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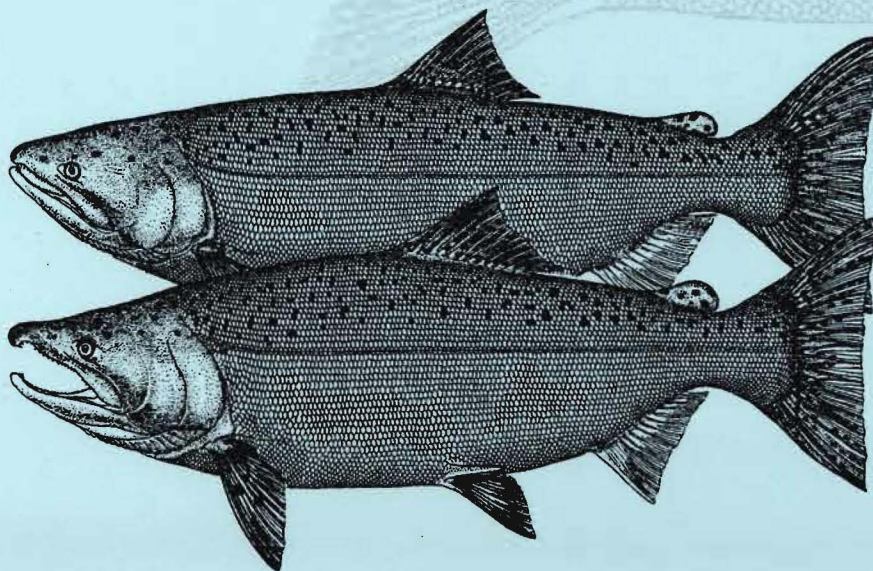
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# ***Research related to transportation of juvenile salmonids on the Columbia and Snake Rivers, 1994***

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February 1996



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## EXECUTIVE SUMMARY

In 1994, the National Marine Fisheries Service (NMFS) researched two principal areas related to smolt transportation: evaluation of the effectiveness of barge transportation and assessment of survival benefits to fish released at a site in the upper estuary, downstream from the standard release site. The first study continued the recovery of adults from fish marked as juveniles and transported from Lower Granite (1986-90) and McNary Dams (1986-88) to a release site below Bonneville Dam. The second was an estuarine release-site study conducted using barged steelhead (*Oncorhynchus mykiss*) smolts marked at Lower Granite Dam from 1992 through 1993.

### Barge Transportation Studies

Low projected flows in Snake River precluded marking of spring/summer chinook salmon (*O. tshawytscha*) and steelhead smolts for the final year of a 3-year reevaluation of transportation from Lower Granite Dam to a release site downstream from Bonneville Dam. Releases for a similar 3-year study of juvenile fall and spring/summer chinook salmon marked and transported from McNary Dam were completed in 1988.

Adult recoveries for the McNary Dam studies continued in 1994, and adult recoveries for juveniles marked at Lower Granite Dam were completed the previous year. We continued to observe high abrasion levels from marine mammal teeth and claws on adult spring/summer chinook salmon sampled at Lower Granite Dam. Prevalence of abrasions in 1994 was 25.5%, with open wounds occurring on about 42% of the fish with abrasions. We also observed lesions on the head and opercula ("headburns") on 5.2% of the adult spring/summer chinook

salmon trapped at the dam this year. The prevalence of these lesions appear to increase during periods of extensive hydroelectric system spill.

For the McNary Dam studies, adult returns from transport and control groups of fall chinook salmon juveniles marked in 1988 are complete. The adult recovery ratio of transport to control groups (T/C) from all areas combined was 3.4, with a 95% confidence interval (CI) between 1.3 and 9.4.

### **Estuarine Release-Site Study**

Between 7 May and 2 June 1994, we marked 9 lots of approximately 9,000 steelhead each for releases near the Columbia River estuary at Tongue Point. Nine lots of 10,000 steelhead each were marked as controls and released at Skamania Light, the standard release site. Overall post-marking delayed mortality and tag loss were low, averaging 2.1 and 2.9%, respectively.

We recovered age-2-ocean steelhead marked as juveniles during the first year of this study in 1992 and age-1-ocean steelhead from the second year of smolt marking in 1993. Adult returns for both study years were much lower than expected. So far, age-1- and age-2-ocean adult returns for the 1992 study year total only 69 fish from the Tongue Point release (0.12% of the juveniles released) and 78 fish from the Skamania Light release (0.10%). Likewise, age-1-ocean adult returns from the 1993 study year total only 29 (0.05%) and 37 (0.06%) fish from the Tongue Point and Skamania Light releases, respectively.

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## TRANSPORTATION STUDIES: LOWER GRANITE AND MCNARY DAMS

### Introduction

Since 1981, the U.S. Army Corps of Engineers (COE) has conducted an annual barge transportation program for juvenile anadromous salmonids migrating downstream through the hydropower complex on the Columbia and Snake Rivers. To continue to monitor the program's relative success, spring/summer chinook salmon (*Oncorhynchus tshawytscha*) smolts were marked at Lower Granite Dam in 1983, 1984, and 1985, and steelhead (*O. mykiss*) smolts were marked in 1984 and 1985. No paired control groups of either species were marked during any of these years.

The 1985 smolt-marking operations were conducted by the Fish Passage Center (formerly the Water Budget Center) under contract to the COE. Therefore, data on these juvenile releases were not reported by NMFS. However, NMFS has reported final adult returns for juveniles marked and released in 1983, 1984, and 1985 (Harmon et al. 1989, Matthews et al. 1990).

By 1985, preliminary adult returns from the 1983 and 1984 marking efforts had indicated that survival of marked, transported smolts had improved considerably compared to returns of smolts marked during the 1976-80 study years (Park et al. 1986). We believe a combination of factors was responsible for the observed increase in smolt-to-adult survival. These factors included the following: major improvements in transport and collection facilities, improved fish quality, greatly improved fish handling/marketing techniques, and a period of favorable near-ocean rearing conditions (Ware and Thomson 1991).

In 1986, a new 3-year transportation study was initiated to assess survival of spring/summer chinook salmon and steelhead transported from Lower Granite Dam and spring/summer and fall chinook salmon transported from McNary Dam. The primary goal of the study was to reevaluate transportation of smolts around dams, utilizing greatly improved collection/transport and handling/marketing techniques, and reflecting other system improvements.

At McNary Dam, we marked transport and inriver-migrating groups of spring/summer and fall chinook salmon for 3 consecutive years (1986-88). At Lower Granite Dam, we marked transport and inriver-migrating groups of spring/summer chinook salmon and steelhead in 1986 and 1989. Drought conditions caused low river flows in 1987 and 1988 and from 1990 through 1993. As a result, no inriver-migrating releases were marked in those years. In 1987, barge transport groups of spring/summer chinook salmon and steelhead were marked to monitor adult return rates. In 1990, only spring/summer chinook salmon smolts were marked for this purpose.

While recovery of adults for some of these marking efforts is complete, other adult recovery efforts are ongoing. Adult return data for spring/summer chinook salmon and steelhead smolts transported from Lower Granite Dam in 1986 and spring/summer chinook salmon smolts released in 1987, 1989, and 1990 have been reported (Matthews et al. 1992, Achord et al. 1992, Harmon et al. 1993, Harmon et al. 1995). For juveniles transported from McNary Dam, complete reports of adult returns include those for spring/summer chinook salmon released in 1986 (Matthews et al. 1992), 1987 (Achord et al. 1992), and 1988 (Harmon et al. 1993), and for fall chinook salmon released in 1986 (Harmon et al. 1993) and



1987 (Harmon et al. 1995). Here we report the results from complete adult returns of fall chinook salmon marked and transported from McNary Dam in 1988.

To determine the hatchery/wild composition of the Snake River spring/summer chinook salmon population, NMFS and the Oregon Department of Fish and Wildlife (ODFW) began a study in 1991. The study used a discriminant function scale analysis on smolts and returning adults to distinguish between hatchery and wild fish (Achord et al. 1992; Harmon et al. 1993, 1995). In particular, the study was intended to examine the hatchery/wild composition of each marked group of smolts for the transportation study and to examine the scales of those subsequently returning as adults. Since drought conditions precluded marking of smolts for the 1991, 1992, and 1993 study years, we sampled scales from adults returning from previous marking efforts and from the general population in those years. In 1994, we sampled scales only from the smolt population collected at Lower Granite Dam. Results from the 1994 juvenile scale analysis are reported in Appendix B.

## **Methods**

### **General**

Smolts at both dams were anesthetized and marked with coded-wire tags (CWT) and freeze brands during the smolt migration each year. Smolts were marked according to the procedures described by Matthews et al. (1987). After recovery from anesthesia, smolts were either transported by barge for release below Bonneville Dam or released as inriver controls below Little Goose or McNary Dams.



## Recovery of Adults and Data Analysis

Adults were recovered from 3 to 6 years after their release as juveniles, depending upon species and study site. Traps in fish ladders at Lower Granite and Priest Rapids Dams (for McNary Dam releases) were the primary recovery sites for spring/summer chinook salmon and steelhead. Ocean and river commercial fisheries were primary recovery sites for fall chinook salmon marked at McNary Dam. If recoveries were sufficient, trapping efficiencies were estimated for individual release lots by comparing the number of marked trap recoveries to the total number of marked fish returning to the hatcheries and, when available, to recoveries from tributary sport fisheries and natal spawning areas.

Evaluation of transportation was based upon adult recovery transport/control ratios (T/C) from fish marked as juveniles. A 95% confidence interval (CI) was used to test the null hypothesis that the true T/C was equal to one. If the 95% CI did not include a ratio equal to one, then the null hypothesis was rejected. Beginning at Lower Granite Dam in 1989, the study design was adjusted to measure the precision around an expected T/C of 1.5, with a coefficient of variation of 10% for spring/summer chinook salmon and 7.5% for steelhead.

To normalize the distribution, ratios were log-transformed prior to CI construction. The endpoints of the CI were then back-transformed to provide a nonsymmetric CI on the original scale. For analysis of total recoveries, the CI was calculated using both theoretical and empirical estimates of variance. The CI employing the empirical variance estimate was preferred.

