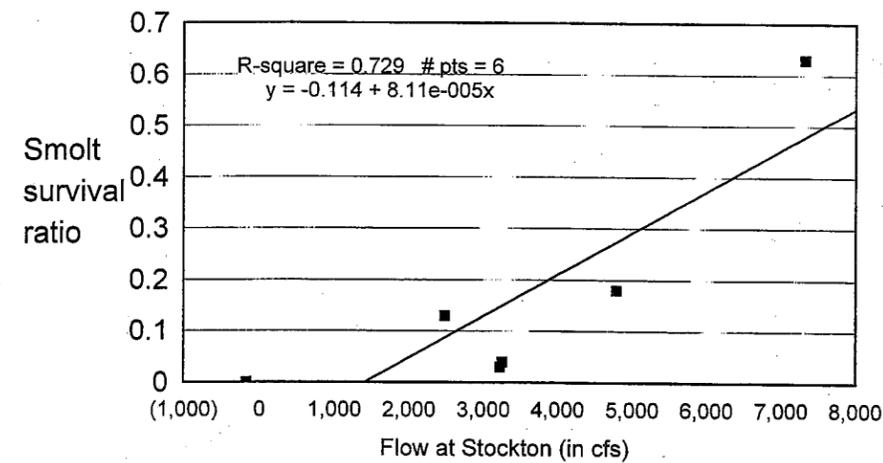


Figure 4

Smolt survival for smolts released at Mossdale in relation to those released at Jersey Point versus flow at Stockton (in cfs).

Table 4. Ratio of Survival Indices to Chipps Island of Smolts Released at Dos Reis and Jersey Point Using Feather River Hatchery (FRH) and Merced River Fish Hatchery (MRFF) Stock in 1997 and 1996

Release Date	Hatchery Stock	Release Site	Survival Index to Chipps Island		Survival Ratio
04/29/97	FRH	Dos Reis	.1883		
05/02/97		Jersey Point	1.0342	=	.18
04/29/97	MRFF	Dos Reis	.1370		
05/02/97		Jersey Point	.5133	=	.27
05/08/97	MRFF	Dos Reis	.1170		
05/12/97		Jersey Point	.3982	=	.29
05/01/96	FRH	Dos Reis	.02		
05/03/96		Jersey Point	.35	=	.057
05/01/96	MRFF	Dos Reis	.10		
05/03/96		Jersey Point	.72	=	.139

fact the mean size of the fish were larger than the Merced stock (Table 3). Since the mean size of release was similar at both release sites within a stock, a ratio between the survival index to Chipps Island of the Dos Reis group relative to the Jersey Point group can be used to factor out any gear selectivity bias associated with the different sizes.

When the ratio's of survival are compared it appears that the survival from Dos Reis to Jersey Point was somewhat greater for smolts from the Merced River hatchery (0.27) than from the Feather River Hatchery (0.18) (Table 4).

Recoveries at Jersey Point for the paired release at Dos Reis from the two hatcheries showed higher catches and survival indices of the Merced River stock than for the Feather River stock. There were no corresponding downstream releases to factor out the size differences, as we did for Chipps Island recoveries. It may be that the Merced group was caught in greater numbers at Jersey Point because they were smaller at release than the Feather River stock. The kodiak trawl used at Jersey Point may be more efficient on the smaller sized fish because the mesh of the net is smaller (1/4") than it is at Chipps Island (5/16"). Ocean recoveries in future years of the two Dos Reis groups from the different hatcheries will also provide a way to assess this size difference between groups. The size difference between the two groups at release is not likely to effect the recoveries of these fish as adults in the ocean fishery.

Physiological Health Assessment Study. An evaluation of the physiological health of the Merced and Feather River CWT fish released at Dos Reis on April 29 was conducted on 30 fish after they had been held in live cages for 48 hours. This was

done to determine if either stock might have a physiological or health advantage, which would explain any observed differential survival rate to Chipps Island.

