

April 2000

**SMOLT MONITORING AT THE HEAD  
OF LOWER GRANITE RESERVOIR  
AND LOWER GRANITE DAM**

Annual Report - 1998 Operations



DOE/BP-11631-14



This report was funded by the Bonneville Power Administration (BPA), U.S. Department of Energy, as part of BPA's program to protect, mitigate, and enhance fish and wildlife affected by the development and operation of hydroelectric facilities on the Columbia River and its tributaries. The views of this report are the author's and do not necessarily represent the views of BPA.

This document should be cited as follows:

*Buettner, Edwin W., Arnold F. Brimmer - Idaho Department of Fish and Game, Smolt Monitoring At The Head Of Lower Granite Reservoir And Lower Granite Dam, Annual Report 1998 Operations, Report to Bonneville Power Administration, Contract No. 1983BP11631, Project No. 19832300, 81 electronic pages (BPA Report DOE/BP-11631-14)*

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**SMOLT MONITORING AT THE HEAD OF LOWER GRANITE  
RESERVOIR  
AND LOWER GRANITE DAM**

**Annual Report  
1998 Operations**

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**Funded by**

**U.S. Department of Energy  
Bonneville Power Administration  
Division of Fish and Wildlife  
Pat Poe, Project Manager  
Contract No. DE-BI79-83BP11631  
Modification No. A021  
Project No. 83-323 B**

**April 2000  
00-14**

## PREFACE

Project 83-323 addresses measure 5.9A.1 of the 1994 Northwest Power Planning Council (NWPPC) Fish and Wildlife Program and the biological need to provide information on the migrating characteristics of the various stocks of salmon and steelhead within the Snake River Basin. This project was initiated in FY 1983 by the National Marine Fisheries Service (NMFS), which built and installed the traps on the Clearwater, Salmon, and Snake rivers. Idaho Department of Fish and Game (Department) assumed this work in 1984 and continues to operate traps as part of the annual coordinated Columbia and Snake River Smolt Monitoring Program. This effort provides field monitoring of smolt movement, marked groups of fish for reach survival estimates, as well as other environmental data necessary for water management decisions.

The management implications of this project include: 1) providing information on salmon and steelhead smolt movement at the upper end of the Snake River's series of dams; 2) providing groups of Passive Integrated Transponder (PIT) tagged fish which are used for post-season survival estimates; and 3) application of this information to assist water managers for in-season management decisions relative to flow augmentation, facility power operations, fish collection and transportation programs and operation of the Federal Columbia River Power System (FCRPS) to maximize benefits to smolt survival.

The following report presents results from the 1997 outmigration season and represents the fifteenth consecutive year of field monitoring in the Snake River system.

Listed below are other reports in this series, which are available from Bonneville Power Administration, Division of Fish and Wildlife, P.O. Box 3621, Portland, Oregon 97208-3621.

Buettner, E.W. and A.F. Brimmer. 1997. (In Press) Smolt monitoring at the head of Lower Granite Reservoir and Lower Granite Dam. Idaho Department of Fish and Game, Boise, Idaho. Annual Report 1996 (LIB REF#D [In Press]; DOE/BP#11631-13) to Bonneville Power Administration, Project 83-323B, Contract DE-B179-83BP11631.

Buettner, E.W. and A.F. Brimmer. 1996. Smolt monitoring at the head of Lower Granite Reservoir and Lower Granite Dam. Idaho Department of Fish and Game, Boise, Idaho. Annual Report 1995 (LIB REF#D 154; DOE/BP#11631-12) to Bonneville Power Administration, Project 83-323B, Contract DE-B179-83BP11631. 89P.

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## ABSTRACT

This project monitored the daily passage of chinook salmon *Oncorhynchus tshawytscha*, steelhead trout *O. mykiss*, and sockeye salmon smolts *O. nerka*, during the 1998 spring outmigration at migrant traps on the Snake and Salmon rivers.

All hatchery chinook salmon released above Lower Granite Dam 19 1998 were marked with a fin-clip. Total annual hatchery chinook salmon catch at the Snake River trap was 226% of the 1997 number and 110% of the 1996 catch. The wild chinook catch was 120% of the 1997 catch but was only 93% of 1996. Hatchery steelhead trout catch was 501% of 1997 numbers but only 90% of the 1996 numbers. Wild steelhead trout catch was 569% of 1997 and 125% of the 1996 numbers. The Snake River trap collected 106 age-0 chinook salmon. During 1998, for the first time, the Snake River trap captured a significant number of hatchery sockeye salmon (1,552) and hatchery coho salmon *O. kisutch* (166). Differences in trap catch between years are due to fluctuations not only in smolt production, but also differences in trap efficiency and duration of trap operation associated with high flows. Trap operations began on March 8 and were terminated for the season due to high flows on June 12. The trap was out of operation for 34 d during the season due to high flow and debris.

Hatchery chinook salmon catch at the Salmon River trap was 476% and wild chinook salmon catch was 137% of 1997 numbers and 175% and 82% of 1996 catch, respectively. The hatchery steelhead trout collection in 1998 was 96% of the 1997 catch and 13% of the 1996 numbers. Wild steelhead trout collection in 1998 was 170% of the 1997 catch and 37% of the 1996 numbers.

Travel time (d) and migration rate (km/d) through Lower Granite Reservoir for PIT-tagged chinook salmon and steelhead trout, marked at the head of the reservoir were affected by discharge. For fish tagged at the Snake River trap, statistical analysis of 1998 detected a significant relation between migration rate and discharge. For hatchery and wild chinook salmon there was a 2.0- and 2.6-fold increase in migration rate, respectively, between 50 and 100 thousands of cubic feet per second (kcfs). For hatchery steelhead trout there was a 2.6-fold increase in migration rate between 50 kcfs and 100 kcfs.

For fish marked at the Salmon River trap, statistical analysis of the 1998 data detected a significant relation between migration rate and discharge for hatchery and wild chinook salmon hatchery and found a 3.3- and 2.6-fold increase in migration rate, respectively, between 50 and 100 kcfs. A significant relation between migration rate and discharge was not detected for hatchery steelhead trout. Insufficient numbers of wild steelhead trout were PIT-tagged at the Salmon River trap to estimate travel time and migration rate to Lower Granite Dam.

Fish marked with PIT-tags at the Snake River trap were interrogated at Lower Granite, Little Goose, Lower Monumental, and McNary dams using PIT-tag detection systems. Because of the addition of a fourth interrogation site (Lower Monumental) in 1993, cumulative interrogation data is not comparable with the prior five years (1988-1992). Cumulative interrogations at the four dams for fish marked at the Snake River trap were 80% for hatchery chinook, 79% for wild chinook, 76% for hatchery steelhead, and 80% for wild steelhead. Cumulative interrogations at the four dams for fish marked at the Salmon River trap were 64% for hatchery chinook, 80% for wild chinook salmon, 76% for hatchery steelhead trout, and 71% for wild steelhead trout.

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## INTRODUCTION

The Pacific Northwest Electric Power Planning and Conservation Act of 1980 (P.L. 96-501) directed the NWPPC to develop programs to mitigate for fish and wildlife losses on the Columbia River system resulting from hydroelectric projects. Section 4(h) of the Act explicitly gives the Bonneville Power Administration (BPA) the authority and responsibility to use its resources "to protect, mitigate, and enhance fish and wildlife to the extent affected by the development and operation of any hydroelectric project on the Columbia River system".

Water storage and regulation for hydroelectric generation severely reduces flows necessary for downstream migration of juvenile steelhead trout *Oncorhynchus mykiss* and chinook salmon *O. tshawytscha*. In response to the fishery agencies and Indian tribes recommendations for migration flows, the NWPPC Columbia River Basin Fish and Wildlife Program proposed a "water budget" for augmenting spring flows.

The federal Endangered Species Act of 1973 (ESA; 16 U.S.C. 1531 et seq.) listing of Snake River spring, summer, and fall chinook salmon in 1992 and the development of a NMFS Biological Opinion (BIOP) established flow measures for the Snake River. The measures within the BIOP establish flow targets and planning dates for providing those flows. The BIOP also requires monitoring and evaluation of the smolt outmigration. The National Marine Fisheries Service (NMFS) established a Technical Management Team (TMT) to oversee implementation of the BIOP measures. The TMT utilizes outmigration monitoring data provided by the Department through this project as a basis for implementing measures within the flexibility provided by the BIOP.

To provide information to the Fish Passage Center (FPC) for use by the TMT on smolt movement prior to arrival at the lower Snake River reservoirs, the Department monitors the daily passage of smolts at the head of Lower Granite Reservoir. This information allows the FPC to request operations for fish passage to the TMT for implementation of BIOP measures to improve passage and migration conditions.

Smolt monitoring is a key component of BIOP implementation under all flow conditions and becomes critical when low-flow conditions constrain BIOP measures and reduce migration rates. In years of low-flow (drought years), knowledge of when most smolts have left tributaries and entered areas that can be affected by releases of stored water allows managers to make informed decisions regarding implementation of measures within the BIOP. Six low-flow years (1987, 1988, 1990, 1991, 1992, and 1994) have occurred during this Smolt Monitoring Project. The indications are that judicious use of the available reservoir storage volumes can greatly enhance the timing and migration rate of juvenile chinook salmon and steelhead trout.

The Department smolt monitoring project also collects other useful data on relative species composition, hatchery and wild steelhead trout ratios, travel time, and migration rate. All wild steelhead trout smolts are PIT-tagged to determine timing of wild adult steelhead trout one and two years later as they return to spawn (Prentice et al. 1987). By monitoring smolt passage at the head of Lower Granite Reservoir and at Lower Granite Dam, migration rates (km/d) under various riverine and reservoir conditions can be estimated and compared. It is possible to determine the relative abundance of hatchery and wild stocks of steelhead trout, which can be used to document wild stock rebuilding progress. This smolt monitoring program's information is complementary to other Snake and Columbia River NWPPC-supported projects.

## OBJECTIVES

1. Provide daily trap catch data at the head of Lower Granite Reservoir for TMTs use in implementing the NMFS BIOP.
2. Determine riverine travel time from the point of release to the smolt traps (index sites) at the upper end of Lower Granite Reservoir for PIT-tagged smolts.
3. Provide an interrogation site for PIT-tagged smolts marked on other projects, at the end of their migration in a riverine environment and the beginning of their migration in a reservoir environment.
4. Determine reservoir travel time for hatchery spring and summer chinook salmon, wild spring and summer chinook salmon, hatchery steelhead trout, and wild steelhead trout from the head of Lower Granite Reservoir to Lower Granite Dam using PIT-tagged smolts marked at the traps and PIT-tagged smolts passing the traps from upriver hatchery releases and rearing areas.
5. Determine cumulative interrogation rate at Lower Granite, Little Goose, Lower Monumental, and McNary dams during the spring outmigration period for PIT-tagged hatchery and wild spring and summer chinook salmon, hatchery and wild steelhead trout.
6. Correlate smolt migration rate with river flow for fish moving in riverine and reservoir environments.
7. Determine trap efficiency for each species at each trap over a range of discharges.
8. Evaluate timing of returning adult wild and natural steelhead crossing Lower Granite Dam.

## METHODS

### **Releases of Hatchery-Produced Smolts**

Anadromous hatchery release information was reported for hatchery smolts, which contributed to the 1998 outmigration in the Snake River drainage upstream of Lower Granite Dam. This information included species, number released, date, release location, number PIT-tagged, and hatchery of origin.

### **Smolt Monitoring Traps**

During the 1998 outmigration, two smolt monitoring traps were operated to monitor the passage of juvenile chinook salmon and steelhead trout. A scoop trap (Raymond and Collins 1974) was located on the Salmon River near Slate Creek, Idaho. A dipper trap (Mason 1966) was located on the Snake River near Lewiston, Idaho (Figure 1). Prior to the 1996 outmigration season, the FPC requested that all smolt monitoring projects reduce handling of fish listed

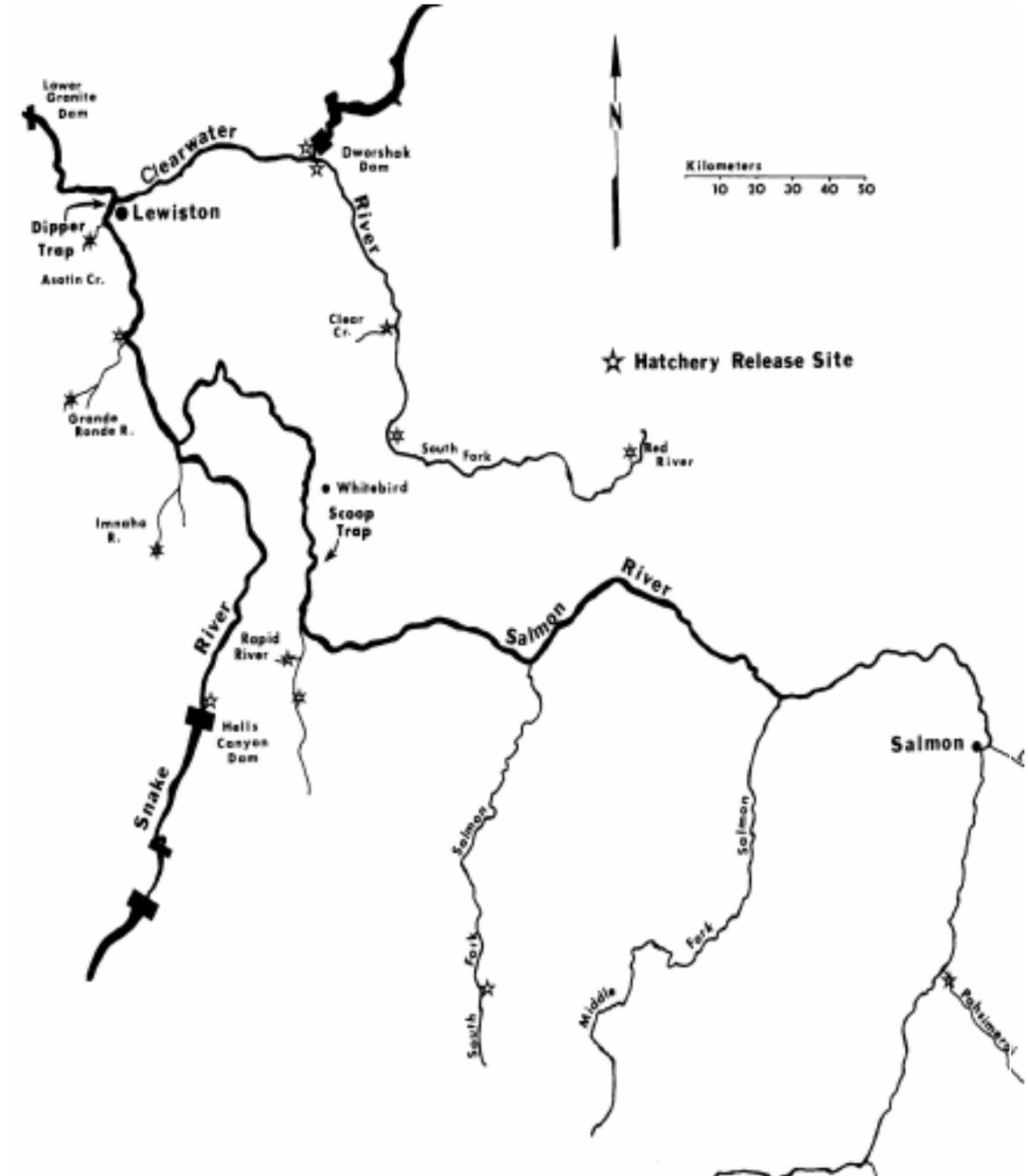


Figure 1. Map of study area.

under the Endangered Species Act. To comply with this request, sampling regimes and PIT-tag quotas were adjusted at this project's collection sites. Sampling periods were based on a standard workweek (Monday-Friday), with Saturday and Sunday left available if necessary to fill weekly PIT-tag quotas. Weekly PIT-tag quotas for hatchery and wild chinook salmon were 600 each. Weekly PIT-tag quotas for hatchery and wild steelhead trout were captured, examined, and enumerated daily at the traps and released back to the river. Fork lengths of up to 100 smolts for each species, run, and rearing-type were measured to the nearest millimeter daily. Up to 2,000 fish were examined daily at the Snake River trap for hatchery brands. Fish at the Salmon River trap were not examined for brands. Smolts were anesthetized with tricaine methanesulfonate (MS-222) before handling and allowed to recover before being returned to the river.

Water temperature (C°) and turbidity (m) were recorded daily at each trap using a centigrade thermometer and 20 cm Secchi disk. Snake River discharge was measured at the U.S. Geological Survey (USGS) Anatone gauge (#13334300), 44.4 km upstream from the Snake River trap. Salmon River discharge was measured at the USGS White Bird gauge (#13317000), 16.6 km downstream from the Salmon River trap.

### **Snake River Trap**

The Snake River trap was positioned approximately 40 m downstream from the Interstate Bridge between Lewiston, Idaho and Clarkston, Washington. The trap was attached by steel cables to bridge piers just east of the drawbridge span. This location is at the head of Lower Granite Reservoir, 0.5 km upstream from the convergence of the Snake and Clearwater arms. River width and depth at this location are approximately 260 m and 12 m, respectively.

Steelhead trout smolts were PIT-tagged at the Snake River trap to estimate travel time from the head of Lower Granite Reservoir to Lower Granite Dam. Median travel time of the daily PIT-tagged release groups was converted to migration rate. Migration rate was correlated with mean Lower Granite Reservoir inflow discharge for the number of days equal to the median travel time to determine how changes in discharge affected smolt migration rate through Lower Granite Reservoir.

Snake River trap operation began on March 8 and continued through June 12, 1998. The trap was out of operation for a total of 34 days during the 1998 season due to mechanical failure, heavy debris loads, or because weekly PIT-tag quotas were reached. All fish captured in the Snake River trap were passively interrogated for PIT-tags as they entered the live well. Interrogation and tagging information was sent daily to the PTAGIS Data Center (managed by Pacific States Marine Fisheries Commission).

The PIT-tag interrogation system on the Snake River trap consists of an 8-inch PVC pipe with two interrogation coils (D-4 and D-6). Each coil is connected to an exciter card and a PIT-tag reader. The system does not have the capability to provide exact time of capture. Since it is checked once daily, the interrogation time is set to 00:00 h. Coil efficiency tests were conducted on the dipper trap interrogation system. A total of 742 test tags were sent through the system. The reading efficiency was calculated to be 96% for both coils combined.

## **Salmon River Trap**

The Salmon River trap site was located at rkm 103, approximately 17 km upstream from the previous trapping location and 1.6 km downstream from Slate Creek. The scoop trap was operated immediately downstream of the upper U.S. Highway 95 bridge at Twin Bridges. This location was chosen to allow the trap to be operated through a wider range of discharge. River width at this location is approximately 90 m and varies with discharge.

Steelhead trout juveniles were PIT-tagged at the Salmon River trap to estimate smolt travel time from the lower portion of the Salmon River to Lower Granite Dam. Median travel time for the daily PIT-tagged release groups was converted to migration rate. Migration rate was correlated with mean Lower Granite Reservoir inflow for the median travel time to determine how changes in discharge affected smolt migration rate through the Lower Salmon River and Lower Granite Reservoir.

Trap operation began on March 9 and continued through May 22, when operations were terminated for the season due to high water. Operations were temporarily suspended for 28 days during the 1998 field season, either because weekly quotas had been reached, or because of high discharge, or mechanical failure. All fish were interrogated for PIT-tags as they were removed from the live well. The tagging and interrogation files were sent to the PTAGIS Data Center daily.

The PIT-tag interrogation system on the Salmon River trap consists of a 4-inch PVC pipe with two interrogation coils. Each coil is connected to an exciter card (D-8), which is in turn attached to a single PIT-tag reader. Coil efficiency tests were conducted on the Salmon River trap interrogation system in 1998. Five hundred test tags were sent through the system. Reading efficiency was calculated to be 100% for both coils combined.

## **Trap Efficiency**

Trap efficiency is the proportion of the migration run being sampled. Since trap efficiency may change as river discharge changes, efficiency has been estimated several times through the range of discharge at which the trap was operated. A linear regression equation (Ott 1977) describing the relation of trap efficiency and discharge was derived to estimate efficiency at any given discharge. During the 1998 trap operations, trap efficiencies were not calculated for any of the smolt traps. Previous trap efficiency estimates are reported in Buettner (1991).

## **Travel Time and Migration Rates**

Migration statistics were calculated for hatchery release groups from release sites to traps. Travel time and migration rates to the traps were calculated using median arrival times at the Snake River and Salmon River traps. Median arrival (or passage) date is the date the 50th percentile fish arrived at the trap or collection facility. Smolts were PIT-tagged at the Snake River trap to determine travel time from the head of Lower Granite Reservoir to Lower Granite Dam. Smolts were PIT-tagged at the Salmon River trap to determine migration rate in a free-flowing section of river plus Lower Granite Reservoir. Distances from release point to recovery location are listed in Table 1. Individual arrival times at the Lower Granite collection facility were determined for each daily release group. A minimum recapture number, sufficient for use in travel time and migration

Table 1. River mile and kilometer location for the Snake River drainage.

