

TRANSPORTATION STUDIES AT
PRIEST RAPIDS DAM, 1986

by
Steve Achord
and
Donn L. Park

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CONTENTS

	Page
INTRODUCTION.....	1
METHODS.....	2
Fish Collection, Handling, and Marking.....	2
Seawater Challenge Stress Studies.....	6
Collection of Adults from Transportation Tests in 1984-1985.....	7
RESULTS AND DISCUSSION.....	7
Fish Handling and Marking.....	7
Seawater Challenge Stress Studies.....	10
Collection of Adults from Transportation Tests in 1984-1985.....	13
SUMMARY AND CONCLUSIONS.....	18
RECOMMENDATIONS.....	19
LITERATURE CITED.....	20
APPENDIX.....	21

INTRODUCTION

Previous research by the National Marine Fisheries Service (NMFS) on the Snake River indicated that transportation of juvenile salmonids from upriver collector dams to a release site below Bonneville Dam can substantially increase the survival of smolts and subsequent numbers of returning adults compared with smolts not transported (Ebel 1980; Park 1980; Park 1985). If transportation of smolts can be proven to be also beneficial at Priest Rapids Dam, managers will be provided with an option for protecting valuable stocks of salmonids from the Mid-Columbia region.

Since 1984, the NMFS has participated in a program with the Grant County Public Utility District (PUD) to determine the benefit of transporting juvenile smolting chinook and sockeye salmon collected at Priest Rapids Dam to a release site downstream from Bonneville Dam. This year (1986) was the third year of a 3-year study for marking juvenile chinook and sockeye salmon at Priest Rapids Dam (one of three related studies conducted under guidelines established by the Mid-Columbia River Studies Committee).

In 1986, NMFS did the following: (1) sorted juvenile salmonids collected at Priest Rapids and Wanapum Dams; (2) marked juvenile chinook and sockeye salmon for the transport study; (3) measured, through seawater challenge, the relative stress induced in spring chinook and sockeye salmon by handling/marking; and (4) monitored the return of adults in the fisheries and at Columbia River trapping facilities from juveniles tagged at Priest Rapids Dam in 1984 and 1985.

METHODS

Fish Collection, Handling, and Marking

Fish handling and marking facilities at Priest Rapids Dam were in operation on 21 April 1986. The same sorting and marking complex, which included two mobile fish marking units and a mobile sorting unit, was used in 1986 as in the two previous years. The facilities, smolt collection gear, methods, and fish transport apparatus were described by Dell et al. (1985).

Grant County PUD personnel collected fish to be used for the study. Most were sampled from the turbine intake gatewells at Priest Rapids Dam, as in 1984 and 1985. As in 1985, supplemental fish were used from Wanapum Dam. Smolt collection gear and methods used at Wanapum Dam were described by Achord et al. (1985).

Limited seawater challenge data from experiments in 1985 indicated that sockeye salmon may be stressed during handling/marketing. In an effort to reduce stress to sockeye salmon in 1986, we increased concentrations of MS-222 in the transfer container from the Priest Rapids' gatewells and in the circular tanks used at Wanapum Dam from 37.5 to 50 ppm. To maintain complete anesthesia of the sockeye salmon during the sorting and marking process, we increased the MS-222 concentration in our anesthetic system from 35 to 40 ppm.

Fish entering the sorting unit were identified by species and examined for prior marks. Brands were recorded for fish collected from Priest Rapids Dam for the Fish Passage Center (FPC). All previously marked fish together with all coho salmon and steelhead were passed via a freshwater line to the circular tank where they were held until nighttime and then released into the Columbia River. Chinook and sockeye salmon to be marked were passed via

anesthetic water lines to the tagging units after receiving an adipose fin clip at the sorting station. All smolt sized fish were marked unless they showed obvious signs of injury or gross descaling. One marking unit was set up for marking transported fish, the other for marking controls for release into the river below the dam. To assure random and equal distribution of species and fish numbers between the two marking units, personnel clipping the adipose fins alternately distributed the fish to each marking unit. In each marking unit, fish were freeze branded with a tool cooled by liquid nitrogen, tagged with a magnetic coded wire tag (CWT), passed through a detection system, and accepted or rejected to ensure the presence of a magnetized tag. Fish markers were rotated periodically between the sorting and marking units to ensure equal marking treatment of transport and control marked groups. Following marking, the fish passed through a pipe via fresh water to either a fish holding tank for release into the river at night (control) or to a transport tank for transportation by truck to the release site in the Columbia River near Corbett Station below Bonneville Dam. During fish marking operations, fish were periodically taken from the marking lines and held for a 5-day observation period to determine delayed mortality, tag retention, and brand legibility.

Wire tag codes and brands were changed either on a weekly basis or as marked group quotas were met to obtain contribution data from the various segments of the smolt outmigration. Different wire codes and brands were used to identify fish collected from Wanapum and Priest Rapids Dams as well as transport and control releases. Different wire codes and brands were also used on sockeye and chinook salmon, except the same brand was used on the two species for the first part of the marking season (Tables 1 and 2).

Table 1.--Summary of brands and wire codes used to identify juvenile spring chinook and sockeye salmon that were collected and marked at Priest Rapids Dam and transported by truck to below Bonneville Dam or released as controls below Priest Rapids Dam, 1986.

Marking period	Brand position symbol, & orientation ^{a/}	Wire code	Number marked
<u>Truck Transport</u>			
<u>Chinook salmon</u>			
23 Apr - 03 May	RA-E, 1	23-17-60	9,832
05 May - 11 May	RA-E, 2	23-17-61	12,458
12 May - 18 May	RA-E, 3	23-17-62	6,961
20 May - 25 May	RA-E, 4	23-17-63	3,887
27 May - 29 May	RA-Y, 1	23-18-01	1,510
		Total	34,648
<u>Sockeye salmon</u>			
23 Apr - 26 Apr	RA-E, 1	23-17-31	8,624
27 Apr - 03 May	RA-E, 2	23-17-32	4,664
05 May - 11 May	RA-E, 3	23-17-33	5,037
12 May - 18 May	RA-T, 1	23-17-34	9,637
20 May - 22 May	RA-T, 2	23-17-35	11,038
23 May - 27 May	RA-T, 3	23-17-36	10,270
28 May - 29 May	RA-T, 4	23-18-62	693
		Total	49,963
<u>Control</u>			
<u>Chinook salmon</u>			
23 Apr - 03 May	LA-H, 1	23-18-02	9,464
05 May - 11 May	LA-H, 2	23-18-03	12,473
12 May - 18 May	LA-H, 3	23-18-04	7,880
20 May - 25 May	LA-H, 4	23-18-05	5,113
27 May - 29 May	LA-J, 1	23-18-06	665
		Total	35,595
<u>Sockeye salmon</u>			
23 Apr - 26 Apr	LA-H, 1	23-17-37	8,711
27 Apr - 03 May	LA-H, 2	23-17-38	4,932
05 May - 11 May	LA-H, 3	23-17-39	4,313
12 May - 18 May	LA-V, 1	23-18-18	10,186
20 May - 22 May	LA-V, 2	23-18-19	10,671
23 May - 27 May	LA-V, 3	23-18-20	9,415
28 May - 29 May	LA-V, 4	23-19-01	2,414
		Total	50,642

^{a/} Brand positions abbreviations are: RA = right anterior, LA = left anterior. Brand symbol is self explanatory. Brand orientation--refers to rotation of the brand around its centerpoint, e.g., 1 corresponds to the normal orientation, A; 2 to \triangleright ; 3 to ∇ ; 4 to \triangleleft .