The results of this evaluation showed similar visceral fat and condition factors between the two hatchery stocks, with no abnormalities in scale, gill, or eye-condition in either group. Fish from both groups were quite silver in appearance, indicating a transition to the migratory smolt life stage. There were some minor internal abnormalities found on a few of the examined fish, but nothing that would be expected to contribute to a different survival rate at the juvenile life stage. In subsamples of 10 fish, both stocks were found to be free of pathogens such as PKX (kidney parasites). The most significant difference between the two stocks, as mentioned earlier, was that the Feather River stock (average 88mm fork length) was significantly larger and heavier than Merced River stock (average 74mm fork length). This size difference could be expected to favor the Feather River stock with a juvenile survival advantage of unknown magnitude.

The role of exports, flows and water temperatures. Three CWT releases were made at Dos Reis using smolts from MRFF between April 29 and May 27. Flow and export conditions were generally stable between April 15 and May 14, but starting May 15 flows at Vernalis were reduced and the barrier was breached due to Delta smelt concerns. Exports also started to increase starting May 24 (Table 5). In addition, water temperatures at release increased between the first and last release groups.

The first group released at Dos Reis on April 29 survived to Chipps Island relative to the Jersey Point group at a rate of 0.27. The second Dos Reis

release of May 8, survived relative to the Jersey Point group at a similar rate (0.29). As mentioned earlier, conditions were similar. Mean flow at Vernalis between release and the last fish recovered at Chipps Island, was 5,289 and 4,810 cfs for the first and second groups, respectively. Mean CVP and SWP exports for the same time period were also similar between the two releases at 2,264 and 2,126 cfs, respectively. Water temperatures were higher for the second set of releases than for the first.

The last Merced group released at Dos Reis survived at an index of 0.16. This compares to raw indices from the other Dos Reis groups using Merced fish of 0.13 and 0.11. No control group was made at Jersey Point for the last release group. Water temperatures (72°F) and exports (6,115 cfs) were higher, flows lower (3,457 cfs), and no barrier was in place for last release. It is unclear why survival was not lower for this group, given the less favorable conditions. Without a control group release at Jersey Point, it is somewhat uncertain if survival was actually higher than for the previous releases made at Dos Reis in 1997.

Sampling was not conducted long enough at Jersey Point to get comparative survival indices to Jersey Point for all three releases made at Dos Reis.

Effect of the barrier on smolt survival. The survival indices to Chipps Island and Jersey Point, for the Mossdale release was similar to that for the Dos Reis release. This is evidence that the barrier was beneficial to Delta survival. Without a barrier, survival for smolts released at Mossdale in past years has been generally lower than those released at Dos Reis.

Survival for FRH smolts released at Mossdale in 1997 was relatively high compared to past releases made at

Mossdale since 1992 (Table 6), also providing some general evidence that the barrier improved smolt survival in 1997. Environmental conditions have varied between years making differences attributable to the barrier difficult to isolate. A more direct comparison would be between 1996 and 1997, as Vernalis flow and total export conditions were similar between the two years. The Mossdale survival indices were much higher in 1997 than 1996 and could be attributable to the barrier being in place in 1997 whereas it was not in 1996.

The survival index of smolts released at Dos Reis was also higher in 1997 than in 1996 (Table 6). Fish released at Dos Reis would be less affected by a barrier in Upper Old River than fish released at Mossdale. A potential mechanism for the increased survival of the Dos Reis group could be from the increase in flow at Stockton, which occurs when the barrier is in place. Although Vernalis flows were similar in 1996 and 1997, flows at Stockton were different because of the effect of the barrier.

When Dos Reis indices of survival to Chipps Island are plotted against Stockton flows, no relationship is observed (Figure 2). But when the Dos Reis survival indices are divided by the corresponding release at Jersey Point and plotted against flow at Stockton a relationship emerges (Figure 3). This pairing of release groups factors out many of the biases associated with gear efficiency, fish size, and potentially water temperature differences within and between years. Results using both Feather River and Merced River stock are shown in Figure 3. The number of releases, using Merced River stock alone, are too few (4) to detect a relationship. Using the releases from Feather River stock