LGRSmolt98Rpt

	Mouth of Columbia River		Mouth of Snake River		Lower Granite Dam		Snake River trap site		Clearwater River trap site		Salmon River trap site	
	mi	km	mi	km	mi	km	mi	km	mi	km	mi	km
Asotin Creek rel. site	470.3	756.7	146.0	234.9	38.5	61.9	6.4	10.3	--	--	--	--
Big Canyon Creek	585.9	942.7	261.6	420.9	154.1	247.9	122.0	196.3	--	--	--	--
Catherine Creek	636.9	1024.8	312.6	503.0	205.1	330.0	173.0	278.4	--	--	--	--
Clearwater R. trap site	470.0	756.2	145.7	234.4	38.2	61.5	--	--	0.0	0.0	--	--
Cottonwood Creek	521.7	839.4	197.4	317.6	89.9	144.6	57.8	93.0	--	--	--	--
Crooked River	604.3	972.3	280.0	450.5	172.5	277.6	--	--	134.3	216.0	--	--
Deer Creek	504.3	811.4	180.0	289.6	72.5	116.7	40.4	65.0	--	--	--	--
Dworshak NFH	504.3	811.4	180.0	289.6	72.5	116.6	--	--	34.3	55.2	--	--
E.F. Salmon at trap site	873.6	1405.6	549.3	883.8	441.8	710.9	409.7	659.2	--	--	297.0	478.0
Grande Ronde R. mouth	493.0	793.2	168.7	271.4	61.2	98.5	29.1	46.8	--	--	--	--
Hazard Creek	618.7	995.5	294.4	473.7	186.9	300.7	154.8	249.1	--	--	42.1	67.9
Hells Canyon Dam	571.3	919.2	247.0	397.4	139.5	224.5	107.4	172.8	--	--	--	--
Highway 95 boat launch	473.2	761.4	148.9	239.6	41.5	66.8	--	--	3.2	5.1	--	--
Imnaha Coll. Facility	565.6	910.2	241.3	388.3	133.8	215.4	101.7	163.6	--	--	--	--
Imnaha River mouth	516.0	830.3	191.7	309.1	84.2	135.7	52.1	83.8	--	--	--	--
Kooskia NFH	541.6	871.4	217.3	349.6	109.8	176.7	--	--	71.5	115.0	--	--
Little Sheep Creek	553.8	891.1	229.5	369.3	122.0	196.3	89.9	144.6	--	--	--	--
Lookingglass Creek	580.4	933.9	256.1	412.1	148.6	239.1	116.5	187.4	--	--	--	--
Lower Granite Dam	431.8	694.8	107.5	173.0	0.0	0.0	32.1	51.6	38.3	61.5	144.8	232.8
Lower Monumental Dam	365.9	588.7	41.6	66.9	65.9	106.0	98.0	157.7	--	--	192.1	308.9
Pahsimeroi Hatchery	817.5	1315.4	493.2	793.6	385.7	620.6	353.6	568.9	--	--	240.1	387.7
Rapid River Hatchery	605.8	974.7	281.5	452.9	174.0	280.0	141.9	228.3	--	--	29.2	47.1
Red River rearing pond	618.0	994.4	293.7	472.6	186.2	299.6	--	--	148.0	238.1	--	--
Salmon River mouth	512.5	824.6	188.2	302.8	80.7	129.8	48.6	78.2	--	--	64.1	103.0
Salmon River trap site	576.6	927.6	252.3	405.8	144.8	232.8	112.7	181.2	--	--	0.0	0.0
Sawtooth Hatchery	896.7	1444.2	573.3	922.4	465.8	749.5	433.7	697.8	--	--	321.0	516.6
Snake River mouth	324.3	521.8	0.0	0.0	107.5	172.9	139.6	224.6	145.7	234.5	252.3	405.8
Snake River trap site	463.9	746.4	139.6	224.6	32.1	51.6	0.0	0.0	--	--	112.7	181.2
S.F. Salmon at Knox Bridge	719.7	1158.0	395.4	636.2	287.9	463.2	255.8	411.6	--	--	143.1	230.4
Spring Creek	614.4	988.6	290.1	466.8	182.6	293.8	150.5	242.2	--	--	--	--
Wildcat Creek	546.2	878.8	221.9	357.0	114.4	184.3	82.3	132.4	--	--	--	--

6

rate estimations, was derived from an empirical distribution function of the travel time for each individual release group (Steinhorst et al. 1988). If recapture numbers were less than five, or less than the number derived from the empirical distribution function, the daily data were combined with another day's data or the data were not used. If they were combined, they were added to daily data from an adjacent release day that had similar discharge and travel time.

Smolt migration rate/discharge relations through Lower Granite Reservoir were investigated using linear regression analysis after both variables were stratified into 5-kcfs discharge intervals (Mosteller and Tukey 1977) and log (ln) transformed (Zar 1984). The 0.05 level was used to determine significance. This analysis was performed for the PIT-tagged hatchery steelhead trout, and wild steelhead trout groups marked at the Snake or Salmon River traps. Normally, hatchery and wild chinook salmon are included in this evaluation but due to the extreme low number of outmigrants expected in 1997, FPC requested that no chinook salmon be PIT-tagged in order to reduce handling.

The migration rate/discharge relations for PIT-tagged hatchery steelhead trout, and wild steelhead trout released from the Snake River trap were individually examined from 1988 to 1997, using analysis of covariance to determine if there were groups of years with common slopes and intercepts. Plots were used to help identify years that differ when non-homogeneous slopes between years were found. Subsequent analyses were run without these years to determine if common slopes and intercepts existed for a smaller subset of years. Also, the analysis of variance was used to determine if there was a sufficient overlap in the covariate (discharge) between years to continue the analysis (Ostle and Mensing 1975). If the final hypothesis of common intercepts was not rejected, then a significant difference in the migration rate/discharge relations between years was not detected and the yearly data were pooled. After pooling, linear regression was used to find the best-fitting equation to describe the relation between migration rate and discharge for an individual species over several years.

### **Interrogation Rates of PIT-tagged Fish**

Interrogation rates of PIT-tagged fish marked at the head of Lower Granite Reservoir to Lower Granite Dam, Little Goose Dam, Lower Monumental Dam, and McNary Dam collection facilities included data from 1988 to 1998 for the Snake River trap, 1989 to 1995 for the Clearwater River trap, and 1993 to 1998 for the Salmon River trap. The data have been examined to ensure that multiple interrogations within a dam and between dams have been removed.

## **RESULTS AND DISCUSSION**

### **Hatchery Releases**

#### **Chinook Salmon**

Chinook salmon released into the Snake River drainage upstream of Lower Granite Dam were reared at seven locations in Idaho, two in Oregon, and one in Washington. A total of 4,192,378 chinook salmon smolts were released at 15 locations in Idaho and two locations in Oregon (Table 2).

Table 2. Hatchery chinook salmon released into the Snake River system upriver from Lower Granite Dam contributing to the 1998 outmigration.

<b>Drainage Release Site</b>	<b>Hatchery</b>	<b>Stock</b>	<b>Release Date</b>	<b>No. Released [No. PIT Tagged]</b>
Salmon River				
Pahsimeroi River at Pahsimeroi Weir	Pahsimeroi	Summer	4/15-25/98	65,648 [993]
Salmon River at Sawtooth Hatchery	Sawtooth	Spring	4/10-22/98	43,161
South Fork Salmon River at Knox Bridge	McCall	Summer	3/31-4/9/98	393,872 [47,499]
South Fork Salmon River at Stolle Meadows	McCall	Summer	7/7/97	24,990
Rapid River at Rapid River Hatchery	Rapid River	Spring	3/16-4/21/98	896,170 [48,357]
			Drainage Total	<b>1,423,841</b>
<b>Snake River and Non-Idaho Tributaries</b>				
Snake River at Pittsburg Landing	Clearwater	Spring	3/16-18/98	304,096
	Lyons Ferry <sup>a.</sup>	Fall	4/1-15/98	147,585 [9,942]
			5/14-7/7/98	51,500 [31,951]
Snake River at Captain John Acclimation Pond <sup>a.</sup>	Lyons Ferry	Fall	4/1-15/98	135,710 [1,253]
Snake River at rkm 265 & 270 <sup>a.</sup>	Lyons Ferry	Fall	6/2-7/7/98	21,685 [21,685]
Imnaha River at rkm 74 <sup>b.</sup>	Imnaha	Summer	4/6/98	93,127 [19,829]

Table 2. continued

Release Site	Hatchery	Stock	Release date	No. Released [No. PIT tagged]
Lookingglass Creek at rkm 3.0 <sup>b.</sup>	Lookingglass	Spring	7/25/97	7,230 [3,600]
			4/6/98	338,416 [43,608]
			Drainage Total	<b>1,099,349</b>
Clearwater River				
Upper Selway River at Beaver Point	Clearwater	Spring	4/21-22/98	8,892 [300]
Upper Lochsa River at Walton Creek	Powell	Spring	4/6-8/98	244,847 [1,675]
Red River at Red River Weir	Red River	Spring	4/7-9/98	51,208 [1,000]
Crooked River at Crooked River Weir	Crooked River	Spring	4/7-9/98	205,906 [499]
Clear Creek at Kooskia Hatchery <sup>c.</sup>	Kooskia	Spring	4/14-24/98	76,846 [1,001]
North Fork Clearwater River at Dworshak Hatchery <sup>c.</sup>	Dworshak	Spring	3/25-26/98	973,400 [47,705]
Clearwater River at Big Canyon Creek <sup>a.</sup>	Lyons Ferry	Fall	4/1-15/98	76,571 [7,459]
			5/26-7/6/98	31,518 [31,518]
			Drainage Total	<b>1,669,188</b>
			<b>GRAND TOTAL</b>	<b>4,192,378</b>

<sup>a.</sup> Fall chinook hatchery release information provided by FPC.

<sup>b.</sup> Hatchery release information provided by Oregon Department of Fish & Wildlife.

<sup>c.</sup> Hatchery release information provided by U. S. Fish & Wildlife Service.

## **Steelhead Trout**

Steelhead trout released into the Snake River drainage upstream of Lower Granite Dam were reared at five locations in Idaho, two in Oregon, and one in Washington. A total of 8,953,690 steelhead trout were released at 21 locations in Idaho, five in Oregon, and one in Washington (Table 3). Fall releases of steelhead trout have not been included in this report.

## **Sockeye and Coho Salmon**

Hatchery coho salmon *O. kisutch* released into the Snake River drainage upstream of Lower Granite Dam were reared at one location in Idaho and one location in Washington. A total of 696,280 coho were released at three locations in Idaho (Table 4). Summer and fall releases of coho salmon have not been included in this report.

Hatchery sockeye salmon that contributed to the 1998 outmigration were reared at one location in Idaho and one location in Oregon. A total of 81,615 sockeye were released at two locations in Idaho (Table 4). Summer and fall releases of hatchery sockeye salmon have not been included in this report.

## **Smolt Monitoring Traps**

### **Snake River Trap Operation**

The Snake River trap captured 3,487 hatchery and 1,063 wild age-1 chinook salmon, 8,001 hatchery and 1,116 wild steelhead trout, 1,552 hatchery and 26 wild sockeye/kokanee salmon, 166 hatchery coho salmon and 106 age-0 wild chinook salmon in 1998 (Table 5).

Hatchery chinook salmon first arrived at the trap on March 19. Catch rates remained below 100 fish per day until April 17 when daily catch reached 336. Daily catch dipped below 100 per day for the next six days. The highest daily catch for the month occurred on April 24 when 1,188 hatchery chinook salmon were captured. Daily catch declined on April 27 and remained below 120 fish per day for the remainder of the month. Daily catch averaged 150 hatchery chinook per day during the first week of May but decreased to less than 40 per day for the remainder of the month. No hatchery chinook salmon were captured in June (Figure 2.) About 5% of the total season catch was captured in March, 65% in April, and 30% in May.

Wild chinook salmon passage was similar to hatchery chinook salmon passage for March, April, and May, but not for June. Wild chinook salmon passage was still in progress when operations were terminated on June 12, whereas hatchery chinook salmon passage had nearly ended by June 1. About 28% of the total catch of wild chinook salmon was captured in March, nearly 38% in April, 31% in May, and three percent in June (trap operated five days in June).

Physical characteristics were used to differentiate between age-0 chinook salmon and other chinook salmon. About 7% of the season total was collected in March, 14% in April, 56% in May, and 23% in June.

Table 3. Hatchery steelhead trout released into the Snake River system upstream from Lower Granite Dam contributing to the 1998 outmigration.

<b>Drainage Release Site</b>	<b>Hatchery</b>	<b>Stock</b>	<b>Release Date</b>	<b>No. Released [No. PIT Tagged]</b>
Salmon River				
Salmon River at Mouth of Lemhi River	Magic Valley	A	4/21-24/98	154,565
Salmon River at Red Rock	Magic Valley	A	4/21-24/98	137,060 [300]
Pahsimeroi River at Pahsimeroi Hatchery	Niagara Springs	A	4/11-28/98	801,541 [300]
East Fork Salmon River at East Fork Trap	Magic Valley	B	4/30-5/1/98	126,920 [300]
East Fork Salmon River at Herd Creek	Magic Valley	B	4/24-29/98	321,725 [1,205]
Upper Salmon River at Slate Creek	Magic Valley	B	4/4-5/7/98	174,580 [300]
Salmon River at Shoup Bridge	Magic Valley	A	4/15-16/98	108,915 [300]
Salmon River at McNabb Point	Magic Valley	A	4/16-17/98	158,660 [300]
Salmon River at Cottonwood Creek	Magic Valley	A	4/16-17/98	142,650
Salmon River at Squaw Creek	Magic Valley	B	4/13/98	52,800 [899]
Salmon River at Sawtooth Hatchery	Sawtooth	A	4/24/98	621,861 [2,098]
	Hagerman NFH <sup>a</sup>	A	4/24/98	61,354 [300]

Table 3. Continued.

Drainage Release Site	Hatchery	Stock	Release Date	No. Released [No. PIT Tagged]
Little Salmon River at Stinky Springs	Magic Valley	B	4/13-15/98	280,950 [300]
	Hagerman <sup>a</sup>	A	4/3-29/98	347,470 [300]
Little Salmon River at Warm springs	Niagara Springs	A	5/3-5/98	26,528 [300]
Lower Salmon River at Hammer Creek	Niagara Springs	A	4/7-9/98	141,320 [300]
Lower Salmon River at Pine Bar	Niagara Springs	A	4/6/98	31,160
			Drainage Total	<b>3,690,059</b>
Snake River and Non – Idaho Tributaries				
Snake River at Pittsburg Landing	Niagara Springs	A	3/23-4/5/98	653,276 [300]
Catherine Creek at rkm 31 <sup>b</sup>	Irrigon	A	4/8-9/98	62,505
Spring Creek at rkm 1.0 <sup>b</sup>	Wallowa	A	3/25-4/8/98	362,956 [864]
		A	5/1-20/98	396,446 [580]
Little Sheep Creek at rkm 8 <sup>b</sup>	Little Sheep Facility	A	4/26/98	86,442 [867]
		A	5/19/98	30,674
Grande Ronde River at rkm 264-274 <sup>b</sup>	Irrigon	A	4/6-9/98	199,960

Table 3. Continued.

Drainage Release Site	Hatchery	Stock	Release Date	No. Released [No. PIT Tagged]
Deer Creek at rkm 1.0 <sup>b</sup> .	Big Canyon Facility	A	3/31-4/1/98	192,952 [558]
		A	5/12-27/98	169,189 [648]
Grande Ronde River at rkm 45.4 <sup>c</sup> .	Cottonwood Cr. Acclimation Pond	A	4/1-28/98	250,211
Drainage Total				<b>2,404,611</b>
Clearwater River				
Red River at Soda Creek Bridge	Clearwater	B	4/24/98	4,497 [4,497]
Clearwater River at Kooskia Bridge 0	Dworshak NFH <sup>a</sup> .	B	4/20/98	30,601
South Fork Clearwater River at Red House Hole	Dworshak NFH <sup>a</sup> .	B	4/20-23/98	606,201
	Clearwater	B	4/27-29/98	487,792 [300]
Clear Creek at Kooskia Hatchery	Dworshak NFH <sup>a</sup> .	B	4/20-24/98	290,986
	Clearwater	B	4/20-21/98	209,999 [302]
Clearwater River at Dworshak Hatchery	Dworshak NFH <sup>a</sup> .	B	4/27-4/30/98	1,228,944 [3,479]
Drainage Total				<b>2,859,020</b>
<b>GRAND TOTAL</b>				<b>8,953,690</b>

<sup>a</sup>. Hatchery release information provided by U.S. Fish & Wildlife Service.

<sup>b</sup>. Hatchery release information provided by Oregon Department of Fish & Wildlife.

<sup>c</sup>. Hatchery release information provided by Washington Department of Fish & Wildlife.

Table 4. Hatchery coho and sockeye salmon released into the Snake River system upstream from Lower Granite Dam contributing to the 1998 outmigration.

<b>Drainage Release Site</b>	<b>Hatchery</b>	<b>Species</b>	<b>Release Date</b>	<b>No. Released [No. PIT tagged]</b>
Salmon River				
Red Fish Lake & Salmon River at Sawtooth Hatchery	Eagle & Bonneville	Sockeye	5/1/98	81,615 [4,052]
			Drainage Total	<b>81,615</b>
			GRAND TOTAL	<b>81,615</b>
Clearwater River				
0 Lapwai Creek <sup>a</sup>	Willard	Coho	3/16/98	244,640 [1,487]
Potlatch Creek <sup>a</sup>	Willard	Coho	3/18/98	231,640 [1,497]
Clear Creek <sup>a</sup>	Dworshak NFH	Coho	5/11-22/98	220,000 [1,593]
			Drainage Total	<b>696,280</b>
			GRAND TOTAL	<b>696,280</b>

<sup>a</sup>. Hatchery coho release information provided by FPC.

Table 5. Historical catch of hatchery chinook salmon (HC), wild chinook salmon (WC), hatchery steelhead trout (HS), and wild steelhead trout (WS) collected at the Snake, Clearwater, and Salmon rivers traps for the outmigration years of 1993 through 1998.

Year	Species / Run	Snake River Trap	Clearwater River Trap	Salmon River Trap
1998	HC	3,487	No Data	10,852
	WC	1,063		1,459
	HS	8,001		1,218
	WS	1,116		112
1997	HC	1,543	No Data	2,280
	WC	898		1,065
	HS	1,600		1,267
	WS	196		66
1996	HC	3,163	No Data	6,205
	WC	1,140		1,776
	HS	8,921		9,566
	WS	896		304
1995	HC	26,919	13,475	45,349
	WC	6,564	1,534	9,396
	HS	23,994	8,314	3,948
	WS	1,750	285	499
1994	HC	22,342	32,789	38,902
	WC	1,471	1,343	4,774
	HS	31,662	4,615	7,383
	WS	3,439	1,798	564
1993	HC	15,271	9,761	28,326
	WC	2,683	320	5,147
	HS	35,183	10,122	7,315
	WS	3,046	882	948

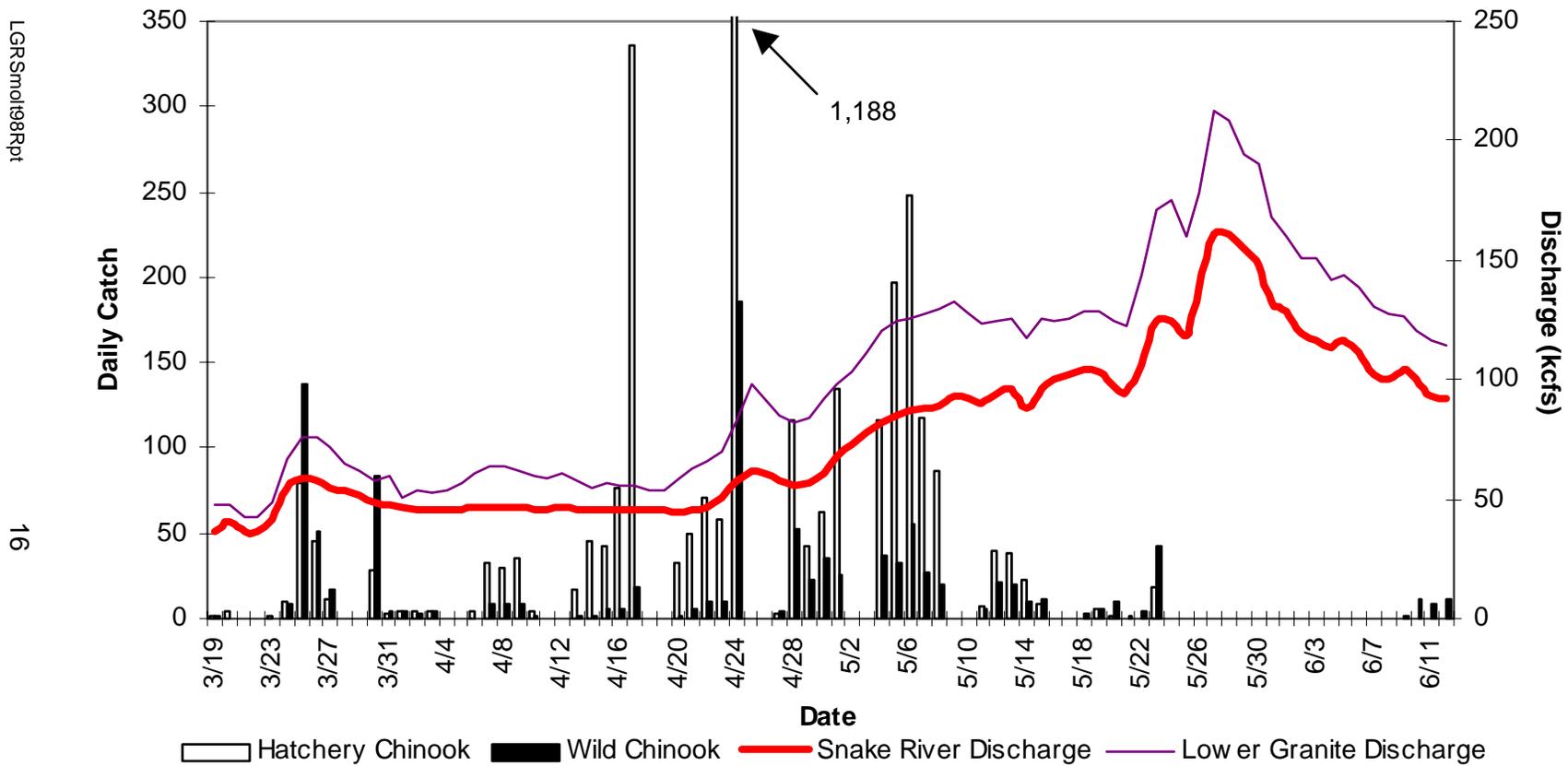


Figure 2. Snake River trap daily catch of hatchery chinook salmon and wild chinook salmon overlaid by Snake River and Lower Granite discharge, 1998.