The 95% CI obtained using transformed data based on theoretical variance was derived by the following term:

$$\ln(T/C) \pm 1.96 \sqrt{\frac{1}{n_t} + \frac{1}{n_c} - \frac{1}{N_t} - \frac{1}{N_c}}$$

The 95% CI was then back-transformed to its original scale using the following term:

$$\left( e^{\ln(T/C) - 1.96 \sqrt{\frac{1}{n_t} + \frac{1}{n_c} - \frac{1}{N_t} - \frac{1}{N_c}}}, e^{\ln(T/C) + 1.96 \sqrt{\frac{1}{n_t} + \frac{1}{n_c} - \frac{1}{N_t} - \frac{1}{N_c}}} \right)$$

The 95% CI obtained using transformed data based on empirical variance was derived by the following term:

$$\ln(T/C) \pm t_{0.05}^{n-1} SE(\ln(T/C))$$

The 95% CI was then back-transformed to the original scale using the following term:

$$\left( e^{\ln(T/C) - t_{0.05}^{n-1} SE(\ln(T/C))}, e^{\ln(T/C) + t_{0.05}^{n-1} SE(\ln(T/C))} \right)$$

where,

$T/C$  = overall transport recovery percentage divided by  
overall control recovery percentage

$SE$  = standard deviation of the  $r$  replicate  $\ln(T/C)$ 's  
divided by  $r^{1/2}$

$n_t$  = total of transport recoveries

$n_c$  = total of control recoveries

$N_t$  = total of transport releases

$N_c$  = total of control releases

$t$  = the  $t$  probability for a two-sided significance level  
 $\alpha = 0.05$  and  $n-1$  degrees of freedom

1.96 = the normal probability for a two-sided  $\alpha = 0.05$

## **Results and Discussion**

### **Adult Recoveries for Lower Granite Dam Studies**

Adult recoveries were completed in 1993 for all spring/summer chinook salmon and steelhead smolts marked at Lower Granite Dam for recent barge transport research or indexing purposes. Results from these recoveries were reported by Achord et al. (1992), Matthews et al. (1992), and Harmon et al. (1993, 1995).

**Marine mammal abrasions**--We continued monitoring the prevalence of marine mammal tooth and claw abrasions on adult spring/summer chinook salmon during 1994. Overall prevalence of abrasions was the highest ever recorded, averaging 25.5% of the fish sampled (Table 1). Approximately 42% of the abrasions were open wounds of varying severity, and this percentage also represented the highest prevalence ever recorded. As in past years, the prevalence of abrasions was generally higher during the earliest portion of the run (Matthews et al. 1992; Achord et al. 1992; Harmon et al. 1993, 1995). We continue to be concerned about the potential negative effects of marine mammals on depressed runs of wild Snake River spring/summer chinook salmon.

**"Headburns"**--In 1993, we first reported numerous adult spring/summer chinook salmon with a malady not observed for many years--lesions occurring primarily on the top of

Table 1. Weekly prevalence (25 April to 31 July) of marine mammal tooth and claw abrasions on adult spring/summer chinook salmon at Lower Granite Dam in 1994.

Date	Sample size	Incidence (%)
25 April-1 May	12	50.0
2-8 May	30	26.7
9-15 May	87	33.3
16-22 May	69	31.9
23-29 May	65	24.6
30 May-5 June	41	29.3
6-12 June	58	25.9
13-19 June	60	20.0
20-26 June	46	8.7
27 June-3 July	43	25.6
4-10 July	28	17.9
11-17 July	14	14.3
18-24 July	4	25.0
25-31 July	3	0.0
Total	560	Average 25.5*

\* Open wounds were associated with 42.0% of the abrasions.

the head and, to a lesser extent, on the opercula (Harmon et al. 1995). We termed these lesions "headburns" because of their similarity in appearance to third-degree burns. The condition appears to coincide with periods of sustained spill in the hydropower system (Harmon et al. 1995).

We continued monitoring headburn incidence at Lower Granite Dam in 1994. Lesions occurred on 5.2% of the adult spring/summer chinook salmon sampled. This percentage was somewhat lower than that measured in 1993 (8.3%), when hydropower system flow and spill levels were higher. The lesions were also smaller and less severe than those observed in 1993. Approximately 66% of the fish with lesions were observed after 15 June. Prespawning mortality would undoubtedly be higher than normal for fish suffering from this affliction as well as for fish with open, pinniped-related wounds.

### **Adult Recoveries for McNary Dam Studies**

**Fall chinook salmon**--Adult returns are complete for fall chinook salmon marked and released as juvenile transport and inriver control groups from McNary Dam in 1988 (Table 2 and Appendix Tables 1.0 through 2.6). Only 60 transports and 18 controls were recovered from all recovery areas combined. We constructed 95% CIs using empirical standard errors (Table 3). For all recovery sites combined, the T/C and 95% CI were 3.3 and (1.3, 9.4). Even though recovery numbers were low, the data also showed significant transport benefits to the ocean and river commercial fisheries. The T/Cs for the 1988 study year are similar to those reported for the 1986 (Harmon et al. 1993) and 1987 (Harmon et al. 1995) study years.

Table 2. Summary of recovered adult fall chinook salmon marked at McNary Dam in 1988 (recoveries through January 1995). Numbers in parentheses represent fish that were jaw-tagged at the dam and subsequently recovered upstream.

Groups	Number released	Ocean-age	Observed adult returns						Total	
			Ocean fishery	Bonneville Dam	River fishery	Indian fishery	Hatcheries	Stream surveys	N	%
1988 Transport	60,013	1	1	0	1	0	1	0	3	0.00
		2	5	3 (2)	1	1	1	0	9	0.01
		3	9	4	6	5	3	1	28	0.05
		4	7	4	4	4	0	0	19	0.03
		5	1	0	0	0	0	0	1	0.00
		Total	23	11 (2)	12	10	5	1	60	0.10
1988 Control	60,010	1	0	0	0	0	1	0	1	0.00
		2	2	2	1	2	0	0	7	0.01
		3	0	1	0	1	0	1	3	0.00
		4	4	1	1	0	1	0	7	0.01
		5	0	0	0	0	0	0	0	0.00
		Total	6	4	2	3	2	1	18	0.03

\* Fish captured more than once were only counted once in totals.

Table 3. Summary of T/Cs and 95% CIs for adult recoveries of fall chinook salmon marked as smolts at McNary Dam in 1986, 1987, and 1988.

Recovery site	1986		1987		1988	
	T/C <sup>a</sup>	(95% CI <sup>b</sup> )	T/C	(95% CI)	T/C	(95% CI)
Ocean fishery	3.0	(1.7, 5.4)	4.6	(2.0, 10.5)	3.8	(1.6, 9.4)
River commercial	3.4	(1.8, 6.2)	4.0	(1.8, 8.7)	6.0	(1.3, 26.8)
Bonneville Dam	3.8	(1.3, 11.1)	2.9	(1.4, 6.1)	2.8	(0.9, 8.6)
Indian fishery	3.1	(1.2, 7.8)	4.4	(1.2, 17.2)	3.3	(0.9, 12.1)
Hatcheries	1.5	(0.4, 5.9)	1.5	(0.6, 3.8)	2.5	(0.5, 12.9)
Spawning ground	3.3	(---, ---) <sup>c</sup>	3.8	(1.2, 11.3)	1.0	(0.1, 16.0)
Combined	2.8	(1.4, 5.6)	3.5	(1.7, 7.1)	3.3	(1.3, 9.4)

<sup>a</sup> Adult recovery transport to control ratio

<sup>b</sup> Empirical confidence interval

<sup>c</sup> Insufficient adult recoveries to estimate



## ESTUARINE RELEASE-SITE STUDY

### Introduction

There is a growing body of evidence suggesting that survival of juvenile salmonids can be enhanced by releasing them into upper areas of estuaries rather than farther upstream in freshwater areas. In Scandinavian countries, releases of hatchery-reared Atlantic salmon (*Salmo salar*) smolts directly into estuarine waters have resulted in increased survival compared to similar releases in fresh water (Gunnerod et al. 1988). Macdonald et al. (1988) and Levings et al. (1989) speculated that increased survival of salmonid juveniles released into estuarine areas was related to decreased predation and stress, increased food availability, and ease of osmoregulation in the estuary. In a 5-year study, Solazzi et al. (1991) released hatchery-reared coho salmon (*O. kisutch*) immediately below Bonneville Dam (control), at Tongue Point (upper intrusion of salt water in the estuary), and at several locations offshore in the Columbia River plume. They reported a smolt-to-adult survival rate 1.6 times higher for fish released at Tongue Point than for the control group.

After release at the site immediately below Bonneville Dam, smolts transported from the Snake River must migrate approximately 150 km through the lower Columbia River before arriving at the estuary. Although the river is free-flowing in this reach, the area is known to harbor large numbers of predators, primarily northern squawfish (*Ptychocheilus oregonensis*) and various avian species. The studies mentioned above suggest that mortality from predation alone may be of sufficient magnitude to warrant the additional transport distance.

In spring 1992, we began a 3-year study to determine if marked hatchery and wild steelhead smolts, transported by barge and released in the upper estuary at Tongue Point, would return as adults to Lower Granite Dam in significantly greater numbers than those transported by barge and released at the traditional site near Skamania Light (just downstream from Bonneville Dam). In spring 1993, we marked steelhead smolts for the second year of this study. Spring/summer chinook salmon were not included in the present study, because it was not feasible to mark the excessively large numbers of smolts required to detect small differences in survival for this species. Depending upon the results of the study for steelhead, spring/summer chinook salmon may be tested in the future.

In spring 1994, we marked steelhead smolts for the third and final year of the study and recovered age-2-ocean adult steelhead from the 1992 study year and age-1-ocean adult steelhead from the 1993 study year. Results of these efforts are reported here.

### Methods

In 1994, all sampling and marking was again conducted using a new fish-handling system, which we designed and installed adjacent to the new upstream raceways at Lower Granite Dam in 1993. The system included preanesthesia handling equipment (Matthews et al. 1986). With this facility, the large numbers of smolts required for transportation research were sorted and marked without impacting other sampling and fish-handling activities at the collection facility.

The basic marking methodology was the same as that described by Matthews et al. (1987) and Harmon et al. (1993). Fish used in the study were systematically sampled from

the population passing through the fish and debris separator at the juvenile fish collection and handling facility. Two of the upstream raceways were used to collect and hold sampled fish prior to marking. Tongue Point (upper estuary) releases were considered test groups and Skamania Light (below Bonneville Dam) releases were considered control groups. From 7 May to 2 June, we marked 9 release lots of approximately 19,000 steelhead each with CWTs, freeze brands, and left ventral fin clips, for a total of 147,155 marked fish (Appendix Table 3.0). Lots consisted of approximately 10,000 steelhead smolts each for release at Skamania Light and 9,000 steelhead smolts each for release in the upper estuary near Tongue Point. These numbers of marked smolts were sufficient to test a T/C of 1.1, with a 5.0% coefficient of variation.

Fish for each release lot were marked and transferred into a raceway the first day and loaded onto a barge the next day. For the Tongue Point releases, additional fish were loaded onto the 2000-series barges so that hauling densities approached those on the barge used for the Skamania Light releases. Periodic samples of marked smolts were held for 24 hours to measure post-marking delayed mortality and tag loss.