Table 5. Flow and Export Conditions During Spring 1997

Date	Flow at Vernalis	CVP+SWP Exports	Date	Flow at Vernalis	CVP+SWP Exports
15-Apr-97	3557	1568	14-May-97	5699	2178
16-Apr-97	3708	1863	15-May-97	5306	2317
17-Apr-97	4632	1904	16-May-97	4902	2088
18-Apr-97	5205	2192	17-May-97	4471	2603
19-Apr-97	5593	2205	18-May-97	4192	1775
20-Apr-97	5569	2223	19-May-97	4062	1116
21-Apr-97	5493	2251	20-May-97	3898	816
22-Apr-97	5321	3112	21-May-97	3755	1260
23-Apr-97	5572	1703	22-May-97	3749	2151
24-Apr-97	5813	2278	23-May-97	3803	1387
25-Apr-97	5708	2215	24-May-97	3919	4549
26-Apr-97	5570	2221	25-May-97	3749	6164
27-Apr-97	5532	2202	26-May-97	3739	5212
28-Apr-97	5520	2240	27-May-97	3608	5565
29-Apr-97	5454	2217	28-May-97	3515	8081
30-Apr-97	5312	2200	29-May-97	3614	7338
01-May-97	5200	2202	30-May-97	3631	7537
02-May-97	5012	2212	31-May-97	3592	7473
03-May-97	4828	2214	01-Jun-97	3487	6179
04-May-97	4703	2301	02-Jun-97	3416	6239
05-May-97	5059	2262	03-Jun-97	3441	6276
06-May-97	5227	2278	04-Jun-97	3478	6257
07-May-97	5083	2305	05-Jun-97	3533	6219
08-May-97	5057	2362	06-Jun-97	3562	5088
09-May-97	5319	3217	07-Jun-97	3493	5348
10-May-97	6020	2927	08-Jun-97	3287	5253
11-May-97	6318	2152	09-Jun-97	3224	5172
12-May-97	6443	1212	10-Jun-97	2979	5179
13-May-97	5913	1845			

Table 6. Survival Indices to Chipps Island of Merced River Fish Facility (MRH) and Feather River Hatchery (FRH) Smolts Released in the San Joaquin Delta and Tributaries between 1982 and 1997.

Year / Origin	Release Sites									
	Dos Reis Mixed	Mossdale w/o HORB FRH	Mossdale w/ HORB FRH	Upper Old River Mixed	Upper Merced MRH	Lower Merced MRH	Upper Tuolumne MRH	Lower Tuolumne MRH	Upper Stanislaus MRH	Lower Stanislaus MRH
1997	0.19(FRH) 0.14(MRH)	-	0.19	-	0.04	0.14	0.04	0.17	-	-
1996	0.02(FRH) 0.09(MRH)	0.02	-	-	0.01	0.01	0.04	0.07	-	-
1995	0.15(FRH)	0.22	-	-	0.15	0.20	0.25	0.22	-	-
1994	-	0.00	0.02	-	0.06	0.02	0.03	0.04	-	-
1993	-	0.04	-	-	-	-	-	-	-	-
1992	-	0.07	-	-	-	-	-	-	-	-
1991	-	0.07	-	-	-	-	-	-	-	-
1990	0.16(FRH)	-	-	-	-	-	-	-	-	-
1989	0.04 (FRH)	-	-	0.02(FRH)	-	-	0.04	0.01	-	-
1988	0.04(FRH)	-	-	0.01(FRH)	-	-	-	-	-	-
1987	0.14(FRH)	-	-	0.09(FRH)	-	0.05	-	-	0.05	0.21
1986	0.15(MRH)	-	-	0.05(MRH)	-	-	-	-	-	0
1985	-	-	-	-	-	-	-	-	0.07	0.09
1984	**0.83(MRH) *	-	-	0.16(MRH)	-	-	0.05	0.18	-	-
1983	0.34(MRH)	-	-	0.2(MRH)	-	-	0.40	0.27	0.34	0.56
1982	0.59(MRH)spraydyed	-	-	0.62(MRH)	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-
	***0.6(MRH)	-	-	-	0.62	-	-	-	-	-

* A number of 0.38 is obtained if modified using the ratio of ocean recovery rates of the Dos Reis and Upper Old River groups.
 ** Release temperature of 70 F.
 *** A number of 0.70 is obtained if modified using the ratio of ocean recovery rates between Dos Reis and Merced because sampling at Chipps Island was not started for the first week after the release.

Steelhead Work Team Forming

Dennis McEwan, DFG

Management and restoration of Central Valley steelhead stocks has been greatly hampered by an acute lack of baseline information. Recently, the California Department of Fish and Game and the U. S. Fish and Wildlife Service implemented a program to fin-clip all steelhead raised in Central Valley hatcheries so naturally-pro-

duced steelhead can be identified in the various salmonid monitoring projects.