Three major peaks in hatchery steelhead trout passage were observed at the Snake River trap in 1998. The first occurred during the third full week of April; the second peak occurred during the first week of May, and the last during the third week of May. Generally, major peaks in hatchery steelhead passage were associated with increases in Snake River discharge (Figure 3). Analysis of catch by month revealed that less than one percent of the season total was collected in March, about 46% in April, 53% in May, and less than one percent in June (trap operated for five days in June).

Wild steelhead trout passage was similar to hatchery steelhead trout passage (Figure 3). About four percent of the total catch of wild steelhead trout was collected in March, 46% in April, and 50% in May. No wild steelhead were collected in June.

This was the first year the Snake River trap captured a significant number of hatchery-reared sockeye salmon due to the release of 81,615 hatchery fish in the upper Salmon River basin. The Snake River trap intercepted 1.9% of the hatchery release. The majority of the hatchery sockeye were collected in May (97.3%) with 2.7% collected in June.

For the first time the Snake River trap captured a significant number of hatchery coho salmon. These fish were released into the Clearwater River drainage and must have strayed up the Snake River for them to be captured in the trap. The majority of the hatchery coho was captured in May (96.2%) with the remainder being captured in June (3.8%).

Snake River discharge, measured at Anatone gauge, ranged from 32.2 kcfs to 58.3 kcfs in March. March average discharge (40.1 kcfs) in 1998 was 38.2 kcfs less than in 1997 and 31.0 kcfs less than in 1996, but 3.7 kcfs greater than in 1995. April mean discharge (49.1 kcfs) was 34.9 and 33.6 kcfs less than in 1997 and 1996, respectively, but 7.4 kcfs greater than in 1995. May average discharge of 99.8 kcfs was 6.6 kcfs less than in 1997, but 17.2 and 21.7 kcfs greater than in 1996 and 1995, respectively. June mean discharge (90.5 kcfs) was 26.0 kcfs less than in 1997, 13.4 kcfs less than in 1996, and 2.3 kcfs less than in 1995.

Water temperature at the Snake River trap was 6°C at the beginning of the trapping season. Water temperature gradually increased throughout the sampling season and reached a maximum of 15.5°C on June 10 (Figure 4). Secchi disk transparency measurements were taken daily at the Snake River trap. Transparencies fluctuated throughout the trapping season and ranged from 0.4 m to 1.6 m (Figure 4).

### **Salmon River Trap Operation**

The Salmon River scoop trap captured 10,852 age-1 hatchery chinook salmon, 1,459 age-1 wild chinook salmon, 1,218 hatchery steelhead trout, 112 wild steelhead trout, and 10 hatchery sockeye salmon in 1998 (Table 5).

Two peaks in hatchery chinook salmon passage were observed at the Salmon River trap in 1998. The first began in mid-March and concluded at the end of the month. The majority of hatchery chinook salmon captured during this period probably originated from the Rapid River Fish Hatchery (RRFH). The second peak in passage began on April 6 and continued throughout the remainder of the month.

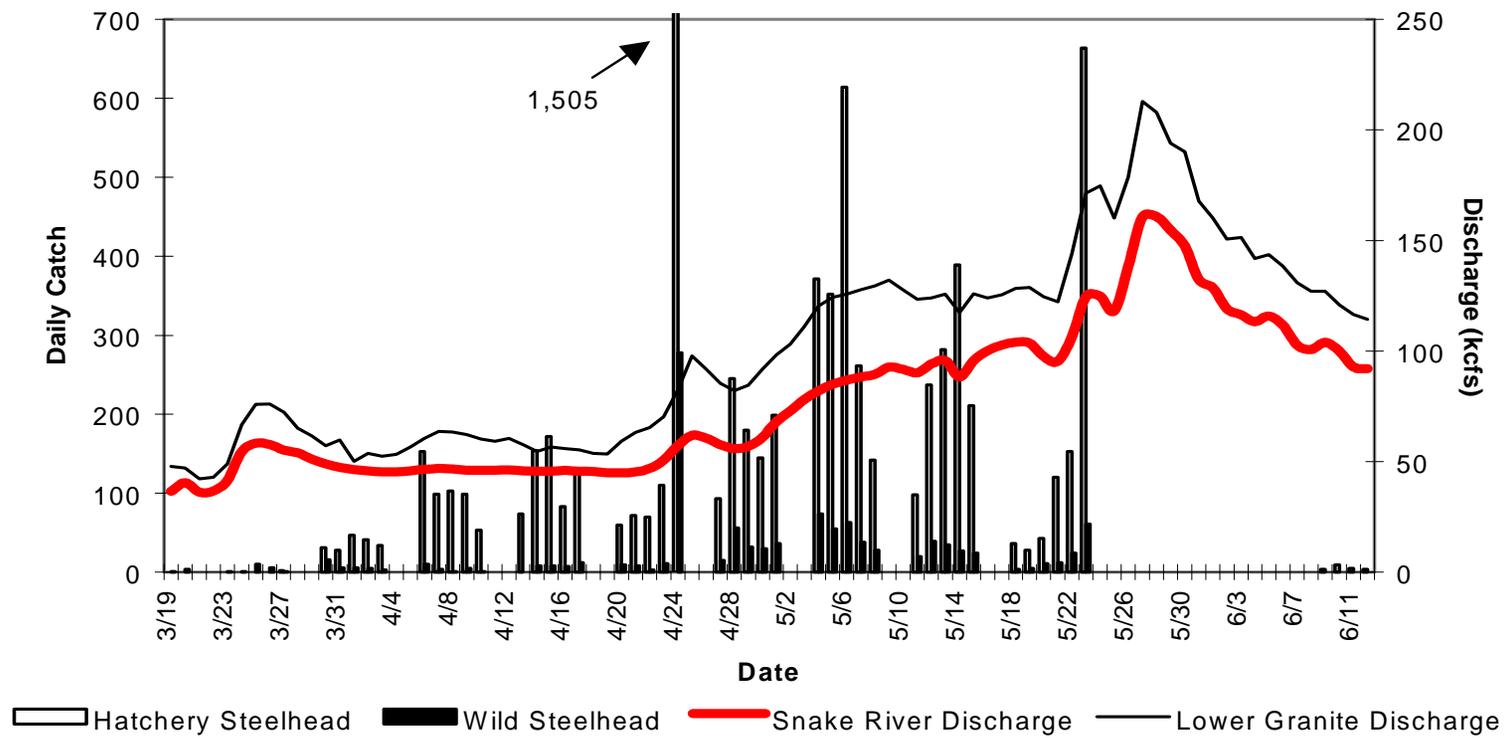


Figure 3. Snake River trap daily catch of hatchery steelhead trout and wild steelhead trout overlaid by Snake River and Lower Granite discharge, 1998. Snake River trap PIT-tag groups, 1988-1998.

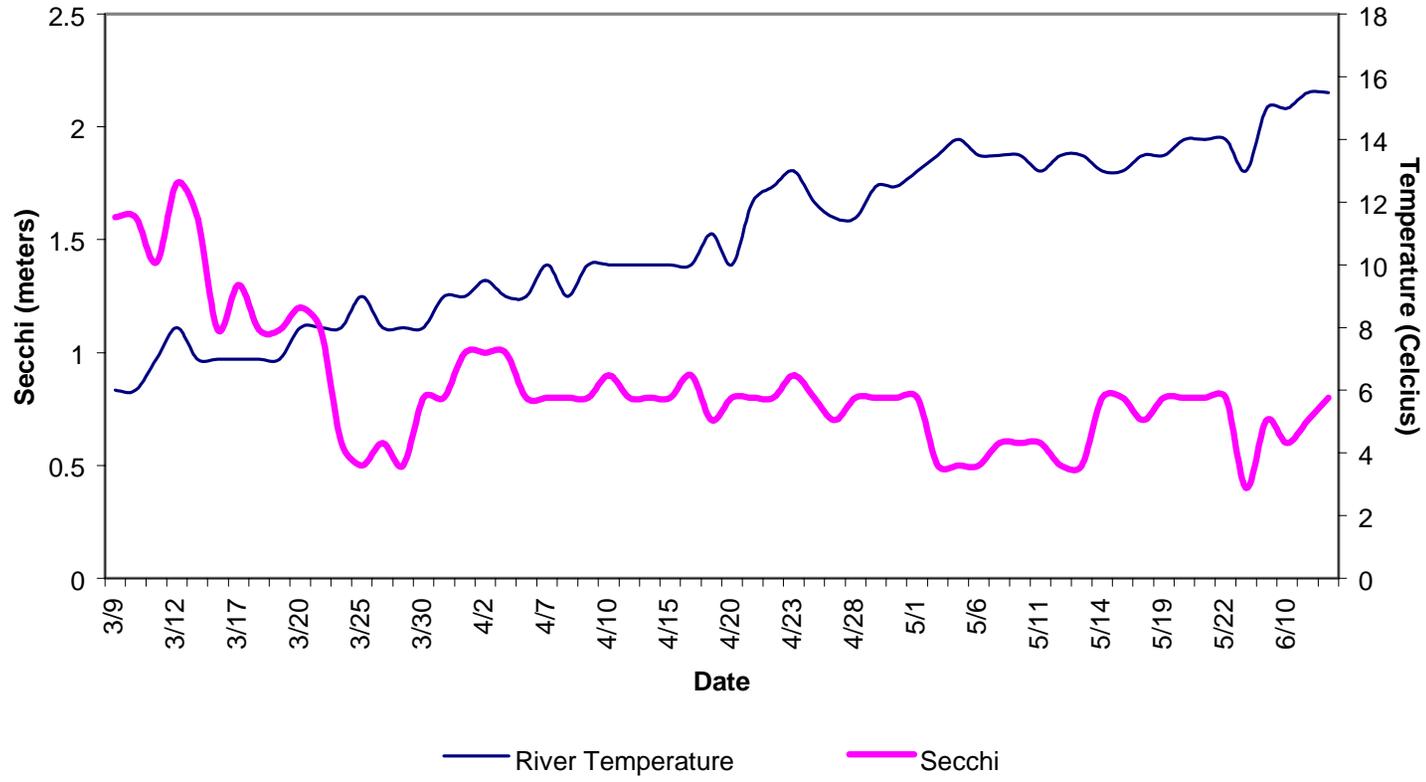


Figure 4. Daily water temperature and Secchi disk transparency for the Snake River at the trap, 1998

Any additional peaks in passage that may have occurred during May were not detected due to poor trap location (trap not in thalweg) or because the trap was not in operation (Figure 5). About 58 % of the total catch of hatchery chinook salmon was captured in March, 41% was collected in April, and about one percent in May (trap operated for eight days).

Only one relatively small peak in wild chinook salmon passage was observed at the Salmon River trap in 1998. The peak began on March 18, reached its maximum on March 24, and tapered off by the end of the month. Wild chinook salmon passage remained low (<95/day) for the remainder of the field season (Figure 5). Additional peaks in passage that may have occurred during late April and in May were not detected due either to poor trap location or because the trap was not in operation. Approximately 56% of the season total was collected in March, 43% was captured in April, and one percent in May.

Two peaks in hatchery steelhead trout passage were observed at the Salmon River trap in 1998. The first peak began on April 16 and continued through April 30. The trap sustained damage on May 5 and was out of operation until May 17. The second peak in passage began on May 18 and was still in progress when operations were terminated for the season on May 22 (Figure 6). There were no hatchery steelhead trout collected during March, but 86% of the season total was collected in April and 14% in May. Wild steelhead trout passage was similar to hatchery steelhead trout passage (Figure 6). Nearly four percent of the season total was captured in March, 85% in April, and 11% in May.

Salmon River daily mean discharge ranged from 4.1 kcfs to 14.9 kcfs and averaged 6.8 kcfs during March. Average March discharge (1998) was less than observed in 1997 (9.2 kcfs), 1996 (9.1 kcfs), and 1995 (7.7 kcfs). Discharge increased in April and ranged from 7.5 kcfs to 21.8 kcfs. April mean daily discharge (11.0 kcfs) was 7.5 kcfs less than in 1997, 7.9 kcfs less than in 1996, but 1.2 kcfs greater than in 1995. May average daily discharge was 36.5 kcfs and ranged from 24.2 kcfs to 48.8 kcfs. May average discharge for 1997, 1996, and 1995 was 59.0, 41.5, and 32.3 kcfs, respectively.

Water temperatures at the Salmon River trap ranged from 3.0°C to 10.0°C and fluctuated throughout the field season (Figure 7). Secchi disk transparency fluctuated throughout the trapping season and ranged from 0.25 m to 2.8 m (Figure 7).

### **Wild steelhead trout.**

In 1998, nine PIT-tagged wild steelhead trout were interrogated at the Snake River trap. One was released from the Grande Ronde River trap, five from the Imnaha River trap (average travel time to the Snake River trap was 13 d), one from the Pahsimeroi River, and two from the Snake River trap.

### **Sockeye Salmon.**

In 1998, there were 25 PIT-tagged hatchery sockeye salmon interrogated at the Snake River trap. Twelve were released into Alturus Lake and three were released into Red Fish Lake in the fall of 1997. Three were released from the Red Fish Lake Creek trap and seven were released from the Sawtooth trap (average travel time to the Snake River trap was 4 d).

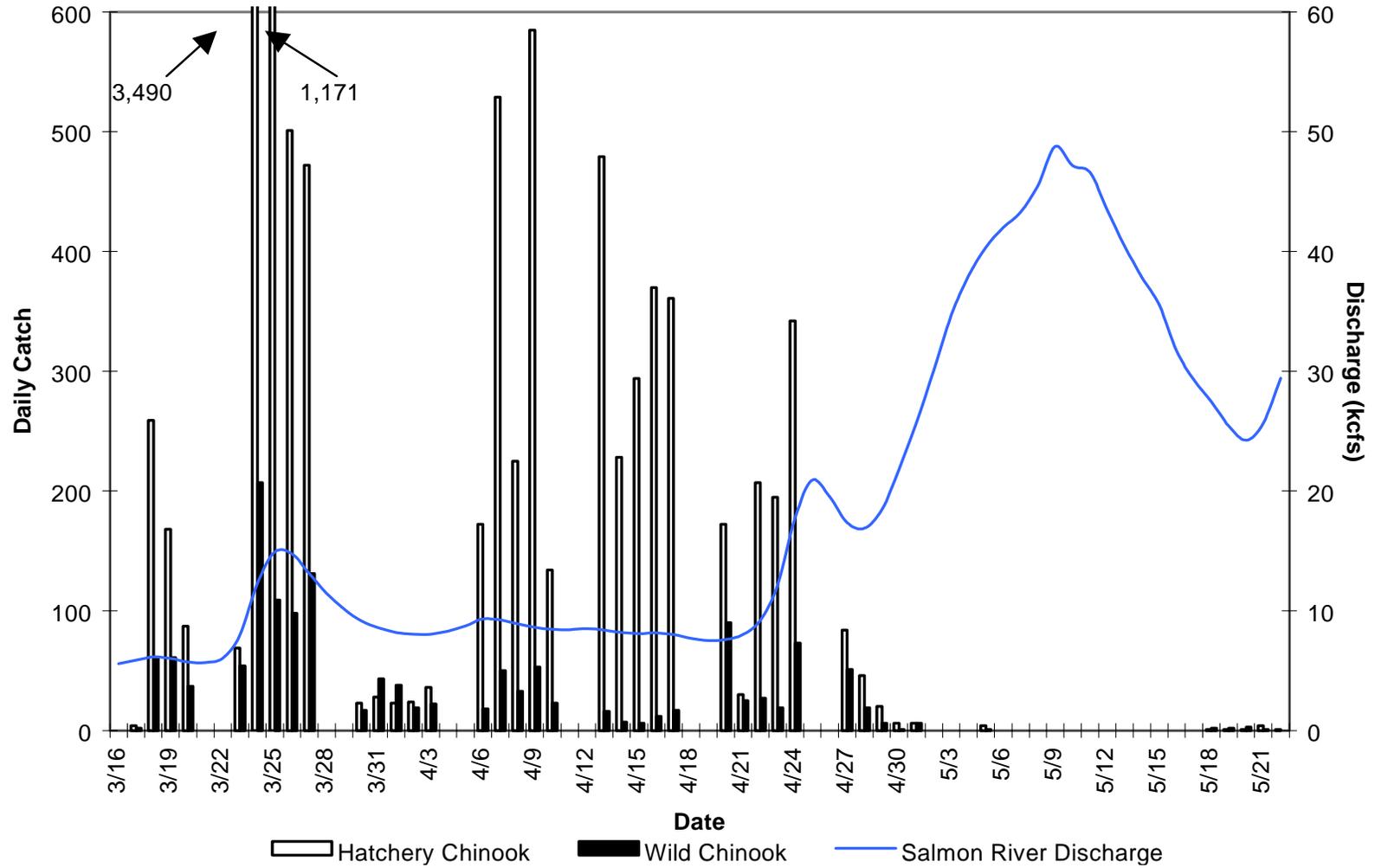


Figure 5. Salmon River trap daily catch of hatchery chinook salmon and wild chinook salmon overlaid by Salmon River Discharge, 1998.

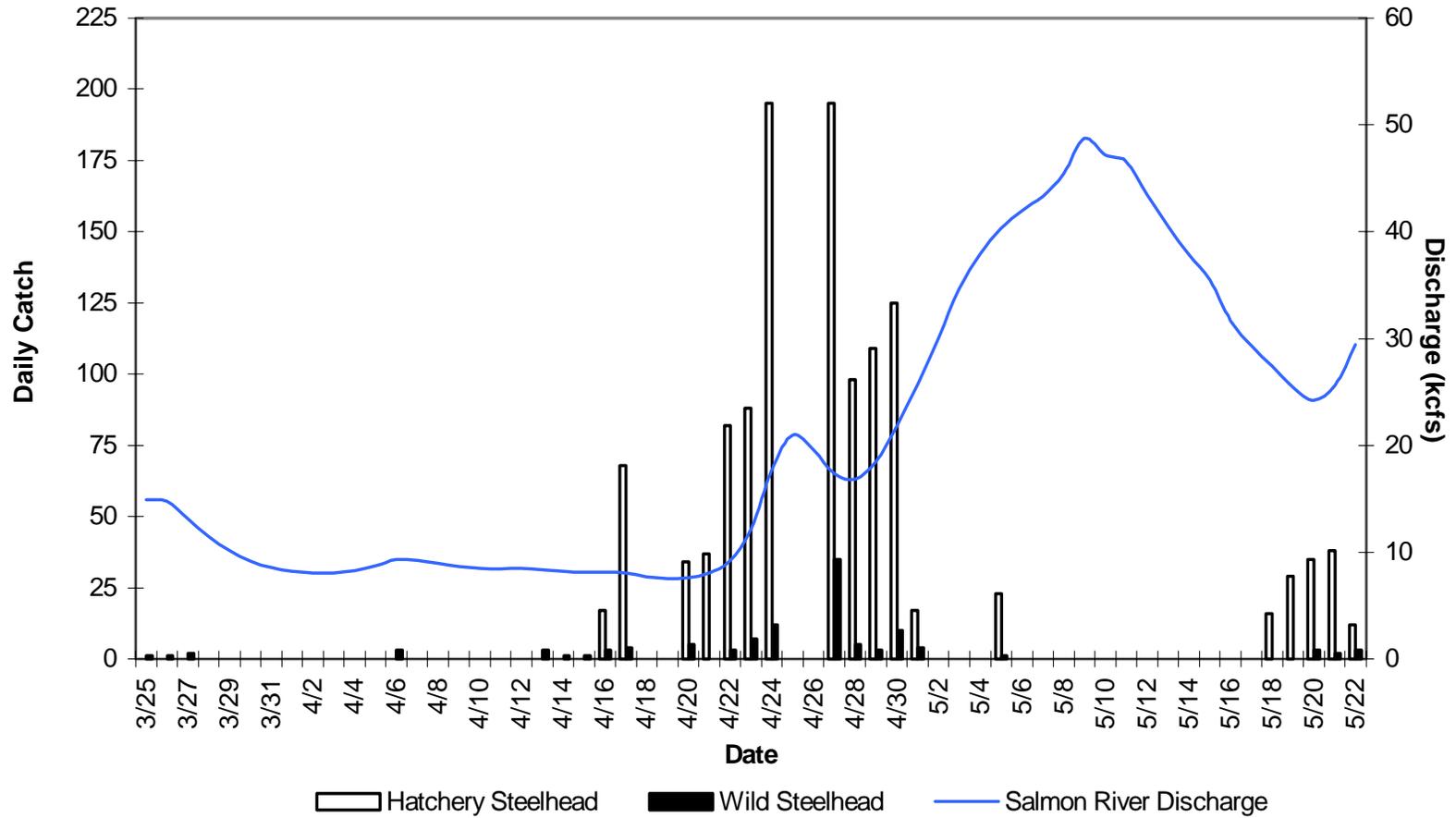


Figure 6. Salmon River trap daily catch of hatchery steelhead trout and wild steelhead trout overlaid by Salmon River discharge, 1998.

