EFFECTS OF PULSE FLOWS ON JUVENILE CHINOOK MIGRATION IN THE STANISLAUS RIVER

1998 ANNUAL REPORT

Prepared for

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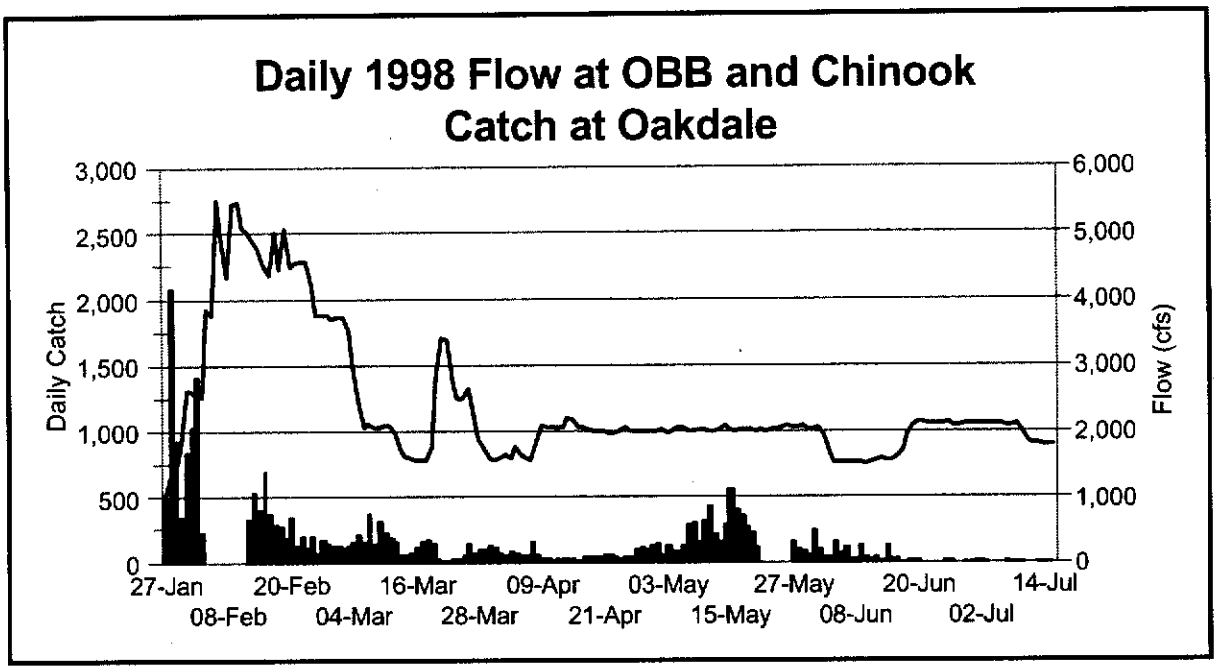

Figure 4. Daily catches of juvenile chinook and Stanislaus River flow, 1998.

TRAP EFFICIENCY

Between March 2 and June 24, we released 9 groups of marked natural migrants and 2 groups of marked hatchery chinook to estimate trapping efficiency (see Table 2). Flow varied between release groups from 1,561 cfs to 3,508 cfs. Capture rates of marked fish ranged 2.7% to 8.6%.

In order to predict the capture efficiency for each day of the sampling season, we needed to relate the efficiency (the response variable) estimated in each of our tests to a predictor variable that was measured on every day that the screw traps were operating. The

predictor variables explored were flow (f) (cubic feet per second, cfs) measured at Orange Blossom Bridge (OBB), fish size (s) (millimeters, mm), and turbidity (t) (NTU's). The analysis revealed that neither fish size nor turbidity contributed significantly to the predictive capability of trap efficiency once flow was included as a predictor variable (Appendix A). Therefore, efficiency (e), the proportion of test fish recovered, was related to flow on the day of release using the logistic equation:

$$e = \frac{1}{1 + \exp^{[-b(0) - b(f) * f]}}$$

This can be rearranged to the "logit" linear transform,

$$logit\ (e) = \ln\left[\frac{e}{1 - e}\right] = b(0) + b(f) * f$$

In the above equations "exp" is the exponential function, "ln" is the natural log, "b(0)" is a coefficient associated with the intercept[1], and b(f) is the coefficient relating the logit transform of efficiency to flow. A major reason for choosing the logistic model is that the predicted efficiency in that model can never be less than 0 and can never exceed 1 (100%). The logistic regression used assumes that variation in trap efficiency follows the binomial distribution.