To facilitate implementation of projects to monitor and assess Central Valley steelhead, and to coordinate steelhead data collection at existing monitoring projects, a Steelhead Project Work Team is being formed as a

satellite team of the Central Valley Salmon Team. We plan to have our first meeting in February. If you are interested in participating, please contact:

Dennis McEwan, California Dept. of Fish and Game, Inland Fisheries Division. (916) 653-9442 dmcewan@hq.dfg.ca.gov.

alone or in combination with the Merced River stock show a statistically significant relationship ($p < 0.05$).

If smolts from Dos Reis survive at a higher rate because of increased flows at Stockton, a similar relationship should be observed for smolts released at Mossdale. The barrier would serve as the mechanism to increase flows at Stockton. It appears that a relationship does exist (Figure 4). It could be that survival is improved via the barrier because of the route, but also because of the increased flows. If this is true then the barrier did improve survival through the Delta in 1997.

One additional piece of evidence that appears to support the conclusion that the barrier did improve survival of smolts migrating through the Delta is shown when Delta survival is compared to tributary survival. In most past years, when Delta survival was low (1996) or high (1995), survival indices from the tributaries were of similar magnitude. For example in 1996, survival for smolts released at Mossdale was 0.02 whereas at the upper Merced and Tuolumne it was 0.01 and 0.04 - of the same magnitude (Table 6). Similarly in 1995, survival from smolts released at Mossdale was 0.22, when the upper tributary release groups survived at a rate of 0.15 and 0.25; again, of the same magnitude. In contrast, 1997 survival index from Mossdale was 0.19 and the upper tributary survival indices were 0.04, indicating that survival through the Delta in 1997 was higher relative to tributary survival than in 1995 and 1996. This indicates that Delta survival was higher in 1997, and could be a result of the barrier.

Although relative to tributary sur-

vival, Delta survival was greater in 1997 than in 1995 or 1996, on an absolute scale, survival through the Delta was actually similar to survival down the tributaries (0.28 and 0.18 for the Merced and Tuolumne rivers respectively, and 0.19 for the Mossdale release). As we did for the Mossdale group relative to the Jersey Point group, survival down the tributaries is estimated using the ratio of the survival index to Chipps Island of the upper tributary group divided by the lower tributary group. Again sampling was not conducted long enough at Jersey Point to generate similar indices or ratios from the tributary releases recovered at Jersey Point.

Real time monitoring and fish facility recoveries. Most recoveries made at real-time monitoring stations were at Turner Cut (Table 3). Although it is difficult to assess the magnitude, it appears salmon do migrate toward the facilities using these routes (i.e. Turner and Columbia Cuts, Webb Tract and False River). The number of expanded SWP and CVP recoveries from the two Dos Reis groups released while the barrier was in place were similar to those recovered from the Mossdale group, again indicating that the barrier was successful at keeping most fish out of Upper Old River (Table 3). Historically we have seen more fish at the facilities from Mossdale releases than from the Dos Reis releases when there is no barrier.

Conclusions and Recommendations for 1998

The barrier and resulting increased flows at Stockton appeared to increase the survival of CWT fish released at Mossdale. Delta survival for those released in the tributaries also seemed to improve over many previous years. The unmarked fish migrating from the San Joaquin basin

while the barrier was in place and during the pulse flow period, likely also experienced improved survival.

Information generated in 1997 seemed to indicate that the impact of the culverts were minimal to smolts passing between Mossdale and Dos Reis.

It is unclear why the last Dos Reis group appeared to survive at a similar rate of earlier Dos Reis releases, after the barrier was removed, flows decreased and exports increased. MRFF smolts released at Dos Reis survived at a higher rate to Chipps Island, relative to the Jersey Point group, than Feather River smolts.

The additional recovery numbers at Jersey Point increases the precision of survival indices to Jersey Point, but needs to be evaluated in light of using paired releases (as done at Chipps Island) to factor out gear efficiency, size, and potentially temperature differences within and between years.

Releases should be continued at both Dos Reis and Mossdale to evaluate any design of a barrier (including no barrier) in Upper Old River. In addition, Jersey Point releases should be continued and paired with Delta and upstream releases to factor out background conditions and any potential bias.