Both of the older, 2000-series barges and an additional tugboat were required for this study. Each 2000-series barge was used in tandem with a larger barge for the trip from Lower Granite Dam to Bonneville Dam. Once at Bonneville Dam, the additional tugboat moved the 2000-series barge with the test group the remaining distance downstream to the Tongue Point release site. The tug then returned the empty 2000-series barge to Bonneville Dam for reattachment to a larger barge returning to Lower Granite Dam.

The 2000-series barges were used only for the Tongue Point releases because their compartments cannot be emptied independently. The Skamania Light releases were transported and released with the same barges used during normal smolt transport operations. To avoid delaying releases of Tongue Point fish, the marking was scheduled so that 2000-series barges were at opposite ends of the transport cycle at any given time.

Adults will be recovered in each of 3 years following the juvenile releases with Lower Granite Dam as the primary evaluation point. Statistical analysis of the results will be the same as previously described for the other transportation studies.

## **Results and Discussion**

### **Smolt Marking**

Smolt marking was delayed until 7 May because all barges were engaged in the transport of large numbers of smolts collected for normal transport operations prior to that time. Also, both test groups marked on 7 May had to be released at Skamania Light in order to expedite the return of both barges to Lower Granite Dam. The barges were needed to transport the unexpectedly large numbers of smolts still arriving at the dam. Therefore, adult returns from the 7 May releases will not be used to calculate survival ratios.

Post-marking delayed mortality and tag loss were low, averaging 2.1% and 2.9%, respectively (Appendix Table 4.0). The new handling/marketing system at Lower Granite Dam continued to perform exceptionally well, allowing us to quickly and safely handle and mark large numbers of smolts.

## **Adult Recoveries**

At Lower Granite Dam, preliminary adult returns of steelhead smolts marked for the release-site study in 1992 and 1993 have been exceptionally poor (Table 4 and Appendix Tables 5.0 through 8.6). Age-1- and age-2-ocean adult returns from the 1992 study year totaled only 69 fish from the Tongue Point releases (0.12% of the release) and 78 fish from the Skamania Light releases (0.10% of the release). Likewise, age-1-ocean adult returns from the 1993 study year total only 29 fish from the Tongue Point releases (0.05% of the release) and 37 fish from the Skamania Light releases (0.06% of the release).

These adult return rates were much lower than expected for both study years, but were consistent with the overall very poor adult returns observed for both steelhead and spring/summer chinook salmon from the two smolt migration years. Low river flows and warmer-than-normal water temperatures during spring 1992 may have contributed to the abysmal adult returns for that study year. However, we believe that periodic, exceptionally unfavorable estuary and/or early-ocean conditions continued as the primary causative factors of poor adult returns, as posited earlier by Achord et al. (1992).

To complete the release-site study, we will continue recovering adult steelhead at Lower Granite Dam. Complete adult returns for the 3-year study will be available in spring 1998. Unfortunately, the extremely depressed adult steelhead returns reported above have already compromised results from the first 2 study years.

Table 4. Preliminary summary of recovered adult steelhead marked at Lower Granite Dam in 1992 and 1993 and transported to either Tongue Point or below Bonneville Dam (recoveries through January 1995). Numbers in parentheses represent fish that were jaw-tagged at the dams and subsequently recovered upstream.

Group	Number released	Observed adult returns							Total	
		Ocean-age	River fishery	Indian fishery	Lower Granite Dam			Hatcheries	N	%
					N		%			
1992										
Tongue Point	55,366	1	12	2	32	(10)	0.06	2	38	0.07
		2	2	4	37	(2)	0.07	0	41	0.07
		Total	14	6	69	(12)	0.12	2	79	0.14
1992										
Bonneville	60,577	1	8	1	32	(6)	0.05	0	35	0.06
		2	3	3	46	(3)	0.08	0	49	0.08
		Total	11	4	78	(9)	0.10	0	84	0.14
1993										
Tongue Point	62,348	1	0	1	29		0.05	0	30	0.05
1993										
Bonneville	65,987	1	1	2	37	(1)	0.06	0	39	0.06

\* Fish captured more than once were only counted once in totals.

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## **Appendix A**

### **Data Tables**

Appendix Table 1.0. Summary of all recoveries of adult fall chinook salmon released as juveniles below McNary Dam in 1988.

Master File Date : 10 January 1995  
 RELEASE GROUPS INCLUDED: 8804A 8804B 8804C 8804D 8804E 8804F 8804G

1988 MCNARY

TRANS CONTROL

BELOW MCNARY

FALL CHINOOK

Brands Used: LAIT1 LAIT2 LAIT3 LAIT4 LA2X1 LA2X3 LAIC1  
 Wire Codes Used: 232246 232247 232248 232249 232250 232048 232049

RECOVERY AREA	1988	YEAR OF RETURN		1991	1992	1993	NUMBER RELEASED: 60010	
		1989	1990				TOTAL	% RETURN
RIVER SYSTEM TRAPS								
BONNEVILLE TRAP	0	0	2	1	1	0	4	0.007
OCEAN FISHERIES								
ALASKA	0	0	0	0	3	0	3	0.005
BRITISH COLUMBIA	0	0	1	0	1	0	2	0.003
OREGON	0	0	1	0	0	0	1	0.002
RIVER SPORT	0	0	0	0	0	0	0	0.000
RIVER COMMERCIAL								
COMMERCIAL NET	0	0	1	0	0	0	1	0.002
COL. R. TEST FSHRY (ORE)	0	0	0	0	1	0	1	0.002
INDIAN FISHERIES								
FALL INDIAN NET	0	0	2	1	0	0	3	0.005
HATCHERIES								
PRIEST RAPIDS H.	0	1	0	0	1	0	2	0.003
STREAM SURVEY								
GENERAL	0	0	0	1	0	0	1	0.002
TOTALS	0	1	7	3	7	0	18	0.030
PERCENT OF RECOVERY	%	0.0	5.6	38.9	16.7	38.9	0.0	

Appendix Table 1.1. Recoveries of adult fall chinook salmon released as juveniles below McNary Dam from 13 to 21 June 1988.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 8804A

1988 MCNARY

TRANS CONTROL

BELOW MCNARY

FALL CHINOOK

Brands Used: LAIT1  
Wire Codes Used: 232246

RECOVERY AREA	1988	YEAR OF RETURN		1991	1992	1993	NUMBER RELEASED: 10002	
		1989	1990				TOTAL	% RETURN
RIVER SYSTEM TRAPS								
BONNEVILLE TRAP	0	0	1	1	0	0	2	0.020
OCEAN FISHERIES								
ALASKA	0	0	0	0	2	0	2	0.020
OREGON	0	0	1	0	0	0	1	0.010
RIVER SPORT	0	0	0	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0	0	0	0.000
INDIAN FISHERIES								
FALL INDIAN NET	0	0	1	0	0	0	1	0.010
HATCHERIES	0	0	0	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0	0	0	0.000
TOTALS	0	0	3	1	2	0	6	0.060
PERCENT OF RECOVERY	%	0.0	0.0	50.0	16.7	33.3	0.0	

Appendix Table 1.2. Recoveries of adult fall chinook salmon released as juveniles below McNary Dam from 23 to 26 June 1988.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 8804C

1988 MCNARY

TRANS CONTROL

BELOW MCNARY

FALL CHINOOK

Brands Used: LAIT3  
Wire Codes Used: 232248

NUMBER RELEASED: 10002

RECOVERY AREA	1988	YEAR OF RETURN		1991	1992	1993	TOTAL	% RETURN
		1989	1990					
RIVER SYSTEM TRAPS								
BONNEVILLE TRAP	0	0	1	0	1	0	2	0.020
OCEAN FISHERIES	0	0	0	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0	0	0	0.000
INDIAN FISHERIES								
FALL INDIAN NET	0	0	1	0	0	0	1	0.010
HATCHERIES								
PRIEST RAPIDS H.	0	1	0	0	1	0	2	0.020
STREAM SURVEY	0	0	0	0	0	0	0	0.000
TOTALS	0	1	2	0	2	0	5	0.050
PERCENT OF RECOVERY	%	0.0	20.0	40.0	0.0	40.0	0.0	

Appendix Table 1.3. Recoveries of adult fall chinook salmon released as juveniles below McNary Dam from 27 June to 1 July 1988.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 8804D

1988 MCNARY

TRANS CONTROL

BELOW MCNARY

FALL CHINOOK

Brands Used: LAIT4  
Wire Codes Used: 232249

RECOVERY AREA	1988	YEAR OF RETURN		1991	1992	1993	NUMBER RELEASED:	
		1989	1990				TOTAL	% RETURN
RIVER SYSTEM TRAPS	0	0	0	0	0	0	0	0.000
OCEAN FISHERIES								
BRITISH COLUMBIA	0	0	1	0	0	0	1	0.010
RIVER SPORT	0	0	0	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0	0	0	0.000
INDIAN FISHERIES	0	0	0	0	0	0	0	0.000
HATCHERIES	0	0	0	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0	0	0	0.000
TOTALS	0	0	1	0	0	0	1	0.010
PERCENT OF RECOVERY	%	0.0	0.0	100.0	0.0	0.0	0.0	

Appendix Table 1.4. Recoveries of adult fall chinook salmon released as juveniles below McNary Dam from 5 to 13 July 1988.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 8804E

1988 MCNARY

TRANS CONTROL

BELOW MCNARY

FALL CHINOOK

Brands Used: LA2X1  
Wire Codes Used: 232250

							NUMBER RELEASED:	10002
RECOVERY AREA	1988	YEAR OF RETURN		1991	1992	1993	TOTAL	% RETURN
		1989	1990					
RIVER SYSTEM TRAPS	0	0	0	0	0	0	0	0.000
OCEAN FISHERIES								
BRITISH COLUMBIA	0	0	0	0	1	0	1	0.010
RIVER SPORT	0	0	0	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0	0	0	0.000
INDIAN FISHERIES								
FALL INDIAN NET	0	0	0	1	0	0	1	0.010
HATCHERIES	0	0	0	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0	0	0	0.000
TOTALS	0	0	0	1	1	0	2	0.020
PERCENT OF RECOVERY	%	0.0	0.0	0.0	50.0	50.0	0.0	



Appendix Table 1.5. Recoveries of adult fall chinook salmon released as juveniles below McNary Dam from 13 to 14 July 1988.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 8804F

1988 MCNARY

TRANS CONTROL

BELOW MCNARY

FALL CHINOOK

Brands Used: LA2X3  
Wire Codes Used: 232048

RECOVERY AREA	1988	YEAR OF RETURN		1991	1992	1993	NUMBER RELEASED:	
		1989	1990				TOTAL	% RETURN
RIVER SYSTEM TRAPS	0	0	0	0	0	0	0	0.000
OCEAN FISHERIES ALASKA	0	0	0	0	1	0	1	0.020
RIVER SPORT	0	0	0	0	0	0	0	0.000
RIVER COMMERCIAL COMMERCIAL NET	0	0	1	0	0	0	1	0.020
INDIAN FISHERIES	0	0	0	0	0	0	0	0.000
HATCHERIES	0	0	0	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0	0	0	0.000
TOTALS	0	0	1	0	1	0	2	0.040
PERCENT OF RECOVERY	%	0.0	0.0	50.0	0.0	50.0	0.0	