Table 2.--Summary of brands and wire codes used to identify juvenile spring chinook and sockeye salmon that were collected at Wanapum Dam, marked at Priest Rapids Dam, and transported by truck to below Bonneville Dam or released as controls below Priest Rapids Dam, 1986.

Marking period	Brand position symbol, & orientation ^{a/}	Wire code	Number marked
<u>Truck transport</u>			
<u>Chinook salmon</u>			
24 Apr - 02 May	RA-N, 1	23-18-27	10,479
05 May - 08 May	RA-N, 2	23-18-28	8,831
12 May - 16 May	RA-N, 3	23-18-29	4,782
19 May - 23 May	RA-N, 4	23-18-30	1,457
27 May - 02 June	RA-Y, 3	23-18-31	1,327
		Total	26,876
<u>Sockeye salmon</u>			
24 Apr - 25 Apr	RA-N, 1	23-18-21	2,006
28 Apr - 02 May	RA-N, 4	23-18-22	2,018
05 May - 08 May	RA-N, 3	23-18-23	853
12 May - 16 May	RA-U, 1	23-18-24	2,205
19 May - 23 May	RA-U, 2	23-18-25	4,180
27 May - 02 June	RA-U, 3	23-18-26	3,159
		Total	14,421
<u>Control</u>			
<u>Chinook salmon</u>			
24 Apr - 02 May	LA-B, 1	23-18-39	10,438
05 May - 08 May	LA-B, 2	23-18-40	8,898
12 May - 16 May	LA-B, 3	23-18-41	5,250
19 May - 23 May	LA-B, 4	23-18-42	1,521
27 May - 02 June	LA-Z, 3	23-18-43	1,176
		Total	27,283
<u>Sockeye salmon</u>			
24 Apr - 25 Apr	LA-B, 1	23-18-33	2,239
28 Apr - 02 May	LA-B, 4	23-18-34	1,919
05 May - 08 May	LA-B, 3	23-18-35	779
12 May - 16 May	LA-L, 1	23-18-36	2,189
19 May - 23 May	LA-L, 2	23-18-37	4,065
27 May - 02 June	LA-L, 3	23-18-38	3,093
		Total	14,284

^{a/} See Table 1 ^{a/}

Seawater Challenge Stress Studies

In 1986, seawater challenge tests measured the stress of handling and marking on both spring chinook and sockeye salmon. The tests were conducted in the mobile laboratories located at Priest Rapids Dam. Static seawater challenge bioassay techniques and sampling procedures were used (Park et al. 1983 and Matthews et al. 1986). Information was recorded on coho salmon and steelhead inadvertently sampled with spring chinook and sockeye salmon. All test series were conducted in 34 ppt artificial seawater.

Debilitating stress incurred via the handling/marking process was determined by measuring seawater mortality in test groups sampled prior to and after marking. Fish for the prior to marking group (termed "pre-mark" test condition) were obtained from unanesthetized fish sampled from the transfer container upon arrival at the marking facility. Fish for the post marking group (termed "pre-transport" test condition) were obtained from the transport truck prior to transport and at least 2h after marking. Each of these test series had three replicates for each sample point, with each replicate containing 20 to 30 fish of each species. The test series were conducted on 7, 15, and 20 May.

Data on individual lengths, live and dead fish numbers, and descaling were recorded at the conclusion of each 24-h seawater challenge test series (Appendix Table 1). Two-way contingency tables with chi-square statistics were utilized to measure levels of significance. Significance was established at $P < 0.05$, $df = n$ for comparison between test groups.

Collection of Adults from Transportation Tests in 1984-1985

Adult spring chinook and sockeye salmon returning in 1986 from transportation tests conducted in 1984-1985 were monitored from ocean fishing catches; Columbia River and tributary catches; spawning grounds; and trapping facilities at Bonneville, McNary, and Priest Rapids Dams.

Adult trapping facilities were constructed and placed into operation for the first time this year at Priest Rapids Dam. These facilities were operated by Grant County PUD personnel from late April through August, which covered the major portions of the spring chinook and sockeye salmon runs. NMFS personnel operated similar facilities through the adult runs at Bonneville and McNary Dams. Trapping was accomplished 7 days/week in most cases, however, at Priest Rapids Dam sampling was restricted to limited hours of operation each day. At Bonneville Dam, we estimate NMFS sampled approximately 30% of the sockeye migration and a very low percentage of the spring chinook salmon run. At McNary Dam no reasonable estimate of sampling could be established for either species. The sampling rate at Priest Rapids Dam is as yet unknown but should be available from adults marked at the trap and subsequently recovered at upstream hatcheries and the spawning grounds. These data will be available later.

RESULTS AND DISCUSSION

Fish Handling and Marking

From fish collected at Priest Rapids Dam during the marking season (23 April to 29 May), 34,648 spring chinook salmon and 49,963 sockeye salmon were marked with CWT, freeze brands, and adipose fin clips and transported by truck to a release site below Bonneville Dam (Table 1). In addition, 26,876 spring

chinook salmon and 14,421 sockeye salmon collected from Wanapum Dam (24 April to 2 June) were marked and likewise transported (Table 2). An additional 35,595 spring chinook salmon and 50,642 sockeye salmon collected from Priest Rapids Dam (Table 1) and 27,283 spring chinook salmon and 14,284 sockeye salmon collected from Wanapum Dam (Table 2) were marked and released as controls below Priest Rapids Dam.