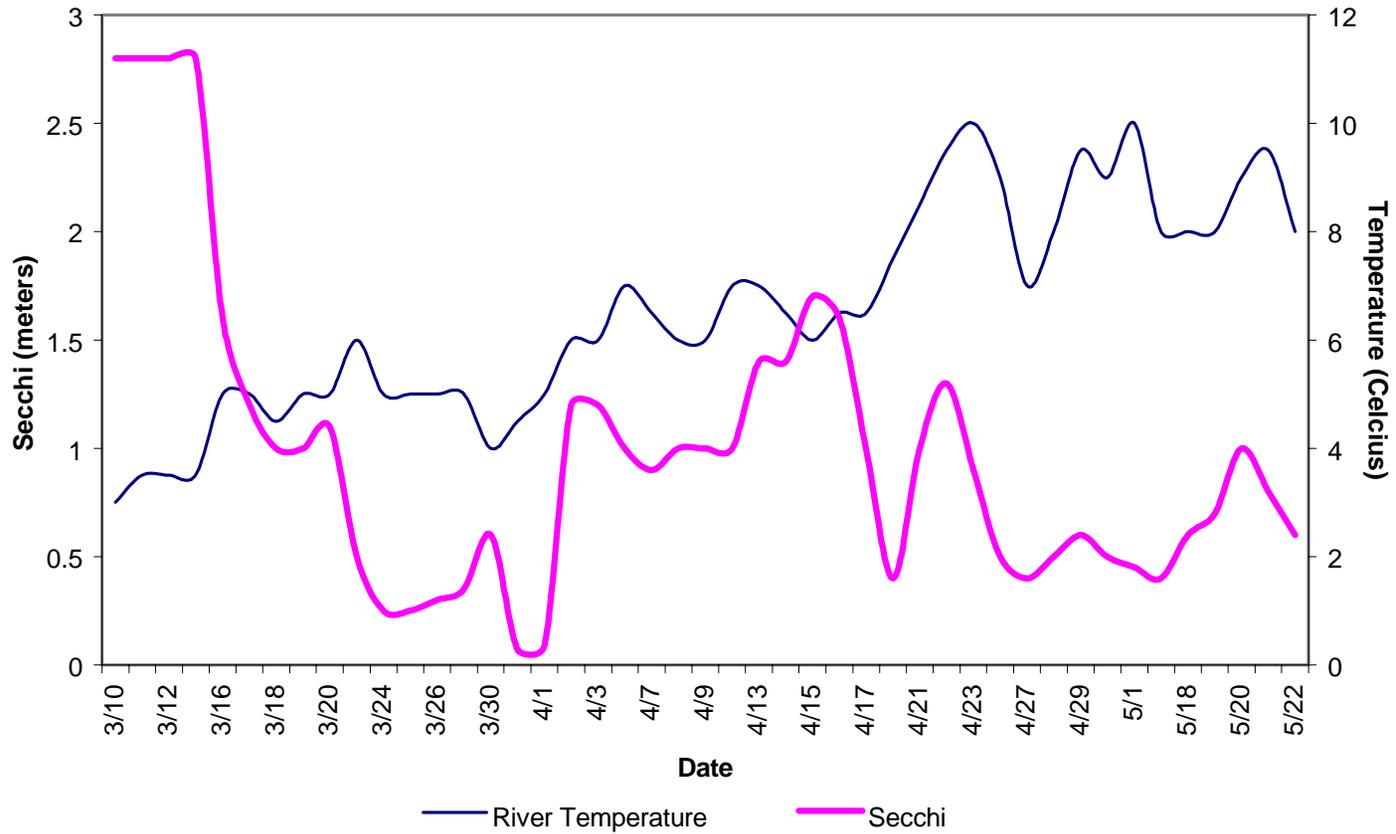


Figure 7. Daily water temperature and Secchi disk transparency for the Salmon River trap, 1998.

In 1998, five wild sockeye were collected at the Snake River trap, all of which were released from the Red Fish Lake Creek trap (average travel time to the Snake River trap was 5 d).

## **Release Sites to the Salmon River Trap**

### **Hatchery chinook salmon.**

In 1998, 251 PIT-tagged hatchery chinook salmon were interrogated at the Salmon River trap. A group released into South Fork Salmon River had 114 recaptured at the Salmon River trap. Travel time ranged from 3 d to 28 d and averaged 11 d. A group that was released from RRFH had 135 recaptured at the Salmon River trap. Travel time could not be calculated because this group was volitionally released and a release date could not be calculated. One fish from each group released from the Sawtooth Fish Hatchery and South Fork Salmon River trap, were captured at the Salmon River trap.

### **Wild chinook salmon.**

In 1998, 19 PIT-tagged wild chinook salmon were interrogated at the Salmon River trap. One was released from Elk Creek, three from the Lemhi River weir, one from the Sawtooth trap, and three from Marsh Creek. Four were released from the South Fork Salmon River trap, one from the lower South Fork Salmon River trap, four from Lake Creek, and two were released into the Secesh River. All fish were tagged and released in the fall of 1997, except the one fish released from the Sawtooth trap.

### **Hatchery steelhead trout.**

In 1998, one PIT-tagged hatchery steelhead trout was interrogated at the Salmon River trap. It was released in Herd Creek.

### **Wild steelhead trout.**

No PIT-tagged wild steelhead trout were interrogated at the Salmon River trap in 1998.

### **Sockeye salmon.**

No PIT-tagged wild or hatchery sockeye salmon were interrogated at the Salmon River trap in 1998.

## **Head of Lower Granite Reservoir to Lower Granite Dam**

The PIT-tag sample rate at the dams changed significantly during the 1998 outmigration, mainly due to the fluctuation of spill. This is the sixth year since the Smolt Monitoring Project began PIT-tagging in 1987 that a significant period of spill occurred. The following example illustrates how median travel time estimates are affected by spill.

A group of fish tagged and released at the Snake River trap passes Lower Granite Dam over a ten-day period. When spill occurs, the facility sampling efficiency for these fish is decreased because a portion of the fish that would normally be sampled instead passes via spill. Spill during the second half of the passage period could cause the number of fish during that half to be underestimated, making the date the median fish passed Lower Granite earlier than the actual date. Likewise, spill during the first half of the passage period would artificially shift the date of median passage later than the true date. The calculation of mean discharge for the median migration period is affected by the incorrect estimate of the median migration period. If discharge were increasing for the passage period of the above group and spill occurred during the second half thereby making the date of median passage earlier, then mean discharge for that group is also underestimated.

Another effect spill may have on migration rate is that the more highly smolted fish are more buoyant and migrate higher in the water column. They are also the fastest migrating fish (Beeman and Rondorf, In Press). The ten-foot-deep debris boom in front of the turbines at Lower Granite Dam may divert a greater number of these higher-floating fish to the spill where they are not interrogated. A greater number of the deeper-migrating, slower-moving fish may migrate through the powerhouse and be collected and subsequently interrogated (Giorgi et al. 1988). This type of bias would incorrectly estimate migration rate, with the estimated median migration rate being less than the true rate. This makes any interpretation of the PIT-tag data at the dams extremely difficult during the periods of major operational changes. It also means that if fish that are collected at Lower Granite Dam are transported, then the portion of the population that passes Lower Granite is no longer representative of the population that arrived at Lower Granite.

#### **Hatchery chinook salmon PIT-tag groups.**

Sufficient numbers of hatchery chinook salmon were PIT-tagged daily at the Snake River trap to provide 29 daily release groups (2,468 individual fish) for median migration rate calculations through Lower Granite Reservoir from March 25 through May 23 (Appendix A, Table A-1). Median travel time ranged from 23.5 to 3.3 d (2.2 km/d to 15.6 km/d migration rate) and averaged 9.1 d (7.4 km/d).

Linear regression analysis detected a significant relation between migration rate in Lower Granite Reservoir and average Lower Granite inflow (Table 6) for PIT-tagged hatchery chinook salmon groups (Table 7). The equation shows that as discharge increases, migration rate increases.

Sufficient numbers of hatchery chinook salmon were PIT-tagged daily at the Salmon River trap to provide 31 daily release groups (3,261 individual fish) for median migration rate calculations through Lower Granite Reservoir from March 17 through April 29 (Appendix A, Table A-5). Median travel time ranged from 40.4 to 11.6 d (5.8 km/d to 20.0 km/d migration rate) and averaged 25.3 d (10.7 km/d).

Linear regression analysis detected a significant relation between migration rate from the Salmon River trap to Lower Granite Dam and average Lower Granite inflow (Table 8) for PIT-tagged hatchery chinook salmon groups (Table 7). The equation shows that as discharge increases, migration rate increases.

### **Wild chinook salmon PIT-tag groups.**

Sufficient numbers of wild chinook salmon were PIT-tagged daily at the Snake River trap to provide 19 daily release groups (1,020 individual fish) for median migration rate calculations through Lower Granite Reservoir from March 25 through May 23 (Appendix A, Table A-2). Median travel time ranged from 22.4 to 4.2 d (2.3 km/d to 12.3 km/d migration rate) and averaged 8.6 d (7.9 km/d).

Linear regression analysis detected a significant relation between migration rate in Lower Granite Reservoir and average Lower Granite inflow (Table 6) for PIT-tagged wild chinook salmon groups (Table 7). The equation shows that as discharge increases, migration rate increases.

Sufficient numbers of wild chinook salmon were PIT-tagged daily at the Salmon River trap to provide 27 daily release groups (1,431 individual fish) for median migration rate calculations through Lower Granite Reservoir from March 17 through April 28 (Appendix A, Table A-6). Median travel time ranged from 26.5 to 7.4 d (8.8 km/d to 31.5 km/d migration rate) and averaged 17.6 d (15.2 km/d).

Linear regression analysis detected a significant relation between migration rate from the Salmon River trap to Lower Granite Dam and average Lower Granite inflow (Table 8) for PIT-tagged wild chinook salmon groups (Table 7). The equation shows that as discharge increases, migration rate increases

### **Hatchery steelhead trout PIT-tag groups.**

Sufficient numbers of hatchery steelhead trout were PIT-tagged daily at the Snake River trap to provide 41 daily release groups (4,292 individual fish) for median migration rate calculations through Lower Granite Reservoir from March 30 through May 23 (Appendix A, Table A-3). Median travel time ranged from 5.43 to 0.9 d (9.5 km/d to 58.6 km/d migration rate) and averaged 2.8 d (23.6 km/d).

Linear regression analysis detected a significant relation between migration rate in Lower Granite Reservoir and average Lower Granite inflow (Table 6) for PIT-tagged hatchery steelhead trout groups (Table 7). The equation shows that as discharge increases, migration rate increases.

Hatchery steelhead trout migration rate/discharge relation for Snake River trap PIT-tag groups was examined to determine if there was a difference in this relation between years (1988-1998). The analysis of covariance was used with the data averaged by 5-kcfs groups. The analysis showed a significant difference in the slope of the migration rate/discharge relation between years ( $F=4.857$ ,  $N=132$ ,  $P<0.001$ ).

Table 6. Migration rates (km/day), stratified by 5 kcfs intervals from the Snake River trap to Lower Granite Dam, 1998.

Discharge Interval	Hatchery Chinook	Wild Chinook	Hatchery Steelhead	Wild Steelhead
50 - 55	-	-	11.46	9.90
55 - 60	3.55	3.27	12.37	8.57
60 - 65	3.61	3.96	10.68	7.93
65 - 70	6.00	-	14.33	10.38
70 - 75	-	-	18.49	15.27
75 - 80	7.70	-	20.31	-
80 - 85	8.05	-	30.00	21.68
85 - 90	-	7.49	20.64	20.81
90 - 95	6.85	7.85	26.06	21.86
95 - 100	7.96	8.08	21.41	20.81
100 - 105	7.88	9.23	32.05	26.88
105 - 110	11.19	-	-	-
110 - 115	11.34	8.32	-	-
115 - 120	-	9.17	-	-
120 - 125	9.59	12.26	33.59	32.82
125 - 130	10.92	8.91	32.25	31.56
130 - 135	-	-	32.05	32.35
135 - 140	-	-	-	-
140 - 145	-	-	-	-
145 - 150	-	-	30.71	27.30
150 - 155	-	8.87	-	-
155 - 160	-	-	35.59	40.31
160 - 165	-	-	-	-
165 - 170	33.73	-	-	-
170 - 175	-	17.73	58.64	54.32

Table 7. Linear regression statistics for migration rate/discharge relations by species, rearing type, and trap, using data stratified by 5-kcfs intervals, 1998.

Species	Trap	N	Intercept	Slope	r <sup>2</sup>	P
Hatchery	SNK	12	-3.846	1.309	0.823	<0.001
Chinook	SAL	12	-5.010	1.710	0.903	<0.001
Wild	SNK	11	-4.289	1.389	0.931	<0.001
Chinook	SAL	9	-3.039	1.376	0.851	<0.001
Hatchery	SNK	17	-2.049	1.151	0.852	<0.001
Steelhead	SAL	11	1.256	0.585	0.355	0.053
Wild	SNK	16	-3.443	1.428	0.905	<0.001
Steelhead	SAL	Not enough data				

Table 8. Migration rates (km/day), stratified by 5 kcfs intervals from the Salmon River trap to Lower Granite Dam, 1998.

Discharge Interval	Hatchery Chinook	Wild Chinook	Hatchery Steelhead	Wild Steelhead
50 - 55	6.39	9.96	-	30.59
55 - 60	-	-	-	-
60 - 65	6.39	12.86	-	35.17
65 - 70	7.66	12.04	-	25.55
70 - 75	8.74	19.40	-	50.17
75 - 80	9.50	22.32	39.22	-
80 - 85	11.91	-	49.90	-
85 - 90	18.68	24.14	52.43	52.83
90 - 95	14.99	24.87	35.87	-
95 - 100	16.04	-	52.37	44.77
100 - 105	16.51	22.36	60.47	67.28
105 - 110	19.40	-	70.76	-
110 - 115	20.03	29.45	-	-
115 - 120	14.96	-	-	-
120 - 125	-	-	-	-
125 - 130	14.59	-	49.85	89.88
130 - 135	-	-	-	-
135 - 140	-	-	47.70	-
140 - 145	-	-	-	-
145 - 150	-	-	63.78	-
150 - 155	-	-	80.55	-
155 - 160	-	-	-	-
160 - 165	-	-	84.96	-

The slope of the regression lines for 1988, 1992, and 1994 were slightly less steep than the other year's data and the height of the 1996-1998 regression lines was higher (Figure 8). Interestingly, the three years (1988, 1992, and 1994) are the poorest flow years and occurred during the drought and the 1996-1998 years were the highest flow years. After removing the six years data, a significant difference in the slopes was still detected between the remaining five years ( $F=8.336$ ,  $N=63$ ,  $P<0.001$ ). First 1995 ( $F=11.292$ ,  $N=57$ ,  $P<0.001$ ) and then 1993 data were removed before no significant differences could be detected between the remaining three years ( $F=0.033$ ,  $N=41$ ,  $P=0.967$ ). The analysis of covariance was continued and no significant difference could be detected in the intercepts (heights) of the three years data ( $F=2.920$ ,  $N=41$ ,  $P=0.066$ ). The three years data were pooled, and the regression analysis was run. A very strong relation was found between migration rate and discharge ( $r^2=0.912$ ,  $N=41$ ,  $P<0.001$ ). The linear regression equation was:

$$\ln(\text{migration rate}) = -4.477 + 1.616 \ln(\text{mean discharge}).$$

The analysis of covariance was used with the other two sets of years (1988, 1992, 1994, and 1996 and 1998), which were removed from the above analysis, and no significant difference between years was detected with either group ( $F=0.013$ ,  $N=27$ ,  $P=0.987$ , and  $F=1.762$ ,  $N=42$ ,  $P=0.186$ , respectively). The analysis of covariance was continued and a significant difference was detected in the intercepts (heights) of the three low-flow years of data ( $F=4.618$ ,  $N=27$ ,  $P=0.021$ ) but no significant difference was detected for the three high-flow years ( $F=1.871$ ,  $N=42$ ,  $P=0.168$ ). Figure 8 shows that the differences were not major, so the data were pooled despite the difference in the height of the lines and the regression analysis was run. A very strong relation was found between migration rate and discharge for both the three low-flow years ( $r^2=0.865$ ,  $N=27$ ,  $P<0.001$ ) and for the three high-flow years ( $r^2=0.824$ ,  $N=42$ ,  $P<0.001$ ). The linear regression equation for the low-flow years was:

$$\ln(\text{migration rate}) = -2.568 + 1.163 \ln(\text{mean discharge})$$

and for the high-flow years was:

$$\ln(\text{migration rate}) = -1.418 + 1.006 \ln(\text{mean discharge})$$

The eleven years of migration rate discharge data (1988-1998) were combined and the linear regression analysis conducted to provide an average regression equation. A strong relation was found between migration rate and discharge ( $r^2=0.835$ ,  $N=132$ ,  $P<0.001$ ). The best linear regression equation was:

$$\ln(\text{migration rate}) = -3.370 + 1.382 \ln(\text{mean discharge}).$$

A two-fold increase in discharge will translate into a 2.6 fold increase in migration rate.

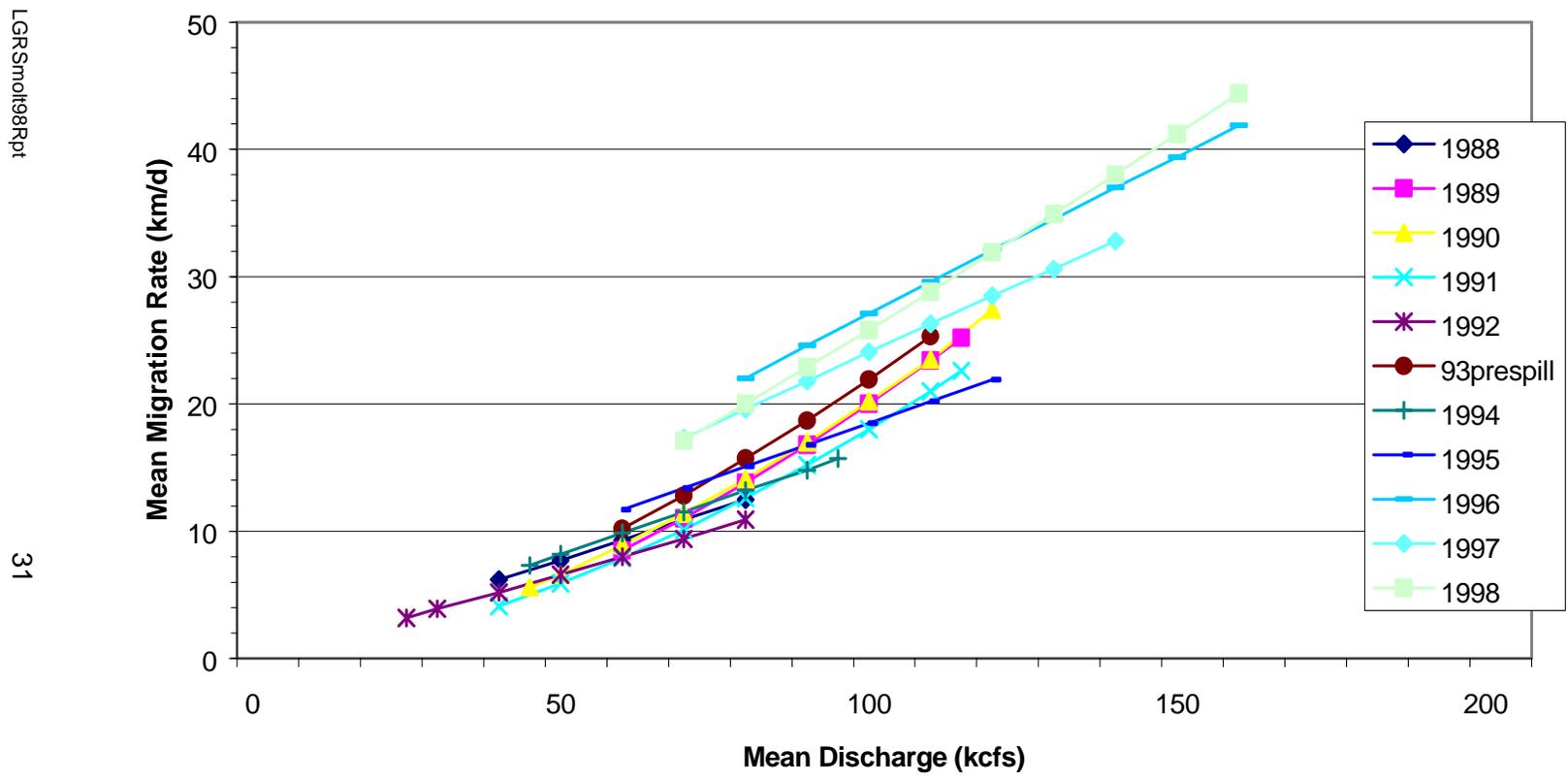


Figure 8. Hatchery steelhead migration rate/discharge relations for Snake River trap PIT-tag groups, 1988-1998.