Appendix Table 1.6. Recoveries of adult fall chinook salmon released as juveniles below McNary Dam from 18 to 21 July 1988.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 8804G

1988 MCNARY

TRANS CONTROL

BELOW MCNARY

FALL CHINOOK

Brands Used: LAIC1  
Wire Codes Used: 232049

RECOVERY AREA	1988	YEAR OF RETURN		1991	1992	1993	NUMBER RELEASED:	
		1989	1990				TOTAL	% RETURN
RIVER SYSTEM TRAPS	0	0	0	0	0	0	0	0.000
OCEAN FISHERIES	0	0	0	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0	0	0	0.000
RIVER COMMERCIAL COL. R. TEST FSHRY (ORE)	0	0	0	0	1	0	1	0.020
INDIAN FISHERIES	0	0	0	0	0	0	0	0.000
HATCHERIES	0	0	0	0	0	0	0	0.000
STREAM SURVEY GENERAL	0	0	0	1	0	0	1	0.020
TOTALS	0	0	0	1	1	0	2	0.040
PERCENT OF RECOVERY	%	0.0	0.0	0.0	50.0	50.0	0.0	

Appendix Table 2.0. Summary of all recoveries of adult fall chinook salmon transported as juveniles by barge from McNary Dam to below Bonneville Dam in 1988.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 8803A 8803B 8803C 8803D 8803E 8803F

1988 MCNARY

TRANS BARGE

BELOW BONNEVILLE

FALL CHINOOK

Brands Used: RAIU1 RAIU2 RAIU3 RAIU4 RAID1 RAID3  
Wire Codes Used: 232260 232261 232301 232302 232303 232304

NUMBER RELEASED: 60013

RECOVERY AREA	1988	YEAR OF RETURN		1991	1992	1993	TOTAL	% RETURN
		1989	1990					
RIVER SYSTEM TRAPS								
BONNEVILLE TRAP	0	0	3	4	4	0	11	0.018
OCEAN FISHERIES								
ALASKA	0	0	3	5	3	1	12	0.020
BRITISH COLUMBIA	0	1	1	4	4	0	10	0.017
WASHINGTON	0	0	1	0	0	0	1	0.002
RIVER SPORT								
COLUMBIA R. BELOW SNAKE R.	0	0	1	1	1	0	3	0.005
COLUMBIA R. ABOVE SNAKE R.	0	0	0	1	1	0	2	0.003
RIVER COMMERCIAL								
COMMERCIAL NET	0	1	0	4	2	0	7	0.012
INDIAN FISHERIES								
INDIAN GENERAL	0	0	1	0	0	0	1	0.002
FALL INDIAN NET	0	0	0	5	4	0	9	0.015
HATCHERIES								
PRIEST RAPIDS H.	0	1	1	3	0	0	5	0.008
STREAM SURVEY								
GENERAL	0	0	0	1	0	0	1	0.002
TOTALS	0	3	11	28	19	1	62	0.103
PERCENT OF RECOVERY	%	0.0	4.8	17.7	45.2	30.6	1.6	

Appendix Table 2.1. Recoveries of adult fall chinook salmon transported as juveniles by barge from McNary Dam to below Bonneville Dam from 13 to 21 June 1988.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 8803A

1988 MCNARY

TRANS BARGE

BELOW BONNEVILLE

FALL CHINOOK

Brands Used: RAIU1  
Wire Codes Used: 232260

RECOVERY AREA	1988	YEAR OF RETURN		1991	1992	1993	NUMBER RELEASED: 10002	
		1989	1990				TOTAL	% RETURN
RIVER SYSTEM TRAPS								
BONNEVILLE TRAP	0	0	2	0	1	0	3	0.030
OCEAN FISHERIES	0	0	0	0	0	0	0	0.000
RIVER SPORT								
COLUMBIA R. BELOW SNAKE R.	0	0	1	0	1	0	2	0.020
RIVER COMMERCIAL	0	0	0	0	0	0	0	0.000
INDIAN FISHERIES	0	0	0	0	0	0	0	0.000
HATCHERIES								
PRIEST RAPIDS H.	0	0	0	1	0	0	1	0.010
STREAM SURVEY	0	0	0	0	0	0	0	0.000
TOTALS	0	0	3	1	2	0	6	0.060
PERCENT OF RECOVERY	%	0.0	0.0	50.0	16.7	33.3	0.0	

Appendix Table 2.2. Recoveries of adult fall chinook salmon transported as juveniles by barge from McNary Dam to below Bonneville Dam from 21 to 23 June 1988.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 8803B

1988 MCNARY

TRANS BARGE

BELOW BONNEVILLE

FALL CHINOOK

Brands Used: RAIU2  
Wire Codes Used: 232261

RECOVERY AREA	1988	YEAR OF RETURN					NUMBER RELEASED:	
		1989	1990	1991	1992	1993	TOTAL	% RETURN
RIVER SYSTEM TRAPS	0	0	0	0	0	0	0	0.000
OCEAN FISHERIES ALASKA	0	0	1	1	0	0	2	0.020
RIVER SPORT	0	0	0	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0	0	0	0.000
INDIAN FISHERIES	0	0	0	0	0	0	0	0.000
HATCHERIES PRIEST RAPIDS H.	0	0	1	0	0	0	1	0.010
STREAM SURVEY	0	0	0	0	0	0	0	0.000
TOTALS	0	0	2	1	0	0	3	0.030
PERCENT OF RECOVERY	%	0.0	0.0	66.7	33.3	0.0	0.0	

Appendix Table 2.3. Recoveries of adult fall chinook salmon transported as juveniles by barge from McNary Dam to below Bonneville Dam from 23 to 26 June 1988.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 8803C

1988 MCNARY

TRANS BARGE

BELOW BONNEVILLE

FALL CHINOOK

Brands Used: RAIU3  
Wire Codes Used: 232301

RECOVERY AREA	1988	YEAR OF RETURN					NUMBER RELEASED:	
		1989	1990	1991	1992	1993	TOTAL	% RETURN
RIVER SYSTEM TRAPS								
BONNEVILLE TRAP	0	0	1	2	1	0	4	0.040
OCEAN FISHERIES	0	0	0	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0	0	0	0.000
INDIAN FISHERIES								
INDIAN GENERAL	0	0	1	0	0	0	1	0.010
HATCHERIES								
PRIEST RAPIDS H.	0	1	0	0	0	0	1	0.010
STREAM SURVEY	0	0	0	0	0	0	0	0.000
TOTALS	0	1	2	2	1	0	6	0.060
PERCENT OF RECOVERY	%	0.0	16.7	33.3	33.3	16.7	0.0	

Appendix Table 2.4. Recoveries of adult fall chinook salmon transported as juveniles by barge from McNary Dam to below Bonneville Dam from 27 June to 1 July 1988.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 8803D

1988 MCNARY

TRANS BARGE

BELOW BONNEVILLE

FALL CHINOOK

Brands Used: RAIU4  
Wire Codes Used: 232302

NUMBER RELEASED: 10002

RECOVERY AREA	1988	YEAR OF RETURN		1991	1992	1993	TOTAL	% RETURN
		1989	1990					
RIVER SYSTEM TRAPS	0	0	0	0	0	0	0	0.000
OCEAN FISHERIES								
ALASKA	0	0	0	0	1	0	1	0.010
BRITISH COLUMBIA	0	0	0	0	1	0	1	0.010
RIVER SPORT	0	0	0	0	0	0	0	0.000
RIVER COMMERCIAL								
COMMERCIAL NET	0	0	0	1	0	0	1	0.010
INDIAN FISHERIES								
FALL INDIAN NET	0	0	0	3	0	0	3	0.030
HATCHERIES								
PRIEST RAPIDS H.	0	0	0	2	0	0	2	0.020
STREAM SURVEY	0	0	0	0	0	0	0	0.000
TOTALS	0	0	0	6	2	0	8	0.080
PERCENT OF RECOVERY	%	0.0	0.0	0.0	75.0	25.0	0.0	



Appendix Table 2.5. Recoveries of adult fall chinook salmon transported as juveniles by barge from McNary Dam to below Bonneville Dam from 5 to 13 July 1988.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 8803E

1988 MCNARY

TRANS BARGE

BELOW BONNEVILLE

FALL CHINOOK

Brands Used: RAID1  
Wire Codes Used: 232303

RECOVERY AREA	1988	YEAR OF RETURN		1991	1992	1993	NUMBER RELEASED: 10002	
		1989	1990				TOTAL	% RETURN
RIVER SYSTEM TRAPS								
BONNEVILLE TRAP	0	0	0	2	0	0	2	0.020
OCEAN FISHERIES								
ALASKA	0	0	0	2	1	0	3	0.030
BRITISH COLUMBIA	0	0	1	2	2	0	5	0.050
WASHINGTON	0	0	1	0	0	0	1	0.010
RIVER SPORT								
COLUMBIA R. ABOVE SNAKE R.	0	0	0	0	1	0	1	0.010
RIVER COMMERCIAL								
COMMERCIAL NET	0	0	0	3	1	0	4	0.040
INDIAN FISHERIES								
FALL INDIAN NET	0	0	0	0	1	0	1	0.010
HATCHERIES	0	0	0	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0	0	0	0.000
TOTALS	0	0	2	9	6	0	17	0.170
PERCENT OF RECOVERY	%	0.0	0.0	11.8	52.9	35.3	0.0	

Appendix Table 2.6. Recoveries of adult fall chinook salmon transported as juveniles by barge from McNary Dam to below Bonneville Dam from 13 to 21 July 1988.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 8803F

1988 MCNARY

TRANS BARGE

BELOW BONNEVILLE

FALL CHINOOK

Brands Used: RAID3  
Wire Codes Used: 232304

NUMBER RELEASED: 10002

RECOVERY AREA	1988	YEAR OF RETURN		1991	1992	1993	TOTAL	% RETURN
		1989	1990					
RIVER SYSTEM TRAPS								
BONNEVILLE TRAP	0	0	0	0	2	0	2	0.020
OCEAN FISHERIES								
ALASKA	0	0	2	2	1	1	6	0.060
BRITISH COLUMBIA	0	1	0	2	1	0	4	0.040
RIVER SPORT								
COLUMBIA R. BELOW SNAKE R.	0	0	0	1	0	0	1	0.010
COLUMBIA R. ABOVE SNAKE R.	0	0	0	1	0	0	1	0.010
RIVER COMMERCIAL								
COMMERCIAL NET	0	1	0	0	1	0	2	0.020
INDIAN FISHERIES								
FALL INDIAN NET	0	0	0	2	3	0	5	0.050
HATCHERIES	0	0	0	0	0	0	0	0.000
STREAM SURVEY								
GENERAL	0	0	0	1	0	0	1	0.010
TOTALS	0	2	2	9	8	1	22	0.220
PERCENT OF RECOVERY	%	0.0	9.1	9.1	40.9	36.4	4.5	

Appendix Table 3.0. Summary of steelhead marked at Lower Granite Dam in 1994 for releases site study.