For some outmigration days, not all predictor variable values were available. Linear extrapolations from the nearest straddling days with true variable measures were used to estimate the missing values of flow, fish size, and turbidity, the extrapolation being based on the number of days separating the missing value from the true measures used. The methods are explained in Appendix A.

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1 Intercept value = $1/\{1+\exp^{-b(0)}\}$ when f = 0.

This missing-value-substitution method is different than that used in previous years because there were longer runs of missing values in 1998, especially for turbidity. For consistency, this same method was then used to recompute missing values of flow and turbidity from 1996; therefore, some of the predictor variable values given in this report differ from those given in the previous report for the 1996 passage. The above methods were also used to interpolate missing daily chinook counts.

SIZE SELECTIVITY OF SCREW TRAP

We examined mean lengths of chinook prior to release and mean lengths at recapture to determine if there was evidence that the traps tended to catch more of the smaller or larger fish from the trap efficiency release groups (Figure 5, Table 3). The prediction method assumes that the trapped fish would be representative of all fish passing the trap. The mean size of recaptured fish did not differ significantly from the mean size of fish at release (Table 3), so there was no evidence that trap efficiency changed with fish size.

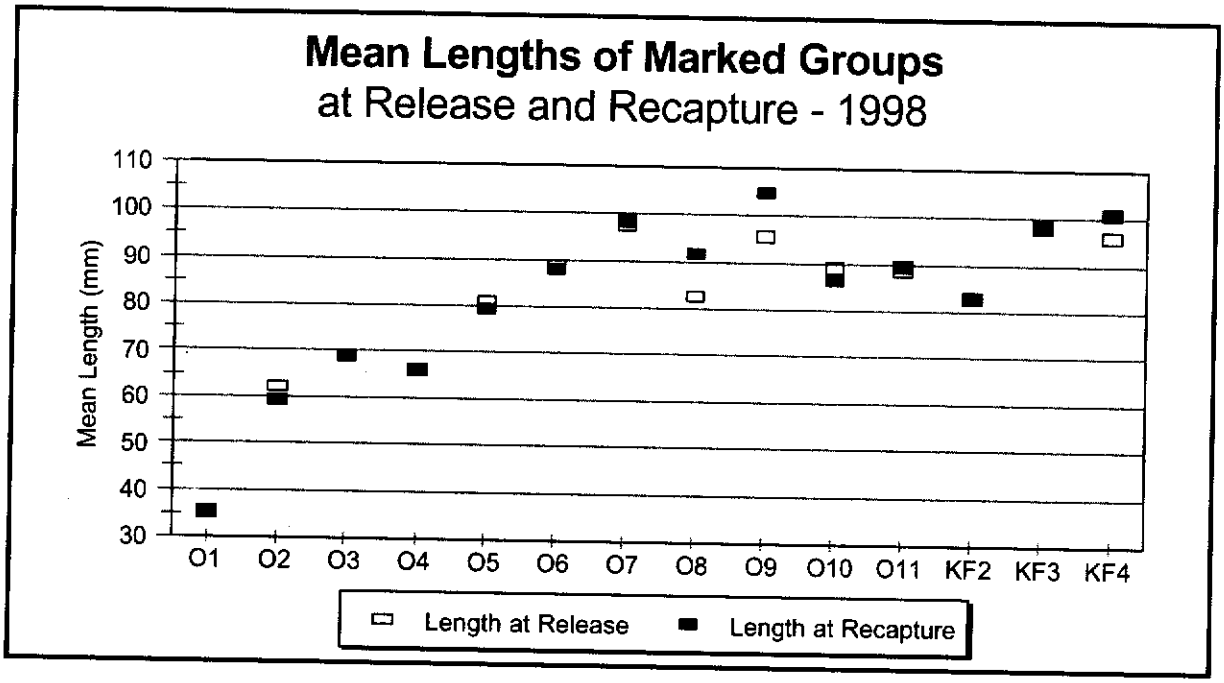

Figure 5. Mean lengths at release and recapture for all marked fish released in 1998.

Table 3. Mean lengths of marked fish at release and recapture.