A total of 482 spring chinook salmon were marked and held during four 5-day holding periods and 649 sockeye salmon were marked and held during five 5-day holding periods, throughout the marking season (Table 3). Delayed mortality was 0.0% for chinook salmon and 1.8% for sockeye salmon. Tag loss averaged 1.0% for chinook salmon and 1.2% for sockeye salmon. Brand placement, retention, and legibility were judged good throughout the season for chinook salmon, with only 6.4% of the brands categorized as poor (Table 3). From 23 April to 11 May, sockeye salmon were branded with the "rocking series" brands. During this time, 32.7 and 37.1% of the total sockeye salmon were branded for the season from Priest Rapids and Wanapum Dams, respectively. After the second holding period for sockeye salmon, however, it was decided to completely change the brand series because the "rocking series" 3/16-inch brands were judged to be of very poor quality (37.8% categorized as poor) (Table 3). From 12 May to 2 June the remaining 67.3 and 62.9% of the sockeye salmon from Priest Rapids and Wanapum Dams, respectively, were marked with selected single brands for the two dams. Brand condition for this time period indicated 0.0% poor brands, with 99.4% of the brands judged good (Table 3).

A combined total for both dams of 11 chinook salmon subyearlings, 34,033 chinook salmon yearlings, 22,303 sockeye salmon, 34,420 steelhead, and 23,329 coho salmon were sorted directly to a holding tank and subsequently released

Table 3.--Summary of survival, mortality, tag loss, and brand placement and condition after 5-day holding of marked juvenile spring chinook and sockeye salmon at Priest Rapids Dam, 1986.

Holding period	Number alive	Number dead	Number with lost tags	Number good	Brand condition	
					Number fair	Number poor
<u>Chinook</u>						
02 May - 07 May	120	0	4	63	37	20
09 May - 14 May	187	0	1	150	30	7
16 May - 21 May	87	0	0	65	20	2
27 May - 01 June	<u>88</u>	<u>0</u>	<u>0</u>	<u>82</u>	<u>4</u>	<u>2</u>
Totals	482	0	5	360	91	31
<u>Sockeye</u>						
26 Apr - 01 May	108	1	0	37	30	41
02 May - 07 May	109	2	2	15	20	74
09 May - 14 May	103	0	3	79	18	6
*16 May - 21 May	143	0	1	141	2	0
27 May - 01 June	<u>174</u>	<u>9</u>	<u>2</u>	<u>174</u>	<u>0</u>	<u>0</u>
Totals	637	12	8	446	70	121

* - Brand series changed

into the river during the marking period. A grand total of 370,059 juvenile salmonids was handled at the sorting and marking complex in 1986. Grand totals for 1985 and 1984 were 369,133 and 197,204, respectively (Table 4).

Seawater Challenge Stress Studies

The results of seawater challenge stress tests with spring chinook and sockeye salmon are presented in Figure 1 and Appendix Table 1. Data indicate that, as in 1984 and 1985, no significant increase in stress occurred during handling and marking of spring chinook salmon. Data does, however, indicate an increase in stress occurred during handling and marking of sockeye salmon. Previous studies where plasma cortisol was used as a stress indicator for sockeye salmon (Dell et al. 1985) and limited seawater challenge data in 1985 support these findings.

The inconsistency of mortality among tests and replicates (two tests showed an increase in stress and one test a decrease in stress) indicates sockeye salmon exhibit considerable variability in response to handling/marking, and maybe, different stress responses exist for different stocks. Previous studies showed higher and more variable cortisol levels for sockeye salmon than for chinook salmon (Dell et al. 1985).

Length-frequency data indicate that the average size of dead sockeye in the pre-transport group was considerably less than the average size of live sockeye from that group and both dead and live fish from the pre-mark group (Appendix Table 1). This suggests that handling/marking may elicit a higher stress response in small-size sockeye salmon; more information is obviously needed. This year's data does not indicate whether the increased concentration of MS-222 used in the transfer containers and marking anesthetic system minimized handling stress in sockeye salmon. However, 3 years of

Table 4.--Summary of total numbers and species composition of fish handled at the Priest Rapids sorting and marking complex, 1986 (21 Apr - 02 June), 1985 (20 Apr - 05 June), and 1984 (01 May - 06 June).

Species	1986					
	Priest Rapids		Wanapum		Total	
	No.	%	No.	%	No.	%
Chinook "0"	99	0.0	12	0.0	111	0.0
Chinook "1"	82,209	35.3	77,977	56.9	160,186	43.3
Sockeye	117,220	50.3	34,793	25.4	152,013	41.1
Steelhead	20,715	8.9	13,705	10.0	34,420	9.3
Coho	<u>12,813</u>	<u>5.5</u>	<u>10,516</u>	<u>7.7</u>	<u>23,329</u>	<u>6.3</u>
Totals	233,056		137,003		370,059	

Species	1985					
	Priest Rapids		Wanapum		Total	
	No.	%	No.	%	No.	%
Chinook "0"	239	0.1	16	0.0	255	0.1
Chinook "1"	111,602	41.3	58,754	59.5	170,356	46.2
Sockeye	123,365	45.6	20,408	20.7	143,773	38.9
Steelhead	34,270	12.7	18,857	19.1	53,127	14.4
Coho	<u>905</u>	<u>0.3</u>	<u>717</u>	<u>0.7</u>	<u>1,622</u>	<u>0.4</u>
Totals	270,381		98,752		369,133	

Species	1984					
	Priest Rapids		Wanapum		Total	
	No.	%	No.	%	No.	%
Chinook "0"	428	0.2	0	0.0	428	0.2
Chinook "1"	78,206	39.6	0	0.0	78,206	39.6
Sockeye	43,775	22.2	0	0.0	43,775	22.2
Steelhead	44,882	22.8	0	0.0	44,882	22.8
Coho	<u>29,913</u>	<u>15.2</u>	<u>0</u>	<u>0.0</u>	<u>29,913</u>	<u>15.2</u>
Totals	197,204		0		197,204	