Replicate number	Release site	Marking period	Release date	Brand position, <sup>a</sup> symbol, and orientation. <sup>b</sup>	Wire-tag code	Number barged		
						Hatchery	Wild	Total
*	Bonneville	7 May	10 May	RASU-1	23-19-58	9,424	254	9,678
	Bonneville	7 May	10 May	LAAN-1	23-17-20	9,026	121	9,147
1	Tongue Pt.	13 May	16 May	RAV-1	23-30-04	9,136	166	9,302
	Bonneville	13 May	16 May	LAF-1	23-30-16	9,577	503	10,080
2	Tongue Pt.	15 May	18 May	RAV-2	23-23-57	8,371	425	8,796
	Bonneville	15 May	18 May	LAF-2	23-23-56	9,431	534	9,965
3	Tongue Pt.	19 May	22 May	RAV-3	23-24-24	8,290	850	9,140
	Bonneville	19 May	22 May	LAF-3	23-24-23	9,473	809	10,282
4	Tongue Pt.	21 May	24 May	RAV-4	23-24-37	8,428	593	9,021
	Bonneville	21 May	24 May	LAF-4	23-24-36	9,140	1,003	10,143
5	Tongue Pt.	26 May	29 May	RA) (-1	23-24-39	7,564	1,203	8,767
	Bonneville	26 May	29 May	LAS-1	23-24-38	8,810	1,153	9,963
6	Tongue Pt.	28-29 May	31 May	RA) (-2	23-24-41	4,118	782	4,900
	Bonneville	28-29 May	31 May	LAS-2	23-24-40	5,362	941	6,303
7	Tongue Pt.	30-31 May	2 Jun	RASU-2	23-24-43	6,156	898	7,054
	Bonneville	30-31 May	2 Jun	LAAN-2	23-24-42	6,836	1,340	8,176
8	Tongue Pt.	1-2 Jun	4 Jun	RASU-3	23-30-17	2,495	541	3,036
	Bonneville	1-2 Jun	4 Jun	LAAN-3	23-30-18	2,854	548	3,402
Total						134,491	12,664	147,155

<sup>a</sup> RA and LA (position) indicate right and left anterior sides of fish, respectively.

<sup>b</sup> Orientation refers to rotation of brand around its center point.

\* Both groups were released below Bonneville Dam because of an emergent need for the barges at Lower Granite Dam. Therefore, this release lot will not be used for statistical analysis of adult returns.

Appendix Table 4.0. Mortality and tag loss of tagged steelhead that were held 24 hours at Lower Granite Dam in 1994.

Date	Wire-tag code	Number held	Mortality	Lost tags
7 May	23-19-58	50	0	1
7 May	23-17-20	50	2	0
13 May	23-30-16	50	0	1
13 May	23-30-04	50	0	1
15 May	23-23-56	35	1	0
15 May	23-23-57	40	0	1
21 May	23-24-36	51	1	1
21 May	23-24-37	40	3	3
26 May	23-24-38	54	4	3
26 May	23-24-39	57	0	0
28-29 May	23-24-40	47	0	3
28-29 May	23-24-41	54	0	2
30-31 May	23-24-42	45	0	1
30-31 May	23-24-43	<u>51</u>	<u>1</u>	<u>0</u>
	Total	578	12	17
% Mortality and tag loss			2.1	2.9

Appendix Table 5.0. Summary of all recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to Tongue Point in 1992.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9207A 9207B 9207C 9207D 9207E 9207F

1992 L.GRANITE

LGR RELEASE SITE

TONGUE POINT

STEELHEAD

Brands Used: RAL 1 RASU1 RASU2 RASU3 RASU4 RAZ 1  
Wire Codes Used: 232445 232447 232448 232449 232450 232444

NUMBER RELEASED: 55366

RECOVERY AREA	1992	YEAR OF RETURN		1995	TOTAL	% RETURN
		1993	1994			
RIVER SYSTEM TRAPS						
LOWER GRANITE TRAP	0	32	37	0	69	0.125
OCEAN FISHERIES	0	0	0	0	0	0.000
RIVER SPORT						
COLUMBIA R. BELOW SNAKE R.	0	1	0	0	1	0.002
SNAKE R.	0	8	2	0	10	0.018
CLEARWATER R.	0	3	0	0	3	0.005
RIVER COMMERCIAL	0	0	0	0	0	0.000
INDIAN FISHERIES						
FALL INDIAN NET	0	2	4	0	6	0.011
HATCHERIES						
DESCHUTES R. HATCHERIES	1	0	0	0	1	0.002
SAWTOOTH H. AND TRAP	0	1	0	0	1	0.002
BIG CANYON TRAP	0	1	0	0	1	0.002
STREAM SURVEY	0	1	0	0	1	0.002
TOTALS	1	49	43	0	93	0.168
PERCENT OF RECOVERY	%	1.1	52.7	46.2	0.0	

Appendix Table 5.1. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to Tongue Point on 4 May 1992.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9207A

1992 L.GRANITE

LGR RELEASE SITE

TONGUE POINT

STEELHEAD

Brands Used: RAL 1  
Wire Codes Used: 232445

NUMBER RELEASED: 9199

RECOVERY AREA	1992	YEAR OF RETURN		1995	TOTAL	% RETURN
		1993	1994			
RIVER SYSTEM TRAPS						
LOWER GRANITE TRAP	0	12	18	0	30	0.326
OCEAN FISHERIES	0	0	0	0	0	0.000
RIVER SPORT						
SNAKE R.	0	4	1	0	5	0.054
CLEARWATER R.	0	1	0	0	1	0.011
RIVER COMMERCIAL	0	0	0	0	0	0.000
INDIAN FISHERIES						
FALL INDIAN NET	0	0	2	0	2	0.022
HATCHERIES						
BIG CANYON TRAP	0	1	0	0	1	0.011
STREAM SURVEY	0	0	0	0	0	0.000
TOTALS	0	18	21	0	39	0.424
PERCENT OF RECOVERY	%	0.0	46.2	53.8	0.0	

Appendix Table 5.2. Recoveries of adult steelhead transported  
as juveniles by barge from Lower Granite Dam  
to Tongue Point on 10 May 1992

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9207B

1992 L.GRANITE

LGR RELEASE SITE

TONGUE POINT

STEELHEAD

Brands Used: RASU1  
Wire Codes Used: 232447

NUMBER RELEASED: 9418

RECOVERY AREA	1992	YEAR OF RETURN			TOTAL	% RETURN
		1993	1994	1995		
RIVER SYSTEM TRAPS						
LOWER GRANITE TRAP	0	4	7	0	11	0.117
OCEAN FISHERIES	0	0	0	0	0	0.000
RIVER SPORT						
COLUMBIA R. BELOW SNAKE R.	0	1	0	0	1	0.011
SNAKE R.	0	2	0	0	2	0.021
RIVER COMMERCIAL	0	0	0	0	0	0.000
INDIAN FISHERIES						
FALL INDIAN NET	0	0	1	0	1	0.011
HATCHERIES	0	0	0	0	0	0.000
STREAM SURVEY	0	1	0	0	1	0.011
TOTALS	0	8	8	0	16	0.170
PERCENT OF RECOVERY	%	0.0	50.0	50.0	0.0	

Appendix Table 5.3. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to Tongue Point on 12 May 1992.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9207C

1992 L.GRANITE

LGR RELEASE SITE

TONGUE POINT

STEELHEAD

Brands Used: RASU2  
Wire Codes Used: 232448

RECOVERY AREA	1992	YEAR OF RETURN			TOTAL	% RETURN
		1993	1994	1995		
RIVER SYSTEM TRAPS						
LOWER GRANITE TRAP	0	3	2	0	5	0.055
OCEAN FISHERIES	0	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0	0.000
INDIAN FISHERIES						
FALL INDIAN NET	0	0	1	0	1	0.011
HATCHERIES	0	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0	0.000
TOTALS	0	3	3	0	6	0.066
PERCENT OF RECOVERY	%	0.0	50.0	50.0	0.0	

NUMBER RELEASED: 9137



Appendix Table 5.4. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to Tongue Point on 16 May 1992.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9207D

1992 L.GRANITE

LGR RELEASE SITE

TONGUE POINT

STEELHEAD

Brands Used: RASU3  
Wire Codes Used: 232449

NUMBER RELEASED: 9118

RECOVERY AREA	1992	YEAR OF RETURN		1995	TOTAL	% RETURN
		1993	1994			
RIVER SYSTEM TRAPS						
LOWER GRANITE TRAP	0	5	4	0	9	0.099
OCEAN FISHERIES	0	0	0	0	0	0.000
RIVER SPORT						
SNAKE R.	0	2	0	0	2	0.022
RIVER COMMERCIAL	0	0	0	0	0	0.000
INDIAN FISHERIES						
FALL INDIAN NET	0	2	0	0	2	0.022
HATCHERIES						
SAWTOOTH H. AND TRAP	0	1	0	0	1	0.011
STREAM SURVEY	0	0	0	0	0	0.000
TOTALS	0	10	4	0	14	0.154
PERCENT OF RECOVERY	%	0.0	71.4	28.6	0.0	

Appendix Table 5.5. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to Tongue Point on 18 May 1992.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9207E

1992 L.GRANITE

LGR RELEASE SITE

TONGUE POINT

STEELHEAD

Brands Used: RASU4  
Wire Codes Used: 232450

NUMBER RELEASED: 9220

RECOVERY AREA	1992	YEAR OF RETURN			TOTAL	% RETURN
		1993	1994	1995		
RIVER SYSTEM TRAPS						
LOWER GRANITE TRAP	0	5	4	0	9	0.098
OCEAN FISHERIES	0	0	0	0	0	0.000
RIVER SPORT						
SNAKE R.	0	0	1	0	1	0.011
CLEARWATER R.	0	1	0	0	1	0.011
RIVER COMMERCIAL	0	0	0	0	0	0.000
INDIAN FISHERIES	0	0	0	0	0	0.000
HATCHERIES						
DESCHUTES R. HATCHERIES	1	0	0	0	1	0.011
STREAM SURVEY	0	0	0	0	0	0.000
TOTALS	1	6	5	0	12	0.130
PERCENT OF RECOVERY	%	8.3	50.0	41.7	0.0	

Appendix Table 5.6. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to Tongue Point on 22 May 1992.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9207F

1992 L.GRANITE

LGR RELEASE SITE

TONGUE POINT

STEELHEAD

Brands Used: RAZ 1  
Wire Codes Used: 232444

NUMBER RELEASED: 9274

RECOVERY AREA	1992	YEAR OF RETURN			TOTAL	% RETURN
		1993	1994	1995		
RIVER SYSTEM TRAPS						
LOWER GRANITE TRAP	0	3	2	0	5	0.054
OCEAN FISHERIES	0	0	0	0	0	0.000
RIVER SPORT						
CLEARWATER R.	0	1	0	0	1	0.011
RIVER COMMERCIAL	0	0	0	0	0	0.000
INDIAN FISHERIES	0	0	0	0	0	0.000
HATCHERIES	0	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0	0.000
TOTALS	0	4	2	0	6	0.065
PERCENT OF RECOVERY	%	0.0	66.7	33.3	0.0	

Appendix Table 6.0. Summary of all recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to below Bonneville Dam in 1992.