Fifteen groups of hatchery steelhead trout (1,118 fish) were PIT-tagged at the Salmon River trap in 1998 for use in median migration rate calculations to Lower Granite Reservoir (Appendix A, Table A-7). Median travel time ranged from 6.7 to 2.9 d (34.8 km/d to 80.5 km/d) and averaged 4.6 d (52.9 km/d).

Data stratified by 5 kcfs groups were used in the regression analysis (Table 8). The linear regression analysis detected a significant relation between migration rate from the Salmon River trap to Lower Granite Dam and average Lower Granite discharge for PIT-tagged hatchery steelhead trout groups marked at the Salmon River trap (Table 7). The equation shows that as discharge increases, migration rate increases.

### **Wild steelhead trout PIT-tag groups.**

Sufficient numbers of wild steelhead trout were PIT-tagged daily at the Snake River trap to provide 26 daily release groups (1,060 individual fish) for median migration rate calculations through Lower Granite Reservoir from March 25 through May 21 (Appendix A, Table A-4). Median travel time ranged from 10.8 to 1.0 d (4.8 km/d to 54.3 km/d migration rate) and averaged 2.8 d (24.8 km/d).

Linear regression analysis detected a significant relation between migration rate in Lower Granite Reservoir and average Lower Granite inflow (Table 6) for PIT-tagged wild steelhead trout groups (Table 7). The equation shows that as discharge increases, migration rate increases.

Insufficient numbers of wild steelhead trout (97) were PIT-tagged at the Salmon River trap to estimate travel time and migration rate to Lower Granite Dam (Appendix A, Table A-8).

### **Interrogation of PIT-tagged Fish**

Interrogation data in 1998 are not directly comparable with the earlier years. All species-run-rearing types will be underestimated due to a reduction in collection efficiency during spill at the dams. During other times of the season the interrogation rate may vary sporadically due to fluctuations in turbine operations. The fourth collection facility in the system, at Lower Monumental Dam, became operational in 1993 and total interrogations may be greater beginning in 1993 than in previous years. Therefore, any comparison in trends of cumulative detection at dams must be done cautiously, in a manner that incorporates these additional factors.

Percent interrogation of Snake River trap hatchery chinook salmon and wild chinook salmon daily PIT-tag release groups at Lower Granite Dam, after combining to remove groups with small sample size, ranged from 27.3% to 70.6% for hatchery fish (Appendix B, Table B-1). Wild chinook ranged from 12.8% to 80.0%, (Appendix B, Table B-2). Seasonal cumulative interrogation rate of PIT-tagged hatchery chinook salmon to Lower Granite, Little Goose, Lower Monumental, and McNary dams ranged between 31.6% and 90.5%, and averaged 80.3% (Table 9). Wild chinook salmon cumulative interrogation rates ranged between 51.3% and 100%, and averaged 79.4% (Table 9).

Table 9. Interrogations of PIT-tagged fish from the Snake River trap, 1987 - 1998; Clearwater River trap, 1989 - 1995; and Salmon River trap, 1993 – 1998, at downstream collection facilities.

Site	Year	Species	Number Tagged	Number Interrogated/Site									Grand Total Ints	Total % Obs.
				Ints at Lower Granite	% GRJ	Ints at Little Goose	% GOJ	Ints at Lower Monumental	% LMJ	Ints at McNary	% MCJ			
Snake	1998	CH	2303	1077	46.8%	510	22.2%	192	8.3%	71	3.1%	1850	80.3%	
	1997	CH	-	-	-	-	-	-	-	-	-	-	-	
	1996	CH	1,450	497	34.3%	259	17.9%	189	13.0%	40	2.8%	985	67.9%	
	1995	CH	3,927	1,646	41.9%	643	16.4%	430	11.0%	153	3.9%	2,872	73.1%	
	1994	CH	2,844	885	31.1%	332	11.7%	223	7.8%	329	11.6%	1,769	62.2%	
	1993	CH	3,203	1,336	41.7%	494	15.4%	246	7.7%	134	4.2%	2,210	69.0%	
	1992	CH	410	166	40.5%	83	20.2%	-	0.0%	48	11.7%	297	72.4%	
Snake	1998	CW	961	442	46.0%	190	19.8%	89	9.3%	42	4.4%	763	79.4%	
	1997	CW	-	-	-	-	-	-	-	-	-	-	-	
	1996	CW	842	269	31.9%	190	22.6%	119	14.1%	40	4.8%	618	73.4%	
	1995	CW	2,067	1,023	49.5%	366	17.7%	216	10.5%	68	3.3%	1,673	80.9%	
	1994	CW	934	354	37.9%	95	10.2%	82	8.8%	83	8.9%	614	65.7%	
	1993	CW	1,125	576	51.2%	150	13.3%	57	5.1%	46	4.1%	829	73.7%	
Snake	1992	CU	615	249	40.5%	106	17.2%	-	0.0%	72	11.7%	427	69.4%	
	1991	CU	2,131	929	43.6%	409	19.2%	-	0.0%	115	5.4%	1,453	68.2%	
	1990	CU	2,245	956	42.6%	310	13.8%	-	0.0%	180	8.0%	1,446	64.4%	
	1989	CU	6,222	2,384	38.3%	1,367	22.0%	-	0.0%	482	7.7%	4,233	68.0%	
	1988	CU	3,767	1,237	32.8%	543	14.4%	-	0.0%	299	7.9%	2,079	55.2%	
	1987 <sup>b</sup>	CU	3,275	1,067	32.6%	338	10.3%	-	0.0%	308	9.4%	1,713	52.3%	
Snake	1998	SH	4,274	2230	52.2%	640	15.0%	303	7.1%	61	1.4%	3,234	75.7%	
	1997	SH	1,459	750	51.4%	328	22.5%	123	8.4%	12	0.8%	1,213	83.1%	
	1996	SH	1,363	675	49.5%	247	18.1%	139	10.2%	24	1.8%	1,085	79.6%	
	1995	SH	2,244	1,477	65.8%	236	10.5%	165	7.4%	19	0.8%	1,897	84.5%	
	1994	SH	3,239	1,298	40.1%	216	6.7%	112	3.5%	40	1.2%	1,666	51.4%	
	1993	SH	2,521	1,925	76.4%	235	9.3%	63	2.5%	13	0.5%	2,236	88.7%	
	1992	SH	3,904	1,496	38.3%	227	5.8%	-	0.0%	30	0.8%	1,753	44.9%	

Table 9. continued

Site	Year	Species	Number Tagged	Ints at Lower Granite	% GRJ	Ints at Little Goose	% GOJ	Ints at Lower Monumental	% LMJ	Ints at McNary	% MCJ	Grand Total Ints	Total % Obs.
	1991	SH	2,577	2,032	78.9%	268	10.4%	-	0.0%	11	0.4%	2,311	89.7%
	1990	SH	3,112	2,272	73.0%	282	9.1%	-	0.0%	33	1.1%	2,587	83.1%
	1989	SH	2,525	1,773	70.2%	268	10.6%	-	0.0%	35	1.4%	2,076	82.2%
	1988	SH	1,743	1,069	61.3%	190	10.9%	-	0.0%	12	0.7%	1,271	72.9%
	1987	SH	827	324	39.2%	52	6.3%	-	0.0%	6	0.7%	382	46.2%
<b>Snake</b>	1998	SW	1,088	624	57.4%	154	14.2%	81	7.4%	8	0.7%	867	79.7%
	1997	SW	148	82	55.4%	38	25.7%	6	4.1%	1	0.7%	127	85.8%
	1996	SW	655	293	44.7%	137	20.9%	67	10.2%	12	1.8%	509	77.7%
	1995	SW	1,537	967	62.9%	195	12.7%	122	7.9%	13	0.8%	1,297	84.4%
	1994	SW	2,840	1,546	54.4%	319	11.2%	158	5.6%	51	1.8%	2,074	73.0%
	1993	SW	2,867	1,982	69.1%	267	9.3%	133	4.6%	32	1.1%	2,414	84.2%
	1992	SW	2,538	1,511	59.5%	307	12.1%	-	0.0%	31	1.2%	1,849	72.9%
	1991	SW	3,549	2,266	63.8%	625	17.6%	-	0.0%	66	1.9%	2,957	83.3%
	1990	SW	3,078	2,016	65.5%	356	11.6%	-	0.0%	60	1.9%	2,432	79.0%
	1989	SW	1,798	1,170	65.1%	240	13.3%	-	0.0%	52	2.9%	1,462	81.3%
	1988	SW	1,186	698	58.9%	166	14.0%	-	0.0%	20	1.7%	884	74.5%
	1987	SW	464	229	49.4%	48	10.3%	-	0.0%	8	1.7%	285	61.4%
<b>Clearwater</b>	1995	CH	2,467	950	38.5%	414	16.8%	269	10.9%	109	4.4%	1,742	70.6%
	1994	CH	1,998	500	25.0%	192	9.6%	188	9.4%	247	12.4%	1,127	56.4%
	1993	CH	1,624	553	34.1%	193	11.9%	106	6.5%	77	4.7%	929	57.2%
	1992	CH	5,200	1,654	31.8%	745	14.3%	-	0.0%	429	8.3%	2,828	54.4%
<b>Clearwater</b>	1995	CW	1,051	464	44.1%	173	16.5%	88	8.4%	37	3.5%	762	72.5%
	1994	CW	761	308	40.5%	94	12.4%	81	10.6%	41	5.4%	524	68.9%
	1993	CW	298	134	45.0%	43	14.4%	25	8.4%	18	6.0%	220	73.8%
<b>Clearwater</b>	1992	CU	1,461	502	34.4%	202	13.8%	-	0.0%	136	9.3%	840	57.5%
	1991	CU	3,943	1,483	37.6%	668	16.9%	-	0.0%	235	6.0%	2,386	60.5%
	1990	CU	4,242	1,359	32.0%	674	15.9%	-	0.0%	281	6.6%	2,314	54.6%
	1989	CU	2,441	756	31.0%	452	18.5%	-	0.0%	140	5.7%	1,348	55.2%

Table 9. continued

Site	Year	Species	Number Tagged	Ints at Lower Granite	% at Little Goose	% GRJ	Ints at Lower Monument	% LMJ	Ints at McNary	%MCJ	Grand Total Ints	Total % Obs.
<b>Clearwater</b>	1995	SH	867	602	69.4%	69	8.0%	56	6.5%	0.3%	730	84.2%
	1994	SH	1,250	729	58.3%	119	9.5%	30	2.4%	0.8%	888	71.0%
	1993	SH	1,102	813	73.8%	79	7.2%	24	2.2%	0.5%	922	83.7%
	1992	SH	1,567	823	52.5%	118	7.5%	-	0.0%	0.4%	947	60.4%
	1991	SH	1,215	926	76.2%	89	7.3%	-	0.0%	0.2%	1,018	83.8%
	1990	SH	1,228	880	71.7%	63	5.1%	-	0.0%	0.8%	953	77.6%
	1989	SH	290	173	59.7%	16	5.5%	-	0.0%	0.7%	191	65.9%
	1995	SW	268	157	58.6%	40	14.9%	16	6.0%	0.4%	214	79.9%
	1994	SW	1,297	421	32.5%	150	11.6%	106	8.2%	1.9%	701	54.0%
	1993	SW	849	560	66.0%	106	12.5%	58	6.8%	1.1%	733	86.3%
1992	SW	2,996	1,599	53.4%	477	15.9%	-	0.0%	3.8%	2,189	73.1%	
1991	SW	1,300	767	59.0%	126	9.7%	-	0.0%	1.7%	915	70.4%	
1990	SW	727	409	56.3%	102	14.0%	-	0.0%	3.9%	539	74.1%	
1989	SW	104	53	51.0%	16	15.4%	-	0.0%	2.9%	72	69.2%	
<b>Salmon</b>	1998	CH	3,025	1,098	36.3%	565	18.7%	201	6.6%	2.9%	1,951	64.5%
	1997	CH	-	-	-	-	-	-	-	-	-	-
	1996	CH	2,554	618	24.2%	343	13.4%	258	10.1%	2.6%	1,286	50.4%
	1995	CH	5,074	1,777	35.0%	757	14.9%	531	10.5%	3.7%	3,251	64.1%
	1994	CH	3,633	870	23.9%	322	8.9%	258	7.1%	9.9%	1,808	49.8%
	1993	CH	3,138	1,144	36.5%	385	12.3%	233	7.4%	5.0%	1,919	61.2%
	1998	CW	1,416	657	46.4%	305	21.5%	105	7.4%	4.9%	1,137	80.3%
	1997	CW	-	-	-	-	-	-	-	-	-	-
	1996	CW	1,425	381	26.7%	289	20.3%	181	12.7%	2.2%	882	61.9%
	1995	CW	3,937	1,790	45.5%	689	17.5%	366	9.3%	3.1%	2,967	75.4%
1994	CW	2,913	1,113	38.2%	287	9.9%	188	6.5%	6.9%	1,790	61.4%	
1993	CW	2,169	1,112	51.3%	286	13.2%	125	5.8%	4.2%	1,614	74.4%	
1998	SH	1,117	608	54.4%	158	14.2%	76	6.8%	0.6%	849	76.0%	
1997	SH	1,252	627	50.1%	213	17.0%	118	9.4%	0.1%	960	76.6%	

Table 9. continued

Site	Year	Species	Number Tagged	Ints at Lower Granite	%GRJ	Ints at Little Goose	%GOJ	Ints at Lower Monumental	%LMJ	Ints at McNary	%MCJ	Grand Total Ints	Total % Obs.
Salmon	1996	SH	1,410	598	42.4%	205	14.5%	140	9.9%	24	1.7%	967	68.6%
	1995	SH	1,556	937	60.2%	190	12.2%	118	7.6%	14	0.9%	1,259	80.9%
	1994	SH	2,596	1,001	38.6%	164	6.3%	70	2.7%	36	1.4%	1,271	49.0%
	1993	SH	1,641	1,203	73.3%	112	6.8%	44	2.7%	13	0.8%	1,372	83.6%
	1998	SW	112	56	50.0%	13	11.6%	10	8.9%	1	0.9%	80	71.4%
	1997	SW	59	38	64.4%	6	10.2%	5	8.5%	0	0.0%	49	83.1%
	1996	SW	251	112	44.6%	49	19.5%	21	8.4%	1	0.4%	183	72.9%
	1995	SW	435	251	57.7%	59	13.6%	32	7.4%	1	0.2%	343	78.9%
	1994	SW	532	260	48.9%	44	8.3%	32	6.0%	10	1.9%	346	65.0%
	1993	SW	902	575	63.7%	73	8.1%	36	4.0%	5	0.6%	689	76.4%

<sup>a</sup>CH=hatchery chinook, CW=wild chinook, CU=unknown chinook, SH=hatchery steelhead, SW=wild steelhead.

<sup>b</sup>Bias may exist as only "quality" fish were tagged.

Percent interrogation of Salmon River trap hatchery chinook salmon daily PIT-tag release groups at Lower Granite Dam, after combining to remove groups with small sample size, ranged from 27.4% to 46.5% (Appendix B, Table B-5). Wild chinook salmon ranged from 28.0% to 75.0%, (Appendix B, Table B-6). Seasonal cumulative interrogation rate of PIT-tagged hatchery chinook salmon to Lower Granite, Little Goose, Lower Monumental, and McNary dams ranged between 45.5% and 100%, and averaged 64.5% (Table 9). Wild chinook salmon cumulative interrogation rates ranged from 59.7% to 100% and averaged 80.3% (Table 9).

Percent interrogation of Snake River trap hatchery steelhead trout and wild steelhead trout daily PIT-tag release groups at Lower Granite Dam, after combining to remove groups with small sample size, ranged from 14.9% to 75.6% for hatchery fish (Appendix B, Table B-3). Wild steelhead trout ranged from 8.3% to 91.7%, (Appendix B, Table B-4). Seasonal cumulative interrogation rate of PIT-tagged hatchery steelhead trout to Lower Granite, Little Goose, Lower Monumental, and McNary dams ranged between 52.7% and 89.5%, and averaged 75.7% (Table 9). Wild steelhead trout cumulative interrogation rates ranged between 33.3% and 100%, and averaged 79.7% (Table 9).

Percent interrogation of Salmon River trap hatchery steelhead trout daily PIT-tag release groups at Lower Granite Dam, after combining to remove groups with small sample size, ranged from 22.9% to 64.7% (Appendix B, Table B-7). Not enough wild steelhead trout were PIT-tagged to calculate daily interrogation rate (Appendix B, Table B-8). Seasonal cumulative interrogation rate of PIT-tagged hatchery steelhead trout to Lower Granite, Little Goose, Lower Monumental, and McNary dams ranged between 42.1% and 86.4%, and averaged 76.0% (Table 9). Wild steelhead trout averaged 71.4% (Table 9).

## SUMMARY

Hatchery chinook salmon releases above Lower Granite Dam for 1998 were 294% of 1997 numbers and 194% of 1996's total. Hatchery steelhead trout releases were 93% of 1997 numbers and 88% of 1996 numbers. Hatchery production of chinook salmon in the Clearwater River drainage was 302%, the Snake River and non-Idaho tributaries 261%, and the Salmon River drainage 316% of 1997 production. Hatchery production of steelhead trout in the Clearwater River drainage was 90%, the Snake River and non-Idaho tributaries was 89%, and the Salmon River was 97% of last year's total. Hatchery production of chinook salmon and steelhead trout released above Lower Granite Dam was 4,192,378 and 8,953,690 respectively, in 1998. Significant numbers of hatchery sockeye salmon (81,615) and hatchery coho salmon (696,280) were released in 1998.

The Snake River trap was operated on the east side of the river from March 8 through June 12th, and was out of operation for 34 days during this period due to high flow, mechanical failures, or because quotas were reached. The Snake River trap captured 3,487 age-1 hatchery chinook salmon, 1,063 wild chinook salmon, 106 wild age-0 chinook salmon, 8,001 hatchery steelhead trout, 1,116 wild steelhead trout, 1,552 hatchery sockeye, 26 wild sockeye/kokanee, and 166 hatchery coho.

The Salmon River trap was operated on the east side of the river from March 9 through May 22, and was out of operation for 28 days during this period due to high flow, mechanical failures, or because quotas were reached. The Salmon River trap captured 10,852 age-1 hatchery chinook salmon, 1,459 wild chinook salmon, 1,218 hatchery steelhead trout, 112 wild steelhead trout, and ten hatchery sockeye salmon.

Significant migration rate/discharge relations were detected for hatchery and wild chinook salmon released from both traps to Lower Granite Dam. Significant migration rate/discharge relations were detected for hatchery steelhead trout released from both traps to Lower Granite Dam. A significant migration rate/discharge relation was detected for wild steelhead trout from the Snake River trap to Lower Granite Dam. Insufficient numbers of wild steelhead trout were PIT-tagged at the Salmon River trap to estimate travel time and migration rate to Lower Granite Dam.

In all instances where the migration rate/discharge relation was significant, the same trend was seen, as discharge increased migration rate increased. A 40 kcfs (60-100 kcfs) increase in discharge would generally produce about a two-fold increase in migration rate for hatchery chinook salmon released from the Snake River trap during the low flow years 1988, 1990-1992, and 1994. The same increase in discharge generally produced about a five-fold increase for near normal flow years 1989, 1993, and 1995. During the two above-average flow years tested (1996 and 1998) the migration rate/discharge relation was not significant for 1996 and showed a slightly greater than three-fold increase in migration rate over the 90 kcfs increase in discharge (60-150) for 1998. Hatchery and wild steelhead trout released from the Snake River trap both showed about a two- to three-fold increase in migration rate with a two-fold increase in discharge.

The four-dam interrogation rates for 1998 were only comparable to 1993-1996, because of the addition of a new collection facility at Lower Monumental Dam in 1993. The comparability between the four years is questionable because of collection efficiency changes during the outmigration due to operational changes and spill at the dams.