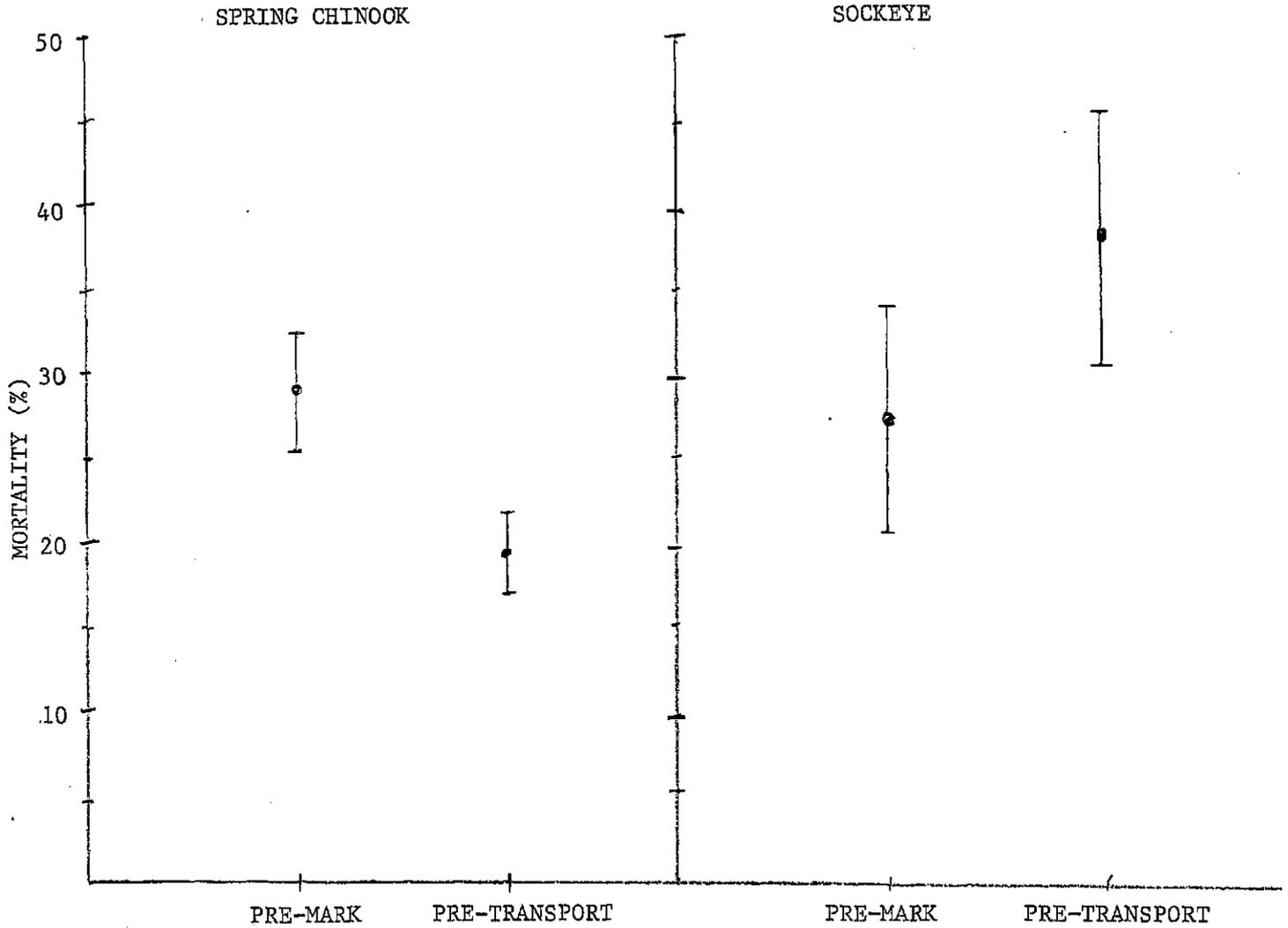


Figure 1.--Seawater challenge tests for relative stress of spring chinook and sockeye salmon smolts sampled prior to marking and prior to transport at Priest Rapids Dam, 1986 (vertical bars indicate S.E.).

stress work supports the pre-anesthesia concept (anesthetizing fish prior to handling) for minimizing stress during fish handling/marking operations (Matthews^{1/}).

Collection of Adults from Transportation Tests in 1984-1985

Over 500 identifiable tagged adults were recovered in 1986 and are included in our analyses. The majority of these were 1+ocean age sockeye salmon returning from 1985 experiments. All but 19 fish were recovered at the adult collection facilities at dams, demonstrating their importance in our evaluations (Table 5). In addition, 72 sockeye salmon that had unreadable brands were recovered at trapping facilities. Summary data for all confirmed branded fish recovered and for all confirmed CWTs extracted from adults are presented in Appendix Tables 2 to 13 (appendix tables are listed in order by year of study, treatment group, and species. (Note: Subsequent to our analyses, about 100 tagged adult fish were recovered from tributary spawning grounds and hatcheries--these will be added to the data base in a subsequent report).

Data accumulated so far are preliminary since returns are not complete for any group. Therefore, no conclusions can be drawn at this time. There are however, some implications that can be noted from the preliminary data. Returns for spring chinook salmon are poor for 1984. Further, there was a negative transport benefit ratio; a result never observed in almost 20 years of similar studies on the Snake River. The data strongly suggest that multiple handling of spring chinook salmon dipped from Wanapum Dam gatewells

^{1/} Gene Matthews, Biologist, National Marine Fisheries Service, 2725 Montlake Boulevard East, Seattle, WA 98112, pers. commun., December 1986.

Table 5.--Summary of 1 and 2 ocean age spring chinook and sockeye salmon adults by recovery area that were marked and released in 1984-1985. Data from 1985 releases includes only 1-ocean age fish.

Year, species, release site, and experimental group	Recovery area (site)				
	Bonneville	McNary	Priest R.	Ocean	Other
1984 - Spring chinook					
Test - Bonneville	5	10	1	1	1
Control - Priest Rapids	13	26	16	0	7
1985 - Spring chinook					
Test - Bonneville	1	3	5	4	1
Control Priest Rapids	2	4	0	3	1
Test - Bonneville ^{a/}	0	0	0	1	0
Control - Priest Rapids ^{a/}	0	0	0	0	0
1984 - Sockeye					
Test - Bonneville	49	6	19	0	0
Control - Priest Rapids	25	17	28	0	0
1985 - Sockeye					
Test - Bonneville	99	15	49	0	0
Control - Priest Rapids	22	10	46	0	0
Test - Bonneville ^{a/}	26	1	8	0	0
Control - Priest Rapids ^{a/}	9	2	3	0	0

^{a/} Smolts from these groups were collected at Wanapum Dam, transferred to Priest Rapids Dam, marked, and subsequently treated the same as those fish from Priest Rapids Dam.

reduced their survival when compared to fish marked from Priest Rapids Dam gatewells in 1985 (1 return in 50,000 vs 24 returns in 100,000) (Table 6).

Survival of sockeye salmon marked in 1984 and 1985 appears to be good. Survival of transported fish is much higher than controls. However, benefit ratios are much reduced between Bonneville Dam and Priest Rapids Dam. This suggests there is either a differential mortality of transported fish during upstream passage or a homing loss. Since benefit ratios at McNary Dam (Table 5) are more like that observed at Priest Rapids Dam, the loss must be occurring downstream from McNary Dam (Table 5).

From the preliminary data (1-ocean age returns from 1985 only), it would appear that mortality or homing loss is affecting a particular segment of transported sockeye salmon smolts (Table 7). The number and percent return of transported fish are nearly equal at Bonneville and Priest Rapids Dams for the first four groups, whereas returns for the last two groups (transported as smolts from 20 May-4 June) are more numerous at Bonneville Dam. Since smolts released at Priest Rapids Dam as controls have returned to Bonneville and Priest Rapids Dams in near equal ratios for all six groups, it would appear that the problem lies with the latter two groups of transport releases. As more adult return data becomes available, we should be able to more clearly define transportation benefits for sockeye salmon.