Master File Date : 10 January 1995  
 RELEASE GROUPS INCLUDED: 9208A 9208B 9208C 9208D 9208E 9208F

1992 L.GRANITE

LGR RELEASE SITE

BELOW BONNEVILLE

STEELHEAD

Brands Used: LAF 1 LAF 3 LAF 4 LAV 1 LAV 2 LAV 3  
 Wire Codes Used: 232419 232417 232418 232420 232421 232422

NUMBER RELEASED: 60577

RECOVERY AREA	1992	YEAR OF RETURN		1995	TOTAL	% RETURN
		1993	1994			
RIVER SYSTEM TRAPS						
LOWER GRANITE TRAP	0	32	46	0	78	0.129
OCEAN FISHERIES	0	0	0	0	0	0.000
RIVER SPORT						
COLUMBIA R. BELOW SNAKE R.	0	2	0	0	2	0.003
SNAKE R.	0	6	2	0	8	0.013
CLEARWATER R.	0	0	1	0	1	0.002
RIVER COMMERCIAL	0	0	0	0	0	0.000
INDIAN FISHERIES						
FALL INDIAN NET	0	1	3	0	4	0.007
HATCHERIES	0	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0	0.000
TOTALS	0	41	52	0	93	0.154
PERCENT OF RECOVERY	%	0.0	44.1	55.9	0.0	

Appendix Table 6.1. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to below Bonneville Dam on 4 May 1992.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9208A

1992 L.GRANITE

LGR RELEASE SITE

BELOW BONNEVILLE

STEELHEAD

Brands Used: LAF 1  
Wire Codes Used: 232419

RECOVERY AREA	1992	YEAR OF RETURN			TOTAL	% RETURN	NUMBER RELEASED:	9740
		1993	1994	1995				
RIVER SYSTEM TRAPS								
LOWER GRANITE TRAP	0	12	15	0	27	0.277		
OCEAN FISHERIES	0	0	0	0	0	0.000		
RIVER SPORT								
SNAKE R.	0	4	0	0	4	0.041		
RIVER COMMERCIAL	0	0	0	0	0	0.000		
INDIAN FISHERIES								
FALL INDIAN NET	0	0	1	0	1	0.010		
HATCHERIES	0	0	0	0	0	0.000		
STREAM SURVEY	0	0	0	0	0	0.000		
TOTALS	0	16	16	0	32	0.329		
PERCENT OF RECOVERY	%	0.0	50.0	50.0	0.0			

Appendix Table 6.2. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to below Bonneville Dam on 10 May 1992.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9208B

1992 L.GRANITE

LGR RELEASE SITE

BELOW BONNEVILLE

STEELHEAD

Brands Used: LAF 3  
Wire Codes Used: 232417

NUMBER RELEASED: 10285

RECOVERY AREA	1992	YEAR OF RETURN		1995	TOTAL	% RETURN
		1993	1994			
RIVER SYSTEM TRAPS						
LOWER GRANITE TRAP	0	11	19	0	30	0.292
OCEAN FISHERIES	0	0	0	0	0	0.000
RIVER SPORT						
COLUMBIA R. BELOW SNAKE R.	0	1	0	0	1	0.010
SNAKE R.	0	2	2	0	4	0.039
RIVER COMMERCIAL	0	0	0	0	0	0.000
INDIAN FISHERIES	0	0	0	0	0	0.000
HATCHERIES	0	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0	0.000
TOTALS	0	14	21	0	35	0.340
PERCENT OF RECOVERY	%	0.0	40.0	60.0	0.0	

Appendix Table 6.3. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to below Bonneville Dam on 12 May 1992.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9208C

1992 L.GRANITE

LGR RELEASE SITE

BELOW BONNEVILLE

STEELHEAD

Brands Used: LAF 4  
Wire Codes Used: 232418

RECOVERY AREA	1992	YEAR OF RETURN			TOTAL	% RETURN
		1993	1994	1995		
RIVER SYSTEM TRAPS						
LOWER GRANITE TRAP	0	5	9	0	14	0.138
OCEAN FISHERIES	0	0	0	0	0	0.000
RIVER SPORT						
CLEARWATER R.	0	0	1	0	1	0.010
RIVER COMMERCIAL	0	0	0	0	0	0.000
INDIAN FISHERIES						
FALL INDIAN NET	0	1	1	0	2	0.020
HATCHERIES	0	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0	0.000
TOTALS	0	6	11	0	17	0.168
PERCENT OF RECOVERY	%	0.0	35.3	64.7	0.0	

NUMBER RELEASED: 10149

Appendix Table 6.4. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to below Bonneville Dam on 16 May 1992.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9208D

1992 L.GRANITE

LGR RELEASE SITE

BELOW BONNEVILLE

STEELHEAD

Brands Used: LAV 1  
Wire Codes Used: 232420

NUMBER RELEASED: 10073

RECOVERY AREA	1992	YEAR OF RETURN			TOTAL	% RETURN
		1993	1994	1995		
RIVER SYSTEM TRAPS						
LOWER GRANITE TRAP	0	0	3	0	3	0.030
OCEAN FISHERIES	0	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0	0.000
INDIAN FISHERIES	0	0	0	0	0	0.000
HATCHERIES	0	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0	0.000
TOTALS	0	0	3	0	3	0.030
PERCENT OF RECOVERY	%	0.0	0.0	100.0	0.0	



Appendix Table 6.5. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to below Bonneville Dam on 18 May 1992.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9208E

1992 L.GRANITE

LGR RELEASE SITE

BELOW BONNEVILLE

STEELHEAD

Brands Used: LAV 2  
Wire Codes Used: 232421

NUMBER RELEASED: 10112

RECOVERY AREA	1992	YEAR OF RETURN			TOTAL	% RETURN
		1993	1994	1995		
RIVER SYSTEM TRAPS						
LOWER GRANITE TRAP	0	3	0	0	3	0.030
OCEAN FISHERIES	0	0	0	0	0	0.000
RIVER SPORT						
COLUMBIA R. BELOW SNAKE R.	0	1	0	0	1	0.010
RIVER COMMERCIAL	0	0	0	0	0	0.000
INDIAN FISHERIES						
FALL INDIAN NET	0	0	1	0	1	0.010
HATCHERIES	0	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0	0.000
TOTALS	0	4	1	0	5	0.049
PERCENT OF RECOVERY	%	0.0	80.0	20.0	0.0	

Appendix Table 6.6. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to below Bonneville Dam on 22 May 1992.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9208F

1992 L.GRANITE

LGR RELEASE SITE

BELOW BONNEVILLE

STEELHEAD

Brands Used: LAV 3  
Wire Codes Used: 232422

NUMBER RELEASED: 10218

RECOVERY AREA	1992	YEAR OF RETURN		1995	TOTAL	% RETURN
		1993	1994			
RIVER SYSTEM TRAPS						
LOWER GRANITE TRAP	0	1	0	0	1	0.010
OCEAN FISHERIES	0	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0	0.000
INDIAN FISHERIES	0	0	0	0	0	0.000
HATCHERIES	0	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0	0.000
TOTALS	0	1	0	0	1	0.010
PERCENT OF RECOVERY	%	0.0	100.0	0.0	0.0	

Appendix Table 7.0. Summary of all recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to Tongue Point in 1993.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9301A 9301B 9301C 9301D 9301E 9301F 9301G

1993 L.GRANITE

LGR RELEASE SITE

TONGUE POINT

STEELHEAD

Brands Used: RAPI1 RAPI2 RAPI3 RAPI4 RAP 1 RAP 2 RAP 3  
Wire Codes Used: 232960 232961 232962 232963 233001 233002 233003

NUMBER RELEASED: 62348

RECOVERY AREA	1993	YEAR OF RETURN		TOTAL	% RETURN
		1994	1995		
RIVER SYSTEM TRAPS					
LOWER GRANITE TRAP	0	29	0	29	0.047
OCEAN FISHERIES	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERIES					
FALL INDIAN NET	0	1	0	1	0.002
HATCHERIES	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0.000
TOTALS	0	30	0	30	0.048
PERCENT OF RECOVERY	%	0.0	100.0	0.0	

Appendix Table 7.1. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to Tongue Point on 16 May 1993.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9301A

1993 L.GRANITE

LGR RELEASE SITE

TONGUE POINT

STEELHEAD

Brands Used: RAPII  
Wire Codes Used: 232960

NUMBER RELEASED: 9083

RECOVERY AREA	1993	YEAR OF RETURN		TOTAL	% RETURN
		1994	1995		
RIVER SYSTEM TRAPS					
LOWER GRANITE TRAP	0	5	0	5	0.055
OCEAN FISHERIES	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERIES					
FALL INDIAN NET	0	1	0	1	0.011
HATCHERIES	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0.000
TOTALS	0	6	0	6	0.066
PERCENT OF RECOVERY	%	0.0	100.0	0.0	

Appendix Table 7.2. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to Tongue Point on 18 May 1993.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9301B

1993 L.GRANITE

LGR RELEASE SITE

TONGUE POINT

STEELHEAD

Brands Used: RAPI2  
Wire Codes Used: 232961

NUMBER RELEASED: 9074

RECOVERY AREA	1993	YEAR OF RETURN		TOTAL	% RETURN
		1994	1995		
RIVER SYSTEM TRAPS LOWER GRANITE TRAP	0	7	0	7	0.077
OCEAN FISHERIES	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERIES	0	0	0	0	0.000
HATCHERIES	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0.000
TOTALS	0	7	0	7	0.077
PERCENT OF RECOVERY	%	0.0	100.0	0.0	

Appendix Table 7.3. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to Tongue Point on 23 May 1993.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9301C