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## APPENDIX A

Appendix A - 1. Pit-tagged hatchery chinook salmon travel time, with 95% confidence intervals, from the Snake River trap to Lower Granite Dam, 1998.

Release Date	Median Travel Time	Lower Confidence Interval <sup>a</sup>	Upper Confidence Interval	Minimum Travel Time	Maximum Travel Time	Number Recaptured	Number Tagged	Percent Recaptured	Mean Discharge	Migration Rate (km/day)
3/25/98	16.27	11.49	21.68	9.17	33.25	24	76	31.58%	61.435	3.2
3/26/98	23.51	18.64	25.83	10.23	46.47	17	45	37.78%	59.020	2.2
3/30/98	21.44	16.27	23.78	8.92	33.39	19	37	51.35%	57.245	2.4
4/2/98	18.94	14.61	27.48	14.61	27.48	6	11	54.55%	57.760	2.7
4/7/98	15.23	13.46	20.44	7.28	29.55	18	32	56.25%	58.994	3.4
4/8/98	16.16	10.04	24.70	6.71	44.55	16	30	53.33%	60.776	3.2
4/9/98	12.57	8.73	14.52	5.32	14.64	9	34	26.47%	58.350	4.1
4/10/98 <sup>b</sup>	8.71	0.00	0.00	8.71	8.71	1	4	25.00%	56.710	5.9
4/13/98	10.51	6.50	13.06	5.72	17.50	9	17	52.94%	60.642	4.9
4/14/98	8.11	6.49	11.42	5.03	20.18	16	44	36.36%	57.467	6.4
4/15/98	7.93	6.87	12.39	3.39	21.58	24	42	57.14%	59.211	6.5
4/16/98	9.50	8.48	14.43	4.55	23.43	25	74	33.78%	68.055	5.4
4/17/98	7.71	7.39	8.23	3.27	26.31	144	331	43.50%	66.767	6.7
4/20/98	6.03	5.00	9.60	4.28	31.65	19	32	59.38%	75.729	8.6
4/21/98	7.38	4.57	9.34	3.49	19.48	24	49	48.98%	79.800	7.0
4/22/98	6.46	5.50	8.61	2.44	22.53	35	70	50.00%	82.171	8.0
4/23/98	6.38	4.55	9.94	2.58	16.48	25	57	43.86%	84.900	8.1
4/24/98	7.53	7.14	8.11	1.75	29.51	201	395	50.89%	90.800	6.9
4/27/98 <sup>b</sup>	7.53	0.00	0.00	7.53	7.53	1	2	50.00%	100.078	6.9
4/28/98	6.48	5.46	7.58	2.25	14.49	49	114	42.98%	98.729	8.0
4/29/98	5.56	4.30	6.65	3.51	20.60	16	42	38.10%	104.757	9.3
4/30/98	4.61	3.98	5.56	2.33	34.43	33	62	53.23%	108.150	11.2
5/1/98	4.55	4.04	5.54	2.44	16.34	60	133	45.11%	113.783	11.3
5/4/98	5.32	4.80	6.20	1.67	10.46	43	115	37.39%	126.600	9.7
5/5/98	4.57	4.23	5.04	1.61	26.38	68	166	40.96%	127.817	11.3
5/6/98	3.99	3.53	4.88	2.28	16.28	69	171	40.35%	128.520	12.9
5/7/98	4.96	3.43	5.67	1.91	18.00	46	99	46.46%	127.383	10.4
5/8/98	5.45	3.38	6.50	1.47	8.28	21	49	42.86%	127.033	9.5

Appendix A-1. continued

Release Date	Median Travel Time	Lower Confidence Interval <sup>a</sup>	Upper Confidence Interval	Minimum Travel Time	Maximum Travel Time	Number Recaptured	Number Tagged	Percent Recaptured	Mean Discharge	Migration Rate (km/day)
5/12/98	3.31	2.06	5.36	1.37	9.48	16	46	34.78%	123.225	15.6
5/13/98	5.50	2.77	5.72	2.58	9.39	9	36	25.00%	125.071	9.4
5/14/98	7.45	2.94	8.46	2.46	8.61	11	28	39.29%	124.575	6.9
5/19/98 <sup>b</sup>	3.30	0.00	0.00	3.16	3.44	2	6	33.33%	129.875	15.6
5/23/98 <sup>b</sup>	1.53	0.00	0.00	1.53	1.53	1	19	5.26%	168.733	33.7
<b>Totals</b>						<b>1077</b>	<b>2468</b>	<b>43.64%</b>		

<sup>a</sup> Confidence Intervals calculated with non parametric statistics

<sup>b</sup> Not used in statistical analysis because analysis showed too few recaptures.

Appendix A – 2. Pit-tagged wild chinook salmon travel time, with 95% confidence intervals, from the Snake River trap to Lower Granite Dam, 1998.

Release Date	Median Travel Time	Lower Confidence Interval <sup>a</sup>	Upper Confidence Interval	Minimum Travel Time	Maximum Travel Time	Number Recaptured	Number Tagged	Percent Recaptured	Mean Discharge	Migration Rate (km/day)
3/25/98	15.05	11.77	19.68	8.75	48.57	52	136	38.24%	61.513	3.4
3/26/98	16.84	9.48	21.87	7.53	28.70	19	49	38.78%	60.461	3.1
3/27/98	22.43	6.48	25.86	6.48	25.86	7	17	41.18%	58.517	2.3
3/30/98	19.36	16.79	21.55	6.16	35.23	31	80	38.75%	57.340	2.7
3/31/98 <sup>b</sup>	15.14	0.00	0.00	11.13	19.14	2	4	50.00%	57.781	3.4
4/3/98 <sup>b</sup>	10.49	0.00	0.00	10.49	10.49	1	4	25.00%	59.045	4.9
4/7/98	11.57	8.41	14.56	6.46	16.74	10	28	35.71%	58.177	4.5
4/17/98	7.25	5.85	8.64	4.24	12.41	18	29	62.07%	62.900	7.1
4/23/98	6.89	5.42	9.37	2.26	11.15	17	27	62.96%	85.775	7.5
4/24/98	7.69	7.18	8.22	2.63	28.29	102	181	56.35%	90.800	6.7
4/27/98 <sup>b</sup>	5.46	0.00	0.00	5.46	5.46	1	4	25.00%	90.833	9.5
4/28/98	6.39	4.99	7.51	3.27	13.68	26	52	50.00%	98.729	8.1
4/29/98	5.59	4.03	9.49	4.03	11.12	11	23	47.83%	104.757	9.2
4/30/98	6.20	4.45	9.22	2.60	24.83	24	35	68.57%	110.657	8.3
5/1/98	5.63	3.21	7.84	2.92	8.42	12	25	48.00%	115.786	9.2
5/4/98	4.77	3.99	7.56	3.12	12.21	12	37	32.43%	126.600	10.8
5/5/98	6.01	3.65	11.22	2.98	15.26	14	29	48.28%	127.186	8.6
5/6/98	4.83	3.57	6.55	1.25	17.75	25	55	45.45%	127.667	10.7
5/7/98	7.02	4.56	13.42	3.92	15.39	14	26	53.85%	125.925	7.4
5/8/98	5.10	3.06	9.95	1.68	14.06	9	19	47.37%	127.033	10.1
5/12/98	4.21	2.46	11.14	2.42	11.24	11	26	42.31%	123.380	12.3
5/13/98	7.03	3.94	8.84	2.45	10.50	17	41	41.46%	125.013	7.3
5/20/98 <sup>b</sup>	5.82	0.00	0.00	4.73	6.91	2	10	20.00%	153.643	8.9
5/23/98 <sup>b</sup>	2.91	0.00	0.00	1.54	5.45	5	42	11.90%	171.200	17.7
<b>Totals</b>						<b>459</b>	<b>1020</b>	<b>45.00%</b>		

<sup>a</sup> Confidence Intervals calculated with non parametric statistics

<sup>b</sup> Not used in statistical analysis because analysis showed too few recaptures.

Appendix A – 3. Pit-tagged hatchery steelhead trout travel time, with 95% confidence intervals, from the Snake River trap to Lower Granite Dam, 1998.

Release Date	Median Travel Time	Lower Confidence Interval <sup>a</sup>	Upper Confidence Interval	Minimum Travel Time	Maximum Travel Time	Number Recaptured	Number Tagged	Percent Recaptured	Mean Discharge	Migration Rate (km/day)
3/30/98	4.35	3.95	4.72	3.15	31.17	22	30	73.33%	54.720	11.9
3/31/98	4.33	3.68	9.40	3.49	76.87	17	26	65.38%	53.900	11.9
4/1/98	4.83	3.63	11.01	3.19	25.62	27	45	60.00%	54.467	10.7
4/2/98	4.22	3.64	5.68	3.12	70.96	31	41	75.61%	55.320	12.2
4/3/98	3.42	2.81	12.49	2.60	30.68	20	34	58.82%	55.700	15.1
4/6/98	4.94	3.78	8.53	1.78	31.55	41	152	26.97%	61.533	10.4
4/7/98	5.30	4.97	7.13	2.73	26.68	36	99	36.36%	61.517	9.7
4/8/98	4.25	3.78	7.05	2.18	25.89	47	101	46.53%	61.100	12.1
4/9/98	5.43	3.98	9.06	2.39	77.80	43	95	45.26%	59.050	9.5
4/10/98	5.05	3.86	8.58	2.26	18.43	23	53	43.40%	58.100	10.2
4/13/98	3.45	2.99	3.58	2.12	19.30	44	74	59.46%	56.125	15.0
4/14/98	3.46	3.03	3.72	2.34	22.20	87	150	58.00%	55.575	14.9
4/15/98	4.11	3.71	4.84	1.75	32.55	100	168	59.52%	55.000	12.6
4/16/98	4.57	3.86	5.43	2.67	20.97	50	83	60.24%	56.800	11.3
4/17/98	3.83	3.47	4.85	2.57	19.94	68	117	58.12%	57.000	13.5
4/20/98	3.60	3.49	3.72	2.45	9.86	37	58	63.79%	68.100	14.3
4/21/98	2.79	2.73	3.24	2.43	13.22	42	72	58.33%	70.350	18.5
4/22/98	2.54	2.31	2.93	1.73	3.94	27	68	39.71%	78.975	20.3
4/23/98	1.72	1.65	1.93	1.42	3.73	53	108	49.07%	83.533	30.0
4/24/98	1.38	1.30	1.52	0.98	9.38	140	294	47.62%	90.150	37.3
4/27/98	2.56	2.49	2.67	1.76	7.48	59	87	67.82%	85.925	20.2
4/28/98	2.44	2.39	2.52	1.38	12.96	145	241	60.17%	86.133	21.1
4/29/98	2.58	2.49	2.68	1.59	10.51	47	100	47.00%	94.400	20.0
4/30/98	2.41	2.14	2.53	1.43	12.91	68	100	68.00%	97.733	21.4
5/1/98	1.61	1.54	1.77	1.22	17.01	53	77	68.83%	104.133	32.0
5/4/98	1.53	1.45	1.65	1.16	13.70	179	300	59.67%	123.433	33.7
5/5/98	1.55	1.49	1.96	1.26	5.29	47	75	62.67%	125.933	33.3
5/6/98	1.49	1.41	1.58	1.23	13.20	44	75	58.67%	126.750	34.6

Appendix A-3. continued

Release Date	Median Travel Time	Lower Confidence Interval <sup>a</sup>	Upper Confidence Interval	Minimum Travel Time	Maximum Travel Time	Number Recaptured	Number Tagged	Percent Recaptured	Mean Discharge	Migration Rate (km/day)
5/7/98	1.58	1.52	1.66	1.21	10.66	40	75	53.33%	129.767	32.6
5/8/98	1.52	1.44	1.63	1.17	2.40	31	75	41.33%	129.700	33.9
5/11/98	1.58	1.50	1.72	1.27	15.16	71	95	74.74%	124.367	32.7
5/12/98	1.42	1.31	1.50	1.06	10.10	136	236	57.63%	124.850	36.3
5/13/98	1.47	1.44	1.52	1.11	11.70	111	153	72.55%	121.550	35.1
5/14/98	1.68	1.57	2.44	1.13	6.89	27	58	46.55%	122.400	30.7
5/15/98	1.60	1.53	1.69	1.38	12.97	44	59	74.58%	125.133	32.1
5/18/98	1.69	1.50	2.68	1.43	7.66	18	29	62.07%	127.200	30.5
5/19/98	1.77	1.55	2.67	1.40	4.19	12	28	42.86%	125.200	29.1
5/20/98	1.61	1.46	1.94	1.31	4.97	19	42	45.24%	130.233	32.0
5/21/98	1.68	1.59	1.88	1.16	8.48	49	119	41.18%	145.833	30.7
5/22/98	1.45	1.40	1.51	1.08	9.13	38	150	25.33%	157.650	35.6
5/23/98	0.88	0.77	1.60	0.65	20.21	37	250	14.80%	173.000	58.6
<b>Totals</b>						<b>2230</b>	<b>4292</b>	<b>51.96%</b>		

<sup>a</sup> Confidence Intervals calculated with non parametric statistics

<sup>b</sup> Not used in statistical analysis because analysis showed too few recaptures.

Appendix A – 4. Pit-tagged wild steelhead trout travel time, with 95% confidence intervals, from the Snake River trap to Lower Granite Dam, 1998.

Release Date	Median Travel Time	Lower Confidence Interval <sup>a</sup>	Upper Confidence Interval	Minimum Travel Time	Maximum Travel Time	Number Recaptured	Number Tagged	Percent Recaptured	Mean Discharge	Migration Rate (km/day)
3/25/98	4.97	3.26	16.73	2.60	31.05	9	14	64.29%	68.050	10.4
3/30/98	5.21	4.27	17.29	3.33	17.39	11	20	55.00%	54.467	9.9
4/2/98	10.75	3.15	24.60	3.15	24.60	8	13	61.54%	58.608	4.8
4/6/98	6.51	4.00	11.05	2.81	17.49	10	21	47.62%	60.913	7.9
4/14/98	3.98	3.09	9.71	2.56	10.15	9	16	56.25%	55.220	13.0
4/17/98	3.33	3.13	4.01	2.76	11.03	15	19	78.95%	55.450	15.5
4/21/98	3.38	2.63	4.20	2.54	6.73	12	17	70.59%	70.350	15.3
4/23/98	2.38	1.46	2.76	1.46	2.76	8	14	57.14%	83.533	21.7
4/24/98	2.24	2.18	2.35	1.06	9.18	174	276	63.04%	90.733	23.0
4/27/98	2.59	2.48	2.81	2.41	3.85	10	15	66.67%	85.925	19.9
4/28/98	2.37	2.31	2.47	1.90	9.04	30	55	54.55%	86.133	21.8
4/29/98	2.48	2.39	2.58	1.50	8.05	19	32	59.38%	91.500	20.8
4/30/98	2.48	2.36	3.13	1.44	5.57	21	30	70.00%	97.733	20.8
5/1/98	1.92	1.61	2.42	1.41	5.47	24	36	66.67%	104.133	26.8
5/4/98	1.80	1.47	2.21	1.17	4.69	39	74	52.70%	123.433	28.7
5/5/98	1.66	1.54	1.89	1.35	10.29	32	54	59.26%	125.933	31.1
5/6/98	1.60	1.50	1.78	1.24	3.38	38	62	61.29%	127.633	32.4
5/7/98	1.69	1.51	2.35	1.35	4.09	24	38	63.16%	129.767	30.6
5/8/98	1.46	1.33	1.67	1.29	6.51	12	28	42.86%	130.750	35.2
5/11/98	1.65	1.39	1.78	1.19	3.06	14	20	70.00%	124.367	31.2
5/12/98	1.35	1.26	2.23	1.04	10.16	26	38	68.42%	124.850	38.2
5/13/98	1.49	1.40	1.93	1.29	4.46	22	35	62.86%	121.550	34.6
5/14/98	1.57	1.40	2.09	1.28	3.95	13	27	48.15%	122.400	32.9
5/15/98	1.59	1.47	1.75	1.32	2.60	13	24	54.17%	125.133	32.5
5/20/98	1.73	1.53	3.87	1.49	9.15	12	20	60.00%	130.233	29.7
5/21/98	1.89	1.36	2.87	1.33	3.02	10	12	83.33%	145.833	27.3
5/22/98 <sup>b</sup>	1.28	0.00	0.00	1.18	1.42	4	24	16.67%	157.650	40.3

Appendix A-4. continued

Release Date	Median Travel Time	Lower Confidence Interval <sup>a</sup>	Upper Confidence Interval	Minimum Travel Time	Maximum Travel Time	Number Recaptured	Number Tagged	Percent Recaptured	Mean Discharge	Migration Rate (km/day)
5/23/98 <sup>b</sup>	0.95	0.00	0.00	0.66	2.75	5	60	8.33%	173.000	54.3
<b>Totals</b>						<b>604</b>	<b>1060</b>	<b>56.98%</b>		

<sup>a</sup> Confidence Intervals calculated with non parametric statistics

<sup>b</sup> Not used in statistical analysis because analysis showed too few recaptures.

Appendix A – 5. Pit-tagged hatchery chinook salmon travel time, with 95% confidence intervals, from the Salmon River trap to Lower Granite Dam, 1998.

Release Date	Median Travel Time	Lower Confidence Interval <sup>a</sup>	Upper Confidence Interval	Minimum Travel Time	Maximum Travel Time	Number Recaptured	Number Tagged	Percent Recaptured	Mean Discharge	Migration Rate (km/day)
3/17/98 <sup>b</sup>	34.73	0.00	0.00	34.73	34.73	1	4	25.00%	57.11	6.7
3/18/98	38.17	36.43	41.30	13.87	50.13	79	259	30.50%	59.65	6.1
3/19/98	38.43	37.19	41.41	16.34	50.38	45	165	27.27%	60.95	6.1
3/20/98	40.39	36.12	43.54	15.55	49.67	27	83	32.53%	62.96	5.8
3/23/98	35.23	30.85	36.72	12.40	45.42	20	68	29.41%	63.40	6.6
3/24/98	35.03	33.46	36.61	22.27	49.35	80	258	31.01%	64.32	6.6
3/25/98	35.21	32.24	39.28	24.48	50.36	37	100	37.00%	64.81	6.6
3/26/98	34.46	32.19	37.31	25.31	45.39	33	100	33.00%	64.50	6.7
3/27/98	36.25	33.36	39.47	24.41	47.06	26	101	25.74%	66.88	6.4
3/30/98	33.57	26.88	39.68	26.88	39.68	7	23	30.43%	68.19	6.9
3/31/98	33.56	24.41	35.71	20.82	38.60	9	28	32.14%	69.99	6.9
4/1/98	30.01	23.03	37.41	23.03	37.41	8	23	34.78%	66.29	7.8
4/2/98	28.86	17.92	32.49	17.92	32.49	8	24	33.33%	66.83	8.1
4/3/98	25.96	20.59	31.70	19.82	32.45	10	36	27.78%	65.22	9.0
4/6/98	24.41	21.58	28.39	13.71	47.76	57	172	33.14%	67.63	9.5
4/7/98	26.64	21.45	30.33	15.59	37.69	32	129	24.81%	73.67	8.7
4/8/98	26.52	24.43	27.98	14.41	50.33	33	100	33.00%	75.84	8.8
4/9/98	25.67	23.48	28.55	9.39	38.49	43	126	34.13%	76.30	9.1
4/10/98	24.66	23.35	28.53	10.46	47.74	36	100	36.00%	76.84	9.4
4/13/98	21.14	19.46	22.47	7.78	29.49	63	200	31.50%	76.99	11.0
4/14/98	20.54	18.63	23.61	11.04	30.96	35	100	35.00%	80.02	11.3
4/15/98	20.27	18.49	23.72	10.44	34.56	30	100	30.00%	81.23	11.5
4/16/98	19.73	18.84	20.99	11.30	26.86	34	100	34.00%	84.52	11.8
4/17/98	17.65	16.45	21.78	8.31	28.83	35	100	35.00%	83.87	13.2
4/20/98	15.53	14.45	18.41	6.63	28.11	68	164	41.46%	91.56	15.0
4/21/98	12.46	6.42	24.17	5.76	26.08	11	29	37.93%	86.70	18.7
4/22/98	15.23	13.65	16.75	6.46	29.77	72	158	45.57%	97.63	15.3

Appendix A-5. continued

Release Date	Median Travel Time	Lower Confidence Interval <sup>a</sup>	Upper Confidence Interval	Minimum Travel Time	Maximum Travel Time	Number Recaptured	Number Tagged	Percent Recaptured	Mean Discharge	Migration Rate (km/day)
4/23/98	13.79	12.22	15.40	3.70	28.88	55	151	36.42%	99.78	16.9
4/24/98	14.10	12.45	15.37	6.08	28.47	41	100	41.00%	103.72	16.5
4/27/98	12.00	9.85	14.37	6.36	19.91	34	84	40.48%	108.90	19.4
4/28/98	11.62	9.39	14.51	7.36	17.91	17	46	36.96%	112.15	20.0
4/29/98	15.56	10.42	23.77	10.42	23.77	8	20	40.00%	117.19	14.9
5/1/98 <sup>b</sup>	22.27	0.00	0.00	22.27	22.27	1	6	16.67%	125.42	10.4
5/5/98 <sup>b</sup>	9.64	0.00	0.00	9.62	15.73	3	4	75.00%	125.75	24.1
<b>Totals</b>						<b>1098</b>	<b>3261</b>	<b>33.67%</b>		

<sup>a</sup> Confidence Intervals calculated with non parametric statistics

<sup>b</sup> Not used in statistical analysis because analysis showed too few recaptures.