One should be aware of the impacts of fishnets on sockeye salmon and the subsequent effect on transport benefit ratios. For example, we observed 72 adults that had unreadable brands at trapping facilities--a large percentage of the brands were obscured because of net marks. Of the 72 adults observed with unreadable brands, 49 (68%) were 2 ocean age fish and 23 (32%) were 1 ocean age fish. Since larger sockeye salmon are targeted by mesh size

Table 6.--Summary of returns of chinook and sockeye salmon from control and transport releases of smolts tagged in 1984 and 1985 at Priest Rapids Dam and recovered in 1985-1986.

Year, species, release site, and experimental group	Number of smolts released	Number of adults recovered	
		<u>1-ocean age</u>	<u>2-ocean age</u>
<u>1984 - Sockeye salmon</u>			
Control - Priest Rapids	20,674	1	69
Transport - Bonneville	20,731	4	70
<u>Chinook salmon</u>			
Control - Priest Rapids	38,247	0	62
Transport - Bonneville	38,673	2	16
<u>1985 - Sockeye salmon</u>			
Control - Priest Rapids	55,432	89	-
Transport - Bonneville	55,406	163	-
Control - Priest Rapids ^{a/}	8,559	14	-
Transport - Bonneville ^{a/}	8,602	35	-
<u>Chinook salmon</u>			
Control - Priest Rapids	49,700	10	-
Transport - Bonneville	50,490	14	-
Control - Priest Rapids ^{a/}	25,553	0	-
Transport - Bonneville ^{a/}	26,287	<u>1</u>	<u>-</u>
Totals		333	217

^{a/} Smolts from these groups were collected at Wanapum Dam, transferred to Priest Rapids Dam, marked, and subsequently treated the same as those fish from Priest Rapids Dam.

Table 7.--Survival (percent return) of transport and control lots of sockeye salmon marked and released in 1985 that returned as adults in 1986 to Bonneville and Priest Rapids Dams.^{a/}

Release site	Tag code	No. released	Dates	No. and (%) returned to Bonneville	No. and (%) returned to Priest Rapids
Bonneville	23-17-16	10,232	20-28 Apr	10 (0.097)	5 (0.049)
	23-17-50	8,146	28 Apr-4 May	10 (0.122)	9 (0.110)
	23-17-52	8,171	5-12 May	7 (0.086)	4 (0.049)
	23-17-54	6,506	13-19 May	4 (0.061)	4 (0.061)
	23-17-26	10,259	20-26 May	32 (0.312)	16 (0.156)
	23-17-57	12,092	27 May-4 Jun	<u>36</u> (0.298)	<u>11</u> (0.091)
			Total return (%)	99 (0.178)	53 (0.096)
Priest Rapids	23-17-17	9,614	20-28 Apr	9 (0.094)	8 (0.083)
	23-17-47	8,189	28 Apr-4 May	5 (0.061)	17 (0.208)
	23-17-49	8,171	5-12 May	7 (0.086)	3 (0.037)
	23-17-51	6,451	13-19 May	5 (0.078)	3 (0.047)
	23-17-19	10,403	20-26 May	5 (0.048)	11 (0.106)
	23-17-59	12,604	27 May-4 Jun	<u>2</u> (0.016)	<u>4</u> (0.032)
			Total return (%)	33 (0.060)	46 (0.083)

^{a/} See also Appendix Tables 2 to 13.

restrictions, adult return rates will be affected and may influence observed transport benefit ratios.

Inferences drawn from the preliminary adult return data should be treated with caution. Much more information is needed before valid conclusions can be made. We believe that studies should be undertaken to define the optimum survival capabilities of smolts. This is particularly true for spring chinook salmon. Results of these studies could lead to improved runs whether fish are transported or not.

SUMMARY AND CONCLUSIONS

1. During 1986, 70,243 chinook salmon and 100,605 sockeye salmon were marked from gatewell collection operations at Priest Rapids Dam. An additional 54,159 chinook salmon and 28,705 sockeye salmon were marked from gatewell collection at Wanapum Dam.

2. Seawater challenge tests indicated that chinook salmon smolts were not significantly stressed, but sockeye salmon were stressed during marking operations.

3. Adult recovery efforts provided 105 tagged chinook salmon and 445 sockeye salmon to the data base for transport studies conducted during 1984-1985. Preliminary data suggest that spring chinook salmon transported in 1984 had a negative benefit ratio. Sockeye salmon transported in 1984-1985 have generally positive benefit ratios, however, some of the benefit may be offset by homing loss or unknown mortality factors during their adult migration.

4. Adult spring chinook salmon that returned from groups of smolts dipped from gatewells at Wanapum Dam returned at much lower rates than adults returning from smolts dipped from gatewells at Priest Rapids Dam.

RECOMMENDATIONS

1. Studies should be undertaken to determine why some stocks/species have limited survival capabilities. Studies on spring chinook salmon are urgent.

2. Sampling effort for adult recovery at Priest Rapids Dam should be increased. Since final analyses must be keyed to returns at Priest Rapids Dam, we recommend daily trap operations from daylight to dark during spring chinook and sockeye salmon runs.

3. Supplemental fish from Wanapum Dam should not be used in any future transport experiments at Priest Rapids Dam.

LITERATURE CITED

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APPENDIX

Data Tables

Appendix Table 1.--Seawater challenge test data for spring chinook and sockeye salmon sampled before and after handling/markings at Priest Rapids Dam, spring 1986. Data include test numbers, descaling, and average length of live and dead fish by sample area and replicate after a 24-h exposure to artificial seawater (includes data for steelhead and coho salmon which were unintentionally sampled with spring chinook and sockeye salmon in some tests).