1993 L.GRANITE

LGR RELEASE SITE

TONGUE POINT

STEELHEAD

Brands Used: RAPI3  
Wire Codes Used: 232962

NUMBER RELEASED: 8920

RECOVERY AREA	1993	YEAR OF RETURN		TOTAL	% RETURN
		1994	1995		
RIVER SYSTEM TRAPS					
LOWER GRANITE TRAP	0	1	0	1	0.011
OCEAN FISHERIES	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERIES	0	0	0	0	0.000
HATCHERIES	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0.000
TOTALS	0	1	0	1	0.011
PERCENT OF RECOVERY	%	0.0	100.0	0.0	

Appendix Table 7.4. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to Tongue Point on 25 May 1993.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9301D

1993 L.GRANITE

LGR RELEASE SITE

TONGUE POINT

STEELHEAD

Brands Used: RAPI4  
Wire Codes Used: 232963

NUMBER RELEASED: 8834

RECOVERY AREA	1993	YEAR OF RETURN		TOTAL	% RETURN
		1994	1995		
RIVER SYSTEM TRAPS					
LOWER GRANITE TRAP	0	6	0	6	0.068
OCEAN FISHERIES	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERIES	0	0	0	0	0.000
HATCHERIES	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0.000
TOTALS	0	6	0	6	0.068
PERCENT OF RECOVERY	%	0.0	100.0	0.0	

Appendix Table 7.5. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to Tongue Point on 29 May 1993.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9301E

1993 L.GRANITE

LGR RELEASE SITE

TONGUE POINT

STEELHEAD

Brands Used: RAP 1  
Wire Codes Used: 233001

NUMBER RELEASED: 8930

RECOVERY AREA	1993	YEAR OF RETURN		TOTAL	% RETURN
		1994	1995		
RIVER SYSTEM TRAPS					
LOWER GRANITE TRAP	0	6	0	6	0.067
OCEAN FISHERIES	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERIES	0	0	0	0	0.000
HATCHERIES	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0.000
TOTALS	0	6	0	6	0.067
PERCENT OF RECOVERY	%	0.0	100.0	0.0	



Appendix Table 7.6. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to Tongue Point on 1 Jun 1993.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9301F

1993 L.GRANITE

LGR RELEASE SITE

TONGUE POINT

STEELHEAD

Brands Used: RAP 2  
Wire Codes Used: 233002

NUMBER RELEASED: 9111

RECOVERY AREA	1993	YEAR OF RETURN		TOTAL	% RETURN
		1994	1995		
RIVER SYSTEM TRAPS					
LOWER GRANITE TRAP	0	1	0	1	0.011
OCEAN FISHERIES	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERIES	0	0	0	0	0.000
HATCHERIES	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0.000
TOTALS	0	1	0	1	0.011
PERCENT OF RECOVERY	%	0.0	100.0	0.0	

Appendix Table 7.7. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to Tongue Point on 4 Jun 1993.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9301G

1993 L.GRANITE

LGR RELEASE SITE

TONGUE POINT

STEELHEAD

Brands Used: RAP 3  
Wire Codes Used: 233003

NUMBER RELEASED: 8396

RECOVERY AREA	1993	YEAR OF RETURN		TOTAL	% RETURN
		1994	1995		
RIVER SYSTEM TRAPS					
LOWER GRANITE TRAP	0	3	0	3	0.036
OCEAN FISHERIES	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERIES	0	0	0	0	0.000
HATCHERIES	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0.000
TOTALS	0	3	0	3	0.036
PERCENT OF RECOVERY	%	0.0	100.0	0.0	

Appendix Table 8.0. Summary of all recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to below Bonneville Dam in 1993

Master File Date : 10 January 1995  
 RELEASE GROUPS INCLUDED: 9302A 9302B 9302C 9302D 9302E 9302F 9302G

1993 L.GRANITE

LGR RELEASE SITE

BELOW BONNEVILLE

STEELHEAD

Brands Used: LA3 1 LA3 2 LA3 3 LA3 4 LA2 1 LA2 2 LA2 3  
 Wire Codes Used: 233005 233006 233011 233012 233013 233014 233015

NUMBER RELEASED: 65987

RECOVERY AREA	1993	YEAR OF RETURN		TOTAL	% RETURN
		1994	1995		
RIVER SYSTEM TRAPS					
LOWER GRANITE TRAP	0	37	0	37	0.056
OCEAN FISHERIES	0	0	0	0	0.000
RIVER SPORT					
SNAKE R.	0	1	0	1	0.002
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERIES					
FALL INDIAN NET	0	2	0	2	0.003
HATCHERIES	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0.000
TOTALS	0	40	0	40	0.061
PERCENT OF RECOVERY	%	0.0	100.0	0.0	

Appendix Table 8.1. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to below Bonneville Dam on 16 May 1993.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9302A

1993 L.GRANITE

LGR RELEASE SITE

BELOW BONNEVILLE

STEELHEAD

Brands Used: LA3 1  
Wire Codes Used: 233005

NUMBER RELEASED: 8858

RECOVERY AREA	1993	YEAR OF RETURN		TOTAL	% RETURN
		1994	1995		
RIVER SYSTEM TRAPS					
LOWER GRANITE TRAP	0	6	0	6	0.068
OCEAN FISHERIES	0	0	0	0	0.000
RIVER SPORT					
SNAKE R.	0	1	0	1	0.011
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERIES	0	0	0	0	0.000
HATCHERIES	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0.000
TOTALS	0	7	0	7	0.079
PERCENT OF RECOVERY	%	0.0	100.0	0.0	

Appendix Table 8.2. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to below Bonneville Dam on 18 May 1993.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9302B

1993 L.GRANITE

LGR RELEASE SITE

BELOW BONNEVILLE

STEELHEAD

Brands Used: LA3 2  
Wire Codes Used: 233006

NUMBER RELEASED: 10086

RECOVERY AREA	1993	YEAR OF RETURN		TOTAL	% RETURN
		1994	1995		
RIVER SYSTEM TRAPS					
LOWER GRANITE TRAP	0	1	0	1	0.010
OCEAN FISHERIES	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERIES	0	0	0	0	0.000
HATCHERIES	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0.000
TOTALS	0	1	0	1	0.010
PERCENT OF RECOVERY	%	0.0	100.0	0.0	

Appendix Table 8.3. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to below Bonneville Dam on 22 May 1993.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9302C

1993 L.GRANITE

LGR RELEASE SITE

BELOW BONNEVILLE

STEELHEAD

Brands Used: LA3 3  
Wire Codes Used: 233011

NUMBER RELEASED: 9885

RECOVERY AREA	1993	YEAR OF RETURN		TOTAL	% RETURN
		1994	1995		
RIVER SYSTEM TRAPS					
LOWER GRANITE TRAP	0	3	0	3	0.030
OCEAN FISHERIES	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERIES	0	0	0	0	0.000
HATCHERIES	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0.000
TOTALS	0	3	0	3	0.030
PERCENT OF RECOVERY	%	0.0	100.0	0.0	

Appendix Table 8.4. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to below Bonneville Dam on 24 May 1993.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9302D

1993 L.GRANITE

LGR RELEASE SITE

BELOW BONNEVILLE

STEELHEAD

Brands Used: LA3 4  
Wire Codes Used: 233012

NUMBER RELEASED: 9843

RECOVERY AREA	1993	YEAR OF RETURN		TOTAL	% RETURN
		1994	1995		
RIVER SYSTEM TRAPS					
LOWER GRANITE TRAP	0	15	0	15	0.152
OCEAN FISHERIES	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERIES					
FALL INDIAN NET	0	1	0	1	0.010
HATCHERIES	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0.000
TOTALS	0	16	0	16	0.163
PERCENT OF RECOVERY	%	0.0	100.0	0.0	

Appendix Table 8.5. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to below Bonneville Dam on 29 May 1993.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9302E

1993 L.GRANITE

LGR RELEASE SITE

BELOW BONNEVILLE

STEELHEAD

Brands Used: LA2 1  
Wire Codes Used: 233013

NUMBER RELEASED: 10097

RECOVERY AREA	1993	YEAR OF RETURN		TOTAL	% RETURN
		1994	1995		
RIVER SYSTEM TRAPS					
LOWER GRANITE TRAP	0	9	0	9	0.089
OCEAN FISHERIES	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERIES					
FALL INDIAN NET	0	1	0	1	0.010
HATCHERIES	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0.000
TOTALS	0	10	0	10	0.099
PERCENT OF RECOVERY	%	0.0	100.0	0.0	



Appendix Table 8.6. Recoveries of adult steelhead transported as juveniles by barge from Lower Granite Dam to below Bonneville Dam on 31 May 1993.

Master File Date : 10 January 1995  
RELEASE GROUPS INCLUDED: 9302F

1993 L.GRANITE

LGR RELEASE SITE

BELOW BONNEVILLE

STEELHEAD

Brands Used: LA2 2  
Wire Codes Used: 233014

NUMBER RELEASED: 8411

RECOVERY AREA	1993	YEAR OF RETURN		TOTAL	% RETURN
		1994	1995		
RIVER SYSTEM TRAPS					
LOWER GRANITE TRAP	0	3	0	3	0.036
OCEAN FISHERIES	0	0	0	0	0.000
RIVER SPORT	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERIES	0	0	0	0	0.000
HATCHERIES	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0.000
TOTALS	0	3	0	3	0.036
PERCENT OF RECOVERY	%	0.0	100.0	0.0	

**Appendix B**  
**Scale Analysis Report**

**ANNUAL PROGRESS REPORT**

**FISH RESEARCH PROJECT  
OREGON**

**PROJECT TITLE:** An Estimate of the Percentage of Wild Fish in the Juvenile  
Outmigration of Spring Chinook Salmon at Lower Granite Dam  
Using Scale Analysis

**CONTRACT NUMBER:** 43 ABNF402020

**CONTRACT PERIOD:** July 1, 1994 to December 31, 1994

Prepared by: L.A. Borgerson  
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## **SUMMARY**

### **Objectives for FY 1994**

Determine the hatchery or wild origin of juvenile spring and summer chinook salmon from scales collected at Lower Granite Dam using discriminant analysis.

### **Accomplishments in FY 1994**

We read scales from 999 juvenile chinook salmon from the run-at-large. We classified 166 unmarked juveniles as hatchery or wild. The 833 juveniles with clipped fins were assumed hatchery and were used to develop the discriminant function that classified the unmarked fish.

### **Findings in FY 1994**

We estimated that 12.7% ( $\pm 3.7\%$ ) of the outmigration of juvenile spring and summer chinook salmon at Lower Granite Dam was of wild origin.