Results of 1997 Yolo Bypass Studies

Ted Sommer, Matt Nobriga, and Bill Harrell, DWR

The Yolo Bypass, the primary floodplain of southern Sacramento Valley, is engineered to carry flood flows from the Sacramento River, Feather River, American River, Sutter Bypass, and westside streams (Figure 1). Surface flow from the 59,000-acre region provides a major source of organic material to the estuary. The Bypass supports an impressive diversity of native and nonnative fish; however, there is also evidence that the basin is a source of mortality for species which become stranded after floodwaters recede. Contaminant inputs from streams and land use in the Yolo basin are additional concerns.

A major habitat restoration project, the Yolo Basin Wetlands (Figure 1), has been constructed in the Bypass. Moreover, CALFED is considering various actions including changing land use and water operations in the Yolo basin, designing bypasses in other regions, and constructing shallow water habitat. The aquatic effects of these changes are not yet well understood.

Recognizing the many unresolved issues in the Yolo Bypass, in late 1996 DWR received funding from IEP and CALFED's Category III program to study the region. A Yolo Bypass Project Work Team was formed in 1997 to initiate the project. The long-term objectives for this study are to examine the relationship between the Yolo Bypass and the rest of the estuary and to develop recommendations for restoration actions that would improve Bypass habitat for fisheries and other aquatic organisms. Our 1997 studies were designed primarily as a preliminary effort to gather more information about the region, select study sites, and test methods. However, to the extent possible, we were inter-

ested in collecting initial data about the status of fish in the basin, particularly chinook salmon. An additional goal was to evaluate trends in pesticide and sediment levels during the hydrologic cycle of the Bypass. The following are some of the highlights of the 1997 studies.

Fish Studies

Diversity, Abundance, Growth and Diet: Most fish sampling was delayed until February 1997, when we obtained the necessary permits from DFG and NMFS. At this point, staff conducted beach seining surveys of Yolo Bypass ponds formed by receding floodwaters. Data from adjacent USFWS Sacramento River beach seine stations were used for comparison.

Table 1 lists the top 10 fish species found in the Yolo Bypass and Sacramento River. In general, native species had higher relative abundance ranks in the Sacramento River, but chinook salmon ranked high in both data sets. Shannon indices showed that Yolo Bypass had higher diversity ($H' = 4.4$) than the Sacramento River ($H' = 3.6$).

Juvenile salmon were primarily in the fall-run and spring-run size classes, although 15 were in the winter-run size class. Salmon abundance based on March sampling was significantly higher in the Sacramento River (Figure 2), but it is likely that Bypass densities were originally higher before bird predation during ponding and before emigration during draining of the basin. The differences may also be due to the methodology or type of habitats sampled. Within the Bypass, there appeared to be higher salmon density in the central Bypass although the

differences were not statistically significant.

Mean salmon size increased substantially faster in the Bypass than the Sacramento River, suggesting better growth rates (Figure 3). An alternative explanation is that the smaller mean size of Sacramento River salmon was the result of steady immigration of young fish from upstream areas or from race differences. Data on water temperature, stomach contents, and sizes of coded-wire-tagged salmon (described later) all support the hypothesis that growth was indeed faster in the Yolo Bypass.

February-April water temperatures were significantly higher in the Yolo Bypass than the Sacramento River (Figure 4). Warmer winter and early spring temperatures typically support faster salmon growth.

Stomach content analyses of 20 CWT salmon collected in Yolo Basin ponds during March and April suggest high feeding success. These salmon were hatchery-produced late fall-run released into the Sacramento River. All fish analyzed had prey items in their stomachs. Gut fullness

Table 1. Top Ten Most Abundant Fish Species in the Yolo Bypass and the Adjacent Reach of the Sacramento River

<i>Native species are shown in italics.</i>	
Yolo Bypass	Sacramento River
Threadfin shad	<i>Chinook salmon</i>
<i>Chinook salmon</i>	Inland silverside
Golden shiner	Threadfin shad
Inland silverside	<i>Sacramento squawfish</i>
Fathead minnow	<i>Sacramento sucker</i>
<i>Sacramento squawfish</i>	Fathead minnow
Red shiner	Wakasagi
Bluegill	<i>Lamprey</i>
Mosquitofish	Mosquitofish
<i>Sacramento sucker</i>	Red shiner