Test	Date	Dead fish												Live fish											
		Number nondescaled				Number descaled				Average fork length (mm)				Number nondescaled				Number descaled				Average fork length (mm)			
		SC	SO	ST	CO	SC	SO	ST	CO	SC	SO	ST	CO	SC	SO	ST	CO	SC	SO	ST	CO	SC	SO	ST	CO
Test Condition - Transfer Container - Pre-Mark																									
1/1	07 May	9	3	0	0	1	0	0	0	124.2	87.3	0	0.0	16	14	1	0	0	0	0	0	126.0	85.0	190.0	0.0
1/2	07 May	4	1	0	0	0	0	0	0	119.2	76.0	0	0.0	21	18	0	0	0	0	0	0	122.5	91.8	0.0	0.0
1/3	07 May	6	0	0	0	0	0	0	0	112.2	0.0	0	0.0	14	10	1	0	0	0	0	0	130.4	87.7	165.0	0.0
2/1	15 May	11	5	0	0	0	0	0	0	130.8	110.4	0	0.0	19	7	2	1	1	0	0	0	138.8	111.6	190.0	130.0
2/2	15 May	9	4	0	1	0	0	0	0	126.4	103.7	0	146.0	21	4	0	4	0	0	0	0	135.5	95.7	0.0	169.2
2/3	15 May	10	6	0	0	0	0	0	0	125.3	104.7	0	0.0	26	4	0	1	0	0	0	0	135.0	113.0	0.0	156.0
3/1	20 May	2	10	0	0	0	0	0	0	130.0	110.0	0	0.0	4	22	0	9	0	0	0	0	132.0	111.1	0.0	158.4
3/2	20 May	1	7	0	0	0	1	0	0	122.0	107.5	0	0.0	12	20	4	10	0	0	0	0	133.4	107.6	155.5	157.5
3/3	20 May	5	5	0	0	1	0	0	0	126.3	111.6	0	0.0	11	13	0	7	0	0	0	1	138.8	112.2	0.0	145.2
Totals/averages		57	41	0	1	2	1	0	0	124.8	106.0	0	146.0	144	112	8	32	1	0	0	1	132.4	101.7	169.6	155.3

Appendix Table 1.--continued

Test	Date	Dead fish												Live fish											
		Number nondescaled				Number descaled				Average fork length (mm)				Number nondescaled				Number descaled				Average fork length (mm)			
		SC	SO	ST	CO	SC	SO	ST	CO	SC	SO	ST	CO	SC	SO	ST	CO	SC	SO	ST	CO	SC	SO	ST	CO
Test Condition - Truck - Pre-Transport																									
1/1	07 May	4	1	0	0	0	0	0	0	105.5	81.0	0	0	19	4	0	0	0	0	0	0	130.2	84.5	0	0
1/2	07 May	3	9	0	0	1	0	0	0	112.7	80.7	0	0	20	10	0	0	0	0	0	0	129.9	86.6	0	0
1/3	07 May	4	0	0	0	0	1	0	0	115.5	71.0	0	0	15	16	0	0	0	0	0	0	125.6	89.7	0	0
2/1	15 May	7	9	0	0	0	0	0	0	120.0	94.6	0	0	25	3	0	0	1	1	0	0	131.7	118.0	0	0
2/2	15 May	9	19	0	0	0	0	0	0	123.1	97.6	0	0	30	13	0	0	0	0	0	0	133.5	105.4	0	0
2/3	15 May	3	5	0	0	0	1	0	0	123.0	90.8	0	0	13	37	0	0	0	0	0	0	123.9	111.2	0	0
3/1	20 May	0	15	0	0	0	1	0	0	0.0	100.5	0	0	9	16	0	0	0	0	0	0	132.2	114.7	0	0
3/2	20 May	4	6	0	0	0	1	0	0	128.5	91.7	0	0	10	21	0	0	1	0	0	0	136.8	109.9	0	0
3/3	20 May	<u>1</u>	<u>31</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>2</u>	<u>0</u>	<u>0</u>	<u>132.0</u>	<u>103.0</u>	<u>0</u>	<u>0</u>	<u>6</u>	<u>40</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>121.2</u>	<u>115.1</u>	<u>0</u>	<u>0</u>
Totals/averages		35	95	0	0	1	6	0	0	119.4	96.8	0	0	147	160	0	0	2	1	0	0	130.3	107.7	0	0

Appendix Table 2.--Adult recoveries from smolts clipped from gatewells at Priest Rapids Dam and subsequently transported to Bonneville Dam (Corbett Landing) in 1984.

RELEASE GROUPS INCLUDED: B401A B401B B401C B401D
 1984 TRANS TEST TRUCK
 SPRING/SUMMER CHINOOK

Brands Used: RAIC1 RAID1 RAIF1 RAIC3
 Wire Codes Used: 231703 231705 231707 231709

NUMBER RELEASED: 38673

RECOVERY AREA	YEAR OF RETURN			TOTAL	% RETURN
	1984	1985	1986		
RIVER SYSTEM TRAPS					
BONNEVILLE TRAP	0	1	4	5	0.013
MCNARY TRAP	0	0	10	10	0.026
LOWER GRANITE TRAP	0	0	0	0	0.000
PRIEST RAPIDS TRAP	0	0	1	1	0.000
OCEAN FISHERIES					
ALASKA	0	0	0	0	0.000
BRITISH COLUMBIA	0	0	0	0	0.000
WASHINGTON	0	0	0	0	0.000
OREGON	0	1	0	1	0.000
CALIFORNIA	0	0	0	0	0.000
OTHER	0	0	0	0	0.000
RIVER SPORT					
COLUMBIA R. BELOW SNAKE R.	0	0	0	0	0.000
COLUMBIA R. ABOVE SNAKE R.	0	0	0	0	0.000
WENATCHEE R.	0	0	1	1	0.000
SNAKE R.	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERY	0	0	0	0	0.000
HATCHERIES	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0.000
TOTALS	0	2	16	18	0.047
PERCENT OF RECOVERY	%	0.0	11.1	88.9	

Appendix Table 3.--Adult recoveries from smolts dipped from gatewells at Priest Rapids Dam and subsequently released downstream from Priest Rapids Dam in 1984.

RELEASE GROUPS INCLUDED: 8402A 8402B 8402C 8402D
 1984 TRANS CONTROL
 SPRING/SUMMER CHINOOK
 Brands Used: LAIU1 LAIR1 LAIM1 LAIU3
 Wire Codes Used: 231702 231704 231706 231660

NUMBER RELEASED: 38247 ⁶⁷

RECOVERY AREA	YEAR OF RETURN			TOTAL	% RETURN
	1984	1985	1986		
RIVER SYSTEM TRAPS					
BONNEVILLE TRAP	0	0	13	13	0.040
MCNARY TRAP	0	0	26	26	0.068
LOWER GRANITE TRAP	0	0	0	0	0.000
PRIEST RAPIDS TRAP	0	0	16	16	0.042
OCEAN FISHERIES	0	0	0	0	0.000
RIVER SPORT					
COLUMBIA R. BELOW SNAKE R.	0	0	0	0	0.000
COLUMBIA R. ABOVE SNAKE R.	0	0	1	1	0.003
WENATCHEE R.	0	0	3	3	0.000
SNAKE R.	0	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0	0.000
INDIAN FISHERY	0	0	0	0	0.000
HATCHERIES					
LEAVENWORTH H.	0	0	1	1	0.003
ENTIAT H.	0	0	2	2	0.005
STREAM SURVEY	0	0	0	0	0.000
TOTALS	0	0	62	62	0.162
PERCENT OF RECOVERY	%	0.0	0.0	100.0	

Appendix Table 4.--Adult recoveries from smolts dipped from gatewells at Priest Rapids Dam and subsequently transported to Bonneville Dam (Corbett Landing) in 1984.