## **INTRODUCTION**

Discriminant analysis of fish scale patterns is an accepted method of identifying hatchery or wild origins of salmon. Between 1978 and 1987, the Oregon Department of Fish and Wildlife (ODFW) used discriminant analysis to correctly classify 85-95% of hatchery and wild coho salmon caught in ocean fisheries off Oregon (Borgerson 1988). Fryer and Schwartzberg (1990) used discriminant analysis to correctly classify 84-91% of hatchery and wild spring chinook salmon from the Deschutes, Wenatchee, Grande Ronde, and Imnaha rivers. In 1991, we began analyzing scales on adult spring and summer chinook salmon sampled at Lower Granite Dam (Borgerson 1991). In 1992 and 1993, we analyzed scales from outmigrating juveniles as well as adults (Borgerson 1992, Borgerson and Bowden 1993).

Beginning in 1993, all hatchery juveniles were to be released with clipped fins. In spite of such plans there are usually a few fish that get missed or that regenerate a poor clip. Unfortunately the very small percentage of hatchery fish without fin clips will be counted as wild fish, and can cause a significant over-estimate of the size of the wild run. We chose to continue scale analysis to identify wild fish. This report includes results from the analysis of scales from juveniles sampled in 1994 and a review of the 1992 and 1993 results for comparison.

## METHODS

### Scale Preparation and Reading

Scale collection involved three agencies and two tribes. Personnel from Washington Department of Fish and Wildlife collected the juvenile chinook salmon at Lower Granite Dam. Personnel from Idaho Department of Fish and Game, ODFW, and the Nez Perce and Umatilla tribes collected the known origin scales used to develop the discriminant functions. We provided diagrams showing location of the key scale area (Nicholas and Van Dyke 1982) and sample procedures so all collections were sampled by the same methods.

Mixed-stock juvenile salmon were collected proportionally throughout the run-at-large. We selected the sample size so that the analysis would yield a 95% confidence interval that was  $\pm 25\%$  of the point estimate (Worlund and Fredin 1962). Because the percentage of wild fish in the sample affects the size of the confidence interval, we started our study by assuming that wild fish would comprise 5-10% of the juvenile population.

We mounted the scales from Lower Granite Dam between glass slides and cover slips. Some scales collected at other locations were mounted on gummed cards and impressed in acetate by the collecting agency. All collectors provided data for each sample on location, length, date, and presence or absence of mark.

We used an Apple IIc microcomputer, Altec digitizing board, and Scale Reader Program software (Mullen 1984) to measure and record scale measurements. The scale image was enlarged to 88x magnification using a microfiche reader. Measurements were made along a radius  $20^\circ$  to the anterior-posterior axis on the ventral side of the scale. We made measurements in the freshwater zone on all chinook salmon scales used for the hatchery or wild discriminant analysis (Figure 1). After reading the scales, measurement data were transferred from the Apple IIc computer to an IBM-compatible computer for computation of additional variables (Table 1) and final analysis.

### Hatchery or Wild Classification of Chinook Salmon

We used discriminant analysis to classify chinook salmon by hatchery or wild origin. For discriminant analysis to provide meaningful results, the training populations of known origin samples used to develop the function must be representative of the groups within the unknown sample. For the wild training population we used scale samples from various streams based on the estimated contribution of fish from that stream to the overall population.

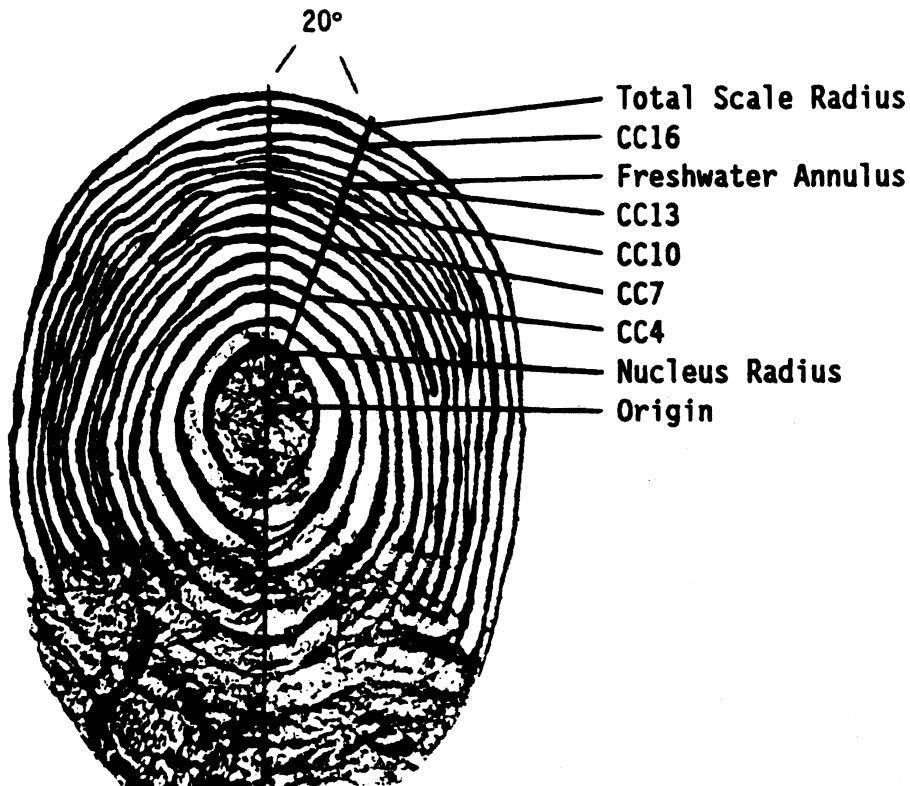


Figure 1. Measurements of scale growth used to discriminate between juvenile hatchery and wild chinook salmon. The scale is from an unmarked spring chinook salmon sampled at Lower Granite Dam that we classified as wild. Measurements are defined in Table 1.

For example, the wild training population was weighted so that 1/4 of the samples were from Oregon tributaries and 3/4 were from Idaho tributaries. The training population representing hatchery fish was composed of all fin-clipped fish within the 1994 collection. The APPENDIX contains a list of specific locations where scales used in the wild training population were collected.

We developed a linear discriminant function using BMDP Statistical Software 88 Release (Dixon et al. 1988) to classify combined spring and summer chinook salmon juveniles. The function classified the unmarked fish according to hatchery or wild origin. Variables were added to or removed from the function in a step-wise method based on their F values. The juvenile chinook salmon function contained four variables (FWANN2, FWAVSP, CC7, and BW1). As in all functions we developed for past analyses of these fish stocks, the variable FWANN2, representing fish size at the end of the winter in fresh water, was the first variable selected and was the most powerful for discriminating between hatchery and wild fish.

Table 1. Definition of scale variables read or calculated.

Variable	Definition
<b>Read:</b>	
FWCC	Number of circuli on the scale.
NR	Measurement from the origin to the nucleus edge, also considered Circulus 1.
FWANN	Measurement from the origin to the winter annulus of the freshwater zone.
FWRAD	Measurement from the origin to the edge of the scale.
CC4	Measurement from the origin to the fourth circulus.
CC7	Measurement from the origin to the seventh circulus.
CC10	Measurement from the origin to the tenth circulus.
CC13	Measurement from the origin to the thirteenth circulus.
CC16	Measurement from the origin to the sixteenth circulus.
<b>Calculated:</b>	
BW1	Width of first band of 3 circuli, CC4-NR.
BW2	Width of second band of 3 circuli, CC7 - CC4.
BW3	Width of third band of 3 circuli, CC10 - CC7.
BW4	Width of fourth band of 3 circuli, CC13 - CC10.
BW12	Bandwidths 1 and 2, CC7 - NR.
BW23	Bandwidths 2 and 3, CC10 - CC4.
BW34	Bandwidths 3 and 4, CC13 - CC7.
BW123	Bandwidths 1, 2, and 3, CC10 - NR.
FWANN2	FWANN - NR.
FWAVSP	Average circuli spacing in the freshwater zone, (FWRAD-NR)/(FWCC-1).

We estimated the correct classification of our spring chinook salmon function using the jackknife method, provided by BMDP Statistical Software (Efron 1982). Our function correctly classified 90.6% of 1,045 known origin samples. After the unmarked samples were classified, we corrected the results for misclassification and calculated confidence intervals using the methods of Worlund and Fredin (1962).

## RESULTS AND DISCUSSION

### Wild or Hatchery Classification of Chinook Salmon

We estimated that 12.7% ( $\pm 3.7\%$ ) of the outmigration of juvenile spring and summer chinook salmon at Lower Granite Dam was of wild origin (calculated



as 127 out of 999 fish sampled). We found that 4.5% of hatchery fish within our sample (including marked fish and fish we classified as hatchery) did not have a recognizeably clipped fin at Lower Granite Dam. If counted as wild fish, this relative small percentage of hatchery fish inflates the wild estimate by 31%.

In 1992 and 1993 we estimated that 11.6% and 22.7%, respectively, of the outmigrating juveniles were wild.

We looked for differences in size and migration timing of hatchery and wild fish that were consistent between the 3 years of our analysis. It should be noted that we looked at uncorrected data. We are unable to correct for misclassification of individual fish. Regarding timing, the bulk of hatchery and wild fish reached Lower Granite Dam during the same time period although there was a small increase in frequency of wild fish near the end of the juvenile outmigration.

The biggest difference between hatchery and wild fish was seen in their lengths (Table 2). We were especially interested in differences between unmarked hatchery fish and wild fish in 1993 and 1994, when all hatchery fish should have been marked. In both years the mean length of marked hatchery fish was larger than that of wild fish, however there was much overlap.

Table 2. Length data (mm) for wild, unmarked hatchery, and marked hatchery fish sampled for scale analysis from the juvenile outmigration of spring and summer chinook salmon at Lower Granite Dam.

Year	Type	Mean	Standard Deviation	Minimum	Maximum	Number
1992	Wild	117	10	91	150	353
1992	Unmarked hatchery <sup>a</sup>	132	11	97	205	814
1992	Marked hatchery	134	12	103	205	486
1993	Wild	114	8	89	136	159
1993	Unmarked hatchery	124	15	102	200	73
1993	Marked hatchery	132	14	92	205	558
1994	Wild	115	10	87	140	110
1994	Unmarked hatchery	121	13	96	150	54
1994	Marked hatchery	136	10	104	192	827

<sup>a</sup> In 1992, hatchery fish were purposely released without marks, so data for unmarked hatchery fish in 1992 are not comparable to the data of 1993 and 1994.

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## APPENDIX

Stock composition of the wild training population used to develop the discriminant function for classifying juvenile spring and summer chinook salmon of unknown origin in 1994.

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Location	Number	Percent
<hr/>		
Clearwater	4	1.9
Grande Ronde	46	21.3
Imnaha	15	6.9
Middle Fork Salmon	89	41.2
Salmon	21	9.7
South Fork Salmon	41	19.0
	216	100.0

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