		Lengths of released (rel) and recovered (rec) fish					
		Released Fish		Recovered Fish		Difference	Weight
Date of Release	Fish Stock	Mean Length	Sample size (n)	Mean Length	Sample size (n)	in mean lengths	for mean comparisons
03/02/98	Natural	35.4	50	35.6	25	0.2	33
03/18/98	Natural	62.2	50	59.3	27	-2.9	35
04/06/98	Natural	68.8	50	69.0	23	0.2	32
04/11/98	Natural	66.3	50	66.1	10	-0.2	17
05/02/98	Natural	81.1	50	79.5	15	-1.6	23
05/30/98	Hatchery	97.6	50	98.5	23	0.9	32
05/30/98	Natural	88.9	50	88.0	19	-0.9	28
06/13/98	Hatchery	95.6	50	104.8	12	9.2	19
06/13/98	Natural	82.7	50	91.7	7	9.0	12
06/24/98	Natural	88.6	50	89.5	4	0.9	7
06/24/98	Natural	89.0	50	86.5	6	-2.5	11
					Weighted1mean difference =	0.576	
					Standard error =	1.104	
					t-ratio (10 d.f.) =	0.52	
					Computed Type I Error probability =	0.6133	

APPENDICIES

Appendix A. Estimated 1998 Trapping Efficiency and Fish Outmigration Index at Oakdale (with updated 1996 outmigration index)

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The daily screw-trap count at Oakdale was expanded by dividing it by the predicted daily trapping efficiency (predicted proportion of fish trapped) to estimate the daily outmigration index:

$$\textit{outmigration index } (o) = \frac{\textit{count } (c)}{\textit{efficiency } (e)}$$

Predicted Trapping Efficiency

Daily screw-trap counts were available from February 6 through June 8, 1996 and from January 27 through July 15, 1998 (hereafter referred to as passage days). On 16 days during these monitoring periods, a total of 20 uniquely marked releases were made at a fixed distance upriver from Oakdale screw trap for the purpose of estimating trapping efficiency[2]. Estimated efficiencies were simply the proportions of the released fish that were later trapped. In order to predict the efficiency for each passage day, the efficiency estimates had to be related as a response or "dependent" variable to predictor or "independent" variable(s) that was (were) measured on every day that the screw traps were operating. Substituting a given day's value(s) of the predictor variable(s) into the predictive relation would then provide an estimate of that day's efficiency.

The prediction method assumes that the trapped fish would be representative of all fish passing the trap. There were no direct methods of assessing this. However, there was evidence that the trapped fish

[2] In 1996, there were 8 release days; on one of those days there were two fish-trap-efficiency releases made. In 1998 there also were 8 release days; on three of those days, there were two fish-trap-efficiency releases per day.

did not differ in size from released fish (whether trapped or not). The mean size of trapped released fish did not significantly or substantially differ from the mean size of a sample of fish taken at release (Table A.1). Even though for the June 13 releases, the released fish's average length exceeded that of the recovered fish my 9 mm or more, this was not representative of the releases. Partitioning the releases into two groups, those with average lengths greater that 70 mm and those with average lengths less than 70 mm, did not result in significant differences in the weighted means of released and recovered fish with groups. For the smaller fish, the weighted mean difference (released - recovered) was only 0.79, and for the larger fish, it was -1.78 mm; neither significantly different than 0 (P = 0.63 and P = 0.26, respectively).

Table A.1. Comparisons in lengths (mm) of fish at times of release and recovery (Oakdale, 1998).

Date of Release	Fish Stock	Lengths of released (rel) and recovered (rec) fish				Difference in mean lengths	Weight for mean comparisons
		Released Fish		Recovered Fish			
		Mean Length	Sample size (n)	Mean Length	Sample size (n)		
03/02/98	Natural	35.4	50	35.6	25	-0.2	33
03/18/98	Natural	62.2	50	59.3	27	2.9	35
04/06/98	Natural	68.8	50	69	23	-0.2	32
04/11/98	Natural	66.3	50	66.1	10	0.2	17
05/02/98	Natural	81.1	50	79.5	15	1.6	23
05/30/98	Hatchery	97.6	50	98.5	23	-0.9	32
05/30/98	Natural	88.9	50	88	19	0.9	28
06/13/98	Hatchery	95.6	50	104.8	12	-9.2	19
06/13/98	Natural	82.7	50	91.7	7	-9	12
06/24/98	Natural	88.6	50	89.5	4	-0.9	7
06/24/98	Natural	89	50	86.5	6	2.5	11
				Weighted[1] mean difference = -0.576			
				Standard error = 1.104			
				t-ratio (10 d.f.) = -0.52			
				Computed Type I Error probability = 0.6133			

[1] Weights are harmonic means of the number of released and recovered fish measured, 2/[1/n(rel)+1/n(rec)], to account for differences in sample numbers within and among pairs