RELEASE GROUPS INCLUDED: 8403A 8403B 8403C 8403D
 1984 TRANS TEST TRUCK
 SOCKEYE

Brands Used: RAIC1 RAID1 RAIF1 RAIC3
 Wire Codes Used: 231653 231655 231657 231659

NUMBER RELEASED: 20731

RECOVERY AREA	1984	YEAR OF RETURN		TOTAL	% RETURN
		1985	1986		
RIVER SYSTEM TRAPS					
BONNEVILLE TRAP	1	3	45	49	0.236
MCNARY TRAP	0	0	6	6	0.029
LOWER GRANITE TRAP	0	0	0	0	0.000
PRIEST RAPIDS TRAP	0	0	19	19	0.092
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 FISHERY	0	0	0	0	0.000
HATCHERIES	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0.000
TOTALS	1	3	70	74	0.357
PERCENT OF RECOVERY	%	1.4	4.1	94.6	

Appendix Table 5.--Adult recoveries from smolts dipped from gatewells at Priest Rapids Dam and subsequently released downstream from Priest Rapids Dam in 1984.

RELEASE GROUPS INCLUDED: B404A B404B B404C B404D
1984 TRANS CONTROL

SOCKEYE

Brands Used: LAIU1 LAIR1 LAIM1 LAIU3
Wire Codes Used: 231654 231656 231658 231708

NUMBER RELEASED: 20574

RECOVERY AREA	YEAR OF RETURN			TOTAL	% RETURN
	1984	1985	1986		
RIVER SYSTEM TRAPS					
BONNEVILLE TRAP	0	1	23	24	0.117
MCNARY TRAP	0	0	17	17	0.083
LOWER GRANITE TRAP	0	0	0	0	0.000
PRIEST RAPIDS TRAP	0	0	28	28	0.136
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 FISHERY	0	0	0	0	0.000
HATCHERIES	0	0	0	0	0.000
STREAM SURVEY	0	0	0	0	0.000
TOTALS	0	1	68	69	0.335
PERCENT OF RECOVERY	%	0.0	1.4	98.6	

Appendix Table 6.--Adult recoveries from smolts dipped from gatewells at Priest Rapids Dam and subsequently transported to Bonneville Dam (Corbett Landing) in 1985.

RELEASE GROUPS INCLUDED: 8501A 8501B 8501C 8501D 8501E 8501F
 1985 TRANS TEST TRUCK
 SPRING/SUMMER CHINOOK

Brands Used: RAIH1 RAIJ1 RAIK1 RAIH3 RAIJ3 RAIK3
 Wire Codes Used: 231746 231710 231712 231714 231748 231756

NUMBER RELEASED: 50490

RECOVERY AREA	1985	YEAR OF RETURN 1986	TOTAL	% RETURN
RIVER SYSTEM TRAPS				
BONNEVILLE TRAP	0	1	1	0.000
MENARY TRAP	1	2	3	0.000
LOWER GRANITE TRAP	0	0	0	0.000
PRIEST RAPIDS TRAP	0	5	5	0.000
OCEAN FISHERIES				
ALASKA	0	0	0	0.000
BRITISH COLUMBIA	0	0	0	0.000
WASHINGTON	0	0	0	0.000
OREGON	4	0	4	0.008
CALIFORNIA	0	0	0	0.000
OTHER	0	0	0	0.000
RIVER SPORT				
COLUMBIA R. BELOW SNAKE R.	0	0	0	0.000
COLUMBIA R. ABOVE SNAKE R.	0	0	0	0.000
WENATCHEE R.	0	1	1	0.000
SNAKE R.	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0.000
INDIAN FISHERY	0	0	0	0.000
HATCHERIES	0	0	0	0.000
STREAM SURVEY	0	0	0	0.000
TOTALS	5	9	14	0.028
PERCENT OF RECOVERY	%	35.7	64.3	

20

Appendix Table 7.--Adult recoveries from smolts dipped from gatewells at Wanapum Dam and subsequently transported to Bonneville Dam (Corbett Landing) in 1985.

RELEASE GROUPS INCLUDED: 8505A 8505B 8505C 8505D 8505E
 1985 TRANS TEST TRUCK
 SPRING/SUMMER CHINOOK

Brands Used: RAIZ1 RAIY1 RAIY3
 Wire Codes Used: 231728 231730 231740 231722 231744

NUMBER RELEASED: 26287
 29

RECOVERY AREA	1985	YEAR OF RETURN 1986	TOTAL	% RETURN
RIVER SYSTEM TRAPS				
BONNEVILLE TRAP	0	0	0	0.000
MCNARY TRAP	0	0	0	0.000
LOWER GRANITE TRAP	0	0	0	0.000
PRIEST RAPIDS TRAP	0	0	0	0.000
OCEAN FISHERIES				
ALASKA	0	0	0	0.000
BRITISH COLUMBIA	0	0	0	0.000
WASHINGTON	0	0	0	0.000
OREGON	0	1	1	0.004
CALIFORNIA	0	0	0	0.000
OTHER	0	0	0	0.000
RIVER SPORT	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0.000
INDIAN FISHERY	0	0	0	0.000
HATCHERIES	0	0	0	0.000
STREAM SURVEY	0	0	0	0.000
TOTALS	0	1	1	0.004
PERCENT OF RECOVERY	%	0.0	100.0	

Appendix Table 8.--Adult recoveries from smolts dipped from gatewells at Priest Rapids Dam and subsequently released downstream from Priest Rapids Dam in 1985.

RELEASE GROUPS INCLUDED: 8503A 8503B 8503C 8503D 8503E 8503F

1985 TRANS CONTROL

SPRING/SUMMER CHINOOK

Brands Used: LAIL1 LAIN1 LAIS1 LAIL3 LAIN3 LAIS3
Wire Codes Used: 231753 231711 231713 231715 231755 231758

NUMBER RELEASED: 49700

RECOVERY AREA	YEAR OF RETURN		TOTAL	% RETURN
	1985	1986		
RIVER SYSTEM TRAPS				
BONNEVILLE TRAP	0	2	2	0.000
MCNARY TRAP	0	4	4	0.008
LOWER GRANITE TRAP	0	0	0	0.000
PRIEST RAPIDS TRAP	0	0	0	0.000
OCEAN FISHERIES				
ALASKA	0	0	0	0.000
BRITISH COLUMBIA	0	0	0	0.000
WASHINGTON	0	0	0	0.000
OREGON	3	0	3	0.000
CALIFORNIA	0	0	0	0.000
OTHER	0	0	0	0.000
RIVER SPORT				
COLUMBIA R. BELOW SNAKE R.	0	0	0	0.000
COLUMBIA R. ABOVE SNAKE R.	0	0	0	0.000
WENATCHEE R.	0	1	1	0.000
SNAKE R.	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0.000
INDIAN FISHERY	0	0	0	0.000
HATCHERIES	0	0	0	0.000
STREAM SURVEY	0	0	0	0.000
TOTALS	3	7	10	0.020
PERCENT OF RECOVERY	% 30.0	70.0		

30

Appendix Table 9.--Adults recovered from smolts dipped from gatewells at Wanapum Dam and subsequently released downstream from Priest Rapids Dam in 1985.