Appendix A – 6. Pit-tagged wild chinook salmon travel time, with 95% confidence intervals, from the Salmon River trap to Lower Granite Dam, 1998.

Release Date	Median Travel Time	Lower Confidence Interval <sup>a</sup>	Upper Confidence Interval	Minimum Travel Time	Maximum Travel Time	Number Recaptured	Number Tagged	Percent Recaptured	Mean Discharge	Migration Rate (km/day)
3/17/98 <sup>b</sup>	28.45	0.00	0.00	28.45	28.45	1	2	50.00%	57.19	8.2
3/18/98	26.56	16.11	32.88	11.56	46.32	27	60	45.00%	57.61	8.8
3/19/98	25.13	17.22	31.51	12.92	37.98	21	58	36.21%	58.37	9.3
3/20/98	16.36	15.38	25.78	14.47	50.49	15	37	40.54%	57.79	14.2
3/23/98	22.06	15.45	25.71	10.05	34.42	29	53	54.72%	60.52	10.5
3/24/98	22.15	20.41	25.18	8.99	42.64	75	203	36.95%	60.85	10.5
3/25/98	20.58	19.61	26.23	8.80	44.49	45	109	41.28%	60.58	11.3
3/26/98	25.28	21.60	29.31	10.04	39.69	46	96	47.92%	59.02	9.2
3/27/98	26.32	22.59	28.31	7.76	43.48	57	131	43.51%	58.78	8.8
3/30/98	24.41	20.43	37.55	15.70	37.63	10	17	58.82%	58.33	9.5
3/31/98	22.01	18.45	27.98	13.45	32.45	18	43	41.86%	57.85	10.6
4/1/98	21.77	20.46	25.41	16.77	38.10	20	38	52.63%	58.30	10.7
4/2/98	21.36	15.36	26.46	11.95	29.52	11	19	57.89%	58.67	10.9
4/3/98	19.34	14.10	21.51	11.32	29.57	13	22	59.09%	58.34	12.0
4/6/98	18.52	14.51	26.49	14.51	26.49	7	18	38.89%	62.76	12.6
4/7/98	18.71	17.02	23.42	12.17	31.49	24	50	48.00%	64.32	12.4
4/8/98	16.96	14.14	23.43	11.86	37.79	15	33	45.45%	62.83	13.7
4/9/98	19.34	14.40	23.98	8.17	33.53	22	53	41.51%	66.34	12.0
4/10/98	14.66	12.42	15.73	11.58	17.60	14	23	60.87%	62.83	15.9
4/13/98	11.16	9.45	19.91	7.41	31.99	12	29	41.38%	60.64	20.8
4/16/98	12.00	10.36	15.50	7.67	16.98	14	28	50.00%	70.46	19.4
4/20/98	10.43	8.67	12.43	6.09	19.08	59	90	65.56%	79.44	22.3
4/21/98	11.53	6.91	13.40	6.57	14.74	11	25	44.00%	86.70	20.2
4/22/98	10.02	7.08	12.46	5.42	17.23	12	27	44.44%	86.62	23.2
4/23/98	7.38	5.38	9.54	5.36	10.76	11	19	57.89%	85.78	31.5
4/24/98	9.36	8.62	10.39	4.35	17.51	45	72	62.50%	92.83	24.9
4/27/98	10.41	8.59	12.81	5.73	15.41	14	51	27.45%	104.93	22.3

Appendix A-6. continued

Release Date	Median Travel Time	Lower Confidence Interval <sup>a</sup>		Upper Confidence Interval	Minimum Travel Time	Maximum Travel Time	Number Recaptured	Number Tagged	Percent Recaptured	Mean Discharge	Migration Rate (km/day)
		Lower Confidence Interval <sup>a</sup>	Upper Confidence Interval								
4/28/98	10.57	7.36	18.14	18.14	7.36	18.14	8	19	42.11%	110.87	22.0
5/1/98 <sup>b</sup>	5.24	0.00	0.00	0.00	5.24	5.24	1	6	16.67%	113.78	44.4
<b>Totals</b>							<b>657</b>	<b>1431</b>	<b>45.91%</b>		

<sup>a</sup> Confidence Intervals calculated with non parametric statistics

<sup>b</sup> Not used in statistical analysis because analysis showed too few recaptures.

Appendix A - 7. Pit-tagged hatchery steelhead trout travel time, with 95% confidence intervals, from the Salmon River trap to Lower Granite Dam, 1998.

Release Date	Median Travel Time	Lower Confidence Interval <sup>a</sup>	Upper Confidence Interval	Minimum Travel Time	Maximum Travel Time	Number Recaptured	Number Tagged	Percent Recaptured	Mean Discharge	Migration Rate (km/day)
4/20/98	6.68	5.90	6.86	4.72	21.36	15	34	44.12%	76.93	34.8
4/21/98	5.19	4.46	7.24	3.53	19.53	22	37	59.46%	78.50	44.8
4/22/98	4.64	4.08	5.05	2.75	17.34	45	82	54.88%	82.18	50.1
4/23/98	4.69	3.79	5.67	2.39	30.85	53	88	60.23%	84.98	49.6
4/24/98	4.44	3.61	4.68	2.42	23.93	122	192	63.54%	87.92	52.4
4/27/98	6.49	5.60	6.86	3.41	27.68	99	189	52.38%	93.73	35.8
4/28/98	4.55	4.43	4.98	3.37	20.61	61	95	64.21%	95.13	51.1
4/29/98	4.34	3.65	4.70	2.86	44.29	62	109	56.88%	97.74	53.6
4/30/98	3.85	3.68	4.54	2.46	43.29	75	124	60.48%	104.92	60.4
5/1/98	3.29	2.29	4.74	1.34	4.82	11	17	64.71%	108.18	70.7
5/5/98	4.67	2.74	23.57	2.65	38.84	10	22	45.45%	127.82	49.8
5/18/98	5.32	2.53	7.17	2.53	7.17	6	16	37.50%	136.52	43.7
5/19/98	4.44	2.77	5.79	2.77	5.79	7	28	25.00%	138.18	52.4
5/20/98	3.65	2.81	5.29	2.81	5.29	8	35	22.86%	147.34	63.7
5/21/98	2.89	2.66	4.18	2.50	4.82	9	38	23.68%	153.03	80.5
5/22/98 <sup>b</sup>	2.74	0.00	0.00	1.90	3.56	3	12	25.00%	162.53	84.9
<b>Totals</b>						<b>608</b>	<b>1118</b>	<b>54.38%</b>		

<sup>a</sup> Confidence Intervals calculated with non parametric statistics

<sup>b</sup> Not used in statistical analysis because analysis showed too few recaptures.

Appendix A - 8. Pit-tagged wild steelhead trout travel time, with 95% confidence intervals, from the Salmon River trap to Lower Granite Dam, 1998.

Release Date	Median Travel Time	Lower Confidence Interval <sup>a</sup>	Upper Confidence Interval	Minimum Travel Time	Maximum Travel Time	Number Recaptured	Number Tagged	Percent Recaptured	Mean Discharge	Migration Rate (km/day)
3/27/98 <sup>b</sup>	7.72	0.00	0.00	7.53	7.92	2	2	100.00%	58.43	30.1
4/6/98 <sup>b</sup>	6.07	0.00	0.00	6.07	6.07	1	3	33.33%	61.39	38.3
4/13/98 <sup>b</sup>	7.50	0.00	0.00	5.66	9.33	2	3	66.67%	56.61	31.0
4/16/98 <sup>b</sup>	9.11	0.00	0.00	6.59	11.62	2	3	66.67%	65.67	25.5
4/17/98 <sup>b</sup>	7.17	0.00	0.00	6.03	8.31	2	4	50.00%	62.90	32.4
4/20/98 <sup>b</sup>	4.64	0.00	0.00	4.61	4.67	2	5	40.00%	73.03	50.1
4/23/98 <sup>b</sup>	4.21	0.00	0.00	4.05	4.37	2	7	28.57%	85.56	55.2
4/24/98	4.59	3.42	7.34	3.34	11.71	10	12	83.33%	87.33	50.7
4/27/98	4.42	3.45	6.28	3.40	7.24	19	35	54.29%	88.38	52.6
4/28/98 <sup>b</sup>	5.20	0.00	0.00	5.20	5.20	1	5	20.00%	95.13	44.7
4/29/98 <sup>b</sup>	4.57	0.00	0.00	4.34	4.64	3	3	100.00%	101.50	50.9
4/30/98	3.48	2.42	3.91	2.42	3.91	7	10	70.00%	101.08	66.8
5/1/98 <sup>b</sup>	2.33	0.00	0.00	2.24	2.42	2	4	50.00%	104.13	99.8
5/5/98 <sup>b</sup>	2.59	0.00	0.00	2.59	2.59	1	1	100.00%	126.80	89.8
<b>Totals</b>						<b>56</b>	<b>97</b>	<b>57.73%</b>		

<sup>a</sup> Confidence Intervals calculated with non parametric statistics

<sup>b</sup> Not used in statistical analysis because analysis showed too few recaptures.

## APPENDIX B

Table B - 1. Pit-tagged hatchery chinook salmon interrogations at Lower Granite (GRJ), Little Goose (GOJ), Lower Monumental (LMJ), and McNary (MCJ) dams from the Snake River Trap, 1998.

Date	Number Tagged	Ints GRJ	% GRJ	Ints GOJ	% GOJ	Ints LMJ	% LMJ	Ints MCJ	% MCJ	Grand Total Ints	Total % Obs.
03/25/98	75	24	32.00%	11	14.67%	8	10.67%	6	8.00%	49	65.33%
03/26/98	45	17	37.78%	6	13.33%	3	6.67%	7	15.56%	33	73.33%
03/27/98	9	5	55.56%	0	0.00%	1	11.11%	0	0.00%	6	66.67%
03/30/98	26	14	53.85%	3	11.54%	3	11.54%	1	3.85%	21	80.77%
03/31/98	3	2	66.67%	0	0.00%	0	0.00%	1	33.33%	3	100.00%
04/01/98	4	2	50.00%	2	50.00%	0	0.00%	0	0.00%	4	100.00%
04/02/98	4	2	50.00%	1	25.00%	0	0.00%	0	0.00%	3	75.00%
04/03/98	3	0	0.00%	1	33.33%	0	0.00%	0	0.00%	1	33.33%
04/06/98	4	0	0.00%	1	25.00%	0	0.00%	0	0.00%	1	25.00%
04/07/98	31	18	58.06%	3	9.68%	1	3.23%	2	6.45%	24	77.42%
04/08/98	29	16	55.17%	5	17.24%	4	13.79%	0	0.00%	25	86.21%
04/09/98	33	9	27.27%	9	27.27%	4	12.12%	2	6.06%	24	72.73%
04/10/98	3	1	33.33%	0	0.00%	1	33.33%	0	0.00%	2	66.67%
04/13/98	15	9	60.00%	3	20.00%	1	6.67%	0	0.00%	13	86.67%
04/14/98	34	16	47.06%	7	20.59%	5	14.71%	0	0.00%	28	82.35%
04/15/98	34	24	70.59%	4	11.76%	1	2.94%	0	0.00%	29	85.29%
04/16/98	71	25	35.21%	13	18.31%	3	4.23%	4	5.63%	45	63.38%
04/17/98	305	144	47.21%	59	19.34%	29	9.51%	8	2.62%	240	78.69%
04/20/98	30	19	63.33%	4	13.33%	4	13.33%	0	0.00%	27	90.00%
04/21/98	45	24	53.33%	10	22.22%	2	4.44%	1	2.22%	37	82.22%
04/22/98	63	35	55.56%	16	25.40%	5	7.94%	1	1.59%	57	90.48%
04/23/98	52	25	48.08%	11	21.15%	2	3.85%	1	1.92%	39	75.00%
04/24/98	358	201	56.15%	79	22.07%	32	8.94%	6	1.68%	318	88.83%
04/27/98	2	1	50.00%	0	0.00%	0	0.00%	0	0.00%	1	50.00%
04/28/98	104	49	47.12%	29	27.88%	8	7.69%	2	1.92%	88	84.62%
04/29/98	41	16	39.02%	12	29.27%	2	4.88%	3	7.32%	33	80.49%

Appendix B-1. continued

Date	Number Tagged	Ints GRJ	% GRJ	Ints GOJ	% GOJ	Ints LMJ	% LMJ	Ints MCJ	% MCJ	Grand Total Ints	Total % Obs.
04/30/98	58	33	56.90%	11	18.97%	2	3.45%	3	5.17%	49	84.48%
05/01/98	125	60	48.00%	35	28.00%	8	6.40%	1	0.80%	104	83.20%
05/04/98	109	43	39.45%	33	30.28%	7	6.42%	5	4.59%	88	80.73%
05/05/98	157	68	43.31%	40	25.48%	18	11.46%	3	1.91%	129	82.17%
05/06/98	156	69	44.23%	40	25.64%	16	10.26%	5	3.21%	130	83.33%
05/07/98	97	46	47.42%	25	25.77%	11	11.34%	2	2.06%	84	86.60%
05/08/98	47	21	44.68%	11	23.40%	1	2.13%	1	2.13%	34	72.34%
05/11/98	6	3	50.00%	1	16.67%	0	0.00%	0	0.00%	4	66.67%
05/12/98	39	13	33.33%	9	23.08%	5	12.82%	0	0.00%	27	69.23%
05/13/98	33	9	27.27%	9	27.27%	3	9.09%	2	6.06%	23	69.70%
05/14/98	18	7	38.89%	1	5.56%	1	5.56%	2	11.11%	11	61.11%
05/15/98	9	4	44.44%	2	22.22%	0	0.00%	1	11.11%	7	77.78%
05/19/98	5	2	40.00%	0	0.00%	0	0.00%	0	0.00%	2	40.00%
05/20/98	2	0	0.00%	0	0.00%	1	50.00%	0	0.00%	1	50.00%
05/23/98	19	1	5.26%	4	21.05%	0	0.00%	1	5.26%	6	31.58%
<b>Totals</b>	<b>2303</b>	<b>1077</b>	<b>46.77%</b>	<b>510</b>	<b>22.15%</b>	<b>192</b>	<b>8.34%</b>	<b>71</b>	<b>3.08%</b>	<b>1850</b>	<b>80.33%</b>

Appendix B - 2. Pit-tagged wild chinook salmon interrogations at Lower Granite (GRJ), Little Goose (GOJ), Lower Monumental (LMJ), and McNary (MCJ) dams from the Snake River Trap, 1998.

Date	Number Tagged	Ints GRJ	% GRJ	Ints GOJ	% GOJ	Ints LMJ	% LMJ	Ints MCJ	% MCJ	Grand Total Ints	Total % Obs.
03/25/98	130	52	40.00%	17	13.08%	10	7.69%	18	13.85%	97	74.62%
03/26/98	46	19	41.30%	4	8.70%	4	8.70%	4	8.70%	31	67.39%
03/27/98	16	7	43.75%	0	0.00%	1	6.25%	1	6.25%	9	56.25%
03/30/98	77	31	40.26%	11	14.29%	9	11.69%	6	7.79%	57	74.03%
03/31/98	4	2	50.00%	1	25.00%	1	25.00%	0	0.00%	4	100.00%
04/01/98	3	0	0.00%	0	0.00%	1	33.33%	1	33.33%	2	66.67%
04/02/98	3	0	0.00%	1	33.33%	0	0.00%	1	33.33%	2	66.67%
04/03/98	4	1	25.00%	2	50.00%	0	0.00%	0	0.00%	3	75.00%
04/07/98	9	5	55.56%	1	11.11%	0	0.00%	0	0.00%	6	66.67%
04/08/98	8	2	25.00%	3	37.50%	0	0.00%	1	12.50%	6	75.00%
04/09/98	7	1	14.29%	4	57.14%	1	14.29%	0	0.00%	6	85.71%
04/10/98	2	1	50.00%	1	50.00%	0	0.00%	0	0.00%	2	100.00%
04/13/98	1	1	100.00%	0	0.00%	0	0.00%	0	0.00%	1	100.00%
04/14/98	2	0	0.00%	0	0.00%	0	0.00%	1	50.00%	1	50.00%
04/15/98	5	2	40.00%	2	40.00%	1	20.00%	0	0.00%	5	100.00%
04/16/98	5	4	80.00%	0	0.00%	0	0.00%	0	0.00%	4	80.00%
04/17/98	19	12	63.16%	3	15.79%	0	0.00%	0	0.00%	15	78.95%
04/20/98	1	1	100.00%	0	0.00%	0	0.00%	0	0.00%	1	100.00%
04/21/98	5	3	60.00%	1	20.00%	0	0.00%	0	0.00%	4	80.00%
04/22/98	10	5	50.00%	3	30.00%	0	0.00%	1	10.00%	9	90.00%
04/23/98	10	8	80.00%	1	10.00%	1	10.00%	0	0.00%	10	100.00%
04/24/98	176	102	57.95%	43	24.43%	14	7.95%	1	0.57%	160	90.91%
04/27/98	4	1	25.00%	2	50.00%	0	0.00%	0	0.00%	3	75.00%
04/28/98	49	26	53.06%	8	16.33%	3	6.12%	1	2.04%	38	77.55%
04/29/98	23	11	47.83%	6	26.09%	3	13.04%	0	0.00%	20	86.96%
04/30/98	34	24	70.59%	6	17.65%	1	2.94%	0	0.00%	31	91.18%

Appendix B-2. continued

Date	Number Tagged	Ints GRJ	% GRJ	Ints GOJ	% GOJ	Ints LMJ	% LMJ	Ints MCJ	% MCJ	Grand Total Ints	Total % Obs.
05/01/98	25	12	48.00%	5	20.00%	3	12.00%	0	0.00%	20	80.00%
05/04/98	36	12	33.33%	10	27.78%	6	16.67%	1	2.78%	29	80.56%
05/05/98	29	14	48.28%	6	20.69%	4	13.79%	0	0.00%	24	82.76%
05/06/98	55	25	45.45%	15	27.27%	6	10.91%	0	0.00%	46	83.64%
05/07/98	25	14	56.00%	7	28.00%	2	8.00%	0	0.00%	23	92.00%
05/08/98	18	9	50.00%	3	16.67%	4	22.22%	0	0.00%	16	88.89%
05/11/98	5	3	60.00%	1	20.00%	1	20.00%	0	0.00%	5	100.00%
05/12/98	20	8	40.00%	4	20.00%	3	15.00%	0	0.00%	15	75.00%
05/13/98	18	7	38.89%	4	22.22%	2	11.11%	1	5.56%	14	77.78%
05/14/98	10	5	50.00%	2	20.00%	2	20.00%	0	0.00%	9	90.00%
05/15/98	11	5	45.45%	1	9.09%	1	9.09%	1	9.09%	8	72.73%
05/18/98	2	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
05/19/98	4	0	0.00%	1	25.00%	0	0.00%	0	0.00%	1	25.00%
05/20/98	9	2	22.22%	1	11.11%	1	11.11%	1	11.11%	5	55.56%
05/22/98	2	0	0.00%	0	0.00%	0	0.00%	1	50.00%	1	50.00%
05/23/98	39	5	12.82%	10	25.64%	4	10.26%	1	2.56%	20	51.28%
<b>Totals</b>	<b>961</b>	<b>442</b>	<b>45.99%</b>	<b>190</b>	<b>19.77%</b>	<b>89</b>	<b>9.26%</b>	<b>42</b>	<b>4.37%</b>	<b>763</b>	<b>79.40%</b>

Appendix B - 3. Pit-tagged hatchery steelhead trout interrogations at Lower Granite (GRJ), Little Goose (GOJ), Lower Monumental (LMJ), and McNary (MCJ) dams from the Snake River Trap, 1998.