RELEASE GROUPS INCLUDED: 8507A 8507B 8507C 8507D 8507E
 1985 TRANS CONTROL

SPRING/SUMMER CHINOOK

Brands Used: LA2C1 LA2J1 LA141 LA2C3 LA2J3
 Wire Codes Used: 231725 231727 231741 231743 231745

NUMBER RELEASED: 25553 31

RECOVERY AREA	YEAR OF RETURN		TOTAL	% RETURN
	1985	1986		
RIVER SYSTEM TRAPS				
BONNEVILLE TRAP	0	0	0	0.000
MCMARY TRAP	0	0	0	0.000
LOWER GRANITE TRAP	0	0	0	0.000
PRIEST RAPIDS TRAP	0	0	0	0.000
OCEAN FISHERIES	0	0	0	0.000
RIVER SPORT	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0.000
INDIAN FISHERY	0	0	0	0.000
HATCHERIES	0	0	0	0.000
STREAM SURVEY	0	0	0	0.000
TOTALS	0	0	0	0.000
PERCENT OF RECOVERY	%	0.0	0.0	

Appendix Table 10.--Adult recoveries from smolts dipped from gatewells at Priest Rapids Dam and subsequently transported to Bonneville Dam (Corbett Landing) in 1985.

RELEASE GROUPS INCLUDED: 8502A 8502B 8502C 8502D 8502E 8502F
 1985 TRANS TEST TRUCK

SOCKEYE

Brands Used: RAIH1 RAIJ1 RAIK1 RAIH3 RAIJ3 RAIK3
 Wire Codes Used: 231716 231750 231752 231754 231726 231757

NUMBER RELEASED: 55406

RECOVERY AREA	YEAR OF RETURN		TOTAL	% RETURN
	1985	1986		
RIVER SYSTEM TRAPS				
BONNEVILLE TRAP	0	99	99	0.179
MCNARY TRAP	0	15	15	0.027
LOWER GRANITE TRAP	0	0	0	0.000
PRIEST RAPIDS TRAP	0	49	49	0.088
OCEAN FISHERIES	0	0	0	0.000
RIVER SPORT	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0.000
INDIAN FISHERY	0	0	0	0.000
HATCHERIES	0	0	0	0.000
STREAM SURVEY	0	0	0	0.000
TOTALS	0	163	163	0.294
PERCENT OF RECOVERY	%	0.0	100.0	

Appendix Table 11.--Adult recoveries from smolts dipped from gatewells at Wanapum Dam and subsequently transported to Bonneville Dam (Corbett Landing) in 1985.

RELEASE GROUPS INCLUDED: B506A B506B B506C B506D B506E
 1985 TRANS TEST TRUCK

SOCKEYE

Brands Used: RAIZ1 RAIY1 RAIX1 RAIZ3 RAIY3
 Wire Codes Used: 231662 231718 231720 231742 231724

NUMBER RELEASED:

33
 B602

RECOVERY AREA	1985	YEAR OF RETURN 1986	TOTAL	% RETURN
RIVER SYSTEM TRAPS				
BONNEVILLE TRAP	1	25	26	0.302
MCNARY TRAP	0	1	1	0.000
LOWER GRANITE TRAP	0	0	0	0.000
PRIEST RAPIDS TRAP	0	8	8	0.093
OCEAN FISHERIES	0	0	0	0.000
RIVER SPORT	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0.000
INDIAN FISHERY	0	0	0	0.000
HATCHERIES	0	0	0	0.000
STREAM SURVEY	0	0	0	0.000
TOTALS	1	34	35	0.407
PERCENT OF RECOVERY	%	2.9	97.1	

Appendix Table 12.--Adult recoveries from smolts dipped from gatewells at Priest Rapids Dam and subsequently released downstream from Priest Rapids Dam in 1985.

RELEASE GROUPS INCLUDED: 8504A 8504B 8504C 8504D 8504E 8504F
1985 TRANS CONTROL

SOCKEYE

Brands Used: LAIL1 LAIN1 LAIS1 LAIL3 LAIN3 LAIS3
Wire Codes Used: 231717 231747 231749 231751 231719 231759

NUMBER RELEASED: 55432

34

RECOVERY AREA	1985	YEAR OF RETURN 1986	TOTAL	% RETURN
RIVER SYSTEM TRAPS				
BONNEVILLE TRAP	0	33	33	0.060
MCNARY TRAP	0	10	10	0.000
LOWER GRANITE TRAP	0	0	0	0.000
PRIEST RAPIDS TRAP	0	46	46	0.083
OCEAN FISHERIES	0	0	0	0.000
RIVER SPORT	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0.000
INDIAN FISHERY	0	0	0	0.000
HATCHERIES	0	0	0	0.000
STREAM SURVEY	0	0	0	0.000
TOTALS	0	89	89	0.161
PERCENT OF RECOVERY	%	0.0	100.0	

Appendix Table 13.--Adult recoveries from smolts clipped from gatewells at Wanapum Dam and subsequently released downstream from Priest Rapids Dam in 1985.

RELEASE GROUPS INCLUDED: 8508A 8508B 8508C 8508D 8508E
1985 TRANS CONTROL

SOCKEYE

Brands Used: LA2C1 LA2J1 LA141 LA2C3 LA2J3
Wire Codes Used: 231661 231663 231701 231721 231723

NUMBER RELEASED: 8599

RECOVERY AREA	YEAR OF RETURN		TOTAL	% RETURN
	1985	1986		
RIVER SYSTEM TRAPS				
BONNEVILLE TRAP	0	9	9	0.000
MCNARY TRAP	0	2	2	0.000
LOWER GRANITE TRAP	0	0	0	0.000
PRIEST RAPIDS TRAP	0	3	3	0.035
OCEAN FISHERIES	0	0	0	0.000
RIVER SPORT	0	0	0	0.000
RIVER COMMERCIAL	0	0	0	0.000
INDIAN FISHERY	0	0	0	0.000
HATCHERIES	0	0	0	0.000
STREAM SURVEY	0	0	0	0.000
TOTALS	0	14	14	0.163
PERCENT OF RECOVERY	%	0.0	100.0	