Date	Number Tagged	Ints GRJ	% GRJ	Ints GOJ	% GOJ	Ints LMJ	% LMJ	Ints MCJ	% MCJ	Grand Total Ints	Total % Obs.
03/30/98	30	22	73.33%	0	0.00%	0	0.00%	0	0.00%	22	73.33%
03/31/98	26	17	65.38%	3	11.54%	1	3.85%	0	0.00%	21	80.77%
04/01/98	45	27	60.00%	4	8.89%	1	2.22%	0	0.00%	32	71.11%
04/02/98	41	31	75.61%	2	4.88%	1	2.44%	1	2.44%	35	85.37%
04/03/98	34	20	58.82%	2	5.88%	2	5.88%	1	2.94%	25	73.53%
04/06/98	152	41	26.97%	21	13.82%	16	10.53%	7	4.61%	85	55.92%
04/07/98	98	36	36.73%	10	10.20%	7	7.14%	3	3.06%	56	57.14%
04/08/98	100	47	47.00%	9	9.00%	3	3.00%	5	5.00%	64	64.00%
04/09/98	95	43	45.26%	6	6.32%	4	4.21%	3	3.16%	56	58.95%
04/10/98	53	23	43.40%	4	7.55%	7	13.21%	1	1.89%	35	66.04%
04/13/98	74	44	59.46%	8	10.81%	4	5.41%	1	1.35%	57	77.03%
04/14/98	149	87	58.39%	14	9.40%	10	6.71%	0	0.00%	111	74.50%
04/15/98	168	100	59.52%	11	6.55%	11	6.55%	2	1.19%	124	73.81%
04/16/98	83	50	60.24%	12	14.46%	7	8.43%	3	3.61%	72	86.75%
04/17/98	115	68	59.13%	14	12.17%	4	3.48%	3	2.61%	89	77.39%
04/20/98	58	37	63.79%	7	12.07%	2	3.45%	1	1.72%	47	81.03%
04/21/98	72	42	58.33%	7	9.72%	7	9.72%	2	2.78%	58	80.56%
04/22/98	67	27	40.30%	14	20.90%	7	10.45%	2	2.99%	50	74.63%
04/23/98	108	53	49.07%	22	20.37%	9	8.33%	2	1.85%	86	79.63%
04/24/98	294	140	47.62%	45	15.31%	30	10.20%	2	0.68%	217	73.81%
04/27/98	87	59	67.82%	12	13.79%	4	4.60%	1	1.15%	76	87.36%
04/28/98	241	145	60.17%	42	17.43%	14	5.81%	2	0.83%	203	84.23%
04/29/98	100	47	47.00%	15	15.00%	14	14.00%	2	2.00%	78	78.00%
04/30/98	100	68	68.00%	10	10.00%	9	9.00%	0	0.00%	87	87.00%
05/01/98	74	53	71.62%	6	8.11%	3	4.05%	0	0.00%	62	83.78%
05/04/98	298	179	60.07%	42	14.09%	23	7.72%	4	1.34%	248	83.22%

Appendix B-3. continued

Date	Number Tagged	Ints GRJ	% GRJ	Ints GOJ	% GOJ	Ints LMJ	% LMJ	Ints MCJ	% MCJ	Grand Total Ints	Total % Obs.
05/05/98	75	47	62.67%	10	13.33%	5	6.67%	0	0.00%	62	82.67%
05/06/98	74	44	59.46%	7	9.46%	6	8.11%	1	1.35%	58	78.38%
05/07/98	75	40	53.33%	19	25.33%	7	9.33%	0	0.00%	66	88.00%
05/08/98	75	31	41.33%	18	24.00%	6	8.00%	1	1.33%	56	74.67%
05/11/98	95	71	74.74%	10	10.53%	2	2.11%	0	0.00%	83	87.37%
05/12/98	235	136	57.87%	52	22.13%	19	8.09%	0	0.00%	207	88.09%
05/13/98	152	111	73.03%	18	11.84%	7	4.61%	0	0.00%	136	89.47%
05/14/98	57	27	47.37%	12	21.05%	2	3.51%	0	0.00%	41	71.93%
05/15/98	59	44	74.58%	6	10.17%	1	1.69%	0	0.00%	51	86.44%
05/18/98	29	18	62.07%	3	10.34%	1	3.45%	0	0.00%	22	75.86%
05/19/98	28	12	42.86%	2	7.14%	1	3.57%	0	0.00%	15	53.57%
05/20/98	42	19	45.24%	5	11.90%	4	9.52%	1	2.38%	29	69.05%
05/21/98	119	49	41.18%	13	10.92%	7	5.88%	3	2.52%	72	60.50%
05/22/98	148	38	25.68%	26	17.57%	14	9.46%	0	0.00%	78	52.70%
05/23/98	249	37	14.86%	97	38.96%	21	8.43%	7	2.81%	162	65.06%
<b>Totals</b>	<b>4274</b>	<b>2230</b>	<b>52.18%</b>	<b>640</b>	<b>14.97%</b>	<b>303</b>	<b>7.09%</b>	<b>61</b>	<b>1.43%</b>	<b>3234</b>	<b>75.67%</b>

Appendix B - 4. Pit-tagged wild steelhead trout interrogations at Lower Granite (GRJ), Little Goose (GOJ), Lower Monumental (LMJ), and McNary (MCJ) dams from the Snake River Trap, 1998.

Date	Number Tagged	Ints GRJ	% GRJ	Ints GOJ	% GOJ	Ints LMJ	% LMJ	Ints MCJ	% MCJ	Grand Total Ints	Total % Obs.
03/25/98	8	6	75.00%	0	0.00%	1	12.50%	0	0.00%	7	87.50%
03/26/98	6	3	50.00%	2	33.33%	0	0.00%	1	16.67%	6	100.00%
03/27/98	1	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
03/30/98	14	8	57.14%	2	14.29%	2	14.29%	0	0.00%	12	85.71%
03/31/98	5	3	60.00%	0	0.00%	1	20.00%	1	20.00%	5	100.00%
04/01/98	5	2	40.00%	0	0.00%	1	20.00%	0	0.00%	3	60.00%
04/02/98	5	4	80.00%	0	0.00%	0	0.00%	0	0.00%	4	80.00%
04/03/98	3	2	66.67%	0	0.00%	0	0.00%	0	0.00%	2	66.67%
04/06/98	10	6	60.00%	0	0.00%	0	0.00%	0	0.00%	6	60.00%
04/07/98	4	1	25.00%	1	25.00%	0	0.00%	0	0.00%	2	50.00%
04/08/98	1	1	100.00%	0	0.00%	0	0.00%	0	0.00%	1	100.00%
04/09/98	5	1	20.00%	1	20.00%	1	20.00%	0	0.00%	3	60.00%
04/10/98	1	1	100.00%	0	0.00%	0	0.00%	0	0.00%	1	100.00%
04/14/98	8	5	62.50%	0	0.00%	2	25.00%	0	0.00%	7	87.50%
04/15/98	8	4	50.00%	2	25.00%	1	12.50%	0	0.00%	7	87.50%
04/16/98	7	4	57.14%	1	14.29%	1	14.29%	0	0.00%	6	85.71%
04/17/98	12	11	91.67%	0	0.00%	0	0.00%	0	0.00%	11	91.67%
04/20/98	9	5	55.56%	0	0.00%	0	0.00%	0	0.00%	5	55.56%
04/21/98	8	7	87.50%	1	12.50%	0	0.00%	0	0.00%	8	100.00%
04/22/98	3	1	33.33%	0	0.00%	0	0.00%	0	0.00%	1	33.33%
04/23/98	11	7	63.64%	1	9.09%	0	0.00%	0	0.00%	8	72.73%
04/24/98	273	174	63.74%	34	12.45%	14	5.13%	1	0.37%	223	81.68%
04/27/98	15	10	66.67%	3	20.00%	0	0.00%	0	0.00%	13	86.67%
04/28/98	54	30	55.56%	7	12.96%	6	11.11%	0	0.00%	43	79.63%
04/29/98	32	19	59.38%	3	9.38%	4	12.50%	0	0.00%	26	81.25%

Appendix B-4. continued

Date	Number Tagged	Ints GRJ	% GRJ	Ints GOJ	% GOJ	Ints LMJ	% LMJ	Ints MCJ	% MCJ	Grand Total Ints	Total % Obs.
04/30/98	30	21	70.00%	4	13.33%	2	6.67%	0	0.00%	27	90.00%
05/01/98	36	24	66.67%	5	13.89%	4	11.11%	0	0.00%	33	91.67%
05/04/98	74	39	52.70%	12	16.22%	8	10.81%	0	0.00%	59	79.73%
05/05/98	54	32	59.26%	9	16.67%	5	9.26%	1	1.85%	47	87.04%
05/06/98	62	38	61.29%	7	11.29%	5	8.06%	0	0.00%	50	80.65%
05/07/98	38	24	63.16%	4	10.53%	3	7.89%	0	0.00%	31	81.58%
05/08/98	28	12	42.86%	7	25.00%	4	14.29%	0	0.00%	23	82.14%
05/11/98	20	14	70.00%	2	10.00%	2	10.00%	0	0.00%	18	90.00%
05/12/98	38	26	68.42%	3	7.89%	2	5.26%	0	0.00%	31	81.58%
05/13/98	34	22	64.71%	5	14.71%	3	8.82%	0	0.00%	30	88.24%
05/14/98	27	13	48.15%	6	22.22%	2	7.41%	0	0.00%	21	77.78%
05/15/98	23	13	56.52%	1	4.35%	1	4.35%	0	0.00%	15	65.22%
05/18/98	4	3	75.00%	0	0.00%	0	0.00%	0	0.00%	3	75.00%
05/19/98	5	3	60.00%	2	40.00%	0	0.00%	0	0.00%	5	100.00%
05/20/98	11	6	54.55%	1	9.09%	0	0.00%	0	0.00%	7	63.64%
05/21/98	12	10	83.33%	0	0.00%	0	0.00%	0	0.00%	10	83.33%
05/22/98	24	4	16.67%	3	12.50%	1	4.17%	0	0.00%	8	33.33%
05/23/98	60	5	8.33%	25	41.67%	5	8.33%	4	6.67%	39	65.00%
<b>Totals</b>	<b>1088</b>	<b>624</b>	<b>57.35%</b>	<b>154</b>	<b>14.15%</b>	<b>81</b>	<b>7.44%</b>	<b>8</b>	<b>0.74%</b>	<b>867</b>	<b>79.69%</b>

Appendix B - 5. Pit-tagged hatchery chinook salmon interrogations at Lower Granite (GRJ), Little Goose (GOJ), Lower Monumental (LMJ), and McNary (MCJ) dams from the Salmon River Trap, 1998.

Date	Number Tagged	Ints GRJ	% GRJ	Ints GOJ	% GOJ
03/17/98	4	1	25.00%	0	0.00%
03/18/98	255	79	30.98%	31	12.16%
03/19/98	162	45	27.78%	16	9.88%
03/20/98	82	27	32.93%	7	8.54%
03/23/98	65	20	30.77%	7	10.77%
03/24/98	241	80	33.20%	40	16.60%
03/25/98	97	37	38.14%	16	16.49%
03/26/98	97	33	34.02%	21	21.65%
03/27/98	95	26	27.37%	13	13.68%
03/30/98	22	7	31.82%	1	4.55%
03/31/98	28	9	32.14%	7	25.00%
04/01/98	23	8	34.78%	4	17.39%
04/02/98	19	8	42.11%	4	21.05%
04/03/98	31	10	32.26%	5	16.13%
04/06/98	141	57	40.43%	29	20.57%
04/07/98	112	32	28.57%	22	19.64%
04/08/98	85	33	38.82%	15	17.65%
04/09/98	116	43	37.07%	27	23.28%
04/10/98	89	36	40.45%	10	11.24%
04/13/98	170	63	37.06%	40	23.53%
04/14/98	89	35	39.33%	16	17.98%
04/15/98	89	30	33.71%	22	24.72%
04/16/98	91	34	37.36%	22	24.18%
04/17/98	95	35	36.84%	23	24.21%
04/20/98	151	68	45.03%	32	21.19%
04/21/98	25	11	44.00%	4	16.00%
04/22/98	155	72	46.45%	34	21.94%
04/23/98	145	55	37.93%	41	28.28%
04/24/98	94	41	43.62%	20	21.28%
04/27/98	77	34	44.16%	15	19.48%
04/28/98	44	17	38.64%	8	18.18%
04/29/98	20	8	40.00%	4	20.00%
04/30/98	6	0	0.00%	4	66.67%
05/01/98	6	1	16.67%	4	66.67%
05/05/98	4	3	75.00%	1	25.00%
<b>Totals</b>	<b>3025</b>	<b>1098</b>	<b>36.30%</b>	<b>565</b>	<b>18.68%</b>

Appendix B – 6. Pit-tagged wild chinook salmon interrogations at Lower Granite (GRJ), Little Goose (GOJ), Lower Monumental (LMJ), and McNary (MCJ) dams from the Salmon River Trap, 1998.

Date	Number Tagged	Ints GRJ	% GRJ	Ints GOJ	% GOJ	Ints LMJ	% LMJ	Ints MCJ	% MCJ	Grand Total Ints	Total % Obs.
03/17/98	2	1	50.00%	0	0.00%	0	0.00%	1	50.00%	2	100.00%
03/18/98	58	27	46.55%	9	15.52%	6	10.34%	6	10.34%	48	82.76%
03/19/98	57	21	36.84%	10	17.54%	2	3.51%	1	1.75%	34	59.65%
03/20/98	37	15	40.54%	8	21.62%	2	5.41%	2	5.41%	27	72.97%
03/23/98	52	29	55.77%	5	9.62%	4	7.69%	5	9.62%	43	82.69%
03/24/98	201	75	37.31%	44	21.89%	13	6.47%	19	9.45%	151	75.12%
03/25/98	106	45	42.45%	22	20.75%	12	11.32%	7	6.60%	86	81.13%
03/26/98	95	46	48.42%	16	16.84%	6	6.32%	3	3.16%	71	74.74%
03/27/98	129	57	44.19%	32	24.81%	7	5.43%	6	4.65%	102	79.07%
03/30/98	17	10	58.82%	4	23.53%	2	11.76%	0	0.00%	16	94.12%
03/31/98	43	18	41.86%	11	25.58%	2	4.65%	3	6.98%	34	79.07%
04/01/98	38	20	52.63%	5	13.16%	3	7.89%	2	5.26%	30	78.95%
04/02/98	19	11	57.89%	5	26.32%	1	5.26%	0	0.00%	17	89.47%
04/03/98	21	13	61.90%	3	14.29%	0	0.00%	1	4.76%	17	80.95%
04/06/98	17	7	41.18%	5	29.41%	1	5.88%	0	0.00%	13	76.47%
04/07/98	48	24	50.00%	13	27.08%	2	4.17%	2	4.17%	41	85.42%
04/08/98	33	15	45.45%	5	15.15%	0	0.00%	3	9.09%	23	69.70%
04/09/98	53	22	41.51%	14	26.42%	5	9.43%	4	7.55%	45	84.91%
04/10/98	23	14	60.87%	3	13.04%	2	8.70%	0	0.00%	19	82.61%
04/13/98	15	5	33.33%	3	20.00%	2	13.33%	1	6.67%	11	73.33%
04/14/98	7	4	57.14%	1	14.29%	1	14.29%	0	0.00%	6	85.71%
04/15/98	6	3	50.00%	1	16.67%	0	0.00%	0	0.00%	4	66.67%
04/16/98	12	9	75.00%	1	8.33%	0	0.00%	0	0.00%	10	83.33%
04/17/98	16	5	31.25%	4	25.00%	1	6.25%	1	6.25%	11	68.75%
04/20/98	90	59	65.56%	20	22.22%	6	6.67%	0	0.00%	85	94.44%
04/21/98	24	11	45.83%	8	33.33%	2	8.33%	1	4.17%	22	91.67%

Appendix B-6. continued

Date	Number Tagged	Ints GRJ	% GRJ	Ints GOJ	% GOJ	Ints LMJ	% LMJ	Ints MCJ	% MCJ	Grand Total Ints	Total % Obs.
04/22/98	27	12	44.44%	9	33.33%	2	7.41%	1	3.70%	24	88.89%
04/23/98	19	11	57.89%	3	15.79%	1	5.26%	0	0.00%	15	78.95%
04/24/98	72	45	62.50%	12	16.67%	6	8.33%	1	1.39%	64	88.89%
04/27/98	50	14	28.00%	17	34.00%	8	16.00%	0	0.00%	39	78.00%
04/28/98	18	8	44.44%	5	27.78%	3	16.67%	0	0.00%	16	88.89%
04/29/98	5	0	0.00%	4	80.00%	1	20.00%	0	0.00%	5	100.00%
04/30/98	1	0	0.00%	1	100.00%	0	0.00%	0	0.00%	1	100.00%
05/01/98	5	1	20.00%	2	40.00%	2	40.00%	0	0.00%	5	100.00%
<b>Totals</b>	<b>1416</b>	<b>657</b>	<b>46.40%</b>	<b>305</b>	<b>21.54%</b>	<b>105</b>	<b>7.42%</b>	<b>70</b>	<b>4.94%</b>	<b>1137</b>	<b>80.30%</b>

Appendix B - 7. Pit-tagged hatchery steelhead trout interrogations at Lower Granite (GRJ), Little Goose (GOJ), Lower Monumental (LMJ), and McNary (MCJ) dams from the Salmon River Trap, 1998.

Date	Number Tagged	Ints GRJ	% GRJ	Ints GOJ	% GOJ	Ints LMJ	% LMJ	Ints MCJ	% MCJ	Grand Total Ints	Total % Obs.
04/20/98	34	15	44.12%	4	11.76%	6	17.65%	1	2.94%	26	76.47%
04/21/98	37	22	59.46%	1	2.70%	0	0.00%	0	0.00%	23	62.16%
04/22/98	82	45	54.88%	12	14.63%	4	4.88%	0	0.00%	61	74.39%
04/23/98	88	53	60.23%	10	11.36%	6	6.82%	0	0.00%	69	78.41%
04/24/98	192	122	63.54%	26	13.54%	11	5.73%	1	0.52%	160	83.33%
04/27/98	189	99	52.38%	27	14.29%	21	11.11%	2	1.06%	149	78.84%
04/28/98	95	61	64.21%	13	13.68%	6	6.32%	0	0.00%	80	84.21%
04/29/98	108	62	57.41%	17	15.74%	9	8.33%	0	0.00%	88	81.48%
04/30/98	124	75	60.48%	15	12.10%	5	4.03%	2	1.61%	97	78.23%
05/01/98	17	11	64.71%	1	5.88%	1	5.88%	0	0.00%	13	76.47%
05/05/98	22	10	45.45%	8	36.36%	0	0.00%	1	4.55%	19	86.36%
05/18/98	16	6	37.50%	3	18.75%	0	0.00%	0	0.00%	9	56.25%
05/19/98	28	7	25.00%	5	17.86%	2	7.14%	0	0.00%	14	50.00%
05/20/98	35	8	22.86%	8	22.86%	2	5.71%	0	0.00%	18	51.43%
05/21/98	38	9	23.68%	5	13.16%	2	5.26%	0	0.00%	16	42.11%
05/22/98	12	3	25.00%	3	25.00%	1	8.33%	0	0.00%	7	58.33%
<b>Totals</b>	<b>1117</b>	<b>608</b>	<b>54.43%</b>	<b>158</b>	<b>14.15%</b>	<b>76</b>	<b>6.80%</b>	<b>7</b>	<b>0.63%</b>	<b>849</b>	<b>76.01%</b>

Appendix B - 8. Pit-tagged wild steelhead trout interrogations at Lower Granite (GRJ), Little Goose (GOJ), Lower Monumental (LMJ), and McNary (MCJ) dams from the Salmon River Trap, 1998.

Date	Number Tagged	Ints GRJ	% GRJ	Ints GOJ	% GOJ	Ints LMJ	% LMJ	Ints MCJ	% MCJ	Grand Total Ints	Total % Obs.
03/25/98	1	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
03/26/98	1	0	0.00%	1	100.00%	0	0.00%	0	0.00%	1	100.00%
03/27/98	2	2	100.00%	0	0.00%	0	0.00%	0	0.00%	2	100.00%
04/06/98	3	1	33.33%	0	0.00%	0	0.00%	0	0.00%	1	33.33%
04/13/98	3	2	66.67%	0	0.00%	0	0.00%	0	0.00%	2	66.67%
04/14/98	1	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
04/15/98	1	0	0.00%	1	100.00%	0	0.00%	0	0.00%	1	100.00%
04/16/98	3	2	66.67%	0	0.00%	0	0.00%	0	0.00%	2	66.67%
04/17/98	4	2	50.00%	0	0.00%	0	0.00%	0	0.00%	2	50.00%
04/20/98	5	2	40.00%	0	0.00%	0	0.00%	0	0.00%	2	40.00%
04/22/98	3	0	0.00%	1	33.33%	0	0.00%	0	0.00%	1	33.33%
04/23/98	7	2	28.57%	2	28.57%	2	28.57%	0	0.00%	6	85.71%
04/24/98	12	10	83.33%	0	0.00%	2	16.67%	0	0.00%	12	100.00%
04/27/98	35	19	54.29%	7	20.00%	3	8.57%	0	0.00%	29	82.86%
04/28/98	5	1	20.00%	0	0.00%	0	0.00%	1	20.00%	2	40.00%
04/29/98	3	3	100.00%	0	0.00%	0	0.00%	0	0.00%	3	100.00%
04/30/98	10	7	70.00%	1	10.00%	0	0.00%	0	0.00%	8	80.00%
05/01/98	4	2	50.00%	0	0.00%	1	25.00%	0	0.00%	3	75.00%
05/05/98	1	1	100.00%	0	0.00%	0	0.00%	0	0.00%	1	100.00%
05/20/98	3	0	0.00%	0	0.00%	1	33.33%	0	0.00%	1	33.33%
05/21/98	2	0	0.00%	0	0.00%	0	0.00%	0	0.00%	0	0.00%
05/22/98	3	0	0.00%	0	0.00%	1	33.33%	0	0.00%	1	33.33%
<b>Totals</b>	<b>112</b>	<b>56</b>	<b>50.00%</b>	<b>13</b>	<b>11.61%</b>	<b>10</b>	<b>8.93%</b>	<b>1</b>	<b>0.89%</b>	<b>80</b>	<b>71.43%</b>

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